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Incorporating Domestic Marketing Margins into the GTAP Model

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Abstract:

Transportation, wholesaling, and retailing activities are a significant segment of economic activity in many economies. The magnitude of these activities can vary greatly between products, users, and regions. However, in most applied general equilibrium (AGE) analyses, these marketing activities are not tied to specific commodities. This paper develops a framework for incorporating domestic marketing margins on domestic and imported goods going to final demand or used as intermediate inputs, and margins on exports into the standard GTAP model. Empirical applications that focus on technological change at the farm, processor, and wholesale/retail segment of food marketing chain illustrate three key findings concerning including domestic marketing activities in AGE models. First, the inclusion of domestic margins reduces the degree of producer price changes transmitted to consumers. Therefore, by not explicitly treating domestic margin activities, AGE models will overestimate the welfare gains from technological change, or any policy liberalization. Second, the magnitude of the elasticity of substitution between commodities and the composite marketing activity is a key parameter. Significant model results are obtained depending on whether the domestic marketing margins are assumed to be fixed or are allowed to vary. Finally, when considering technological change at the farm, processing, and wholesale/retail trade levels of food marketing channel, the welfare gains appear to be much greater the closer one gets to consumers.

Incorporating Domestic Marketing Margins into the GTAP Model

Transportation, wholesaling, and retailing activities, commonly referred to as distribution or marketing activities, play an important role in most economies. The magnitude of these marketing activities can vary widely between products and users. For example, Tables 1 and 2 provide estimates of the share of marketing activities in the overall value of products purchased by households and firms for the United States (US) for all GTAP commodities.¹ For the private household, the marketing share varied from zero on some services to over sixty percent for crops, nec and minerals nec. Excluding services, the average marketing margin on domestic and imported goods purchased by the US private household was 42.5 percent. However, the marketing margins on domestic and imported intermediate imports were much smaller, averaging 14.3 percent. Bradford and Gohin found that the ratio of consumer to producer prices averaged between 1.4 and 1.86 for Australia, Canada, Japan, the Netherlands, the UK, and the US.

In most applied general equilibrium (AGE) analyses, the marketing activities in the economy are not tied to specific commodities. This is a reflection of usual treatment of margins in the underlying input-output tables. The values in these IO tables are computed to reflect producer prices. Thus, all of the marketing margins associated with the purchase of specific commodities are allocated to the appropriate margin activity and then treated as a direct purchase of that margin activity. For example, the purchase of a food product by consumers does not include all transportation, wholesale, and retail activities necessary to get that product from the producer to the consumer. Instead, consumers are assumed to purchase a bundle of marketing services separately from their purchases of commodities. However, this treatment can generate

¹ These estimates are based on the 1992 Use data from the Input-Output benchmark accounts (US Department of Commerce).

inappropriate demand behavior (Dixon *et al.*). For example, by not tying marketing activities to individual commodities, an increase in the price of food (or any commodity) may lead to increasing their purchases of marketing services, even though higher food prices would be expected to reduce the demand for marketing services associated with food products. Of course, the reverse would happen for a reduction in the price of food.

There are two objectives of this paper. The first objective is to develop a modeling framework that incorporates domestic marketing margins into the standard GTAP model. Note the emphasis on domestic marketing margins because transportation margins on all trade commodities are all ready accounted for in the existing GTAP model. The second objective is to illustrate the importance of including domestic marketing margins by comparing the results of several experiments using the standard GTAP model to the results of modified GTAP model that includes domestic marketing margins. These experiments will follow the work of Frisvold and consider the impacts of technological change at various levels of the food marketing channel. Unlike Frisvold, an experiment will assess the impacts of technical change that reduce the marketing margins on food products purchased by US consumers.

Modeling Framework

As discussed by Gohin, marketing margins have been incorporated into AGE models in a variety of ways. In order to minimize the changes in the existing GTAP model structure, the chosen treatment of marketing margins closely follows the specification in the ORANI model and the work of Bradford and Gohin.

In the ORANI model, eight commodities or services are assumed to facilitate the flow of goods from domestic producers or imports to domestic private households, domestic firms, government demands, and foreign demand for exports. The eight services are wholesale trade,

retail trade, road transport, rail transport, water transport, air transport, other insurance, and restaurants and hotels. In the GTAP version 5 data base, there are four comparable services: trade (trd), transport nec (otp), water transport (wtp), and air transport (atp).

It should be pointed out that all of the marketing services may also be “directly consumed” by households. This is because each of these sectors is defined to include a service directly purchased by households. For example, air transport includes commercial airlines that provide services directly to individual consumers; water transport includes ferry services; the trade sector includes the repair of personal and household goods; and transport, nec includes all activities of travel agents. Thus, it is not the case that these four services are used exclusively to provide marketing services.

The demands for the marketing services are associated with the following uses: intermediate or firm purchases of imported goods; firm purchases of domestic goods; private household purchases of imported goods; private household purchases of domestic goods; government purchases of imported goods; government purchases of domestic goods; and exports of all commodities. For all imported goods, the usage of marketing services only pertains to those required to get those goods from the “border” to domestic users. Similarly, for all exported commodities, the use of marketing services only pertains to those required to get the goods from the domestic producer to the border. The GTAP model already contains transport margins for all traded commodities.

To allow some generality in the modeling of domestic marketing margins, substitution possibilities are allowed between the commodity and an aggregate marketing service as well as between marketing services. To illustrate this, consider the nested CES structure of domestic

marketing margins for imported commodities in figure 1.² Notwithstanding the Armington assumption of imports differentiated by region of origin, the level of marketing services required to deliver these imports to the domestic purchaser should be the same regardless of country of origin. For example, the amount of marketing services required for an auto manufactured in Japan and imported into the US should be quite similar to that of an auto manufactured in Germany and imported in the US. (Also the data needed to assume differing marketing margins for imports by region would be excessive.) Thus, the composite imported commodity aggregate is determined before being incorporated with any marketing services. The individual marketing services are also combined in the second level of the nested CES structure in figure 1 to create a composite marketing service. The constant elasticity of substitution σ_s governs the degree of substitutability between individual marketing services, such as land and air transport, as relative prices change.

At the top-level of figure 1, the composite imported commodity and composite marketing service are combined to form a “retail” good purchased by domestic users. Based on previous work by Holloway, Wohlgenant, and others, the potential for substitution between the composite commodity and composite marketing service, denoted as σ_T in figure 1, is allowed in the model. The idea is that if there is producer heterogeneity (e.g., between different retailers) then we could observe input substitution at the industry level even if the individual firms employ Leontief technologies. Certainly in the US, there is a diversity of different types of retailers from the discounters like Wal-Mart to small convenience stores.

² Of course, by replacing the imported composite commodity with the corresponding domestic commodity, figure 1 would then illustrate the marketing margins for domestically produced commodities.

Modification of Private Household Preference Structure

The modified preference structure for the private household is shown in figure 2. The private household allocates income between different “composite” commodities based on a CDE implicit expenditure function. The value of private household purchases of the composite commodity i at agents prices is equal to price of the composite commodity, $PP(i,r)$, times the amount of the composite commodity, $QP(i,r)$, purchased. Each composite commodity is a CES function of domestically produced or imported goods.

The value of expenditures on the i th domestically produced commodity in region r [$VDPA(i,r)$] and on the i th imported commodity in region r [$VIPA(i,r)$] is expressed as follows:

$$VDPA(i,r) = PDP(i,r) * QDP(i,r), \quad (1)$$

$$VIPA(i,r) = PIP(i,r) * QIP(i,r), \quad (2)$$

where $PDP(i,r)$ is the margin inclusive *price* of the *domestically* produced commodity purchased by the *private* household, $QDP(i,r)$ is the margin inclusive *quantity* of the *domestically* produced commodity purchased by the *private* household, $PIP(i,r)$ is the margin inclusive composite *price* of the *imported* commodity purchased by the *private* household, and $QIP(i,r)$ is the margin inclusive composite *quantity* of the *imported* commodity purchased by the *private* household. Note that the notation for these prices and quantities has change from the standard GTAP notation to distinguish that they include domestic marketing margins.

It is assumed that any tax or subsidy applied to a “retail product” occurs after all marketing services have been incorporated into the producer goods. Thus, margin inclusive *value* of expenditures for the composite *imported* commodity by the *private* household *free* of consumption taxes/subsidies is denoted by $VIPF(i,r)$. Similarly, the “tax-free” margin inclusive

value of expenditures on the domestically produced commodity is denoted by $VDPF(i,r)$. These values are defined as:

$$VIPF(i,r) = PIPF(i,r) * QIP(i,r) \text{ and} \quad (3)$$

$$VDPF(i,r) = PDPF(i,r) * QDP(i,r), \quad (4)$$

where $PIPF(i,r)$ and $PDPF(i,r)$ are the *prices* of *imported* or *domestic* commodities purchased by the *private* household *free* of any consumption taxes. Note that

$$VIPA(i,r) = VIPF(i,r) + IPTAX(i,r), \text{ and} \quad (5)$$

$$VDPA(i,r) = VDPF(i,r) + DPTAX(i,r). \quad (6)$$

The value $VIPF(i,r)$ can also be defined as the sum of the *value* of expenditure on the composite *imported* commodity purchased by the *private* household at *market* prices [$VIPM(i,r)$] and the *value* of expenditure on the composite domestic *marketing margin* for the composite *imported* commodity purchased by the *private* household [$VMIP(i,r)$]. Formally,

$$VIPF(i,r) = VIPM(i,r) + VMIP(i,r). \quad (7)$$

Note that the definition of [$VIPM(i,r)$] in equation (7) is slightly different than the standard GTAP definition. The new definition is:

$$VIPM(i,r) = PIM(i,r) * QIPB(i,r), \quad (8)$$

where $PIM(i,r)$ is the composite *price* of the *imported* commodity at *market* prices and $QIPB(i,r)$ is composite *quantity* of the *imported* commodity purchased by the *private* household *before* domestic margins are applied. Thus, $QIPB(i,r)$ represents the composite quantity shipped into region r and its definition is the same as $QPM(i,r)$ in the standard GTAP model.

Next, focusing on the domestic margins applied to the imported commodities, the term $VMIP(i,r)$ is defined as:

$$\begin{aligned}
VMIP(i,r) &= PMIP(i,r) * QMIP(i,r) \\
&= \sum_m VTIP(i,m,r) \\
&= \sum_m PM(m,r) * QTIP(i,m,r),
\end{aligned} \tag{9}$$

where $QMIP(i,r)$ is a composite *quantity* of domestic *marketing* services incorporated into the i th composite *import*, $PMIP(i,r)$ is the composite *price* of domestic *marketing* services for the i th composite *import*, $VTIP(i,m,r)$ is the *value* of m th *trade/transport* marketing service incorporated into the i th *imported* commodity in region r , $QTIP(i,m,r)$ is the *quantity* of the m th *trade/transport* marketing service incorporated into the i th *imported* commodity in region r , and $PM(m,r)$ is the domestic market price of the m th marketing service in region r .

A similar structure for the value $VDPF(i,r)$ can also be defined.

$$VDPF(i,r) = VDPM(i,r) + VMDP(i,r). \tag{10}$$

Again, note that the definition of $[VDPM(i,r)]$ in equation (10) is slightly different than the standard GTAP definition. The new definition is:

$$VDPM(i,r) = PM(i,r) * QDPB(i,r), \tag{11}$$

where $PM(i,r)$ is the domestic market price and $QDPB(i,r)$ is the *quantity* of the *domestic* commodity purchased by the *private* household *before* domestic margins are applied. The term $VMDP(i,r)$ is defined as:

$$\begin{aligned}
VMDP(i,r) &= PMDP(i,r) * QMDP(i,r) \\
&= \sum_m VTDP(i,m,r) \\
&= \sum_m PM(m,r) * QTDP(i,m,r),
\end{aligned} \tag{12}$$

where $QMDP(i,r)$ is a composite *quantity* of domestic *marketing* services incorporated into the i th *domestic* commodity, $PMDP(i,r)$ is the composite *price* of domestic *marketing* services for the i th *domestic* commodity, $VTIP(i,m,r)$ is the *value* of m th *trade/transport* marketing service

incorporated into the i th *domestic* commodity in region r , and $QTDP(i,m,r)$ is the *quantity* of the m th *trade/transport* marketing service incorporated into the i th *domestic* commodity in region r .

In equations (1) through (12), there are six new price variables and eight new quantity variables that now need formal definitions. First, consider the demand for the individual marketing services required to get the i th composite imported commodity from the border to domestic consumers:³

$$qtip(i,m,r) = qmip(i,r) + ESUBPM(i) * \{pmip(i,r) + afmp(i,m,r) - pm(m,r)\} - afmp(i,m,r), \quad (13)$$

where $ESUBPM(i)$ is the elasticity of substitution between marketing services and $afmp(i,m,r)$ is a biased technical change variable to allow for the possibility of a marketing service saving technical change.

Moving up one level in figure 2, the composite price and quantity of marketing services incorporated in the i th imported commodity are defined as:

$$pmip(i,r) = \sum_m SMIP(i,m,r) * \{pm(m,r) - afmp(i,m,r)\}, \quad (14)$$

where $SMIP(i,m,r)$ is the share of marketing service m in the total cost of all marketing services incorporated in the i th imported commodity.

$$qmip(i,r) = qip(i,r) + ESUBPT(i) * \{pipf(i,r) + atmp(i,r) - pmip(i,r)\} - atmp(i,r), \quad (15)$$

where $ESUBPT(i)$ is the elasticity of substitution between the composite marketing service and the composite imported commodity, and $atmp(i,r)$ is a Hick's neutral technical change variable.

Next, the composite quantity of imported commodity i purchased by the private household is defined as:

³ The standard GTAP nomenclature of designating percentage changes with lower case and the levels with upper case variables is followed in this manuscript.

$$qipb(i, r) = qip(i, r) + ESUBPT(i) * \{pipf(i, r) - pim(i, r)\} \quad (16)$$

Next, the margin inclusive, before tax composite price of imports is defined as:

$$pipf(i, r) = SIPF(i, r) * \{pmip(i, r) - atmp(i, r)\} + \{1 - SIPF(i, r)\} * pim(i, r), \quad (17)$$

where $SIPF(i, r)$ is the cost share of total marketing services in the “tax free” cost of the imported commodity. The margin inclusive composite quantity of imports is defined as:

$$qip(i, r) = qp(i, r) + ESUBD(i) * [pp(i, r) - pip(i, r)], \quad (18)$$

where $qp(i, r)$, $pp(i, r)$, and $ESUBD(i)$ maintain their standard GTAP definitions. Finally, the after tax, margin inclusive composite price of the imported commodity is defined as:

$$pip(i, r) = pipf(i, r) + atpm(i, r), \quad (19)$$

where $atpm(i, r) = tpm(i, r) + tp(r)$ has the standard GTAP definition.

Continuing with the domestic commodity portion of the private household preference structure, the quantity of the m th marketing service required for the i th domestically produced commodity is defined as:

$$qtdp(i, m, r) = qmdp(i, r) + ESUBPM(i) * \{pmdp(i, r) + afmp(i, m, r) - pm(m, r)\} - afmp(i, m, r), \quad (20)$$

The composite price and quantity of marketing services incorporated into the i th domestically produced commodity purchased by the private household are defined as:

$$qmdp(i, r) = qdp(i, r) + ESUBPT(i) * \{pdpf(i, r) + atmp(i, r) - pmdp(i, r)\} - atmp(i, r), \quad (21)$$

$$pmdp(i, r) = \sum_m SMDP(i, m, r) * \{pm(m, r) - afmp(i, m, r)\}, \quad (22)$$

where $SMDP(i, m, r)$ is the share of marketing service m in the total cost of all marketing services incorporated in the i th domestic commodity. The quantity of the i th domestic commodity

purchased by the private household and the tax-free (or margin inclusive) composite price of the i th domestic commodity are defined as:

$$qdpb(i, r) = qdp(i, r) + ESUBPT(i) * \{pdpf(i, r) - pm(i, r)\} \text{ and} \quad (23)$$

$$pdpf(i, r) = SDPF(i, r) * \{pmdp(i, r) - atmp(i, r)\} + \{1 - SDPF(i, r)\} * pm(i, r), \quad (24)$$

where $SDPF(i, r)$ is the cost share of total marketing services in the “tax free” cost of the domestic commodity. The margin inclusive quantity of domestic commodity i purchased is defined as:

$$qdp(i, r) = qp(i, r) + ESUBD(i) * [pp(i, r) - pdp(i, r)], \quad (25)$$

where again $qp(i, r)$, $pp(i, r)$, and $ESUBD(i)$ maintain their standard GTAP definitions. Finally, the the after tax, margin inclusive composite price of the domestic commodity is defined as:

$$pdp(i, r) = pdpf(i, r) + atpd(i, r), \quad (26)$$

where $atpd(i, r) = tpd(i, r) + tp(r)$ has the standard GTAP definition.

Modification of Government Preference Structure

The preference structure for the government is modified the same way as the private household. These changes are shown in figure 3. Since the modifications to the government preference structure differ only in nomenclature from the private household, all modified and new equations for the government are listed below without any further discussion.

$$VDGA(i, r) = PDG(i, r) * QDG(i, r), \quad (27)$$

$$VIGA(i, r) = PIG(i, r) * QIG(i, r), \quad (28)$$

$$VIGF(i, r) = PIGF(i, r) * QIG(i, r) \quad (29)$$

$$VDGF(i, r) = PDGF(i, r) * QDG(i, r), \quad (30)$$

$$VIGA(i, r) = VIGF(i, r) + IGTAX(i, r), \quad (31)$$

$$VDGA(i, r) = VDGF(i, r) + DGTAX(i, r). \quad (32)$$

$$VIGF(i, r) = VIGM(i, r) + VMIG(i, r). \quad (33)$$

$$VIGM(i, r) = PIM(i, r) * QIGB(i, r), \quad (34)$$

$$\begin{aligned} VMIG(i, r) &= PMIG(i, r) * QMIG(i, r) \\ &= \sum_m VTIG(i, m, r) \\ &= \sum_m PM(m, r) * QTIG(i, m, r), \end{aligned} \quad (35)$$

$$VDGF(i, r) = VDGM(i, r) + VMDG(i, r). \quad (36)$$

$$VDGM(i, r) = PM(i, r) * QDGB(i, r), \quad (37)$$

$$\begin{aligned} VMDG(i, r) &= PMDG(i, r) * QMDG(i, r) \\ &= \sum_m VTDG(i, m, r) \\ &= \sum_m PM(m, r) * QTDG(i, m, r), \end{aligned} \quad (38)$$

$$\begin{aligned} qtig(i, m, r) &= qmig(i, r) + ESUBGM(i) * \{pmig(i, r) + afmg(i, m, r) - pm(m, r)\} \\ &\quad - afmg(i, m, r), \end{aligned} \quad (39)$$

$$pmig(i, r) = \sum_m SMIG(i, m, r) * \{pm(m, r) - afmg(i, m, r)\}, \quad (40)$$

$$\begin{aligned} qmig(i, r) &= qig(i, r) + ESUBGT(i) * \{pigf(i, r) + atmig(i, r) - pmig(i, r)\} \\ &\quad - atmig(i, r), \end{aligned} \quad (41)$$

$$qigb(i, r) = qig(i, r) + ESUBGT(i) * \{pigf(i, r) - pim(i, r)\} \quad (42)$$

$$pigf(i, r) = SIGF(i, r) * \{pmig(i, r) - atmig(i, r)\} + \{1 - SIGF(i, r)\} * pim(i, r), \quad (43)$$

$$pig(i, r) = pigf(i, r) + atgm(i, r), \quad (44)$$

$$qig(i, r) = qg(i, r) + ESUBD(i) * [pg(i, r) - pig(i, r)], \quad (45)$$

$$qtdg(i, m, r) = qmdg(i, r) + ESUBGM(i) * \{pmdg(i, r) + afmg(i, m, r) - pm(m, r)\} - afmg(i, m, r), \quad (46)$$

$$qmdg(i, r) = qdg(i, r) + ESUBGT(i) * \{pdgf(i, r) + atmg(i, r) - pmdg(i, r)\} - atmg(i, r), \quad (47)$$

$$pmdg(i, r) = \sum_m SMDG(i, m, r) * \{pm(m, r) - afmg(i, m, r)\}, \quad (48)$$

$$qdgb(i, r) = qdg(i, r) + ESUBGT(i) * \{pdgf(i, r) - pm(i, r)\} \quad (49)$$

$$pdgf(i, r) = SDGF(i, r) * \{pmdg(i, r) - atmg(i, r)\} + \{1 - SDGF(i, r)\} * pm(i, r), \quad (50)$$

$$qdg(i, r) = qg(i, r) + ESUBD(i) * [pg(i, r) - pdg(i, r)], \quad (51)$$

$$pdg(i, r) = pdgf(i, r) + atgd(i, r), \quad (52)$$

Modification of Firm Production Structure

Figure 4 shows the modifications to the production structure in the GTAP model to incorporate margins on domestic and imported intermediate inputs. All domestic and imported intermediate inputs are combined with some or all of the four marketing services to form a composite domestic or imported intermediate input. To maintain generality, substitution possibilities are allowed between marketing services and between the domestic or imported commodity and the composite marketing service.

Introducing margins on domestic and imported intermediate inputs requires that six new price and eight new quantity variables be added to the standard GTAP model. First, consider the new price and quantity variables associated with imported intermediate inputs. The *quantity* of the *mth trade/transport* marketing services associated with the use of the *ith imported* intermediate input by *firms* the *jth* industry is defined as:

$$qtif(i, m, j, r) = qmif(i, j, r) + ESUBFM(i) * \{pmif(i, j, r) + afmf(i, m, j, r) - pm(m, r)\} - afmf(i, m, j, r), \quad (53)$$

where $qmif(i, j, r)$ is composite *quantity of marketing* services associated with the i th *imported* intermediate input used by *firms* industry j , $ESUBFM(i)$ is the elasticity of substitution between marketing services for the i th intermediate input, $pmif(i, j, r)$ is the *price* of the composite quantity of *marketing* services for *imported* intermediate input i used by *firms* in industry j , $afmf(i, m, j, r)$ is a biased technical change variable for the m th marketing service, and $pm(m, r)$ is the market price of the m th marketing service in region r . The *value* of the m th *trade/transport* marketing service associated with the i th *imported* intermediate input used by *firms* in industry j in region r :

$$VTIF(i, m, j, r) = PM(m, r) * QTIF(i, m, j, r). \quad (54)$$

The composite quantity and price of marketing services associated with the i th imported intermediate input used by industry j are defined as:

$$pmif(i, j, r) = \sum_m SMIF(i, m, j, r) * \{pm(m, r) - afmf(i, m, j, r)\} \text{ and} \quad (55)$$

$$qmif(i, j, r) = qif(i, j, r) + ESUBFT(i) * \{piff(i, j, r) + atmf(i, j, r) - pmif(i, j, r)\} - atmf(i, j, r), \quad (56)$$

where $SMIF(i, m, j, r)$ is the share of the m th marketing share in the total cost of all marketing services incorporated in the i th imported commodity, $ESUBFT(i)$ is the elasticity of substitution between the imported commodity and the composite marketing service, $piff(i, j, r)$ is the margin inclusive composite *price* of the *imported* intermediate input purchased by *firms* *free* of taxes, and $atmf(i, j, r)$ is a neutral technical change variable. The value of all marketing services associated with the i th imported intermediate input used by industry j is then defined as:

$$VMIF(i, j, r) = PMIF(i, j, r) * QMIF(i, j, r). \quad (57)$$

The *value* of *imported* intermediate inputs purchased by *firms* at *market* prices [$VIFM(i,j,r)$] and the margin inclusive *value* of *imported* intermediate inputs purchased by *firms* *free* of taxes are defined as:

$$VIFM(i,j,r) = PIM(i,r) * QIFB(i,j,r) \text{ and} \quad (58)$$

$$VIFF(i,j,r) = PIFF(i,j,r) * QIF(i,j,r). \quad (59)$$

The price and quantity variables in equations (58) and (59) are defined as:

$$qifb(i,j,r) = qif(i,j,r) + ESUBFT(i) * \{piff(i,j,r) - pim(i,r)\}, \quad (60)$$

$$qif(i,j,r) = qf(i,j,r) + ESUBD(i) * [pf(i,j,r) - pif(i,j,r)], \text{ and} \quad (61)$$

$$piff(i,j,r) = SIFF(i,j,r) * \{pmif(i,j,r) - atmfi(i,j,r)\} + \{1 - SIFF(i,j,r)\} * pim(i,r), \quad (62)$$

where $SIFF(i,j,r)$ is the cost share of all marketing services in the margin inclusive cost of the imported intermediate input, and $qf(i,j,r)$ and $pf(i,j,r)$ maintain their standard GTAP definition.

By adding the tax (or subtracting the subsidy) reported in $IFTAX(i,j,r)$ to $VIFF(i,j,r)$ yields the value of imported intermediate inputs at agents' prices [$VIFA(i,j,r)$]:

$$VIFA(i,j,r) = PIF(i,j,r) * QIF(i,j,r) = VIFF(i,j,r) + IFTAX(i,j,r) \quad (63)$$

The margin and tax inclusive composite *price* of *imported* intermediate inputs purchased by *firms* is then defined as:

$$pif(i,j,r) = piff(i,j,r) + tfm(i,j,r). \quad (64)$$

The treatment of margins on domestic intermediate inputs is completely analogous to the treatment of margins on imported intermediate inputs. For completeness, all of the new price and quantity variables and value terms are listed below.

$$qtdf(i, m, j, r) = qmdf(i, j, r) + ESUBFM(i) * \{pmdf(i, j, r) + afmf(i, m, j, r) - pm(m, r)\} - afmf(i, m, j, r), \quad (65)$$

$$VTDF(i, m, j, r) = PM(m, r) * QTDF(i, m, j, r) \quad (66)$$

$$pmdf(i, j, r) = \sum_m SMDF(i, m, j, r) * \{pm(m, r) - afmf(i, m, j, r)\} \quad (67)$$

$$qmdf(i, j, r) = qdf(i, j, r) + ESUBFT(i) * \{pdff(i, j, r) + atmf(i, j, r) - pmdf(i, j, r)\} - atmf(i, j, r), \quad (68)$$

$$VMDF(i, j, r) = PMDF(i, j, r) * QMDF(i, j, r). \quad (69)$$

$$VDFM(i, j, r) = PM(i, r) * QDFB(i, j, r) \quad (70)$$

$$VDFE(i, j, r) = PDFF(i, j, r) * QDF(i, j, r) \quad (71)$$

$$qdfb(i, j, r) = qdf(i, j, r) + ESUBFT(i) * \{pdff(i, j, r) - pm(i, r)\} \quad (72)$$

$$qdf(i, j, r) = qf(i, j, r) + ESUBD(i) * [pf(i, j, r) - pdf(i, j, r)] \quad (73)$$

$$pdff(i, j, r) = SDFE(i, j, r) * \{pmdf(i, j, r) - atmf(i, j, r)\} + \{1 - SDFE(i, j, r)\} * pm(i, r) \quad (74)$$

$$VDFA(i, j, r) = PDF(i, j, r) * QDF(i, j, r) = VDFE(i, j, r) + DFTAX(i, j, r) \quad (75)$$

$$pdf(i, j, r) = pdff(i, j, r) + tfd(i, j, r). \quad (76)$$

Incorporating Domestic Margins on Exports

Figure 5 illustrates the structure of domestic margins for all exported commodities. Each commodity that is exported is combined with trade and transportation services to form an “f.o.b.” commodity ready for export.

Incorporating domestic margins on exports requires three new quantity and two new price variables and equations be added to the standard GTAP model. Beginning at the bottom of

figure 5, the *quantity* of the *m*th *trade/transport* marketing service associated with the *export* of commodity *i* from region *r* to region *s* is defined as:

$$qtx(m, i, r, s) = qmxa(i, r, s) - afdx(m, i, r, s) + ESUBXM(i) * [pmxa(i, r, s) + afdx(m, i, r, s) - pm(m, r)] \quad (77)$$

where $qmxa(i, r, s)$ is the composite *quantity* of *marketing* services associated with the *export* of commodity *i*, $ESUBXM(i)$ is the elasticity of substitution among marketing services, $pmxa(i, r, s)$ is the *price* index of the composite quantity of *marketing* services required for the *export* of commodity *i*, and $afdx(m, i, r, s)$ is the biased technical change variable for the *m*th marketing service. The *value* of the *m*th *trade/transport* marketing service associated with the *export* of commodity *i* is defined as:

$$VTX(m, i, r, s) = pm(m, r) * qtx(m, i, r, s). \quad (78)$$

The composite price and quantity of marketing services associated with the export of commodity *i* are defined as:

$$qxma(i, r, s) = qxm(i, r, s) - atdx(i, r, s) + ESUBXT(i) * [pmx(i, r, s) + atdx(i, r, s) - pxma(i, r, s)] \quad \text{and} \quad (79)$$

$$pxma(i, r, s) = \sum_m SXMA(m, i, r, s) * [pm(m, r) - afdx(m, i, r, s)], \quad (80)$$

where $qxm(i, r, s)$ is the margin inclusive quantity of commodity *i* exported from region *r* to region *s*, $atdx(i, r, s)$ is a neutral technical change variable, $ESUBXT(i)$ is the elasticity of substitution between the composite marketing service and the export commodity, and $SXMA(m, i, r, s)$ is the share of the *m*th marketing service. The value of all marketing services associated with the export of commodity *i* from region *r* to region *s* is defined as:

$$VXMA(i, r, s) = pxma(i, r, s) * qxma(i, r, s). \quad (81)$$

The last new quantity and price variables are the quantity of commodity i exported from region r to region s and the margin inclusive price of commodity i :

$$qxb(i, r, s) = qxm(i, r, s) + ESUBXT(i) * [pmx(i, r, s) - pm(i, r)] \text{ and} \quad (82)$$

$$pmx(i, r, s) = \sum_s [SHRMX(i, r, s) * pxma(i, r, s) + (1 - SHRMX(i, r, s)) * pm(i, r)], \quad (83)$$

where $SHRMX(i, r, s)$ is the cost share of all marketing services in the margin inclusive cost of commodity i that is being exported. Note that $pmx(i, r, s)$ is not the f.o.b. price, which is redefined to equal:

$$pfob(i, r, s) = pmx(i, r, s) - tx(i, r) - txs(i, r, s). \quad (84)$$

The value of commodity i exported from region r to region s at market prices and the margin inclusive value of exports of commodity i are defined as:

$$VXMD(i, r, s) = pm(i, r) * qxb(i, r, s) \text{ and} \quad (85)$$

$$VXM(i, r, s) = pmx(i, r, s) * qxm(i, r, s). \quad (86)$$

Other Model Modifications

Other than the preference structure of the private and government households, and the technology of domestic firms, incorporating domestic marketing margins will also require other model modifications. The first, and most obvious, is that the market clearing conditions must be modified due to account for the new demands for domestic commodities used as marketing services and due to changes in notation. The modified market clearing condition for all *margin* commodities is now:

$$\begin{aligned}
qds(m, r, s) = & \sum_j SHRDFB(m, j, r) * qdfb(m, j, r) + SHRDPB(m, r) * qdpb(m, r) + \\
& SHRDGB(m, r) * qdgb(m, r) + \sum_{i \in NMRG} [SHRVTDP(i, m, r) * qtdp(i, m, r) + \\
& SHRVTIP(i, m, r) * qtip(i, m, r) + SHRVTDG(i, m, r) * qtdg(i, m, r) + \\
& SHRVTIG(i, m, r) * qtig(i, m, r)] + \sum_{i \in NMRG} \sum_j [SHRVTDF(i, m, j, r) * qtdf(i, m, j, r) + \\
& SHRVTIF(i, m, j, r) * qtif(i, m, j, r)] + \sum_{i \in NMRG} \sum_s SHRVTX(m, i, r, s) * qtx(m, i, r, s),
\end{aligned} \tag{87}$$

where the set *NMRG* refers to the non-margin commodities (a subset of *TRAD_COMM*) and all of the share expressions refer to a share of domestic production.

Second, the computation of taxes must be modified. This change must be made in both the income equation and the decomposition of equivalent variation. The following equations list the changes to the computation of taxes:

$$DPTAX(i, r) = VDPA(i, r) - VDPF(i, r) \tag{88}$$

$$IPTAX(i, r) = VIPA(i, r) - VIPF(i, r) \tag{89}$$

$$DGTAX(i, r) = VDGA(i, r) - VDGF(i, r) \tag{90}$$

$$IGTAX(i, r) = VIGA(i, r) - VIGF(i, r) \tag{91}$$

$$DFTAX(i, j, r) = VDFA(i, j, r) - VDFF(i, j, r) \tag{92}$$

$$IFTAX(i, j, r) = VIFA(i, j, r) - VIFF(i, j, r) \tag{93}$$

Finally, the decomposition of equivalent variation equation must be modified to include the marketing services' technical change variables. The equation for the decomposition of equivalent variation (*EV_DECOMPOSITION*) is now specified as:

$$\begin{aligned}
EV_ALT(r) = & [0.01 * UTILELASEV(r) * INCOMEEV(r)] * \\
& [DPARPRIV(r) * \log(UTILPRIVEV(r)/UTILPRIV(r)) * dppriv(r) \\
& + DPARGOV(r) * \log(UTILGOVEV(r)/UTILGOV(r)) * dpgov(r) \\
& + DPARSAREV(r) * \log(UTILSAVEEV(r)/UTILSAVE(r)) * dpsave(r)] \\
& + [0.01 * EVSCALFACT(r)] * \left[\sum_{i \in NSAV} PTAX(i, r) * [qo(i, r) - pop(r)] \right. \\
& + \sum_{i \in ENDW} \sum_{j \in PROD} ETAX(i, j, r) * [qfe(i, j, r) - pop(r)] \\
& + \sum_{j \in PROD} \sum_{i \in TRAD} IFTAX(i, j, r) * [qif(i, j, r) - pop(r)] \\
& + \sum_{j \in PROD} \sum_{i \in TRAD} DFTAX(i, j, r) * [qdf(i, j, r) - pop(r)] \\
& + \sum_{i \in TRAD} IPTAX(i, r) * [qip(i, r) - pop(r)] + \sum_{i \in TRAD} DPTAX(i, r) * [qdp(i, r) - pop(r)] \\
& + \sum_{i \in TRAD} IGTAX(i, r) * [qig(i, r) - pop(r)] + \sum_{i \in TRAD} DGTAX(i, r) * [qdg(i, r) - pop(r)] \\
& + \sum_{i \in TRAD} \sum_{s \in REG} XTAXD(i, r, s) * [qxs(i, r, s) - pop(r)] \\
& + \sum_{i \in TRAD} \sum_{s \in REG} MTAX(i, s, r) * [qxs(i, s, r) - pop(r)] \\
& + \sum_{i \in ENDW} VOA(i, r) * [qo(i, r) - pop(r)] - VDEP(r) * [kb(r) - pop(r)] \\
& + \sum_{i \in PROD} VOA(i, r) * ao(i, r) + \sum_{j \in PROD} VVA(j, r) * ava(j, r) \\
& + \sum_{i \in ENDW} \sum_{j \in PROD} VFA(i, j, r) * afe(i, j, r) + \sum_{j \in PROD} \sum_{i \in TRAD} VFA(i, j, r) * af(i, j, r) \\
& + \sum_{m \in MARG} \sum_{i \in TRAD} \sum_{s \in REG} VTMFSD(m, i, s, r) * atmfsd(m, i, s, r) \\
& + \sum_{i \in NMARG} (VMDP(i, r) + VMIP(i, r)) * atmp(i, r) \\
& + \sum_{i \in NMARG} \sum_{m \in MARG} (VTDP(i, m, r) + VTIP(i, m, r)) * afmp(i, m, r) \\
& + \sum_{i \in NMARG} (VMDG(i, r) + VMIG(i, r)) * atmg(i, r) \\
& + \sum_{i \in NMARG} \sum_{m \in MARG} (VTDG(i, m, r) + VTIG(i, m, r)) * afmg(i, m, r) \\
& + \sum_{j \in PROD} \sum_{i \in NMARG} (VMDF(i, j, r) + VMIF(i, j, r)) * atmf(i, j, r) \\
& + \sum_{j \in PROD} \sum_{i \in NMARG} \sum_{m \in MARG} (VTDF(i, m, j, r) + VTIF(i, m, j, r)) * afmf(i, m, j, r)
\end{aligned} \tag{94}$$

$$\begin{aligned}
& + \sum_{s \in REG} \sum_{j \in NMARG} \sum_{m \in MARG} VXMT(m, j, r, s) * afdx(m, j, r, s) \\
& + \sum_{s \in REG} \sum_{j \in NMARG} VXMA(j, r, s) * atdx(j, r, s) + \sum_{i \in TRAD} \sum_{s \in REG} VIMS(i, s, r) * ams(i, s, r) \\
& + \sum_{i \in TRAD} \sum_{s \in REG} VXWD(i, r, s) * pfob(i, r, s) + \sum_{i \in MARG} VST(m, r) * pm(m, r) + NETINV(r) * pcgds(r) \\
& - \sum_{i \in TRAD} \sum_{s \in REG} VXWD(i, s, r) * pfob(i, s, r) - \sum_{m \in MARG} VTMD(m, r) * pt(m) \\
& - SAVE(r) * psave(r)] + 0.01 * INCOME EV(r) * pop(r);
\end{aligned}$$

Modifying the GTAP Data Base

To implement the above version of the GTAP model, domestic margins for all transactions must be obtained for all regions.⁴ For the US, the Input-Output accounts contain information on eight different trade and transportation activities: railroads, truck, water, air, pipeline, gas pipeline, wholesale trade, and retail trade. These margin activities correspond to the GTAP margin sectors as follows: wholesale and retail trade correspond to the trade (trd) sector in GTAP, air and water transportation correspond to their counterparts air transport (atp) and water transport (wtp) in GTAP, all of the remaining transport activities in the US IO accounts correspond to the transport, nec (otp) sector in GTAP. Margin information is available for all intermediate input purchases, final demand, and exports.

The margin data in the US IO accounts are aggregated to the GTAP sectoral level. The sizes of the domestic margins are computed by dividing expenditures on trade and transportation by commodity usage. For example, consider private consumption expenditures on beverages and tobacco (b_t). In the US IO accounts, consumers spent \$76.615 billion on beverage and tobacco products valued at manufacturers' prices. In addition, these purchases also generated \$51.989 billion in expenditure on trade (trd) services, \$1.304 billion in expenditure on transport, nec

⁴ Currently, margin data is available only for the US. In empirical illustration, US margins were applied to EU and ROW.

(otd), \$30 million in expenditure on water (wtp) transport, and \$56 million in expenditure on air transport (atp), for a total of \$53.379 billion in expenditure on all margin activities. Thus, the magnitude of domestic margins for beverage and tobacco purchased by private consumers, by margin activity, is 67.9 percent for trade, 1.7 percent for transport nec, 0.04 percent for water transport, and 0.07 percent for air transport, for a total of 69.7 percent. The domestic margins on purchases of beverages for government consumption, intermediate usage, and exports are determined in the same manner.

Once all of the estimated margins for all goods and uses have been obtained, these estimates are then applied to the values in the GTAP data base to obtain the GTAP margin values. The “margin inclusive value” of all purchases by domestic agents is obtained by adding the estimated margins to the value of the agents’ purchases at market and agents’ prices. In order to maintain a balanced set of accounts (i.e., zero profits, a constant level of private consumption expenditures), the total value of margin activities must be subtracted from the value of agent purchases on those activities in the original GTAP data base. For example, consider the case of trade margin activities on good purchased by the private household. In version 5 of the GTAP data base, expenditures on trade by the private household at market prices is \$1,118.204 billion. Estimated expenditures of trade margin related activities for all domestic and imported commodities purchased by the private household are \$826.472 billion (\$652.167 billion on domestic products and \$174.305 billion on imported products). This implies that consumption expenditures for the trade sector is equal to \$291.732 billion.⁵ A similar modification is made to government consumption expenditures. For firms, the intermediate use of trade and transport

⁵ This implies that all imported trade and transport services are consumed directly by agents and not used for domestic margin activities.

services in the version 5 data base are modified by the level of expenditures on margin activities for all intermediate input purchases.

Modifying the version 5 GTAP data base to include domestic margins on exports is more difficult. This is because there is no information available to help adjust the bilateral trade in trade and transport services. In the US IO accounts, a single domestic margin for exports is identified for each margin activity. Thus, it is assumed that the domestic margins on exports are the same, regardless of destination, for a given commodity.⁶ Similar to the procedure for domestic margins on intermediate inputs and final demand, the amount of trade and transport services required for exporting all commodities are subtracted from the level of trade and transport exports in the version 5 data base. For example, using the percentage export margins in the US IO accounts, an estimated \$10.963 billion in trade services are required for all exports from the US (based on GTAP version 5 trade data). The total amount of trade services exported by the US, at exporter market prices, in the version 5 data base is listed as \$11.309 billion. After subtracting out the trade use for domestic export margins, this leaves \$346 million of trade services exports by the US in the margin adjust data base. The problem is then how to allocate the \$10.963 billion reduction in trade service exports from the US to each destination region. This adjustment problem becomes more difficult when several regions must be adjusted simultaneously.

In making the necessary bilateral adjustments in trade in trade and transport services, the underlying accounting relationships of the GTAP data base must be maintained. The total value of exports (at market and world prices) must remain constant for each region. The incorporation of domestic margins on exports will not change these values. In addition, the total value of

⁶ This makes sense because the domestic margin required to get a given good to the US border should not vary much by destination.

imports (at world and market prices) must also remain constant for each importing region. These are two important checks when adjusting the bilateral trade values in trade and transport services. In developing the data base for the empirical illustration discussed in the next section, the bilateral reductions in trade and transport exports were made based on the initial export shares in the version 5 data base. After these adjustments were made, the total value of imports (VIMS) was computed for each region using the margin inclusive bilateral trade flows and compared to the total value of imports in the version 5 data base. The discrepancies in the total value of imports were eliminated based on relative trade shares of trade services and transport services for each region. Table 3 lists the domestic margins used in the empirical illustration presented in the next section.

Empirical Illustration

To illustrate the potential impacts of incorporating domestic marketing margins in the GTAP model, several experiments are conducted that analyze the impacts of technological change at various levels of the food marketing channel. These experiments follow the work of Frisvold, but also consider the impacts of technical change with respect to the domestic margins on food products. The first two experiments conducted are a 2 percent global neutral technical change in the crops sector and a labor augmenting technical change in processed food that reduces total costs by one percent. The results from two different models, the standard GTAP model and a modified GTAP model with domestic marketing margins included, are compared to illustrate the impacts of incorporating domestic marketing margins. Each model has three regions (US, EU, and ROW) and seven traded commodities (crops, livestock, processed food, mining & manufacturing, services, trade, and transportation). Table 4 lists the commodity aggregation used. The level of sectoral detail is chosen to closely match that of Frisvold, who

conducted similar experiments. In the model with domestic marketing margins, two different scenarios with fixed (e.g., no substitution possibilities) and variable marketing margins are considered.

An additional set of experiments are conducted that assess the relative impact on regional welfare of technological change occurring at the farm, processing, and distribution levels of the food marketing chain. The first two experiments follow Frisvold and consider the impacts of a two percent neutral technical change in the US crops sector and a labor augmenting technical change in US process foods that reduced food processing costs by one percent. The final experiment in this group assesses the impact of a trade services augmenting technical change in the domestic margins for food purchased by US consumers.

Global Neutral Technical Change in the Crops Sector

As discussed by Frisvold, the impact of a neutral technical change is to reduce the cost of production in the crops sector, leading to expanded production and reduced prices. The first three columns in table 5 present selected results from the standard GTAP model. Crop production in the US and ROW increases while crop production in the EU decreases. The decrease in crop production in the EU is due to a smaller crop price decrease in the EU, relative to the US and ROW. Because crop production in the EU is much less land intensive than either the US or ROW, (the initial cost share for land is 0.07 for the EU, 0.15 for the US, and 0.20 for the ROW), any reduction in the land rental rates, which experience the largest decline in the experiment due to its specificity in agriculture, have a smaller impact on crop prices in the EU than in other regions. This smaller price decrease leads to a decrease in EU crop exports, due to substitution effects, which leads to a reduction in EU crop production. Livestock and process food production also increases in the US and ROW due to crop price and land rental decreases

that lower the cost of production for these sectors, thereby encouraging expansion. Again, livestock and processed food production in the EU decline because these sectors do not enjoy as large of input cost reduction, due to the relatively smaller decrease in the EU crop price.

The middle three columns in table 5 present selected results for the same experiment with “fixed” domestic marketing margins. The elasticity of substitution between commodities and the composite of marketing services is set to zero. Thus, the composite amount of marketing services is not allowed to change. As will be shown shortly, this parameter plays a key role in determining the outcome of this experiment when domestic marketing margins are introduced.

With fixed marketing margins, the increases in crop, livestock, and processed food production in the US and ROW are much smaller compared that the output changes for the standard GTAP model without marketing margins. For example, there is approximately a 62 percent smaller increase crop production in the US and a 23 percent smaller increase in crop production in the ROW. Slightly smaller output reductions occurred for livestock in the US and ROW (25 percent and 10 percent respectively). In addition, the reductions in crop, livestock, and processed food production are in the EU when fixed domestic marketing margins are introduced into the model. What is driving these differences is the amount of price transmission between producers and consumers in the model. Except for exports, which include inter-regional transportation costs, any price decrease is fully passed on to all users in the standard GTAP model. This is shown by considering the ratio of the change in agents’ price to the change in producers’ price in table 5. However, for the model with fixed marketing margins, the price transmissions ranged from last than 0.5 for domestic and imported crops purchased by the private household to nearly 1.00 for livestock used as intermediate inputs. Because only a fraction of the producer price is being transmitted to users, there is less of a demand response in

the model with fixed marketing margins. Smaller demand response to the decrease in producer prices leads to smaller crop production increases (or larger crop production decreases in the EU).

The last three columns in table 5 present selected results for the case where the elasticity of substitution between commodities and the composite marketing service is set equal to 0.5. In this experiment, the overall size of the domestic marketing margins will change as the relative prices between commodities and marketing services changes. The prices of trade and transportation remained virtually constant, about a 0.03 percent increase, in all experiments. Thus, there is a substitution towards crops, livestock, and processed food and away from the composite domestic margins for those commodities, implying smaller overall domestic margins. This added source of demand, which was not available with fixed margins, leads to larger increases (or smaller decreases) in crop, livestock, and processed food production when compared to the results from the model without domestic margins. In several instances, on a percentage basis, these changes are substantial. The increase in US crop production is nearly twice as large and the increase in ROW crop production is nearly 60 percent larger. In addition, crop production in the EU increases in this model, compared to decreases in the other two models considered. The increase in US livestock nearly 30 percent larger than the increase in the model without margins while the decrease in EU livestock is reduced by one-half. This illustrates the importance of the value of the elasticity of substitution between commodities and the composite market service.

The last set of results to be compared across these three different models is the change in equivalent variation. Using the standard GTAP model, global neutral technical change in the crops sector generates a \$25.627 billion increase in global equivalent variation. However, when domestic marketing margins are introduced, the amount of increase in global equivalent is

smaller than in the no margins case. With fixed marketing margins, increase in equivalent variation is smaller in all regions and the global increase is 3.2 percent, or \$820 million, smaller compared to the no margin case. This is due to smaller level of price transmission in the model with fixed marketing margins. For the case of variable marketing margins, the results are similar to the fixed margins case. The increase in global equivalent variation is 3.6 percent smaller. These results show that one will overestimate the benefits of agricultural research by ignoring domestic marketing margins.

Comparison of Technical at Different Stages of Food Marketing Channel

Frisvold showed that a one percent cost reduction in North American food processing yielded a larger increase in equivalent than a two percent neutral technical change in North American crop production. In this section, these two experiments will be repeated under the assumption of fixed domestic marketing margins. In addition, a third experiment will examine the impacts of trade augmenting technological change that reduces US food marketing margins on private consumption. This may be thought of as a biased technical change that improves the efficiency of wholesale and retail trade inputs into the domestic marketing margins, but leaves transportation efficiency unchanged. The results for these three experiments are given in table 6.

The impacts on equivalent variation from neutral technical change in the US crops sector and labor augmenting technical change in the US processed food sector are similar to but lower than those of Frisvold. Technical change in US food processing generates \$2.06 billion more in welfare gains than the neutral technical change in US crop production. (This is compared to a \$2.4 billion difference in Frisvold's results.) However, a trade services augmenting technical change in the US food margins for food consumed by the private household generates \$6.227 billion in welfare gain in the US, or approximately \$1.68 billion more than the processed food

technical change. These results not only reiterates the point made by Freebairn, Davis, and Edwards that greater attention to research on productivity growth beyond the farm gate is warranted, but that the gains from such research appear to be greater the closer one gets to consumers. In addition, to the extent that any technological advances in wholesale and retail activities are not transferable to other regions, possible due to differences in the structure of the wholesale and retail sectors across regions, almost all of the benefits of the technological progress are captured by the innovating region. The only benefit captured by the non-innovating regions come through an increase in US export demand due to smaller domestic margins on imported food commodities.

Summary and Conclusions

Transportation, wholesaling, and retailing activities are a significant segment of economic activity in many economies. The magnitude of these activities can vary greatly between products, users, and regions. However, in most applied general equilibrium (AGE) analyses, these marketing activities are not tied to specific commodities, reflecting the usual treatment of margins in the underlying input-output tables. To rectify this deficiency, this paper has developed a framework for incorporating domestic marketing margins on domestic and imported goods going to final demand or used as intermediate inputs, and margins on exports (e.g., trade and transport activities to get the exported commodity to the border) into the standard GTAP model.

To illustrate the potential impact of incorporating domestic marketing activities in an AGE model, several experiments were performed analyzing technological change at the farm level, food processing level, and wholesale/retail level of the food marketing chain. Compared with models that do not incorporate domestic marketing activities, two main results emerge.

First, by tying the domestic marketing activities to specific commodities, the degree of price transmission from producers to users is reduced significantly, compared to a model that does not include margin activities explicitly. Thus, the benefits of technological change at the farm or processing level, in terms of producer price reductions, do not get completely passed through to users (consumers and intermediate use). The implication of this reduction in price transmission is that the welfare effects of the technological change are lower when domestic marketing are explicitly modeled than when that are not explicitly modeled. This result will also apply to any type of policy liberalization, such as removing trade distortions. For example, the entire price reduction of removing an import tariff will only be partially be passed through to consumers as long as the cost of providing domestic trade and transport services for that good remain constant. Therefore, an analysis that does not explicitly account for domestic marketing activities will overstate the benefits of technical or policy change.

The second main result is that the magnitude of the elasticity of substitution between commodities and the composite marketing activity is very important. Previous research by Wohlgenant has suggested that the elasticity of substitution between commodities and marketing services may be non-zero, implying that the marketing margins need not be “fixed.” Allowing “variable” margins creates a new source of demand for commodities. This impact was illustrated in the case of technical change in the crops sector. By allowing the domestic marketing margins to vary resulted in larger increases in crop, livestock, and processed food production that was the case for fixed margins or the case without domestic marketing margins. This result occurred because the relative price decrease in food commodities relative to trade and transport activities, leading to a decrease in the domestic marketing margins for food.

Finally, by explicitly modeling domestic marketing activities, the point made by Freebairn, Davis, and Edwards and Frisvold that greater attention to research on productivity growth beyond the farm gate is warranted is further reiterated. When considering technological change at the farm, processing, and wholesale/retail trade levels of food marketing channel, the welfare gains appear to be much greater the closer one gets to consumers. In addition, to the extent that any technological advances in wholesale and retail activities are not transferable to other regions, almost all of the benefits of the technological progress are captured by the innovating region. Thus, public agencies providing funding for research focused on food wholesale/retail or transport activities would not need to be as concerned about the benefits of that research leaking to other regions.

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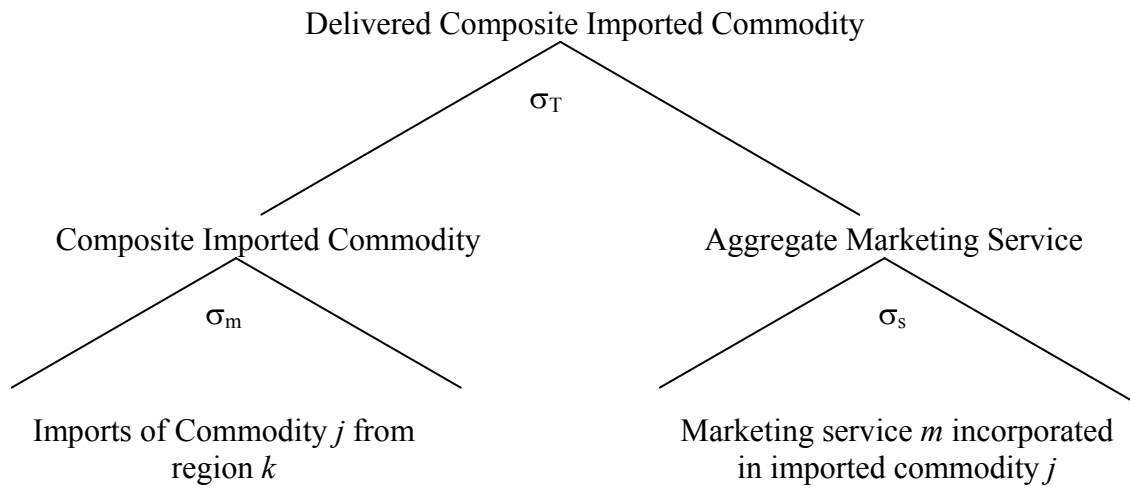


Figure 1. Marketing Margins for Imported Commodities

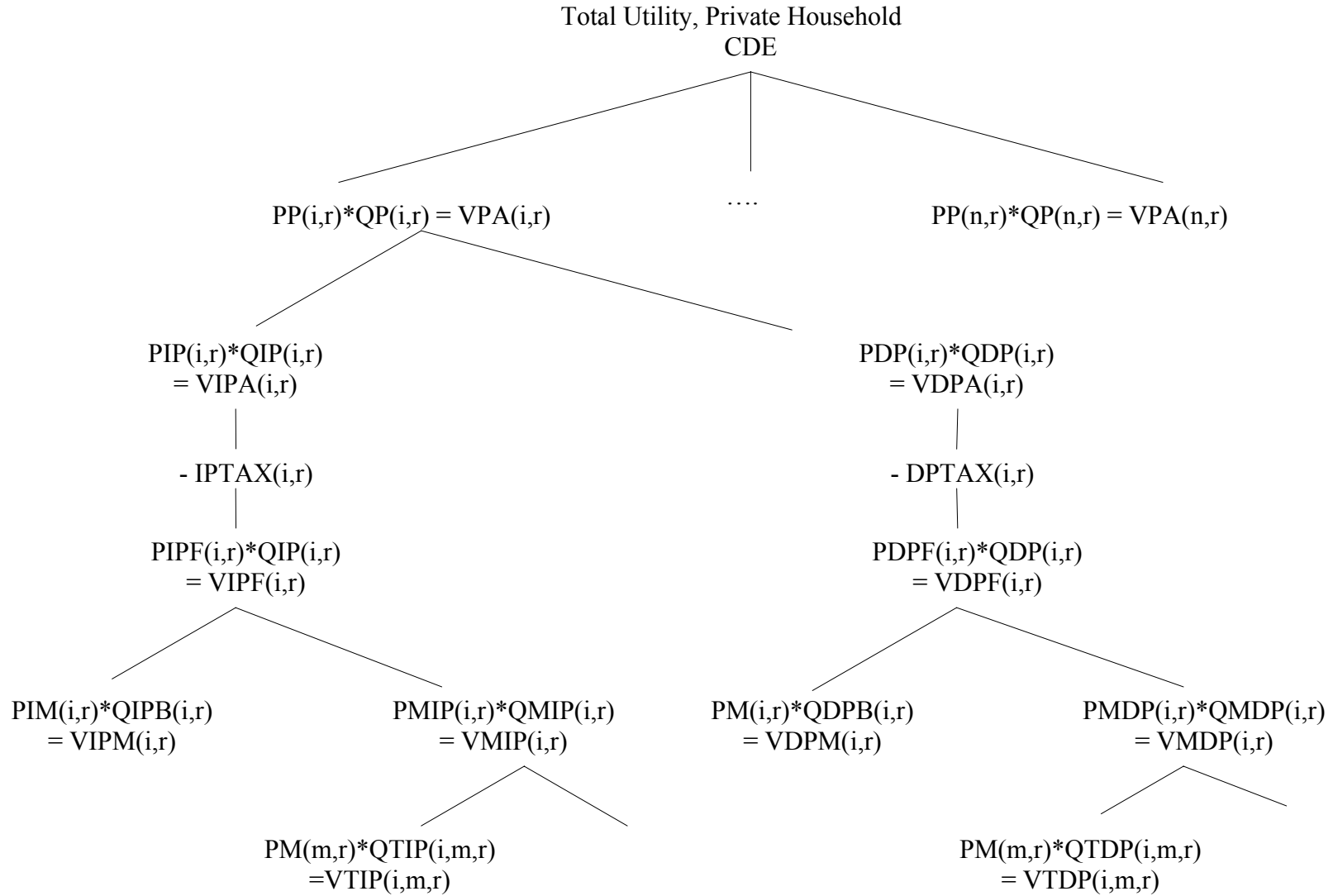


Figure 2. Modified Private Household Preference Structure

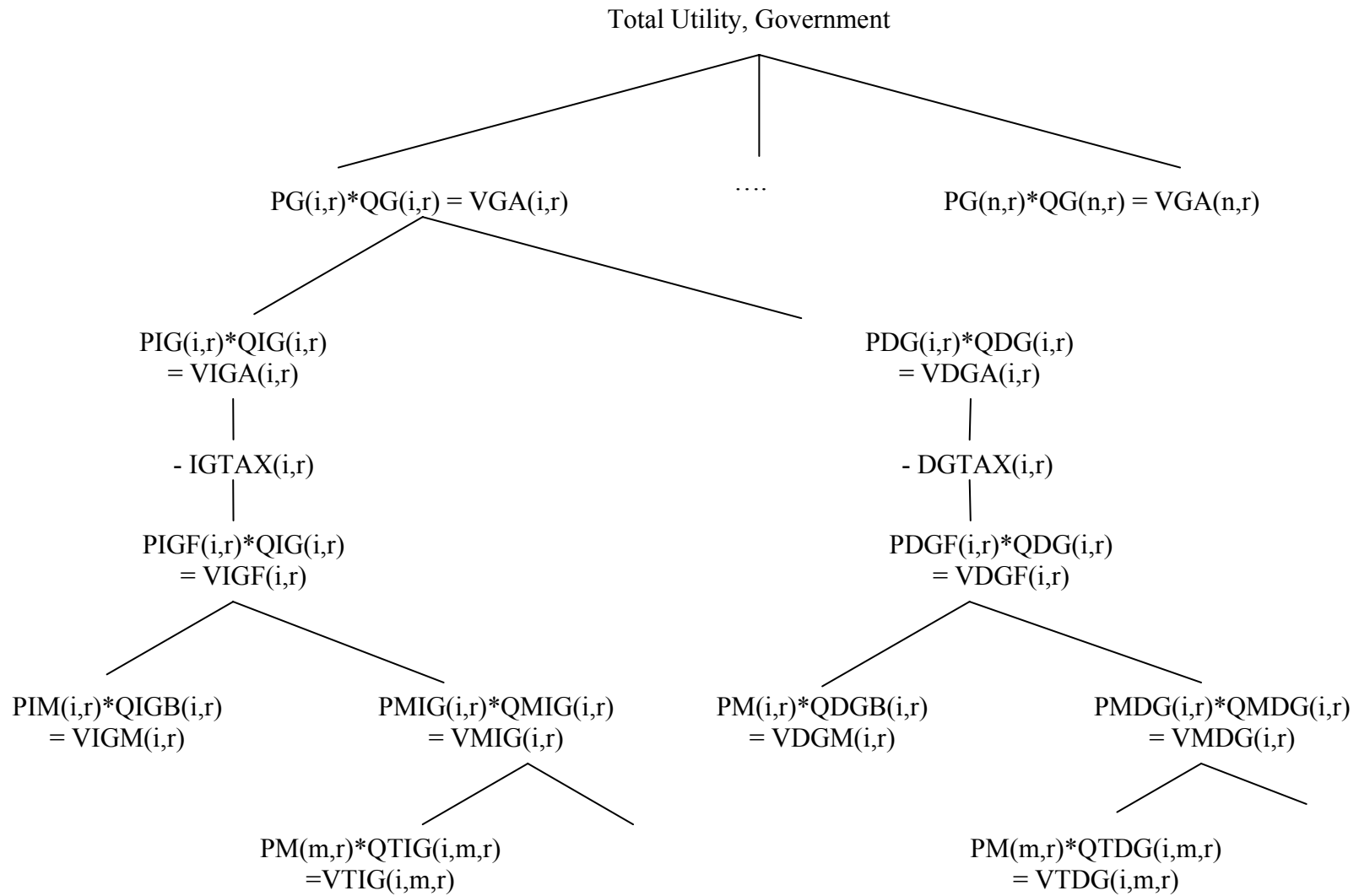


Figure 3. Modified Government Preference Structure

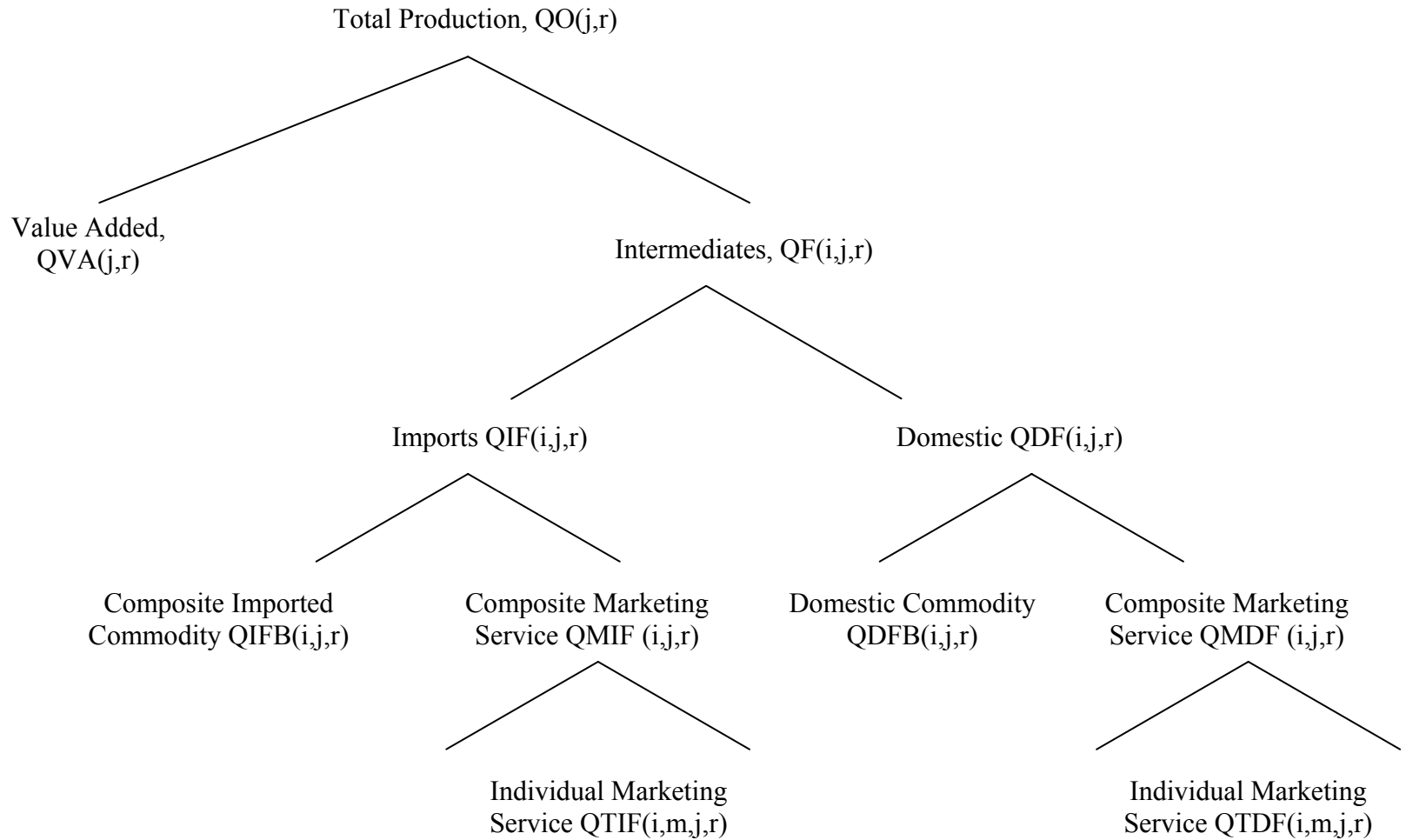


Figure 4. Modified Production Structure

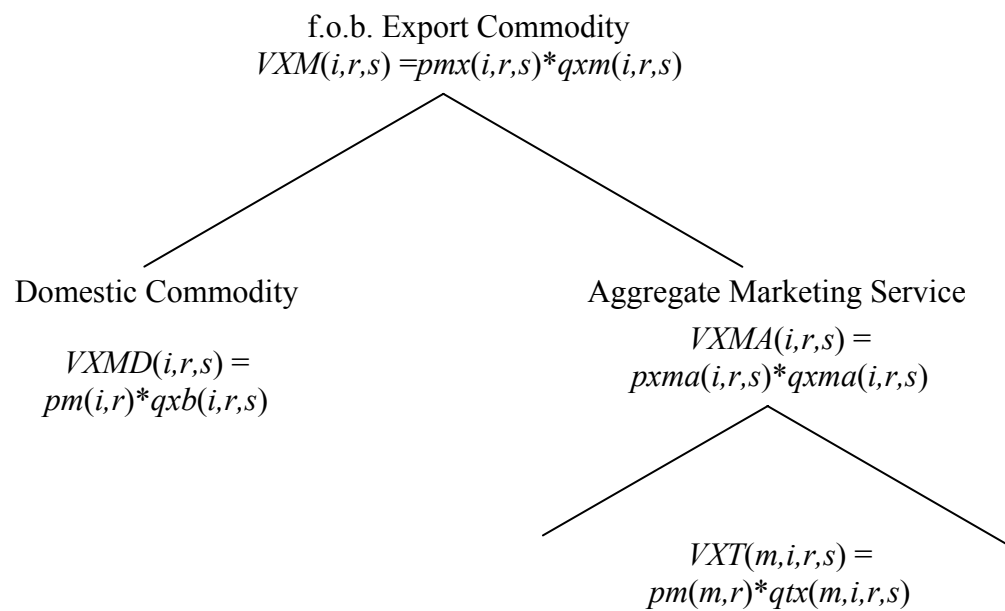


Figure 5. Structure of Domestic Margins on Exported Commodities

Table 1. Marketing Margins on GTAP Commodities Purchased by US Private Household

GTAP Commodity	Share of Total Value GTAP Marketing Activity				Total	Consumer/ Producer Ratio ^a
	trd	otp	wtp	atp		
Pdr	0.237	0.068	0.000	0.000	0.305	1.439
Wht	0.231	0.077	0.000	0.000	0.308	1.445
Gro	0.242	0.066	0.000	0.000	0.309	1.446
v_f	0.379	0.098	0.001	0.006	0.483	1.933
Osd	0.375	0.000	0.000	0.000	0.375	1.600
c_b	0.250	0.063	0.000	0.000	0.313	1.455
Pfb	0.199	0.100	0.000	0.000	0.300	1.428
Ocr	0.579	0.012	0.000	0.035	0.627	2.677
Ctl	0.250	0.000	0.000	0.000	0.250	1.334
Oap	0.257	0.004	0.000	0.016	0.277	1.383
Rmk	0.000	0.000	0.000	0.000	0.000	1.000
Wol	0.000	0.000	0.000	0.000	0.000	1.000
For	0.162	0.000	0.000	0.000	0.162	1.193
Fsh	0.323	0.002	0.001	0.011	0.337	1.509
Col	0.418	0.145	0.024	0.000	0.588	2.427
Oil	N/A	N/A	N/A	N/A	N/A	N/A
Gas	0.000	0.000	0.000	0.000	0.000	1.000
Omn	0.211	0.385	0.046	0.000	0.642	2.795
Cmt	0.306	0.031	0.000	0.001	0.339	1.513
Omt	0.287	0.009	0.000	0.001	0.296	1.421
Vol	0.278	0.049	0.001	0.000	0.327	1.486
Mil	0.303	0.006	0.000	0.004	0.312	1.454
Pcr	0.249	0.046	0.004	0.000	0.300	1.429
Sgr	0.363	0.026	0.003	0.000	0.392	1.646
ofd	0.338	0.017	0.000	0.000	0.355	1.551
b_t	0.400	0.010	0.000	0.000	0.411	1.697
tex	0.481	0.010	0.000	0.001	0.491	1.965
wap	0.516	0.002	0.000	0.002	0.519	2.080
lea	0.515	0.004	0.000	0.000	0.519	2.081
lum	0.496	0.013	0.000	0.000	0.509	2.038
ppp	0.369	0.019	0.000	0.005	0.394	1.649
p_c	0.514	0.017	0.010	0.000	0.540	2.176
crp	0.404	0.026	0.000	0.002	0.432	1.760
nmm	0.530	0.016	0.001	0.002	0.548	2.214
i_s	0.456	0.089	0.000	0.000	0.544	2.194
nfm	0.417	0.024	0.000	0.000	0.441	1.788
fmp	0.484	0.013	0.000	0.001	0.498	1.991
mvh	0.163	0.021	0.000	0.000	0.184	1.226
otn	0.279	0.007	0.000	0.001	0.286	1.401
ele	0.405	0.005	0.000	0.003	0.413	1.703
ome	0.511	0.009	0.000	0.001	0.521	2.089

Table 1. Continued

GTAP Commodity	Share of Total Value GTAP Marketing Activity				Total	Consumer/ Producer Ratio ^a
	trd	otp	wtp	atp		
omf	0.518	0.007	0.000	0.001	0.526	2.108
ely	0.000	0.000	0.000	0.000	0.000	1.000
gdt	0.000	0.000	0.000	0.000	0.000	1.000
wtr	0.000	0.000	0.000	0.000	0.000	1.000
cns	0.000	0.000	0.000	0.000	0.000	1.000
trd	0.000	0.000	0.000	0.000	0.000	1.000
otp	0.000	0.000	0.000	0.000	0.000	1.000
wtp	0.000	0.000	0.000	0.000	0.000	1.000
atp	0.000	0.000	0.000	0.000	0.000	1.000
cmn	0.000	0.000	0.000	0.000	0.000	1.000
ofi	0.000	0.000	0.000	0.000	0.000	1.000
isr	0.000	0.000	0.000	0.000	0.000	1.000
obs	0.011	0.000	0.000	0.000	0.011	1.012
ros	0.013	0.000	0.000	0.000	0.013	1.013
osg	0.000	0.000	0.000	0.000	0.000	1.000
dwe	0.000	0.000	0.000	0.000	0.000	1.000

^a Ratio of consumer or margin inclusive price to producer price.

Table 2. Marketing Margins on GTAP Commodities Purchased by US Firms

GTAP Commodity	Share of Total Value GTAP Marketing Activity				Total	Consumer/ Producer Ratio ^a
	trd	otp	wtp	atp		
pdr	0.112	0.068	0.002	0.000	0.181	1.221
wht	0.280	0.091	0.004	0.000	0.375	1.601
gro	0.114	0.069	0.002	0.000	0.185	1.226
v_f	0.188	0.110	0.000	0.006	0.304	1.436
osd	0.160	0.020	0.000	0.000	0.180	1.220
c_b	0.013	0.043	0.000	0.000	0.057	1.060
pfb	0.163	0.028	0.000	0.000	0.191	1.237
ocr	0.083	0.060	0.000	0.034	0.176	1.214
ctl	0.007	0.008	0.000	0.000	0.015	1.015
oap	0.004	0.005	0.000	0.011	0.020	1.021
rmk	0.034	0.000	0.000	0.000	0.034	1.035
wol	0.004	0.009	0.000	0.013	0.026	1.027
for	0.011	0.044	0.002	0.000	0.057	1.060
fsh	0.121	0.001	0.000	0.009	0.131	1.151
col	0.022	0.153	0.026	0.000	0.201	1.252
oil	0.027	0.074	0.001	0.000	0.102	1.113
gas	0.016	0.093	0.000	0.000	0.109	1.123
omn	0.026	0.261	0.034	0.000	0.321	1.473
cmt	0.060	0.021	0.000	0.000	0.081	1.088
omt	0.043	0.003	0.000	0.000	0.046	1.049
vol	0.032	0.076	0.002	0.000	0.110	1.123
mil	0.087	0.003	0.000	0.002	0.092	1.102
pcr	0.011	0.058	0.001	0.000	0.069	1.074
sgr	0.071	0.065	0.002	0.000	0.138	1.161
ofd	0.086	0.029	0.001	0.000	0.116	1.131
b_t	0.141	0.015	0.001	0.000	0.156	1.185
tex	0.061	0.026	0.000	0.002	0.090	1.098
wap	0.079	0.006	0.000	0.003	0.088	1.096
lea	0.018	0.019	0.000	0.005	0.041	1.043
lum	0.164	0.046	0.001	0.000	0.211	1.267
ppp	0.078	0.040	0.000	0.002	0.121	1.138
p_c	0.227	0.031	0.016	0.000	0.273	1.375
crp	0.124	0.059	0.002	0.002	0.187	1.231
nmm	0.111	0.077	0.003	0.001	0.192	1.238
i_s	0.106	0.047	0.001	0.000	0.154	1.182
nfm	0.091	0.016	0.000	0.002	0.109	1.122
fmp	0.136	0.015	0.000	0.002	0.153	1.181
mvh	0.067	0.016	0.000	0.006	0.089	1.098
otn	0.012	0.001	0.000	0.010	0.023	1.023
ele	0.071	0.001	0.000	0.005	0.077	1.084
ome	0.114	0.026	0.000	0.004	0.143	1.167

Table 2. Continued

GTAP Commodity	Share of Total Value GTAP Marketing Activity				Total	Consumer/ Producer Ratio ^a
	trd	otp	wtp	atp		
omf	0.165	0.053	0.000	0.003	0.220	1.282
ely	0.000	0.000	0.000	0.000	0.000	1.000
gdt	0.000	0.000	0.000	0.000	0.000	1.000
wtr	0.000	0.000	0.000	0.000	0.000	1.000
cns	0.000	0.000	0.000	0.000	0.000	1.000
trd	0.000	0.000	0.000	0.000	0.000	1.000
otp	0.000	0.000	0.000	0.000	0.000	1.000
wtp	0.000	0.000	0.000	0.000	0.000	1.000
atp	0.000	0.000	0.000	0.000	0.000	1.000
cmn	0.000	0.000	0.000	0.000	0.000	1.000
ofi	0.000	0.000	0.000	0.000	0.000	1.000
isr	0.000	0.000	0.000	0.000	0.000	1.000
obs	0.002	0.000	0.000	0.000	0.002	1.002
ros	0.019	0.000	0.000	0.000	0.019	1.020
osg	0.000	0.000	0.000	0.000	0.000	1.000
dwe	0.000	0.000	0.000	0.000	0.000	1.000

^a Ratio of consumer or margin inclusive price to producer price.

Table 3. Domestic Margins on Private Consumption, Exports, and Intermediate Use

	Trade Margins			Transport Margins		
	US	EU	ROW	US	EU	ROW
	Percent of Producer Value					
Private Household						
<i>Domestic Commodities</i>						
Crops	92.5	74.0	55.5	18.0	18.0	18.0
Livestock	34.8	27.9	20.9	2.7	2.7	2.7
Process Food	54.2	43.3	32.5	2.4	2.4	2.4
Mining & Manufacturing	76.0	60.8	45.6	3.0	1.8	1.4
<i>Imports</i>						
Crops	108.8	87.0	65.3	16.8	16.8	16.8
Livestock	33.1	26.5	19.8	2.6	2.6	2.6
Process Food	55.5	44.4	33.3	2.6	2.6	2.6
Mining & Manufacturing	81.3	65.1	48.8	2.0	2.0	2.0
Exports						
Crops	3.1	3.1	3.1	9.9	9.9	9.9
Livestock	0.0	0.0	0.0	2.3	2.3	2.3
Process Food	1.1	1.1	1.1	3.2	3.2	3.2
Mining & Manufacturing	1.7	1.7	1.7	3.3	0.1	0.1
Intermediate Use^a						
<i>Domestic Inputs</i>						
Crops	17.9	17.8	13.0	9.3	7.8	4.9
Livestock	1.3	1.3	0.9	0.8	0.7	0.5
Process Food	9.5	9.0	7.6	2.8	2.7	2.1
Mining & Manufacturing	12.7	11.9	10.0	5.2	4.6	3.8
<i>Imported Inputs</i>						
Crops	16.6	17.9	12.8	12.2	11.9	6.8
Livestock	0.6	0.8	0.7	1.2	1.2	1.0
Process Food	9.6	8.3	7.8	3.8	4.3	2.8
Mining & Manufacturing	10.3	9.9	8.0	4.1	3.8	3.0

^a Aggregate margins across all intermediate uses.

Table 4. Commodity Aggregation for Empirical Application

Aggregate Commodity	GTAP Sector
Crops	Paddy rice Wheat Cereal grains, nec Vegetables, fruit, nuts Oil seeds Sugar cane, sugar beet Plant-based fibers Crops, nec
Livestock	Bovine cattle, sheep and goats, horses Animal products, nec Raw milk Wool, silk-worm cocoons
Processed Food	Fishing Bovine cattle, sheep and goat, horse meat products Meat products, nec Vegetable oils and fats Dairy products Processed rice Sugar Food products, nec Beverages and tobacco products
Mining & manufacturing	Forestry Coal Oil Gas Mineral, nec Textiles Wearing apparel Leather products Wood products Paper products, publishing Petroleum, coal products Chemical, rubber, plastic products Mineral products, nec Ferrous metals Metals, nec Metal products Motor vehicles and parts Transport equipment, etc Electronic equipment Machinery and equipment, nec Manufactures, nec

Table 4. Continued

Aggregate Commodity	GTAP Sector
Services	Electricity Gas manufacture, distribution Water Construction Communication Financial services, nec Insurance Business services, nec Recreational and other services Public administration, defense, education, health Dwellings
Trade	Trade
Transportation	Transport, nec Water transport Air Transport

Table 5. Impacts of Global Technical Change in Crops Sector, With and Without Margins

Variable	No Margins			Fixed Margins			Variable Margins		
	USA	EU	ROW	USA	EU	ROW	USA	EU	ROW
Percentage Change									
Output (qo)									
Crops	0.26	-0.31	0.48	0.10	-0.37	0.37	0.52	0.11	0.77
Livestock	0.18	-0.12	0.36	0.14	-0.16	0.32	0.24	-0.06	0.37
Processed Food	0.14	-0.05	0.47	0.09	-0.08	0.42	0.17	-0.01	0.46
Producer Prices (pm)									
Crops	-3.31	-2.69	-3.38	-3.43	-2.69	-3.48	-3.12	-2.57	-3.13
Livestock	-1.35	-0.79	-1.31	-1.42	-0.80	-1.38	-1.24	-0.71	-1.11
Processed Food	-0.55	-0.42	-0.86	-0.57	-0.41	-0.88	-0.51	-0.38	-0.78
Land Factor Price (pfe)									
Crops	-8.34	-9.14	-6.20	-9.13	-9.37	-6.70	-7.11	-7.52	-4.97
Livestock	-6.85	-7.50	-4.68	-7.55	-7.72	-5.13	-5.76	-6.13	-3.66
Price Transmission	Ratio of Change in Agent's Price to Change in Producer Price								
Domestic Private Household ^a									
Crops	1.00	1.00	1.00	0.47	0.52	0.57	0.45	0.49	0.56
Livestock	1.00	1.00	1.00	0.72	0.76	0.80	0.72	0.78	0.80
Processed Food	1.00	1.00	1.00	0.62	0.67	0.72	0.63	0.68	0.70
Domestic Firms ^b									
Crops	1.00	1.00	1.00	0.81	0.79	0.84	0.78	0.79	0.85
Livestock	1.00	1.00	1.00	0.98	0.98	0.99	0.98	0.98	0.99
Processed Food	1.00	1.00	1.00	0.88	0.89	0.90	0.89	0.89	0.90
Export Prices ^c									
Crops	0.90	0.93	0.91	0.81	0.83	0.81	0.81	0.83	0.81
Livestock	0.95	0.97	0.96	0.93	0.95	0.93	0.93	0.95	0.94
Processed Food	0.92	0.95	0.93	0.88	0.91	0.88	0.88	0.92	0.89

Table 5. Continued

Variable	No Margins			Fixed Margins			Variable Margins		
	USA	EU	ROW	USA	EU	ROW	USA	EU	ROW
Ratio of Change in Agent's Price to Change in Producer Price									
Import Prices									
Private Household ^d									
Crops	1.00	1.00	1.00	0.44	0.49	0.54	0.44	0.49	0.54
Livestock	1.00	1.00	1.00	0.73	0.77	0.81	0.73	0.77	0.81
Processed Food	1.00	1.00	1.00	0.61	0.66	0.71	0.62	0.67	0.71
Firms ^e									
Crops	1.00	1.00	1.00	0.78	0.78	0.84	0.78	0.78	0.84
Livestock	1.00	1.00	1.00	0.98	0.98	0.99	0.98	0.98	0.99
Processed Food	1.00	1.00	1.00	0.87	0.88	0.89	0.87	0.88	0.89
\$US Millions									
Equivalent Variation	\$2,025	\$4,851	\$18,751	\$1,893	\$4,590	\$18,324	\$2,040	\$4,411	\$18,241

^a Ratio of $ppd(i,r)/pm(i,r)$ for no margins (standard GTAP) model and $pdp(i,r)/pm(i,r)$ for fixed and variable margins models.

^b Ratio of input share weighted average $pdf(i,j,r)/pm(i,r)$ for no margins model and $pdf(i,j,r)/pm(i,r)$ for fixed and variable margins models.

^c Ratio of value of exports weighted average of $pcif(i,r,s)/pm(i,r)$ for all models.

^d Ratio of $pim(i,r)/pm(i,r)$ for all models.

^e Ratio of input share weighted average of $pfm(i,j,r)/pm(i,r)$ for no margins model and $pif(i,j,r)/pm(i,r)$ for fixed and variable margins models.

Table 6. Impacts of Technical Change at Various Levels of US Food Marketing Channel with Fixed Margins

Variable	US Crops ^a			US Processed Food ^b			US Marketing Margin ^c		
	US	EU	ROW	US	EU	ROW	US	EU	ROW
Output (<i>qo</i>)	Percent Change								
Crops	1.65	-0.32	-0.21	0.14	-0.01	0.00	0.14	0.03	0.02
Livestock	0.26	-0.05	0.00	0.55	-0.06	-0.03	0.29	0.01	0.01
Processed Food	0.16	-0.03	0.02	0.60	-0.07	-0.09	0.33	0.01	0.00
Land Factor Prices (<i>pfe</i>)									
Crops	-1.56	-1.36	-0.97	1.08	-0.10	-0.06	0.91	0.11	0.09
Livestock	-1.06	-1.14	-0.79	1.43	-0.14	-0.09	1.04	0.10	0.08
Producer Prices (<i>pm</i>)									
Crops	-2.22	-0.11	-0.22	0.17	-0.01	-0.02	0.13	0.01	0.02
Livestock	-0.66	-0.09	-0.18	-0.07	-0.02	-0.02	0.09	0.01	0.02
Processed Food	-0.28	-0.04	-0.10	-0.99	-0.01	-0.02	0.02	0.00	0.01
Consumer Prices (<i>pp</i>)									
Crops	-0.82	-0.10	-0.16	0.07	-0.01	-0.01	-1.27	0.01	0.02
Livestock	-0.45	-0.07	-0.15	-0.05	-0.01	-0.02	-0.68	0.01	0.02
Processed Food	-0.15	-0.03	-0.08	-0.60	-0.01	-0.03	-1.00	0.00	0.01
Equivalent Variation	\$US Million								
	\$2,484	\$159	\$579	\$4,545	\$70	\$273	\$6,227	\$11	\$56

^a Two percent neutral technical change in US crop sector.

^b Labor augmenting technical change in US processed food that achieves a one percent reduction in cost.

^c Trade service augmenting technical change in US domestic marketing margins on food products (crops, livestock, and processed food) for private consumption. A three percent technical change is assumed for all food products.