August 2009

IIDE
technical report:
200908-03

IIDE institute for international and development economics

TECHNICAL REPORT

This technical report brings together two papers on the linear and non-linear versions of the multi-region trade simulation model known as GSIM.

An Extended Global Simulation Model: Analysis of Tariffs & Anti-Dumping Policy Impacts on Prices, Output, Incomes, and Employment

(Joseph Francois)

Global Simulation Analysis of Industry-Level Trade Policy

(Joseph Francois and Keith Hall)

Joseph Francois (Johannes Kepler University Linz and CEPR)
H. Keith Hall (U.S. Bureau of Labor Statistics)

Disclaimer: this paper does not represent the official views of any institution with which the authors have ever been affiliated.

Contact: Joseph.francois@jku.at

Stichting IIDE, Institute for International & Development Economics
www.i4ide.org

An Extended Global Simulation Model: Analysis of Tariffs & Anti-Dumping Policy Impacts on Prices, Output, Incomes, and Employment

Joseph Francois,
Tinbergen Institute and CEPR

Version 6.0: April 2007

Abstract: In this paper, we outline a modeling strategy for the partial equilibrium analysis of tariff and antidumping policy on a global level. The framework is scalable, employs national product differentiation, and allows for the simultaneous assessment of trade policy changes (duties and undertakings), at the industry level, on a global, regional, or national level. Results allow the assessment of importer and exporter effects related to tariff revenues, exporter (producer) surplus, and importer (consumer) surplus. With additional data, national employment effects can also be fit into the basic framework.

Keywords: antidumping, partial equilibrium model, trade policy modeling, simulation model, global markets

1. INTRODUCTION

In this paper, we outline a global simulation model for the analysis of tariff and antidumping actions. Our goal in developing the model is to provide a relatively transparent, yet flexible framework for detailed analysis of tariff and antidumping policy in combination with the detailed tariff and trade flow data necessary for such analysis. In this sense, we share goals behind the development of the GSIM and SMART models. Where we depart from earlier applications in this area is in (1) taking advantage of available greater computational power, (2) stressing global market clearing conditions rather than import markets, and (3) working with a non-linear (and hence more precise) formulation of the model. By focusing on global markets, we are able to assess value of global market shifts for exporters, in addition to the import market effects stressed by existing tools in this area.

The approach we develop is partial equilibrium, being industry focused but global in scope. By definition, partial equilibrium models do not take into account many of the factors emphasized in our elegant general equilibrium trade theory. This implies practical limitations to the approach developed here. It also implies some useful advantages. Because we focus on a very limited set of factors, the approach followed allows for relatively rapid and transparent analysis of a wide range of commercial policy issues with a minimum of data and computational requirements. In our view, as long as the limitations of the partial equilibrium approach are kept in mind, useful insights can be drawn with regard to relatively complex, multi-country trade policy changes at the industry level. This includes interaction of multiple market access concessions across various trading partners, exporter gains, consumer surplus (importer) gains, and changes in tariff revenue.

The paper is organized as follows. Sections 2 and 3 develop the basic mathematical structure of the simulation model. The discussion is based on AD duties, though the model as implemented can also accommodate price undertakings or other discriminatory measures. The definition of revenue and welfare effects is also discussed. Section discusses calculations of employment effects.

2. BASIC RELATIONSHIPS

The goal here is to develop a model with a spreadsheet interface, precluding the requirement that users know GAMS or a related advanced programming language. At the same time, the framework developed here can of course be extended in such a direction. When modeling trade policy at an industry level, the potential exists for our model to quickly become unmanageable for spreadsheet application. For example, it is well known that the complexity of global general equilibrium models tends to increase geometrically as we add regions and sectors. A similar problem exists even when we focus on an individual sector. For example, if we are modeling trade policy for left-handed horseshoe nails across 100 countries, there are 9,900 potential bilateral trade flows.

To avoid this problem, we reduce the solution set of the model to those global prices that clear global markets. Once we have a global set of equilibrium prices, we can then backsolve for national results. Within this context, we work with a non-linear representation of import demand, combined with generic export-supply equations. This is a significant improvement in the linear approach to this problem (See Francois and Hall 2003, 1997). This reduced-form system, which only includes as many equations as there are exporters, is then solved for the set of world (exporter) prices.

A basic assumption is national product differentiation.[1] As developed here, this means that imports are imperfect substitutes for each other. The elasticity of substitution is held to be equal and constant across products from different sources within a country. The elasticity of demand in aggregate is also constant. These elasticities can, however, be assumed to vary across importing countries. Finally, global supply from each country is also characterized by constant (supply) elasticities. Such an approach is consistent with the Armington (1969) approach to product differentiation at the national level (See Francois and Hall 1997, Roningen 1997), or with the Flam-Helpman (1987) model of firm-level differentiation (where firm-specific capital fixes varieties).

In this section we spell out the basic structure of the model. This includes the development of relevant own- and cross-price elasticities, and the inclusion of these terms in global supply and demand definitions and market clearing conditions.

[1] This can result, in an Ethier-Krugman type model, if product varieties are fixed. It may also be a result of national differences in product characteristics (like French vs. Australian wine).

2.1 CES (Armington) Import Demands

A critical element of the model approach developed here is the underlying assumption of product differentiation that can be indexed by country of origin. Formally, we will specify import demand as follows:

$$M_{(i,v),r} = f(P_{(i,v),r} \ , P_{(i,v),s\neq r} \ , y_{(i,v)}) \tag{1}$$

where $y_{(i,v)}$ is total expenditure on imports of i in country v, $P_{(i,v),r}$ is the internal price for goods from region r within country v, and $P_{(i,v),s\neq r}$ is the price of other varieties. In demand theory, this results from the assumption of weak separability. (To avoid confusion on the part of the reader or the author, Table 1 summarizes notation).

We will assume that equation (1) follows from CES demand for imports. From the first-order conditions for CES demand functions, we then have the following:

$$M_{(i,v),r} = g^{\sigma}_{(i,v),r}\left(\frac{P_{(i,v),r}}{P_v}\right)^{-\sigma} E_v P_v^{-1} \tag{2}$$

where α_i is the CES expenditure weight, E is expenditure, P is the CES composite price, and σ is the composite demand elasticity.

2.2 National Demand and Supply Equations

Having defined demand at the import flow level, we next need to define composite demand for national product varieties. In addition, we will need national supply functions if we are to specify full market clearing.

Defining $P_{i,r}{}^*$ as the export price received by exporter r on world markets, and $P_{(i,v),r}$ as the internal price for the same good, we can link the two prices as follows:

$$P_{(i,v),r} = (1 + t_{(i,v),r})P_{i,r}{}^* = T_{(i,v),r}P_{i,r}{}^* \tag{3}$$

In equation (3), $T = 1 + t$ is the power of the tariff (the proportional price markup achieved by the tariff t.) We will define export supply to world markets as being a function of the world price P^*. [2]

[2] While we do not do so here, it would be straightforward to introduce export subsidies or taxes, in addition to import taxes. These would enter into equations (5) and (7). We could also introduce production subsidies through the same equations.

(4) $$X_{i,r} = ks_{i,r} \left(P_{i,r}^{*}\right)^{es(i,r)}$$

Here, *ks* is a constant term, and *es* is the elasticity of supply. Finally, we also define composite demand in each region as a constant elasticity function of the regional composite price index, P_v. In expenditure form, this yields the following:

(5) $$E_{(i,v)} = ka_{(i,v)} P_v^{NA_v+1}$$

where *NA* is the composite demand elasticity, and *ka* a demand equation constant to be set in calibration.

An important point to make here is that while we center the discussion in the text around production for export, we also include domestic production for domestic consumption within the actual implementation of this framework. In particular, we index home market demand through equation (2), supplied as is other demand for production through equation (3). This means that, when data on domestic production are available, we can include domestic industry effects by modeling home market trade in addition to foreign trade, using a non-nested import and domestic demand structure.

2.3 GLOBAL EQUILIBRIUM CONDITIONS

From the system of equations above, global equilibrium is defined as the sum of all import demands being set to national supply. Combined with national equations for total composite demand (equation 5), which can be substituted into equations defined by (2), and setting the sum of demands equal to supply, we then have a system of equations equal to the number of regions in the model. With this system of equations, we are able to solve for equilibrium price. This is the approach followed in the spreadsheet. Once the price vector has been solved, we are then able to use equation (4) to solve for the impact on domestic production.

3. WELFARE AND REVENUE EFFECTS

In this section we work with the basic solution set of prices to calculate national welfare and revenue effects. Once we solve the system of equations defined above, we can then use equations (4) to backsolve for export quantities, and equations (2) to solve for import quantities. We can also solve for the change in composite prices for consumers based on a CES price index. From there, calculations of revenue effects are also straightforward, as they involve the application of trade values against tariffs. Price and quantity effects can be combined with partial equilibrium measures of the change in producer (i.e. exporter) surplus ΔPS and net consumer (i.e. importer net of tariff revenue changes) surplus $\Delta CS_{i,v}$ as a crude measure of welfare effects. (See Martin 1997).

Conceptually, our measure of producer surplus is shown in Figure 1 as the area of trapezoid *hsnz*, and approximates the change in the area between the export supply curve and the price line. Formally, this is represented by equation (6) below.

$$\begin{aligned}(6)\qquad \Delta PS_{(i,r)} &= R^0{}_{(i,r)} \cdot \hat{P}_{i,r}{}^* + \tfrac{1}{2} \cdot R^0{}_{(i,r)} \cdot \hat{P}_{i,r}{}^* \cdot \hat{X}_{i,r} \\ &= \left(R^0{}_{(i,r)} \cdot \hat{P}_{i,r}{}^*\right) \cdot \left(1 + \frac{E_{X,(i,r)} \cdot \hat{P}_{i,r}{}^*}{2}\right)\end{aligned}$$

In equation (11), $R^0_{(i,r)}$ represents benchmark export revenues valued at world prices (which is identical to calibrated base quantities).

For consumer welfare, we focus on the implicit composite good, assuming an underlying CES aggregator. This composite good therefore takes the functional form

$$(7)\qquad Q_{i,v} = A_v \cdot \left[\sum_{i=1}^{r} \gamma_{(i,v),r} M^{\rho}_{(i,v),r}\right]^{1/\rho}$$

Because we define the price of the composite good to be 1 in the benchmark equilibrium, the proportional change in the price of *Q* (with total quantity then equal to total consumer expenditure) will be:

$$\begin{aligned}(8)\qquad \hat{P} = \frac{dP}{P} &= \sum_{i=1}^{r} \theta_{(i,v),r} \cdot \hat{P}_{(i,v),r} \\ &= \sum_{i=1}^{r} \cdot \theta_{(i,v),r} \cdot \left[\left((1 + \hat{P}^*{}_{i,r}) \frac{T_{1,(i,v),r}}{T_{0,(i,v),r}}\right) - 1\right]\end{aligned}$$

Where the reader is again referred for Table 1 for help on notation.

Equation (8) is an approximation of the CES composite price equation applied in the spreadsheet example and in the actual model. We use this decomposition here to help the reader understand what happens to this price. It helps to see that it builds on the following relationship:

$$(9)\qquad \frac{dP_{(i,v),r}}{P_{(i,v),r}} = \frac{\left(P_{(i,v),r}\right)_1}{\left(P_{(i,v),r}\right)_0} - 1 = \left[\left(\left\{\frac{\left(P^*{}_{i,r}\right)_0 + dP^*{}_{i,r}}{\left(P^*{}_{i,r}\right)_0}\right\} \cdot \frac{T_{1,(i,v),r}}{T_{0,(i,v),r}}\right) - 1\right]$$

The change in consumer surplus is also represented in Figure 1, as the area of trapezoid *abcd*. It is defined as the change in the area between the demand curve for the composite good and the composite good price, as perceived by consumers. This is formalized in equation (10).

(10) $$\Delta CS_{(i,v)} = \left(\sum_r R^0{}_{(i,v),r} \cdot T^0{}_{(i,v),r} \right) \cdot \left(\tfrac{1}{2} E_{M,(i,v)} \hat{P}_{(i,v)}{}^2 \cdot sign(\hat{P}_{(i,v)}) - \hat{P}_{(i,v)} \right)$$
$$where\ \hat{P}_{(i,v)} = \sum_r \theta_{(i,v),r} \hat{P}_r * + \hat{T}_{(i,v),r}$$

In equation (10), consumer surplus is measured with respect to the composite import demand curve, with $P_{(i,v)}$ representing the price for composite imports, and $R^0_{(i,r)} \cdot T^0{}_{(i,v),r}$ representing initial expenditure (and identically quantity since the implicit calibrated base price is 1 for the composite) at internal prices. To make an approximation of welfare changes, we can combine the change in producer surplus, consumer surplus, and import tariff revenues.

4. Employment Effects

We also introduce calculations in the spreadsheet of employment effects. In particular, we estimate the change in employment for the protected industry, and also for downstream industries.

4.1 Employment in protected industries

First, we will assume that output is a function of value added and labor, subject to a Leontief production function defined over the set of intermediate inputs *I* and value added *V*. This means we have the following for a representative firm *j* producing good *x*.

(11) $$X_j = \min\left[VA_j, I_j \right]$$

We will furthermore assume a Cobb-Douglas production function for value-added in equation (11), defined in equation (12) over capital and labor.

(12) $$VA_j = A_j L_j^{\alpha} K_j^{1-\alpha}$$

Over the relevant time frame for dumping investigations (short- to medium-term) we will assume the capital stock is effectively fixed, so that firm *j* adjusts output by adjusting employment of labor and the use of intermediates. This means we can map changes in output to changes in employment as follows:

(13) $$dVA_j = \alpha A_j L_j^{\alpha-1} K_j^{1-\alpha} dL_j$$

Rearranging terms in equation (13), we then have

(14) $$\frac{dVA_j}{VA_j} = \alpha \frac{dL_j}{L_j}$$

From the core model, we have changes in final output. Since we have a Leontief technology between value added and intermediates, proportional changes in total output can be mapped to proportional changes in value-added, and hence also in employment. Denoting proportional changes by ^, we then have equation (15)

(15) $$\hat{L}_j = \alpha^{-1} \hat{x}_j$$

4.2 EMPLOYMENT IN DOWNSTREAM INDUSTRIES

Again, we will assume that output is a function of value added and labor, subject to a Leontief production function defined over a set of intermediate inputs *I* and value added *V*. This means we have equation (16) for a downstream representative firm *d* producing good *y*.

(16) $$y_d = \min\left[VA_d, I_d\right]$$

Over the relevant time frame for dumping investigations (short- to medium-term) we will assume the capital stock is effectively fixed, so that firm *d* adjusts output by adjusting employment of labor and the use of intermediates. This means we can map changes in intermediate demand in the industry to changes in employment as follows in equation (17):

(17) $$dVA_d = \beta A_d L_d^{\beta-1} K_d^{1-\beta} dL_d$$

Rearranging terms in (17), we then have

(18) $$\frac{dVA_d}{VA_d} = \beta \frac{dL_d}{L_d}$$

We assume that elements of I correspond to the Armington composite good Q calculated as part of our core model (see equation 7). From the core model estimate for demand for the composite intermediate Q, combined with our Leontief technologies, we can therefore map changes in composite demand changes downstream to downstream output and hence to changes in downstream employment.

(19) $$\hat{L}_j = \beta^{-1}\hat{Q}_j$$

For both sets of employment effects, we therefore need to map value added and employment data to core model solutions on protected output changes and also changes in total downstream consumption of composite goods.

REFERENCES

Armington, P. (1969), A Theory of Demand for Products Distinguished by Place of Production," *IMF Staff Papers* 16: 159-177.

Devarajan, S., D.S. Go, J.D. Lewis, S. Robinson, and P. Sinko, "Simple General Equilibrium Modeling," in J.F. Francois and K. Reinert, eds., *Applied Methods for Trade Policy Analysis: A Handbook*, Cambridge University Press: Cambridge, 1997.

Flam, H. and E. Helpman (1987), "Industrial Policy under Monopolistic Competition," *Journal of International Economics* 22:79-102.

Francois, J.F. and H.K. Hall, "Partial Equilibrium Modeling," in J.F. Francois and K. Reinert, eds., Applied *Methods for Trade Policy Analysis*: A Handbook, Cambridge University Press: Cambridge, 1997.

Francois, J.F. and H.K. Hall (2003), "Global Simulation Analysis of Industry-Level Trade Policy," World Bank mimeo.

Martin, W., "Measuring Welfare Changes with Distortions," in J.F. Francois and K. Reinert, eds., Applied *Methods for Trade Policy Analysis*: A Handbook, Cambridge University Press: Cambridge, 1997.

Roningen, V.O., "Multi-market, Multi-Region Partial Equilibrium Modeling," in J.F. Francois and K. Reinert, eds., Applied *Methods for Trade Policy Analysis*: A Handbook, Cambridge University Press: Cambridge, 1997.

UNCTAD/World Bank (1989), *A User's Manual for SMART (Software for Market Analysis and Restrictions on Trade Version 2)*, Geneva and Washington, DC.

Figure 1
Producer and Consumer Surplus Measures

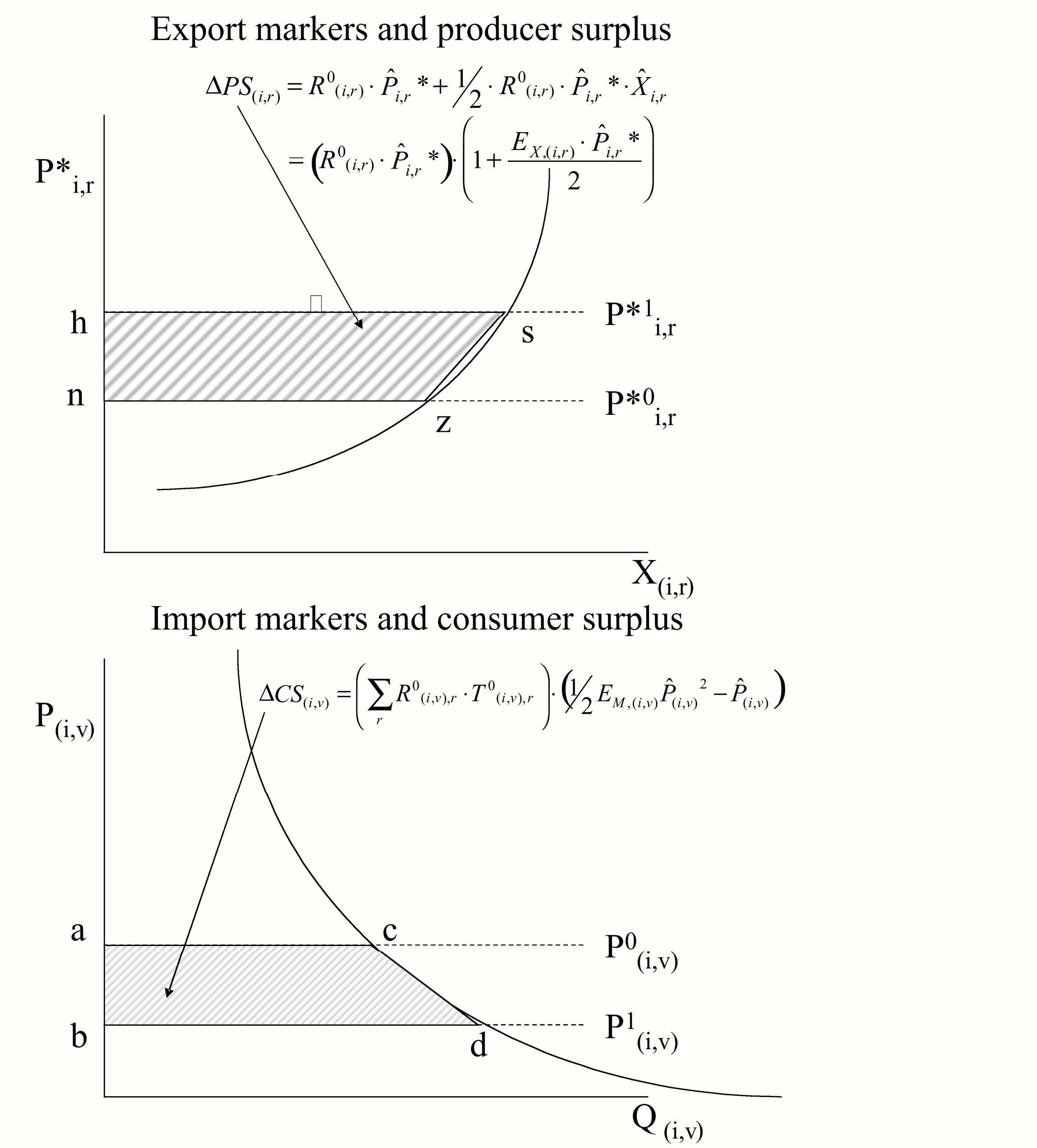


Table 1
Notation

	Indexes
r,s	exporting regions
v,w	importing regions
i	industry designation
	Parameters
$Q_{i,v}$	The composite good in region *v*.
A_V	An efficiency term calibrated so that the price of *Q*, *P*=1.
$\gamma_{(i,v),r}$	The CES expenditure weight term
ρ	The CES exponent term, where the substitution elasticity $E_S = \dfrac{1}{1-\rho}$
β	The labor share in value added in downstream industry
α	The labor share in valued added in the protected industry
	Calibrated coefficients
$N_{(i,v),(r,r)}$	own price demand elasticity
$N_{(i,v),(r,s}$	cross-price elasticity
$T_{(i,v),r}$	The power of the tariff, T=(1+t)
$\theta_{(i,v),r}$	demand expenditure share (at internal prices) $\theta_{(i,v),r} = M_{(i,v),r}T_{(i,v),r} / \sum_s M_{(i,v),s}T_{(i,v),s}$
$\phi_{(i,v),r}$	export quantity shares $\phi_{(i,v),r} = M_{(i,v),r} / \sum_w M_{(i,w),r}$
	Variables
M	imports (quantity)
X	exports (quantity)
P	Composite domestic price
$P^*_{(i,r)}$	World price for exports from region *r*
$P_{(I,r),v}$	Internal prices for goods from region *r* imported into region *v*.
$t_{(i,r),v}$	Import tariffs for goods from region *r* imported into region *v*.
VA	Value added
K	Capital employed in production (protected or downstream, depending on indexing)
L	Labor employed in production (protected or downstream, depending on indexing)

Global Simulation Analysis of Industry-Level Trade Policy

Joseph Francois,
Tinbergen Institute and CEPR

H. Keith Hall,
U.S. Commerce Department

Version 3.0: 21 April 2003

Abstract: In this paper, we outline a modeling strategy for the partial equilibrium analysis of global trade policy changes at the industry level. The framework is scalable, employs national product differentiation, and allows for the simultaneous assessment of trade policy changes, at the industry level, on a global, regional, or national level. Results allow the assessment of importer and exporter effects related to tariff revenues, exporter (producer) surplus, and importer (consumer) surplus. With additional data, domestic production effects can also be fit into the framework.

Keywords: partial equilibrium model, trade policy modeling, simulation model, global markets

1. INTRODUCTION

In trade negotiations, there is a need for capacity within developing countries to assess the impact of tariff changes. This includes not only multilateral liberalization, but also regional and unilateral trade liberalization. In past GATT rounds, this has often involved the World Bank/UNCTAD sponsored SMART model. This is because while CGE models provide estimates of aggregate effects, national policy is made at the tariff line level.

Ultimately, trade ministries need a structured way to combine information on trade flows and trade policy for detailed product categories if they are to weigh the political forces that surround initiatives to liberalize trade.

In this paper, we outline a global simulation model (GSIM) for the analysis of global, regional, and unilateral trade policy changes. Our goal in developing the model is to provide a relatively simple, yet flexible framework for detailed analysis of trade policy in combination with the detailed tariff and trade flow data found in datasets like TRAINS and WITS. In this sense, we share goals with the developers of the GSIM predecessor, SMART. Where we depart from earlier applications in this area is in taking advantage of available greater computational power, and in stressing global market clearing conditions rather than import markets. By focusing on global markets, we hope to facilitate the analysis of the value of collective market access concessions for exporters, in addition to the import market effects stressed by existing tools in this area.

The approach we develop is partial equilibrium, being industry focused but global in scope. By definition, partial equilibrium models do not take into account many of the factors emphasized in our elegant general equilibrium trade theory. This implies practical limitations to the approach developed here. It also implies some useful advantages. Because we focus on a very limited set of factors, the approach followed allows for relatively rapid and transparent analysis of a wide range of commercial policy issues with a minimum of data and computational requirements. In our view, as long as the limitations of the partial equilibrium approach are kept in mind, useful insights can be drawn with regard to relatively complex, multi-country trade policy changes at the industry level. This includes interaction of multiple market access concessions across various trading partners, exporter gains, consumer surplus (importer) gains, and changes in tariff revenue.

The paper is organized as follows. Sections 2 and 3 develops the mathematical structure of the simulation model. This includes calibration of relevant own- and cross-price elasticities, as well as global market clearing conditions. The definition of revenue and welfare effects is also discussed. Section 4 is focused on mapping GSIM relationships to the SMART concepts of trade creation and diversion. Section 5 then discusses a simple 4 region implementation of the model in Excel. This serves to illustrate calculation of producer and consumer surplus changes, tariff revenue changes, and the overall strategy for solving the model. Section 6 discusses a stand-alone version of the model, with additional functionality but requiring subsidy and domestic production data. Two Excel files, GSIM4x4.XLS and GSIM25x25.XLS, are meant to be distributed with this paper.

2. BASIC RELATIONSHIPS

When modeling trade policy at an industry level, the potential exists for out model to quickly become unmanageable. For example, it is well known that the complexity of global general equilibrium models tends to increase geometrically as we add regions and sectors. A similar problem exists even when we focus on an individual sector. For example, if we are modeling trade policy for left-handed horseshoe nails across 100 countries, there are 9,900 potential bilateral trade flows.

To avoid this problem, we reduce the solution set of the model to those global prices that clear global markets. Once we have a global set of equilibrium prices, we can then backsolve for national results. Within this context, we work with a log-linearized (percent-change) representation of import demand, combined with generic export-supply equations. (See Francois and Hall 1997). This reduced-form system, which only includes as many equations as there are exporters, is then solved for the set of world (exporter) prices.

A basic assumption is national product differentiation.[1] As developed here, this means that imports are imperfect substitutes for each other. The elasticity of substitution is held to be equal and constant across products from different sources. The elasticity of demand in aggregate is also constant. Finally, import supply is also characterized by constant (supply) elasticities. Such an approach is consistent with the Armington (1969) approach to product differentiation at the national level (See Francois and Hall 1997, Roningen 1997), or with the Flam-Helpman (1987) model of firm-level differentiation (where firm-specific capital fixes varieties).

In this section we spell out the basic structure of the model. This includes the development of relevant own- and cross-price elasticities, and the inclusion of these terms in global supply and demand definitions and market clearing conditions.

2.1 Elasticities

A critical element of the model approach developed here is the underlying own- and cross-price demand elasticities. To arrive at these values, we start by assuming that, within each importing country *v*, import demand within product category *i* of goods from country *r* is a function of industry prices and total expenditure on the category:

---

[1] This can result, in an Ethier-Krugman type model, if product varieties are fixed. It may also be a result of national differences in product characteristics (like French vs. Australian wine).

Table 1
Notation

	Indexes
r,s	exporting regions
v,w	importing regions
i	industry designation
	Parameters
$Q_{i,v}$	The composite good in region v.
A_V	An efficiency term calibrated so that the price of Q, P=1.
$\gamma_{(i,v),r}$	The CES expenditure weight term
ρ	The CES exponent term, where the substitution elasticity $E_S = \dfrac{1}{1-\rho}$
E_s	elasticity of substitution
$E_{m,(i,v)}$	aggregate import demand elasticity Defined for aggregate imports $M_{(i,v)}$ and composite price $P_{(i,v)}$ $= \dfrac{\partial M_{(i,v)}}{\partial P_{(i,v)}} \cdot \dfrac{P_{(i,v)}}{M_{(i,v)}}$
$E_{x,(i,r)}$	elasticity of export supply $= \dfrac{\partial X_{(i,r)}}{\partial P_{(i,r)}*} \dfrac{P_{(i,r)}*}{X_{(i,r)}}$
	Calibrated coefficients
$N_{(i,v),(r,r)}$	own price demand elasticity
$N_{(i,v),(r,s}$	cross-price elasticity
$T_{(i,v),r}$	The power of the tariff, T=(1+t)
$\theta_{(i,v),r}$	demand expenditure share (at internal prices) $\theta_{(i,v),r} = M_{(i,v),r} T_{(i,v),r} / \sum_s M_{(i,v),s} T_{(i,v),s}$
$\phi_{(i,v),r}$	export quantity shares $\phi_{(i,v),r} = M_{(i,v),r} / \sum_w M_{(i,w),r}$
	Variables
M	imports (quantity)
X	exports (quantity)
P	Composite domestic price
$P*_{(i,r)}$	World price for exports from region r
$P_{(I,r),v}$	Internal prices for goods from region r imported into region v.
$t_{(i,r),v}$	Import tariffs for goods from region r imported into region v.

(1) $$M_{(i,v),r} = f(P_{(i,v),r}\ ,P_{(i,v),s\neq r}\ ,y_{(i,v)})$$

where $y_{(i,v)}$ is total expenditure on imports of *i* in country *v*, $P_{(i,v),r}$ is the internal price for goods from region *r* within country *v*, and $P_{(i,v),s\neq r}$ is the price of other varieties. In demand theory, this results from the assumption of weakly separability. (To avoid confusion on the part of the reader or the authors, Table 1 summarizes our notation).

By differentiating equation (1), applying the Slutsky decomposition of partial demand, and taking advantage of the zero homogeneity property of Hicksian demand, we can then derive the following (See Francois and Hall 1997):

(2) $$N_{(i,v),(r,s)} = \theta_{(i,v),s}(E_m + E_s)$$

(3) $$N_{(i,v),(r,r)} = \theta_{(i,v),r}E_m - \sum_{s\neq r}\theta_{(i,v),s}E_s = \theta_{(i,v),r}E_m - (1-\theta_{(i,v),r})E_s$$

where $\theta_{(i,v),s}$ is and expenditure share, and $E_{M,v}$ is the composite demand elasticity in importing region *v*.

2.2 National Demand and Supply Equations

Having defined own-price and cross-price elasticities, we next need to define demand for national product varieties. In addition, we will need national supply functions if we are to specify full market clearing.

Defining $P_{i,r}*$ as the export price received by exporter *r* on world markets, and $P_{(i,v),r}$ as the internal price for the same good, we can link the two prices as follows:

(4) $$P_{(i,v),r} = (1+t_{(i,v),r})P_{i,r}* = T_{(i,v),r}P_{i,r}*$$

In equation (4), $T = 1 + t$ is the power of the tariff (the proportional price markup achieved by the tariff *t*.) We will define export supply to world markets as being a function of the world price *P**. [2]

(5) $$X_{i,r} = f(P_{i,r}*)$$

Differentiating equations (1), (4) and (5) and manipulating the results, we can derive the following:

(6) $$\hat{P}_{(i,v),r} = \hat{P}_{i,r}* + \hat{T}_{(i,v),r}$$

(7) $$\hat{X}_{i,r} = E_{X(i,r)}\hat{P}_{i,r}*$$

(8) $$\hat{M}_{(i,v),r} = N_{(i,v),(r,r)}\hat{P}_{(i,v),r} + \sum_{s \neq r} N_{(i,v),(r,s)}\hat{P}_{(i,v),s}$$

where ^ denotes a proportional change, so that $\hat{x} = \frac{dx}{x}$.

An important point to make here is that while we center the discussion in the text around production for export, one can also include domestic production for domestic consumption within our framework. In particular, we can index home market demand through equation (11), supplied as is other demand for production through equation (10). This means that, when data on domestic production are available, we can include domestic industry effects by modeling home market trade in addition to foreign trade, using a non-nested import and domestic demand structure.

[2] While we do not do so here, it would be straightforward to introduce export subsidies or taxes, in addition to import taxes. These would enter into equations (5) and (7). We could also introduce production subsidies through the same equations.

2.3 GLOBAL EQUILIBRIUM CONDITIONS

From the system of equations above, we need to make further substitutions to arrive at a workable model defined in terms of world prices. In particular we can substitute equations (6), (2), and (3) into (8), and sum over import markets. This yields equation (9).

$$
\begin{aligned}
(9)\qquad \hat{M}_{i,r} &= \sum_{v} \hat{M}_{(i,v),r} = \sum_{v} N_{(i,v),(r,r)} \hat{P}_{(i,v),r} + \sum_{v} \sum_{s \neq r} N_{(i,v),(r,s)} \hat{P}_{(i,v),s} \\
&= \sum_{v} N_{(i,v),(r,r)} [P_r * + \hat{T}_{(i,v),r}] + \sum_{v} \sum_{s \neq r} N_{(i,v),(r,s)} [\hat{P}_s * + \hat{T}_{(i,v),s}]
\end{aligned}
$$

We can then set equation (9) equal to the modified version of equation (7). This yields our global market clearing condition for each export variety.

$$
\begin{aligned}
(10)\qquad & \hat{M}_{i,r} = \hat{X}_{i,r} \Rightarrow \\
& E_{X(i,r)} \hat{P}_{i,r} * = \sum_{v} N_{(i,v),(r,r)} \hat{P}_{(i,v),r} + \sum_{v} \sum_{s \neq r} N_{(i,v),(r,s)} \hat{P}_{(i,v),s} \\
& \qquad = \sum_{v} N_{(i,v),(r,r)} [P_r * + \hat{T}_{(i,v),r}] + \sum_{v} \sum_{s \neq r} N_{(i,v),(r,s)} [\hat{P}_s * + \hat{T}_{(i,v),s}]
\end{aligned}
$$

Equation (10) is the core equation for the system implemented in the spreadsheet example in Section 4. For any set of *R* trading countries, we can use equation (10) to define $S \leq R$ global market clearing conditions (where we have *R* exporters). If we also model domestic production, we will have exactly $R=S$ market clearing conditions.

3. WELFARE AND REVENUE EFFECTS

In this section we work with the basic solution set of prices to calculate national welfare and revenue effects. Once we solve the system of equations defined by

(13) for world prices, as we do in our spreadsheet example, we can then use equations (7) to backsolve for export quantities, and equations (9) to solve for import quantities. We can also solve for the change in composite prices for consumers. From there, calculations of revenue effects are also straightforward, and they involve the application of trade values against tariffs. Price and quantity effects can be combined with partial equilibrium measures of the change in producer (i.e. exporter) surplus ΔPS and net consumer (i.e. importer net of tariff revenue changes) surplus $\Delta CS_{i,v}$ as a crude measure of welfare effects. (See Martin 1997).

Conceptually, our measure of producer surplus is shown in Figure 1 as the area of trapezoid *hsnz*, and approximates the change in the area between the export supply curve and the price line. Formally, this is represented by equation (11) below.

$$
\begin{aligned}
\Delta PS_{(i,r)} &= R^0{}_{(i,r)} \cdot \hat{P}_{i,r}* + \tfrac{1}{2} \cdot R^0{}_{(i,r)} \cdot \hat{P}_{i,r}* \cdot \hat{X}_{i,r} \\
&= \left(R^0{}_{(i,r)} \cdot \hat{P}_{i,r}*\right) \cdot \left(1 + \frac{E_{X,(i,r)} \cdot \hat{P}_{i,r}*}{2}\right)
\end{aligned}
\tag{11}
$$

In equation (11), $R^0_{(i,r)}$ represents benchmark export revenues valued at world prices (which is identical to calibrated base quantities).

For consumer welfare, we focus on the implicit composite good, assuming an underlying CES aggregator. This composite good therefore takes the functional form

$$
Q_{i,v} = A_v \cdot \left[\sum_{i=1}^{r} \gamma_{(i,v),r} M^{\rho}_{(i,v),r}\right]^{1/\rho} \tag{12}
$$

Because we define the price of the composite good to be 1 in the benchmark equilibrium, the proportional change in the price of *Q* (with total quantity then equal to total consumer expenditure) will be:

$$
\hat{P} = \frac{dP}{P} = \sum_{i=1}^{r} \theta_{(i,v),r} \cdot \hat{P}_{(i,v),r} = \sum_{i=1}^{r} \cdot \theta_{(i,v),r} \cdot \left[\left((1 + \hat{P}*_{i,r}) \frac{T_{1,(i,v),r}}{T_{0,(i,v),r}}\right)\right. \tag{13}
$$

Where the reader is again referred for Table 1 for help on notation.

Equation (13) is the composite price equation applied in the spreadsheet example and in the actual model. It builds on the following relationship:

$$(14) \qquad \frac{dP_{(i,v),r}}{P_{(i,v),r}} = \frac{\left(P_{(i,v),r}\right)_1}{\left(P_{(i,v),r}\right)_0} - 1 = \left[\left(\left\{\frac{\left(P^*_{i,r}\right)_0 + dP^*_{i,r}}{\left(P^*_{i,r}\right)_0}\right\} \cdot \frac{T_{1,(i,v),r}}{T_{0,(i,v),r}}\right) - 1\right]$$

The change in consumer surplus is also represented in Figure 1, as the area of trapezoid *abcd*. It is defined as the change in the area between the demand curve for the composite good and the composite good price, as perceived by consumers. This is formalized in equation (15).

$$(15) \qquad \Delta CS_{(i,v)} = \left(\sum_r R^0{}_{(i,v),r} \cdot T^0{}_{(i,v),r}\right) \cdot \left(\tfrac{1}{2} E_{M,(i,v)} \hat{P}_{(i,v)}{}^2 \cdot sign(\hat{P}_{(i,v)}) - \hat{P}_{(i,v)}\right)$$

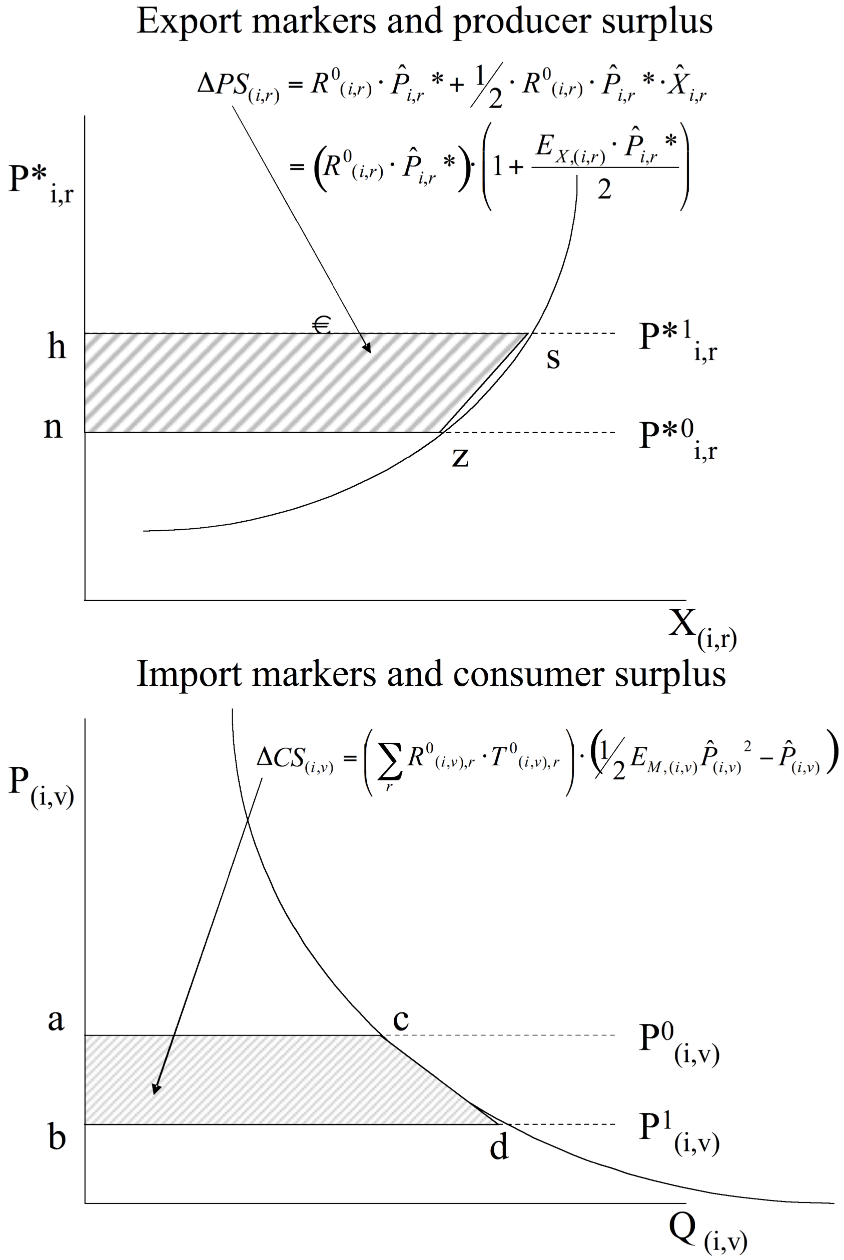
$$where\ \hat{P}_{(i,v)} = \sum_r \theta_{(i,v),r} \hat{P}_r{}^* + \hat{T}_{(i,v),r}$$

In equation (15), consumer surplus is measured with respect to the composite import demand curve, with $P_{(i,v)}$ representing the price for composite imports, and $R^0_{(i,r)} \cdot T^0{}_{(i,v),r}$ representing initial expenditure (and identically quantity since the implicit calibrated base price is 1 for the composite) at internal prices. To make an approximation of welfare changes, we can combine the change in producer surplus, consumer surplus, and import tariff revenues.

4. OWN- and CROSS- TRADE EFFECTS

The SMART model employed measures called trade creation and trade diversion to quantify the effects of trade liberalization. Here, we briefly discuss the comparable measures. It turns out that, in the case of a single, small country, these are identical to the SMART equations for these values. Because these are

Figure 1
Producer and Consumer Surplus Measures



not actually the Vinerian trade creation and diversion measures, we instead will call them own- and cross-trade effects.

Within the system developed above, assume that world prices are fixed, so that price changes are simply driven by tariff changes. In this case, for a single country we have:

(16)
$$\begin{aligned}\hat{M}_{(i,v),r} &= N_{(i,v),(r,r)}\hat{P}_{(i,v),r} + \sum_{s\neq r} N_{(i,v),(r,s)}\hat{P}_{(i,v),s} \\ &= N_{(i,v),(r,r)}\hat{T}_{(i,v),r} + \sum_{s\neq r} N_{(i,v),(r,s)}\hat{T}_{(i,v),s}\end{aligned}$$

Where we can further decompose equation (16) into an own-price and cross-price trade effect:

(17) Own-Trade Effect:

$$TC_{(i,v),r} = M_{(i,v),r} \times [N_{(i,v),(r,r)}\hat{T}_{(i,v),r}]$$

(18) Cross-Trade Effect:

$$TD_{(i,v),r} = M_{(i,v),r} \times \sum_{s\neq r} N_{(i,v),(r,s)}\hat{T}_{(i,v),s}$$

In equations (17) and (18), we have defined own-price (or "trade creation" in SMART) as trade generated by direct tariff reductions for the product concerned, and cross-price (or "trade diversion" in SMART) as trade changes generated by changes in tariffs on imports from third countries. These are really just a special case of the cross-price and own-price effects that make up import demand in equation (9) and equation (10).

5. IMPLEMENTATION – AN EXAMPLE

A 4x4 sample implementation of the model developed above is available as an Excel file. The data input section is illustrated in Figure 2, which highlights the basic data requirements. These include trade flows (valued at a common set of world prices), trade policy wedges, and relevant demand, supply, and substitution elasticities. The same types of data (with greater matrix dimensionality) are also required for larger applications. Note that while elasticities are symmetric for the present example, this is not necessary. On the basis of input data, other key parameters (as defined in equations (2) and (3) above) are calculated for cross-price and own-price effects. These are shown in Figure 3.

The Excel solver is then used to solve the excess demand conditions specified in equation (10) above for equilibrium prices in the counterfactual. This involves specifying one of the *R* excess demand functions for exports as the objective function, with the other excess demand functions then specified as constraints. The same approach can be specified for versions of the model with higher dimensionality. Such an extension is covered in Section 6. (For more on the use of the Excel solver for solving computational models, see Francois and Hall 1997, and Devarajan et al 1997). The core solution values, involving prices and excess demands, are shown in Figure 4.

On the basis of equilibrium price values, other changes in the system can be calculated as well. These include, of course, producer and consumer surplus measures (equations 14 and 15), changes in tariff revenues, trade quantities, and trade values. These are illustrated in Figures 5 and 6. The spreadsheets can be used to explore the actual calculation of values.

The experiment results, while based on synthetic data, still illustrate the types of effects captured in the model. We have modeled an experiment where two regions, the United States and European Union, introduce reciprocal tariff cuts (as might happen from a free trade agreement).

What are the effects of this tariff reduction? As we might expect, there is an increase in import demand on the parts of the EU and US, yielding an increase in prices for both exporters (7.83 percent for the U.S., and 4.55percent for the EU). This in turn translates into gains in producer surplus: 45.6 for the U.S. and 37.7 for EU producers. For producers outside the region, the opposite happens. The preferential liberalization erodes demand for third country exports, and their prices fall. The results is a loss in producer surplus: -25.5 for Japan and -4.8 for the ROW.

On the consumer side, composite prices fall by roughly 9 percent for US and 8 percent for EU consumers. The net effects, involving the combination of producer surplus, consumer surplus, and tariff revenue changes, is also summarized in the spreadsheet. (See Figure 6). The net effect involves gains for the EU and U.S., and losses for Japan and ROW. In the case of both Japan and ROW, producer losses correspond to a terms-of-trade deterioration.

6. AN EXPANDED STAND-ALONE VERSION

The 4x4 version implemented above is designed to work given the limited data environment (in terms of domestic production data) in which large-scale detailed tariff analysis is often undertaken. This 4x4 example is implemented in WITS. There is also a stand-alone version of the model, designed to accommodate a mode detailed set of policy and production data. This is the GSIM25x25.XLS spreadsheet implementation.

The GSIM25x25 model has the following addition features (not implemented in WITS itself, however).

_ Domestic production can be included, where data are available.

_ Domestic production subsidies can be included, where data are available.

_ Bilateral export subsidies can be included, where data are available.

_ Up to 25 countries/regional partners can be specified.

This additional functionality makes necessary the following changes to the basic theory:

(19) $$\hat{X}_{i,r} = E_{X(i,r)}\left(\hat{P}_{i,r}* + \hat{G}_{i,r}\right)$$

(20) $$\hat{P}_{(i,v),r} = \left(1+\hat{P}_{i,r}*\right)\cdot\left(\left(T_{(i,v),r}\right)_1 / \left(T_{(i,v),r}\right)_0\right)\cdot\left(\left(S_{(i,v),r}\right)_0 / \left(S_{(i,v),r}\right)_1\right) - 1$$

where

$\left(S_{(i,v),r}\right)_j$	The subsidy paid for export of product *i* from region *r* to region *v* in time period *j*=0,1 and where *S=1+s* and *s* is the ad valorem subsidy rate (as a share of world price), so that an exporter receives a subsidy of *s* for each unit of revenue earned directly by exports.
$G_{i,r}$	A production subsidy in region *r*.

While the model is still solved for world prices, produced and consumer prices will vary from world prices by the combined effects of import tariffs, production subsidies, and export subsidies. In addition, while tariff revenue is netted against consumer surplus to obtain net consumption benefits, producer and export subsidies must also be netted against producer surplus to obtain production benefits.

The GSIM25x25 implementation also allows for own-trade (i.e. domestic absorption), such that the import demand elasticity is replaced by the aggregate demand elasticity (see Francois and Hall 1997). All the remaining algebra goes through as specified, with the modified assumption that the CES aggregation function in equation (12) is now an explicit non-nested CES aggregator defined over imports and the domestic good. [3]

Because of the differences outlined above, the GSIM25x25 spreadsheet involves a greater set of data requirements. These are outlined in steps on the spreadsheet itself, as shown in Figure 7. The reported results are somewhat different as well, including differences in consumer, market, and producer prices, as well as changes in domestic production and the contribution of change sin subsidy payments to total welfare. This is illustrated in Figure 8.

[3] (Note that the 25x25 implementation uses a slightly different approximation for equation (6), using the internal price change reported in equation (12), so that there may be slight differences in approximate results under the two spreadsheets.)

REFERENCES

Armington, P. (1969), A Theory of Demand for Products Distinguished by Place of Production," *IMF Staff Papers* 16: 159-177.

Devarajan, S., D.S. Go, J.D. Lewis, S. Robinson, and P. Sinko, "Simple General Equilibrium Modeling," in J.F. Francois and K. Reinert, eds., *Applied Methods for Trade Policy Analysis: A Handbook*, Cambridge University Press: Cambridge, 1997.

Flam, H. and E. Helpman (1987), "Industrial Policy under Monopolistic Competition," *Journal of International Economics* 22:79-102.

Francois, J.F. and H.K. Hall, "Partial Equilibrium Modeling," in J.F. Francois and K. Reinert, eds., Applied *Methods for Trade Policy Analysis*: A Handbook, Cambridge University Press: Cambridge, 1997.

Martin, W., "Measuring Welfare Changes with Distortions," in J.F. Francois and K. Reinert, eds., Applied *Methods for Trade Policy Analysis*: A Handbook, Cambridge University Press: Cambridge, 1997.

Roningen, V.O., "Multi-market, Multi-Region Partial Equilibrium Modeling," in J.F. Francois and K. Reinert, eds., Applied *Methods for Trade Policy Analysis*: A Handbook, Cambridge University Press: Cambridge, 1997.

UNCTAD/World Bank (1989), *A User's Manual for SMART (Software for Market Analysis and Restrictions on Trade Version 2)*, Geneva and Washington, DC.

Figure 2
Excel 4x4 implementation of GSIM -- model inputs

INPUTS

trade at world prices:

origin		destination USA	JAPAN	EU	ROW	Totals
	USA	0	50	200	300	550
	JAPAN	500	0	150	200	850
	EU	300	100	200	200	800
	ROW	50	100	110	20	280
	Totals	850	250	660	720	

initial import tariffs

origin		destination USA	JAPAN	EU	ROW
	USA	1	1.21	1.41	1.22
	JAPAN	1.37	1	1.31	1.23
	EU	1.32	1.36	1	1.18
	ROW	1.57	1.41	1.25	1.15

final import tariffs

origin		destination USA	JAPAN	EU	ROW
	USA	1	1.21	1	1.22
	JAPAN	1.37	1	1.31	1.23
	EU	1	1.36	1	1.18
	ROW	1.57	1.41	1.25	1.15

Elasticities:

		USA	JAPAN	EU	ROW
Em	Import Demand	-1.25	-1.25	-1.25	-1.25
Ex	Export Supply	1.5	1.5	1.5	1.5
Es	Substitution	5	5	5	5

Figure 3
Excel 4x4 implementation of GSIM -- Calibrated values

Calibrated values

Notation definitions

θ Import shares at internal prices

		destination			
		USA	JAPAN	EU	ROW
origin	USA	0.00000	0.17926	0.34559	0.42021
	JAPAN	0.59077	0.00000	0.24081	0.28243
	EU	0.34153	0.40296	0.24510	0.27095
	ROW	0.06770	0.41778	0.16850	0.02641
	SUM	1	1	1	1

Notation definitions

φ Export shares at world prices

		destination				
		USA	JAPAN	EU	ROW	SUM
origin	USA	0.0000	0.0909	0.3636	0.5455	1
	JAPAN	0.5882	0.0000	0.1765	0.2353	1
	EU	0.3750	0.1250	0.2500	0.2500	1
	ROW	0.1786	0.3571	0.3929	0.0714	1

Equation (3)

N(i,v),(r,r) Own price elasticities

		destination			
		USA	JAPAN	EU	ROW
origin	USA	-5.0000	-4.3278	-3.7040	-3.4242
	JAPAN	-2.7846	-5.0000	-4.0970	-3.9409
	EU	-3.7193	-3.4889	-4.0809	-3.9839
	ROW	-4.7461	-3.4333	-4.3681	-4.9010

Equation (2)

N(i,v),(r,s) Cross price elasticities

		destination			
		USA	JAPAN	EU	ROW
origin	USA	0.0000	0.6722	1.2960	1.5758
	JAPAN	2.2154	0.0000	0.9030	1.0591
	EU	1.2807	1.5111	0.9191	1.0161
	ROW	0.2539	1.5667	0.6319	0.0990

Figure 4
Excel 4x4 implementation of GSIM – Core solution values

MODEL SOLUTIONS

MARKET CLEARING CONDITIONS
Relative price changes

Equation (10)

		benchmark prices	new prices	change in supply	change in demand	Excess Demand
origin	USA	0.0000	0.0792	0.1188	0.1188	0.0000
	JAPAN	0.0000	-0.0316	-0.0474	-0.0474	0.0000
	EU	0.0000	0.0480	0.0721	0.0721	0.0000
	ROW	0.0000	-0.0184	-0.0276	-0.0276	0.0000

Figure 5
Excel 4x4 implementation of GSIM – Trade Effects

Trade at world prices: change in values

		destination				Export
		USA	JAPAN	EU	ROW	Total
origin	USA	0.0	-12.2	185.9	-59.7	114.0
	JAPAN	-96.0	0.0	-21.0	51.1	-65.9
	EU	218.2	-10.2	-97.4	-11.8	98.9
	ROW	-12.3	16.7	-21.3	4.2	-12.7
	Import Total	110.0	-5.7	46.2	-16.2	

EXPORT CHANGES (world prices)

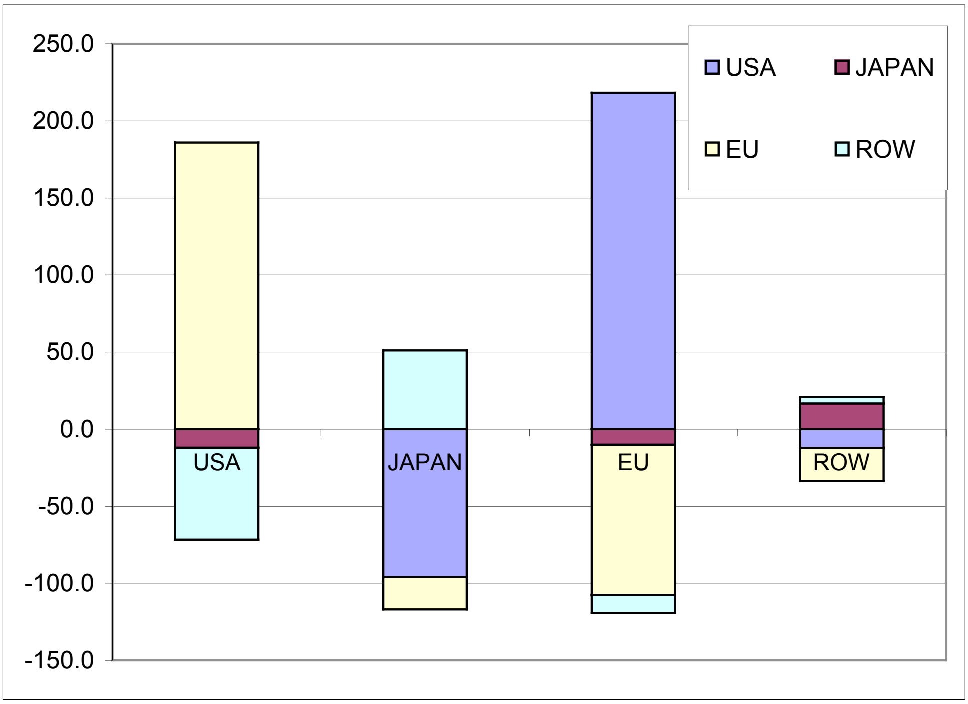


Figure 6
Excel 4x4 implementation of GSIM – Welfare Effects

Total welfare effects

		A	B	C	D=A+B
		Producer surplus	Consumer surplus	Tariff revenue	Net welfare effect
country	USA	46.1	110.6	-138.5	18.2
	JAPAN	-26.2	-8.9	0.6	-34.5
	EU	39.8	68.6	-93.8	14.5
	ROW	-5.1	-32.9	-2.9	-40.8

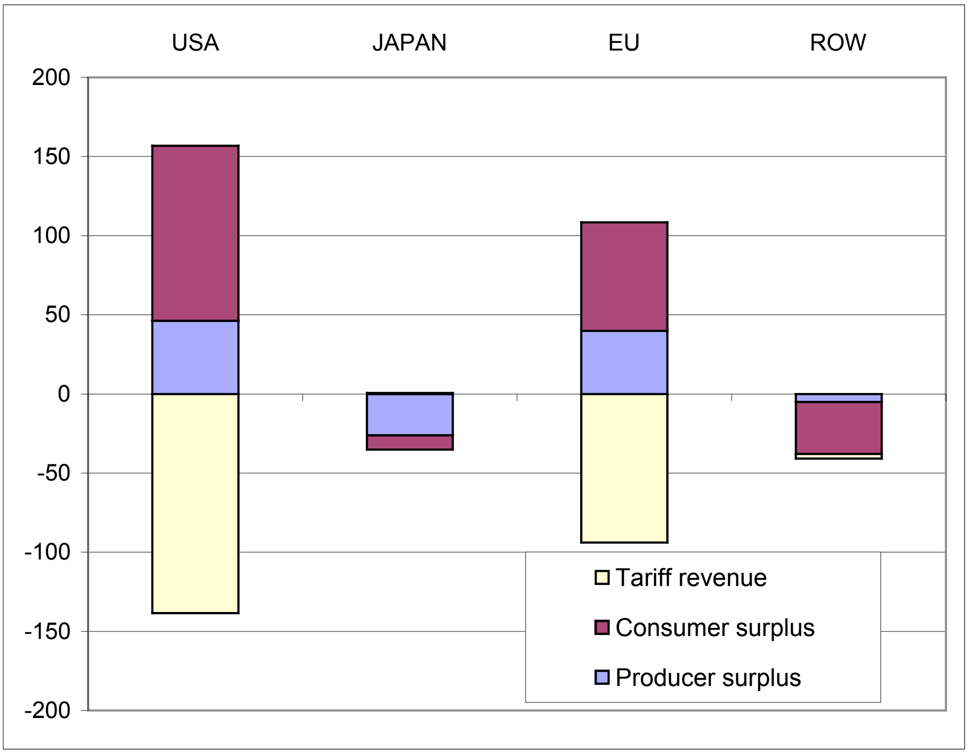


Figure 7
The GSIM25x25 Spreadsheet

INPUTS

STEP 1
Enter Region Names

	name
Region1	USA
Region2	JAPAN
Region3	EU
Region4	ROW
Region5	Reg5
Region6	Reg6
Region7	Reg7
Region8	Reg8
Region9	Reg9
Region10	Reg10
Region11	Reg11
Region12	Reg12
Region13	Reg13
Region14	Reg14
Region15	Reg15
Region16	Reg16
Region17	Reg17
Region18	Reg18
Region19	Reg19
Region20	Reg20
Region21	Reg21
Region22	Reg22
Region23	Reg23
Region24	Reg24
Region25	Reg25

note: For less than 25 regions, leave the rest of the labels and table values empty.

STEP 2

Load the initial bilateral trade matrix, at world prices.

note: Domestic absorption is included as trade with self.

Step 3
Load the initial matrix of bilateral import tariffs in ad valorem form.

note: tariffs are entered as T=1+t, where t is the rate of the tariff markup relative to world price.

trade at world prices:

origin \ destination	USA	JAPAN	EU	ROW	Reg5
USA	750	50	200	300	0
JAPAN	500	0	150	200	0
EU	300	100	200	200	0
ROW	50	100	110	20	0
Reg5	0	0	0	0	0
Reg6	0	0	0	0	0
Reg7	0	0	0	0	0
Reg8	0	0	0	0	0
Reg9	0	0	0	0	0
Reg10	0	0	0	0	0
Reg11	0	0	0	0	0
Reg12	0	0	0	0	0
Reg13	0	0	0	0	0
Reg14	0	0	0	0	0
Reg15	0	0	0	0	0
Reg16	0	0	0	0	0
Reg17	0	0	0	0	0
Reg18	0	0	0	0	0
Reg19	0	0	0	0	0
Reg20	0	0	0	0	0
Reg21	0	0	0	0	0
Reg22	0	0	0	0	0
Reg23	0	0	0	0	0
Reg24	0	0	0	0	0
Reg25	0	0	0	0	0
Totals	1600	250	660	720	0

initial bilateral import tariffs

origin \ destination	USA	JAPAN	EU	ROW	Reg5
USA	1	1.21	1.41	1.22	1
JAPAN	1.37	1	1.31	1.23	1
EU	1.32	1.36	1	1.18	1
ROW	1.57	1.41	1.25	1.15	1
Reg5	1	1	1	1	1
Reg6	1	1	1	1	1
Reg7	1	1	1	1	1

Figure 8
GSIM25x25 Results

Step 11

View Summary Results

Summary of Effects

	welfare					other			
	Producer surplus	Consumer surplus	Tariff revenue	Change in subsidy payments	Net welfare effect	Change in Overall Consumer Prices	Change in Output	Producer Price for Home Good	Market Price for Home Good
	A	B	C	D	E= A+B=C+D	percent	percent	percent	percent
USA	-331.2	-81.7	-54.3	708.3	241.1	4.17%	-51.5%	-34.31%	-1.46%
JAPAN	62.7	-60.2	0.5	0.0	3.0	16.20%	10.5%	7.01%	7.01%
EU	75.1	-204.4	-87.9	0.0	-217.1	22.02%	13.2%	8.81%	8.81%
ROW	29.4	-248.5	-40.6	0.0	-259.7	24.71%	14.7%	9.78%	9.78%
Reg5	0.0	0.0	0.0	0.0	0.0	0.00%	0.0%	0.00%	0.00%
Reg6	0.0	0.0	0.0	0.0	0.0	0.00%	0.0%	0.00%	0.00%
Reg7	50.2	111.5	-140.6	0.0	21.1	-9.10%	12.9%	8.57%	8.57%
Reg8	-27.8	-9.3	0.7	0.0	-36.4	2.72%	-5.0%	-3.35%	-3.35%
Reg9	41.6	67.3	-95.1	0.0	13.8	-7.86%	7.5%	5.01%	5.01%
Reg10	-5.5	-35.3	-3.3	0.0	-44.1	3.96%	-3.0%	-2.00%	-2.00%
Reg11	0.0	0.0	0.0	0.0	0.0	0.00%	0.0%	0.00%	0.00%
Reg12	0.0	0.0	0.0	0.0	0.0	0.00%	0.0%	0.00%	0.00%
Reg13	0.0	0.0	0.0	0.0	0.0	0.00%	0.0%	0.00%	0.00%
Reg14	0.0	0.0	0.0	0.0	0.0	0.00%	0.0%	0.00%	0.00%
Reg15	0.0	0.0	0.0	0.0	0.0	0.00%	0.0%	0.00%	0.00%
Reg16	0.0	0.0	0.0	0.0	0.0	0.00%	0.0%	0.00%	0.00%
Reg17	0.0	0.0	0.0	0.0	0.0	0.00%	0.0%	0.00%	0.00%
Reg18	0.0	0.0	0.0	0.0	0.0	0.00%	0.0%	0.00%	0.00%
Reg19	0.0	0.0	0.0	0.0	0.0	0.00%	0.0%	0.00%	0.00%
Reg20	0.0	0.0	0.0	0.0	0.0	0.00%	0.0%	0.00%	0.00%
Reg21	0.0	0.0	0.0	0.0	0.0	0.00%	0.0%	0.00%	0.00%
Reg22	0.0	0.0	0.0	0.0	0.0	0.00%	0.0%	0.00%	0.00%
Reg23	0.0	0.0	0.0	0.0	0.0	0.00%	0.0%	0.00%	0.00%
Reg24	0.0	0.0	0.0	0.0	0.0	0.00%	0.0%	0.00%	0.00%
Reg25	0.0	0.0	0.0	0.0	0.0	0.00%	0.0%	0.00%	0.00%