Trade Policy and Resource Allocation in the Presence of Product Differentiation

TRADE POLICY AND RESOURCE ALLOCATION IN THE PRESENCE OF PRODUCT DIFFERENTIATION

Jaime de Melo and Sherman Robinson*

I. Introduction

TRADITIONALLY, the empirical analysis of the effects of trade policy on resource allocation has relied both on a partial equilibrium framework using effective rates of protection (Balassa (1971, 1981)) and on a multi-sector, general equilibrium framework (Evans (1972), Taylor and Black (1974), de Melo (1978)). Both approaches have usually been based on fairly aggregated data and have relied on the standard assumption often made in trade theory that domestically produced and imported goods are perfect substitutes in use. Recently, however, there has been a shift in empirical work that reflects a growing dissatisfaction with the assumption of perfect substitutability. For example, Baldwin, Murray and Richardson (1977) in their estimates of the effects of multilateral tariff negotiations on resource allocation and welfare explicitly introduce imperfect substitutability into their partial equilibrium analysis. Some recent empirical general equilibrium models, both multi-sector and multi-country, also introduce product differentiation between domestic and foreign goods.1

The motivation for this new approach is two-fold. First, there has been an increasing amount of empirical evidence suggesting that, even for the most narrowly defined domestic and foreign goods for which prices can be matched (4 and 5 digit SITC categories), the "law of one price" is systematically violated (Isard, 1977). Second, substantial two-way trade is observed in trade statistics at similar levels of aggregation (Grubel and Lloyd, 1975). While other reasons for these observations are possible, the assumption that domestic and foreign goods are imperfect substitutes in use provides both a theoretically satisfying explanation and a specification that is implementable in empirical models. However, in spite of its recent popularity, there has been no systematic investigation of the implications of this new specification for the analysis of the impact of trade policy on relative prices and resource pulls. This paper aims to provide such an investigation.

The paper has two objectives: first, to discuss the theoretical properties and implications of one practical specification of product differentiation and, second, to explore quantitatively the impact of trade policy on relative prices and resource pulls with an empirical general equilibrium model which incorporates product differentiation. In section II we discuss the implications of product differentiation for the autonomy of the domestic price system. The analysis uses a partial equilibrium framework and leads to a classification of sectors according to the extent to which the domestic price is influenced by trade policy. Section III extends the analysis to include intermediate products and discusses the implications of product differentiation for the computation of effective rates of protection. In section IV, we use a computable general equilibrium model to explore the empirical impact of trade policy on relative prices and resource pulls and to compare the effects of changes in tariffs and subsidies in single sectors to changes across many sectors simultaneously.

II. Product Differentiation and Domestic Prices: A Partial Equilibrium Analysis

When domestically produced goods and foreign produced goods are perfect substitutes in use and when the country is small, an increase in the import price results in the same increase in the domestic price. Thus, with the exception of non-traded goods whose prices are determined by
internal conditions, the domestic price system is entirely determined by trade policy. However, if the domestic and foreign goods are imperfect substitutes then, for any sector $i$, the price of the domestic good, $PD_i$, is no longer identical with the domestic currency price of the import substitute, $PM_i$. For simplicity, assume that the degree of substitutability is the same for all internal uses: consumption demand, investment demand and intermediate demand. Let $D_i$ denote the demand for internal use, and $E_i$ export demand (which is a function of the dollar price of exports, $PWE_i$). Then, under partial equilibrium assumptions, the equilibrium condition in the market for the domestically produced good in sector $i$ is

$$X^d_i = X_i^s$$  \hspace{1cm} (1)

where

$$X^d_i = D_i(PD_i, PM_i) + E_i(PWE_i)$$  \hspace{1cm} (2)

and

$$X_i^s = X_i(PD_i).$$  \hspace{1cm} (3)

A natural question is to investigate the extent to which trade policy affects the price of the domestic good. We shall thus discuss more specifically the treatment of imports and exports, using the functional forms adopted later in the quantitative analysis.

**The Demand for Imports and the Demand for Exports**

A convenient way of introducing product differentiation is to follow Armington (1969a) and to define for each commodity category an aggregate or composite commodity $Q_i$, which is a constant elasticity of substitution (CES) function of imports $M_i$ and domestic goods for internal use, $D_i$:

$$Q_i = \delta_i M_i^{-\rho_i} + (1 - \delta_i) D_i^{-\rho_i}$$  \hspace{1cm} (4)

where $\delta_i$ and $\rho_i$ are parameters and $\sigma_i = (1 + \rho_i)^{-1}$ is the "trade substitution elasticity" between foreign and domestic goods. Consumers and producers demand this composite commodity so that the demand for imports and domestic goods becomes a derived demand. If the country's import share in total world supply is small, imports are in infinitely elastic supply and world relative prices change (if $\omega = 1$) it can be assumed constant for small changes around equilibrium. Total differentiation of (8)-(10) and substitution into (11) yields, after some manipulations,

Turning to exports, their supply is equal to the difference between total production and demand for domestic use. In turn, the demand for exports depends both on the country's market share and on the degree of product differentiation characterizing products from different countries. Thus the less substitutable the product in question, the lower the export demand elasticity, $\eta_i$. The foreign demand for exports is given by

$$E_i = E_i(PWE_i)^{-\eta_i}$$  \hspace{1cm} (6)

where the dollar price of export, $PWE_i$, is obtained by dividing the domestic price by the exchange rate times one plus the rate of export subsidy:

$$PWE_i = PD_i/ER(1 + \tau_e).$$  \hspace{1cm} (7)

**A Classification of Sectors by Their Degree of Tradability**

Given the treatment of exports and imports, we can investigate how a change in tariffs and subsidies affects the equilibrium price of the domestic good. Start with partial equilibrium and assume the exchange rate is fixed. Then, assuming demanders minimize the cost of acquiring the composite good, we have the following equations (dropping subscripts):

$$D = (1 - \delta)^\sigma (P/PD)^\sigma Q$$  \hspace{1cm} (8)

$$M = \delta^\sigma (P/PM)^\sigma Q$$  \hspace{1cm} (9)

$$P = \{\delta^\sigma PM^{(1-\sigma)/\sigma} + (1 - \delta)^\sigma PD^{(1-\sigma)}\}^{1/(1-\sigma)}$$  \hspace{1cm} (10)

where (8)-(9) are the first order conditions and (10) is the cost function derived from the CES aggregation function (4). Totally differentiate the equilibrium condition (1) to get

$$\dot{X}^s \cdot X^s = \dot{D}D + \dot{E}E$$  \hspace{1cm} (11)

where $\cdot$ denotes a percentage change.

To obtain expressions in terms of elasticities and shares, define the following:

$$\chi^e = \frac{PM \cdot M}{PQ}; \quad \dot{Q} = -\delta^\sigma \dot{P}; \quad \dot{E} = -\eta \dot{PWE};$$

$$\theta_m = \frac{PM \cdot M}{PQ} = \delta^\sigma (P/PM)^{\sigma - 1}.$$  

Although the import share $\theta_m$ will vary when relative prices change (if $\sigma \neq 1$), it can be assumed constant for small changes around equilibrium. Total differentiation of (8)-(10) and substitution into (11) yields, after some manipu-
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lation, an expression for the percentage change in the domestic price for a small change in the rate of export subsidy, $te$:

$$
\delta \hat{D} = \frac{\eta (e^d + \eta)}{(e^d + \eta)(1 - \theta_m) + e^d (1 - \theta_m)}/E \lambda e^te.
$$

(12)

The corresponding expression for the case of a small change in the tariff rate, $t_m$, is:

$$
\delta \hat{D} = \frac{(\sigma + e^d)\theta_m (e^d + \eta) (1 + \lambda e^te)}{(e^d + \eta) E/D + e^d + e^d + (\sigma + e^d)\theta_m}.
$$

(13)

where

$$
\lambda_m = \frac{tm}{1 + tm}, \lambda_e = \frac{te}{1 + te}.
$$

(14)

What can we conclude from these expressions? First, the demand for the domestic good is clearly a derived demand and the elasticity of supply appears in both expressions. Thus, other things equal, the higher the elasticity of supply, the smaller the adjustment in the domestic price necessary to restore equilibrium in the market. The same can be said of the role of the price elasticity of demand for the composite good, $e^d$.

Second, the role of the elasticity of demand for exports is important in determining the extent to which a change in trade policy affects the domestic price. In the case of an export subsidy, the dominating effect of its value is quite obvious since the higher its value, the larger will be the corresponding domestic price change. Note, however, that export demand is also important when there is a change in the tariff rate, especially when the share of domestically produced goods being exported is large. The higher the elasticity of demand for exports, the smaller will be the domestic price change resulting from a change in tariff policy. A tariff will lead to a fall in exports as domestic output is channeled away from foreign markets towards domestic use and the easier this substitution process the smaller will be the price increase.

Third, expression (13) provides a necessary condition for a rise in import price to lead to a fall in the domestic price; namely, that the trade substitution elasticity be less than the elasticity of demand for the composite good.

The specification of imperfect substitution allows for a richer and more realistic description of the role of different sectors in foreign trade. One is no longer faced with the extreme dichotomy in which sectors are either traded with their prices entirely determined outside the model, or non-traded with their prices entirely determined endogenously. Sectors are characterized by a continuum of 'tradability' and even if all sectors are traded, the domestic price system can have a significant degree of autonomy from world prices.

In analyzing resource pulls, it is useful to distinguish four types of sectors: non-tradables, exportables, import substitutes and import complements. A sector produces 'non-tradables' if both the share of exports in total production and the share of imports in domestic use is small (e.g. construction and services). A sector producing 'exportables' is one in which the ratio of exports to domestic production is high. Sectors characterized by high shares of imports in total domestic use can be divided into 'import substitutes' and 'import complements' depending on the ease of substitution between domestic and foreign goods relative to the sectoral own demand elasticities for the composite good. Import substitutes are sectors for which the trade substitution elasticity exceeds the own composite good demand elasticity so that an increase in the tariff leads to an increase in the domestic price. As $\sigma$ gets very large, these sectors behave as the traditional perfect substitutes for competitive imports. If, on the contrary, the elasticity of substitution in use between domestic and foreign goods is lower than the own demand elasticity, the relevant sectors behave as if sectoral imports are non-competitive in the sense that a tariff on imports does not protect the corresponding domestic industry. The distinction between import substitutes and import complements reflects the traditional distinction between competitive and non-competitive imports, but it allows for a continuum rather than the extreme treatment of imports as either perfect substitutes or perfect complements for domestic goods.

III. Intermediate Products and Effective Protection

A natural way to extend the analysis of section II is to allow for intermediate products. Assume

2 For derivation of (12) and (13) and a discussion of limiting cases, see de Melo and Robinson (1978).
that intermediate products are demanded in fixed proportions and so define value-added or the "net price" in sector \(i\) as

\[PN_i = PD_i - \sum_j a_{ij} P_j\]  

(15)

where the \(a_{ij}\) are intermediate input coefficients expressed in units of composite goods per unit of domestic production.

Effective rates of protection (ERPs) express the protection to value-added accorded by a change in trade taxes and are defined as

\[ERP_i = PN_i^1 / PN_i^0 - 1\]  

(16)

where \(PN_i^1\) and \(PN_i^0\) are the value-added or net prices in that sector before and after the change in trade policy. To simplify the notation, assume that units are defined so that initial prices are equal to unity. Then \(PN_i = 1 - \sum_j a_{ij}\) and the effective rate of protection is given by

\[ERP_i = \frac{PD_i - \sum_j a_{ij} P_j}{1 - \sum_j a_{ij}}\]  

(17)

where a "\(\%\)" indicates a percent change. It is desirable to relate the ERP directly to the change in trade policy, which can be done by totally differentiating equation (10) and substituting into (17). The expression for the ERP becomes

\[ERP_i = \frac{\hat{PD}_i - \sum_j a_{ij} \hat{P}_j}{1 - \sum_j a_{ij}}\]  

(18)

In the presence of product differentiation an across-the-board change in tariffs will not lead to a proportional change in value-added across sectors unless changes in both tariff rates and domestic prices are identical across sectors (\(m_j = \hat{P}_j\) for all \(j\)). But we know that, with a few notable exceptions, the changes in domestic prices resulting from single changes in tariffs are not very large (especially when they are weighted by the share of domestic goods). Therefore, we may neglect the second terms in brackets in equation (18).\(^3\) It then becomes clear that the sectors which have a lower ERP when there is an equal across-the-board change in tariffs are those sectors for which the share of imported intermediate inputs \((\sum_j a_{ij} \theta_{jm})\) is high. Independently of its trade orientation, a sector is classified as "import-dependent" if it has a high ratio of imported to total intermediate inputs. As in the traditional measure of effective protection, the presence of tariffs on imported intermediate inputs lowers the ERP accorded to a sector.

IV. A General Equilibrium Analysis of Resource Pulls

Although the model presented above can be implemented in its partial equilibrium form, it is natural to explore the impact of trade policy on resource allocation and relative prices by specifying a multi-sector general equilibrium. The latter has two distinct advantages. First it allows for an endogenous determination of variables such as the exchange rate which are held constant in a partial equilibrium framework. Second, whereas calculus techniques restrict the investigation to small changes around equilibrium, the direct solution of a general equilibrium model allows one to explore the impact of large changes in trade policy. Following is a brief summary description of the model used for the numerical application.\(^4\)

The model is Walrasian in spirit and determines relative product prices, wages and the exchange rate so as to clear the markets for products, different types of labor, and foreign exchange. On the supply side producers minimize costs. Labor moves across urban sectors until the value of its marginal product is everywhere the same. The agricultural labor force is fixed. Capital stocks, once installed, are assumed to be fixed during the period considered. Sectoral technology is described by a CES production function for capital and labor. Intermediate technology takes place according to a Leontief production function with fixed coefficients (expressed in terms of composite goods).

\(^3\) Note that if domestic and foreign goods were perfect substitutes, equal tariffs would lead to equal ERPs since, given that \(tm_i = tm_j\) for all \(i\) and all \(j\), it would always be true that

\[ERP_i = \frac{tm_i - \sum_j a_{ij} tm_j}{1 - \sum_j a_{ij}} = \frac{tm_i - tm_j (\sum_j a_{ij})}{1 - \sum_j a_{ij}} = tm_i.\]

In this expression it is assumed that all goods are traded and that the small country assumption holds for both imports and exports.

\(^4\) For a detailed description of the structure of a computable general equilibrium model, see Dervis, de Melo, and Robinson (1981). An appendix with the complete set of equations is available upon request.
On the demand side, sectoral consumption demands are given by constant expenditure proportions. This implies that the own-price elasticity of demand for sectoral composite output is unity. This specification has the advantage of simplifying the interpretation of results since the elasticity of response of private final demand to a change in sectoral composite price, itself due to a change in trade policy, is the same across all sectors. Aggregate investment demand is held fixed in real terms which implies a zero own-price elasticity of demand for both the intermediate and the investment components of final demand. Savings are determined residually so as to maintain real investment. This formulation allows a focus on relative prices and resource allocation by leaving out the distributional impact of trade policy and the interactions between trade policy and growth via changes in the level of real investment.\(^5\)

The model outlined above is the basis for the two sets of experiments reported in this section.

\(^5\) Although not mentioned, there is a government sector whose presence is neutralized by a system of transfers to and from the private sector so as to prevent any policy-induced redistribution of income between the private sector and the government sector.

The first set of experiments consists of examining successively the impact on resource allocation of single 50% tariffs and subsidies on a sector by sector basis. They correspond closely to what one might expect from partial equilibrium estimates along the lines described in section II. The second set of experiments consists of across-the-board changes in tariffs and subsidies. The impact of general equilibrium effects is gauged by comparing a ranking of changes in sectoral outputs under both sets of experiments. The analysis is conducted at a 19 sector level of aggregation and the data are based on the 1973 Turkish input-output table.

The structure of the economy in the reference solution, which is a solution of the model without any trade interference, is provided in table 1. Columns 1 and 2 describe the structure of production across sectors. The next three columns provide information about each sector's trade-orientation as discussed in section II. Column 3 indicates that only five sectors export over 10% of their production, with food, textiles and petroleum products being the most export-oriented sectors in the economy. These ratios are quite low, although they are in the range one would expect for developing countries that have fol-

### Table 1.—Structure of the Economy in the Base Solution

<table>
<thead>
<tr>
<th>Sector</th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
<th>7.</th>
<th>8.</th>
<th>9.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Agriculture</td>
<td>21.5</td>
<td>71.5</td>
<td>3.2</td>
<td>1.6</td>
<td>8.6</td>
<td>52.0</td>
<td>3.0</td>
<td>2.0</td>
<td>1.6</td>
</tr>
<tr>
<td>2. Mining</td>
<td>1.0</td>
<td>63.0</td>
<td>10.6</td>
<td>6.8</td>
<td>18.5</td>
<td>18.0</td>
<td>0.5</td>
<td>2.0</td>
<td>2.1</td>
</tr>
<tr>
<td>3. Food</td>
<td>9.8</td>
<td>20.6</td>
<td>17.9</td>
<td>1.2</td>
<td>2.1</td>
<td>73.0</td>
<td>1.25</td>
<td>2.0</td>
<td>0.6</td>
</tr>
<tr>
<td>4. Textiles</td>
<td>5.8</td>
<td>21.4</td>
<td>27.7</td>
<td>3.6</td>
<td>8.2</td>
<td>57.0</td>
<td>1.25</td>
<td>2.0</td>
<td>2.1</td>
</tr>
<tr>
<td>5. Clothing</td>
<td>1.2</td>
<td>56.6</td>
<td>6.0</td>
<td>3.0</td>
<td>4.0</td>
<td>77.0</td>
<td>1.25</td>
<td>2.5</td>
<td>1.9</td>
</tr>
<tr>
<td>6. Wood &amp; Wood Products</td>
<td>1.2</td>
<td>41.9</td>
<td>0.4</td>
<td>0.6</td>
<td>3.6</td>
<td>38.0</td>
<td>1.25</td>
<td>2.5</td>
<td>1.9</td>
</tr>
<tr>
<td>7. Paper &amp; Printing</td>
<td>1.1</td>
<td>31.0</td>
<td>0.9</td>
<td>10.8</td>
<td>10.8</td>
<td>40.0</td>
<td>0.5</td>
<td>2.5</td>
<td>0.3</td>
</tr>
<tr>
<td>8. Chemicals</td>
<td>2.3</td>
<td>35.3</td>
<td>3.8</td>
<td>47.7</td>
<td>31.0</td>
<td>39.0</td>
<td>0.5</td>
<td>2.5</td>
<td>0.2</td>
</tr>
<tr>
<td>9. Rubber &amp; Plastics</td>
<td>1.0</td>
<td>26.6</td>
<td>2.6</td>
<td>18.8</td>
<td>22.6</td>
<td>50.0</td>
<td>0.5</td>
<td>2.5</td>
<td>0.7</td>
</tr>
<tr>
<td>10. Petroleum &amp; Pet. Prod.</td>
<td>3.4</td>
<td>39.5</td>
<td>16.9</td>
<td>50.6</td>
<td>20.8</td>
<td>16.0</td>
<td>3.0</td>
<td>2.5</td>
<td>0.01</td>
</tr>
<tr>
<td>11. Non-Met. Min. Prod.</td>
<td>1.5</td>
<td>38.8</td>
<td>7.5</td>
<td>7.6</td>
<td>10.5</td>
<td>40.0</td>
<td>0.5</td>
<td>2.5</td>
<td>0.6</td>
</tr>
<tr>
<td>12. Basic Metals</td>
<td>3.2</td>
<td>22.6</td>
<td>5.2</td>
<td>24.0</td>
<td>20.6</td>
<td>0.0</td>
<td>0.5</td>
<td>2.5</td>
<td>0.3</td>
</tr>
<tr>
<td>13. Metal Products</td>
<td>1.2</td>
<td>43.3</td>
<td>3.0</td>
<td>16.0</td>
<td>22.8</td>
<td>67.0</td>
<td>0.5</td>
<td>2.5</td>
<td>1.6</td>
</tr>
<tr>
<td>14. Non-electrical Machinery</td>
<td>2.0</td>
<td>40.5</td>
<td>1.9</td>
<td>56.2</td>
<td>44.3</td>
<td>21.0</td>
<td>0.33</td>
<td>2.5</td>
<td>0.3</td>
</tr>
<tr>
<td>15. Electrical Machinery</td>
<td>1.0</td>
<td>40.1</td>
<td>0.6</td>
<td>39.0</td>
<td>27.3</td>
<td>41.0</td>
<td>0.33</td>
<td>2.5</td>
<td>0.5</td>
</tr>
<tr>
<td>16. Transp. Equipment</td>
<td>1.0</td>
<td>39.1</td>
<td>0.2</td>
<td>28.8</td>
<td>22.9</td>
<td>20.0</td>
<td>0.5</td>
<td>2.5</td>
<td>0.7</td>
</tr>
<tr>
<td>17. Construction</td>
<td>2.5</td>
<td>51.3</td>
<td>—</td>
<td>—</td>
<td>17.0</td>
<td>1.0</td>
<td>—</td>
<td>—</td>
<td>1.4</td>
</tr>
<tr>
<td>18. Infrastructure</td>
<td>12.9</td>
<td>67.9</td>
<td>10.1</td>
<td>1.8</td>
<td>16.3</td>
<td>70.0</td>
<td>0.33</td>
<td>1.25</td>
<td>0.2</td>
</tr>
<tr>
<td>19. Services</td>
<td>22.5</td>
<td>80.9</td>
<td>7.2</td>
<td>1.5</td>
<td>4.4</td>
<td>66.0</td>
<td>0.33</td>
<td>1.25</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Notes:
1. Sectoral composition of gross output
2. Sectoral value-added as a percentage of domestic price
3. Ratio of exports to domestic output
4. Share of imports in aggregate composite expenditures
5. Share of imported intermediate inputs in total intermediate input
6. Ratio of private consumption to total composite output
7. Trade substitution elasticities
8. Export demand elasticities
9. Sectoral supply elasticities (see text for definition)
followed an inward-looking development strategy. On the import side, a more typical picture emerges with regard to both the share of imports in aggregate composite expenditures (column 4) and the share of imported intermediate inputs in total intermediate inputs (column 5) (which indicates a sector's degree of trade dependence). With the exception of non-metallic mineral products, intermediates and capital goods are both import-oriented and import-dependent. Construction is the only pure non-traded sector in the economy, yet 17% of its intermediate inputs are imported. Finally, column 6 indicates the share of final demand consumption and therefore gives an approximation of the price elasticity of demand, ϵd.

The last three columns give the important elasticities for determining the resource-pull effects of changes in tariffs and subsidies. The sectoral variation in trade substitution elasticities (column 7) roughly captures the extent of product differentiation due to differences in quality and degree of product homogeneity.6 Thus agricultural and petroleum products are viewed as the most homogeneous products, along with the more traditional non-durable consumer goods which are assumed to be more substitutable in use than other manufactures. Export demand elasticities (column 8) correspond to values one might expect in the short to medium term. Finally, partial-equilibrium sectoral elasticities of supply (defined as the elasticity of substitution between capital and labor times the ratio of the labor share to the capital share in value-added) are given in column 9.

**Trade Policy and the Domestic Price System**

We are now in a position to investigate numerically the range of domestic price and output responses to single 50% tariffs and single 50% export subsidies. The nature of the experiment whereby only one tariff (or one subsidy) is imposed at a time makes the analysis of section II particularly relevant since general equilibrium repercussions should be minor so that the various partial equilibrium elasticities reported in table 1 can serve as indicators in determining the resulting change in domestic prices. This allows the discussion to be brief, the details being left to the reader.

The first two columns in table 2 show the percentage change in sectoral domestic prices and outputs when a 50% tariff is imposed on imports classified under that sector. Consider the percentage change in the domestic price. Primary

### Table 2.—Resource Pulls for Single Tariffs and Subsidies (% changes from base solution)

<table>
<thead>
<tr>
<th>Tariff</th>
<th>Domestic Price</th>
<th>Domestic Output</th>
<th>Subsidy</th>
<th>Domestic Price</th>
<th>Domestic Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Agriculture</td>
<td>0.6</td>
<td>0.0</td>
<td></td>
<td>3.6</td>
<td>0.0</td>
</tr>
<tr>
<td>2. Mining</td>
<td>-0.7</td>
<td>0.5</td>
<td></td>
<td>3.2</td>
<td>9.7</td>
</tr>
<tr>
<td>3. Food</td>
<td>0.2</td>
<td>0.0</td>
<td>6.4</td>
<td>10.6</td>
<td></td>
</tr>
<tr>
<td>4. Textiles</td>
<td>-0.2</td>
<td>-1.9</td>
<td>5.1</td>
<td>23.0</td>
<td></td>
</tr>
<tr>
<td>5. Clothing</td>
<td>0.5</td>
<td>0.4</td>
<td>3.1</td>
<td>6.8</td>
<td></td>
</tr>
<tr>
<td>6. Wood and Wood Products</td>
<td>0.0</td>
<td>0.0</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>7. Paper &amp; Printing</td>
<td>1.1</td>
<td>0.0</td>
<td>0.5</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>8. Chemicals</td>
<td>5.0</td>
<td>-0.7</td>
<td>5.6</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>9. Rubber and Plastics</td>
<td>0.1</td>
<td>-0.1</td>
<td>1.2</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>10. Petroleum and Pet. Prod.</td>
<td>28.0</td>
<td>0.3</td>
<td>15.9</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>11. Non-Met. Min. Prod.</td>
<td>-0.1</td>
<td>0.1</td>
<td>5.5</td>
<td>7.7</td>
<td></td>
</tr>
<tr>
<td>12. Basic Metals</td>
<td>10.7</td>
<td>2.5</td>
<td>7.8</td>
<td>6.8</td>
<td></td>
</tr>
<tr>
<td>13. Metal Products</td>
<td>-0.4</td>
<td>-0.8</td>
<td>0.8</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>14. Non-electrical Machinery</td>
<td>3.6</td>
<td>2.1</td>
<td>3.0</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td>15. Electrical Machinery</td>
<td>0.0</td>
<td>-1.7</td>
<td>0.3</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>16. Transp. Equipment</td>
<td>5.5</td>
<td>2.6</td>
<td>0.0</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>17. Construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Infrastructure</td>
<td>-0.7</td>
<td>0.1</td>
<td>5.5</td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>19. Services</td>
<td>0.1</td>
<td>0.0</td>
<td>4.9</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>
goods and consumer goods which have low im-
port shares and export a relatively large amount
of their output show virtually no price increase at
all. They behave either as non-tradables (e.g.,
wood) or as exportables (e.g., textiles and food).
Intermediates, as a rule, behave as import sub-
stitutes since they generally have fairly large import
shares. The exceptions are rubber and plastics
and non-metallic mineral products, both of which
have low import shares so that their domestic
prices do not change much.

As an example, it is interesting to trace out the
causes of the 28% increase in the domestic price
of petroleum products which far exceeds any
other price change. The reason for this result
may be readily traced out with the information
provided in table 1. It is due to the high import
share, the low elasticity of final demand due to
the fact that petroleum products are mostly used
as intermediates and of course to the fact that
these products are good substitutes in use. These
factors, in conjunction with the extremely low
elasticity of domestic supply, result in a dra-
matic rise in the domestic price of petroleum
products. A similar but less dramatic combina-
tion of shares and elasticities underlies the large
price increases registered for chemicals and basic
metals.

Turning to an examination of the short-run
output changes in column 2, one finds that they
are quite small both because supply elasticities
are low and because there is an inverse relation
between price changes and supply elasticities
captured in equations (12) and (13). Note, how-
ever, that it is supply elasticities and changes in
net prices rather than gross prices that determine
output response. To compare the resource shifts
in column 2 with those that would obtain under a
more traditional trade specification where
domestic and foreign goods are perfect substi-
tutes, multiply the supply elasticities in table 1
(column 9) by one half since in that case the
domestic price would increase by the full amount
of the tariff and \(\dot{P}D = \dot{P}M = 0.5\). This would
provide a rough estimate of the increase in sec-
torial outputs which could then be compared with
the results in column 2. These resource pulls
would still be larger than those which would be
obtained in the very long run with product
differentiation—but not by much. In that case,
letting \(\epsilon^t = \infty\), the output response to a change in
 tariffs would be given by
\[
\dot{X} = \sigma - \epsilon \theta_\mu \dot{P}M,
\]
which turns out to be usually less than the short-
run response with perfect substitution.\(^7\)

While the effects of changes in tariffs on the
domestic price system require careful interpreta-
tion because of the indirect effects caused by
imperfect substitution, on the export side, the
linkages are much easier to follow: the effect of
an export subsidy on the domestic price system
depends mostly on the sectoral elasticity of de-
mand for exports. Moreover, this link is direct
and, given that the pattern of export demand
elasticities is fairly similar across sectors, one
would expect the main determinant of the re-
response of domestic prices to a change in sub-
sidies to be the sectoral share of production that
is exported. Thus the sectors whose prices rise
the most following the imposition of a 50% sub-
sidy are the export-oriented sectors. In table 2,
the sectors that export over 5% of domestic pro-
duction (namely, mining, food, textiles, clothing,
petroleum products, non-metallic products, basic
metals, infrastructure, and services) show the
largest increase in prices (column 3). Since the
increase in domestic prices is much greater than
in the case of a similar change in tariff, the output
response is also greater (column 4).

The magnitude of the export response in col-
umns 3 and 4 confirms the greater sensitivity of
the model to the specification of export demands
than to the specification of import demands be-
cause the effects are direct. These results might
provide a partial explanation as to why policy-
makers in developing countries (where it is often
argued that it is difficult to transform foreign
resources into domestic ones because of
bottlenecks or "gaps") provide much higher ef-
effective exchange rates of protection to imports
than to exports.

\textit{Ranking Sectors by Resource Shifts:
Partial vs. General Equilibrium}

The single tariff and export subsidy experi-
ments with the general equilibrium model corre-
pond closely to partial equilibrium assumptions
in that only one parameter was changed at a time.
It is also interesting to investigate how the econ-
omy responds to across-the-board changes in

\(^7\) The expression for \(\dot{X}\) is obtained from equations (8)-(10)
after noting that \(\epsilon^t = \infty, \dot{P}D = 0\) and hence \(\dot{E} = 0\).
tariffs and subsidies. This is done by devising two experiments that might be viewed as extreme policy packages: an import-substitution strategy (IS) provided by a 120% tariff on imports across-the-board; and an export promotion strategy (EP) provided by 50% across-the-board subsidies.*

There are four important general equilibrium repercussions that must be taken into account in order to compare the resulting resource shifts with those from the single-change experiments. First, there are the effects on intermediate input costs. Other things equal, these sectors which are import-dependent will be adversely affected when there is an across-the-board change in tariffs. Second, there is a strong wage effect that will have a differential impact across sectors. In the case of an IS strategy, the industrial wage falls by 15% compared with its base value, whereas it rises by 9% with the EP strategy. This corroborates the often-made observation that developing countries' exports are labor-intensive so that an EP strategy would alleviate unemployment.

Third, there is an exchange rate effect. In the model, the exchange rate reflects the relative price of domestic and imported goods. Given the normalization rule which fixes a weighted sum of domestic and imported prices, both experiments will result in an appreciation of the value of the exchange rate so as to maintain external balance. In the case of the IS strategy the exchange rate appreciates by 32% and in the case of the EP strategy it appreciates by 18%.

Fourth, there are income effects associated with changes in the international terms of trade. Thus the economy-wide change in tariff structure improves the terms-of-trade by 44% whereas the corresponding across-the-board change in subsidies leads to a deterioration in the terms-of-trade of 17%. Therefore one would expect that sectors which expand will expand more under an IS strategy because of the induced increase in demand for domestic goods caused by the increase in disposable income, and vice versa for the EP strategy.

These effects are reflected in table 3, which ranks sectors for single changes in trade policy and for across-the-board changes in trade policy. In each column the first number indicates the sector and the number in parentheses next to it indicates the percentage change in sectoral output from the level reached in the base solution. Thus 16(2.6) in column 1 means that domestic output in the transport equipment sector expands by 2.6% when the domestic currency price of imports of transport equipment increases by 50%, the domestic currency price of all other imports being held constant. From column 2, when the domestic currency price of all imports

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*The selection of a 120% increase across-the-board is to insure that, after the revaluation of the exchange rate is taken into account (see discussion below), the domestic currency price of imports rises by 50% over the value in the base run, as in the case of a single 50% tariff change when the exchange rate change is usually negligible.

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Table 3.—Comparison of Rankings of Output Responses to Changes in Tariffs and Subsidies

<table>
<thead>
<tr>
<th>50% Tariff (One-by-One)</th>
<th>120% Tariff (Across-the-Board)</th>
<th>50% Subsidy (One-by-One)</th>
<th>50% Subsidy (Across-the-Board)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16(2.6)</td>
<td>5(6.0)</td>
<td>4(23.0)</td>
<td>4(10.7)</td>
</tr>
<tr>
<td>12(2.5)</td>
<td>16(5.2)</td>
<td>3(10.6)</td>
<td>3(3.3)</td>
</tr>
<tr>
<td>14(2.1)</td>
<td>6(4.6)</td>
<td>2(9.7)</td>
<td>2(1.9)</td>
</tr>
<tr>
<td>17(3.5)</td>
<td>12(2.7)</td>
<td>11(7.7)</td>
<td>14(1.1)</td>
</tr>
<tr>
<td>20(0.5)</td>
<td>7(1.0)</td>
<td>12(6.8)</td>
<td>11(0.9)</td>
</tr>
<tr>
<td>5(0.4)</td>
<td>10(0.4)</td>
<td>5(6.8)</td>
<td>12(0.7)</td>
</tr>
<tr>
<td>18(0.1)</td>
<td>18(0.3)</td>
<td>13(4.0)</td>
<td>8(0.5)</td>
</tr>
<tr>
<td>11(0.1)</td>
<td>11(1.1)</td>
<td>9(3.5)</td>
<td>10(0.1)</td>
</tr>
<tr>
<td>3(0.0)</td>
<td>8(1.2)</td>
<td>8(3.2)</td>
<td>15(0.2)</td>
</tr>
<tr>
<td>6(0.0)</td>
<td>9(1.8)</td>
<td>14(2.2)</td>
<td>9(0.3)</td>
</tr>
<tr>
<td>7(0.0)</td>
<td>15(1.9)</td>
<td>7(1.8)</td>
<td>13(0.6)</td>
</tr>
<tr>
<td>9(0.1)</td>
<td>13(2.0)</td>
<td>18(1.4)</td>
<td>18(0.6)</td>
</tr>
<tr>
<td>8(0.7)</td>
<td>2(2.0)</td>
<td>15(1.1)</td>
<td>17(2.2)</td>
</tr>
<tr>
<td>13(0.8)</td>
<td>14(3.2)</td>
<td>7(2.4)</td>
<td>16(3.4)</td>
</tr>
<tr>
<td>15(1.7)</td>
<td>3(3.9)</td>
<td>6(0.5)</td>
<td>5(3.8)</td>
</tr>
<tr>
<td>4(1.9)</td>
<td>10(0.3)</td>
<td>16(0.4)</td>
<td>5(3.8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10(0.3)</td>
<td>6(3.9)</td>
</tr>
</tbody>
</table>

Notes: Figures in parentheses are per cent output changes from the base solution. Sectors are referred to by numbers.
rises by 50% (i.e., when there is a 120% tariff across-the-board), the output expansion in the transport equipment sector is 5.2%.

It is interesting to note the substantial change in rankings among sectors indicated by the criss-crossing of lines joining sectors in columns 1 and 2 and in columns 3 and 4. As one might expect, they are more pronounced for changes in tariffs than for changes in subsidies because the links are more complicated on the import side. The results indicate the empirical importance of the general equilibrium repercussions discussed above.

V. Conclusions

We have argued that the empirical analysis of the price and resource-pull effects of trade policy, especially at a relatively high level of aggregation, is best done in the context of models that explicitly take account of product differentiation. The specification of imperfect substitutability provides a practical way of capturing product differentiation both in a partial equilibrium and in a general equilibrium model. However, results from the empirical general equilibrium model (sections III and IV) show that partial equilibrium based estimates are not likely to be robust when there are substantial policy changes that affect a number of sectors simultaneously.

REFERENCES


