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A SHOVEN–WHALLEY MODEL OF A SMALL OPEN ECONOMY

An Illustration with Philippine Tariffs

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This paper describes an applied general equilibrium model of a price-taking economy in both imports and exports. Sector-specific factors are incorporated to avoid complete-specialization problems. A Hicksian composite traded good market is used for achieving trade balance in the model. Foreign and domestic goods are assumed perfect substitutes. For illustration, Philippine tariffs and export taxes are analyzed using the model.

1. Introduction

In this paper we describe a static Shoven–Whalley model [Shoven and Whalley (1984)] for analyzing policies in a developing country. The main distinction between this and existing applied general equilibrium models of developing economies [e.g. Dervis, de Melo and Robinson (1982)] is that the country is assumed to face exogenous world prices in both its import and export markets. To avoid the complete-specialization problems of small open economy models, we introduce industry-specific factors into the model, resulting in upward-sloping supply curves. As in pure trade models, imports are assumed perfect substitutes for domestic products in contrast to the Armington assumption [Armington (1969)] commonly found in other models. Since world prices of all traded goods are fixed, a Hicksian composite traded good market is used to attain trade balance in the model, rather than a nominal foreign-exchange market as in some models [e.g. see Boadway and Treddenick (1978), Dervis, de Melo and Robinson (1982)].

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While other policy applications are possible, we illustrate a use of our model in analyzing Philippine tariff policies. Tariffs are typically important and widely used policies in developing countries including the Philippines. Concern about the possible deleterious effects of tariff policies has led to extensive measurement of effective protection rates in such countries. However, it is now understood that effective protection rates give only limited information about the effects of tariffs on resource allocation [e.g. see Corden (1966), Anderson and Naya (1969), Bruno (1973), Bhagwati and Srinivasan (1973), Taylor and Black (1974)], as well as on the magnitude of economic waste that they induce.

In analyzing tariff policies, we use applied general equilibrium analysis which is a generally accepted method of evaluating the economic consequences of policy distortions in Public Economics. First used to evaluate the incidence of the U.S. corporate income tax [Shoven and Whalley (1972)], the method has been increasingly applied to several public finance and trade policy issues in a growing number of countries [e.g. see Shoven and Whalley (1984)]. The analysis involves specifying an Arrow–Debreu model of an economy, calibrating the model to a country's benchmark equilibrium data set, solving the model using a fixed-point algorithm [e.g. Scarf (1973), Merrill (1972), Broadie (1983)], and comparing the competitive equilibria with and without the policy distortions in question.[1]

In the next two sections we extend the Shoven–Whalley method to analyze tariff policies in a small open economy. Section 2 describes the theoretical structure of our model. In section 3 we discuss how we calibrated the model with Philippine data. We calculate numerically some of the economic effects of Philippine tariff policies in section 4. Section 5 concludes the paper.

2. A small open economy model

This section describes a general equilibrium model of a competitive, small open economy with homegoods and trade taxes. The model has H utility-maximizing consumers, N profit-maximizing firms producing homegoods and traded goods, and a government. We denote the subset of traded goods as T and the subset of nontraded commodities as NT. Each firm produces only one output. There are M industry-mobile homogeneous factors and N sector-specific factors, one for every good in the model. Every consumer is endowed with fixed amounts of each of the M variable and N sector-specific factors.

Production technology is described by a set of N decreasing-returns-to-

[1]Another tradition to applied general equilibrium analysis is the Johansen–Harberger technique [Johansen (1960), Harberger (1962)]. This method calculates the changes of the endogenous variables of the system following the removal of existing distortions using differential calculus, and hence, is theoretically valid for small changes in policies. In contrast, the Shoven–Whalley approach is suited to any magnitude of policy shifts.

scale production functions:

$$X_j = F_j(FD_j; \bar{Z}_j), \quad j = 1, 2, \ldots, N, \tag{1}$$

where X_j is the amount produced of good j; FD_j is an M-dimensional vector of derived demands for variable factors in sector j; and $\bar{Z}_j$ is the amount of a factor specific to sector j. Intermediate inputs are used in fixed proportion to production. The amount of intermediate input i needed to produce X_j is $X_j a_{ij}$, where a_{ij} is the fixed intermediate demand for input i per unit of output j.

The profit function associated with (1) is $\Pi_j(p, w; \bar{Z}_j)$, which we assume to be linearly homogeneous in prices, p and w. p is the N-dimensional vector of producer commodity prices and w is the M-dimensional vector of factor prices. The supply of good j and the derived demands for factors in sector j are the respective derivatives of the profit function with respect to p_j and w:

$$\begin{aligned} X_j(p, w; \bar{Z}_j) &= \partial \Pi_j(p, w; \bar{Z}_j)/\partial p_j, \qquad j = 1, 2, \ldots, N, \\ FD_{ij}(p, w; \bar{Z}_j) &= -\partial \Pi_j(p, w; \bar{Z}_j)/\partial w_i, \quad i = 1, 2, \ldots, M; \quad j = 1, 2, \ldots, N. \end{aligned} \tag{2}$$

Sector-specific factors provide a natural strategy of avoiding complete-specialization problems associated with small open economy models with constant-returns-to-scale production technologies. Where there are fewer factors than internationally traded goods in such models, competition forces the excess goods to cease being produced. By incorporating sector-specific factors, we can solve the equilibrium factor prices from the exogenous commodity prices using zero-profit conditions [Samuelson (1953)].[2]

To provide firms incentives to hire sector-specific factors, we assume that the respective marginal value products of these factors are non-negative. Given that sector-specific factors are employed, we assume that production profits in the economy are finite. Otherwise, outputs of traded goods become indeterminate at some prices. Such would be the case where a marginal cost curve is asymptotic to the given world price of a traded good. We also postulate that the owners' final demands for such factors are fixed (e.g. equal to zero for simplicity) so that the respective factor supplies to firms are exogenous.

From the homogeneity property of the profit function we have:

$$\begin{aligned} \Pi_j(p, w; \bar{Z}_j) &= p_j X_j - p^T ID_j - w^T FD_j, \\ &\geqq 0, \end{aligned} \qquad \forall j, \tag{3}$$

[2]Komiya (1967) generalized this proposition in models with nontraded goods.

where ID_j is the N-dimensional vector of intermediate demands of sector j. The inequality in (3) allows for rents which are assumed to be finite to accrue to the owners of the sector-specific factor, $\bar{Z}_j$. If the inequality is reversed, the sector shuts down since it is unable to cover all its variable costs of production.

The returns to specific factors go to households as additional income. The distribution of such profits depends upon the exogenous household endowments of such factors. To simplify matters, we introduce exogenous share parameters for allocating the aggregate profits in the economy, $\Pi=\sum_{j=1}^{N}\Pi_j$. In particular, the parameters are $[\sigma_i,\ i=1,\dots,H:\sum_{i=1}^{H}\sigma_i=1]$ which are assumed to reflect the amounts households own of sector-specific factors. Thus, $\sigma_i\Pi$ is the rent going to consumer i.

Each consumer in the economy has a utility function $U^h(C^h)$, where C^h is the N-dimensional vector of final demands of consumer h. These demand schedules are defined on income, Y^h, and the vector of consumer prices, q, given the utility-maximizing behavior of consumers: $C_j^h(q, Y^h)$, $\forall j$, $\forall h$. The market demand for good j, C_j, is the sum of the individual consumer demands, i.e. $C_j=\sum_{h=1}^{H}C_j^h$. We assume that consumers have no demands for sectorally-mobile factors. Hence, the total endowment of consumers in a given factor constitutes the fixed supply of the factor in the model: $\sum_{h=1}^{H}\bar{FS}_i^h=\bar{FS}_i$, where $\bar{FS}$ denotes the $M\times H$ matrix of factor endowments.

The income of consumer h consists of the value of all his factor endowments (including rents) and any public income transfer:

$$Y^h=w^T\bar{FS}^h+\sigma^h\hat{\Pi}+\phi^h L,\quad \forall h, \tag{4}$$

where L is the government's income transfers and ϕ^h is a policy parameter reflecting the consumer's share in L. As in the case of σ, the transfer-share parameters, ϕ, are also exogenous and sum to one. Following Shoven and Whalley (1973), we introduce L in (4) to solve a simultaneity problem typical in applied general equilibrium tax models. The problem arises since tax yield depends on demands that in turn are responsive indirectly to tax revenues. L is then the anticipated taxes that are given to consumers who then calculate their respective incomes and demands based on which actual taxes are collected. As noted below, the anticipated revenues equal actual collections in equilibrium.

We also introduce $\hat{\Pi}$, the anticipated aggregate return to sector-specific factors; $\hat{\Pi}=\sum_{j=1}^{N}\hat{\Pi}_j$. Since actual rents in sector j are calculated as a residual in (3), it is difficult to know from this if the inequality in (3) holds. Thus, we further expand the price simplex to accommodate the anticipated rents. In general equilibrium we require that actual rents are as anticipated, ensuring that firms if they produce can pay their respective variable inputs.

Since their world prices are fixed, the traded goods can be aggregated at world prices to create a Hicksian composite good in accordance with the Hicks aggregation theorem [Hicks (1946)].[3] Thus, the demand, C_T, and supply, X_T, of the composite traded good are defined as follows:

$$C_T = \sum_{j \in T} \bar{p}_j (C_j + ID_j),$$
$$X_T = \sum_{j \in T} \bar{p}_j X_j, \tag{5}$$

where $\bar{p}$ is the vector of exogenous world prices of traded goods. Only the relative prices of homegoods and the composite traded commodity matter in this model since the relative prices of traded goods remain unchanged.

The use of the composite traded good facilitates the model's solution. Since imports are perfect substitutes with domestic products, the excess demand of the composite good, $(C_T - X_T)$, is the trade deficit of the economy. Hence, clearing the composite-commodity market implies trade balance.

Since the choice for a numeraire of the model is arbitrary, we can introduce a scalar, r_T, which is the price of the composite traded good in terms of the chosen numeraire. Clearing the composite-good market requires solving for the equilibrium value of r_T. Where the chosen numeraire is the composite traded good, i.e. $r_T \equiv 1$, trade balance is implied by Walras' Law, provided the rest of the economy is in equilibrium.

Thus, it is the relative price between homegoods and traded goods, or the real exchange rate, that is important for obtaining trade balance in the model. Calculating the equilibrium real exchange rate would involve some price index of traded goods such as r_T. In fact, one can interpret r_T as the real exchange rate in a model involving two traded goods and one homegood, the numeraire. Changes in r_T in such a case is the real exchange rate adjustment in the economy [e.g. Dornbusch (1974)]. This interpretation also holds in a more general case so long as the numeraire is a collection of homegoods.

The government is assumed to impose import and export tariffs and redistribute the revenues to consumers. Since these are the only distortions considered in the model, producer and consumer prices are identical, i.e. $p = q$. Henceforth, we use p to refer to the domestic price vector in the economy. If the vector t denotes the ad valorem trade taxes ($t_j > (<)\ 0$, if t_j is an import tariff (export tax)), then the domestic price of traded good j is given by

$$p_j = r_T \bar{p}_j (1 + t_j), \quad \forall j \in T, \tag{6}$$

[3]A rigorous exposition of Hicks' aggregation theorem can be found in Diewert (1978).

The tax revenue is

$$TR=r_T \sum_{j\in T} \bar{p}_j t_j (C_j+ID_j-X_j), \tag{7}$$

where $(C_j+ID_j-X_j)$ is the net import of tradable j.

In some models the external sector closure rule involves a nominal foreign exchange market [e.g. Boadway and Treddenick (1978), Dervis, de Melo and Robinson (1982)]. In the Boadway–Treddenick model, export and import functions with constant price elasticities are added representing the supply and demand for foreign exchange. A financial exchange rate is then solved to clear the market. A similar approach is followed in the Dervis–de Melo–Robinson model.[4]

In our model, the nominal foreign exchange market closure device is not only unnecessary, but can also be misleading. Since world prices are fixed, the foreign demands and supplies of traded goods are perfectly price elastic. Trade balance is achieved by clearing the composite traded good market. Furthermore, using the nominal foreign exchange market would muddle the underlying real structure of our model, potentially resulting in some errors.

Another distinguishing feature of our model is the assumption that local and foreign goods are homogeneous. Under this treatment, trade creation effects of trade policies tend to be larger than those obtained in Armington-type models [Armington (1969)] which differentiate products by place of origin [e.g. Boadway and Treddenick (1978), Dervis, de Melo and Robinson (1982), Hamilton and Whalley (1985)]. Due to perfect substitution between domestic and foreign goods, a tariff reduction in our model expands foreign trade substantially.

Where products are differentiated, impacts on trade flows of lower tariffs tend to be smaller the less substitutable domestic and foreign goods are to each other. Trade creation would also be dampened further where product differentiation is used in conjunction with price-making behavior with respect to exports. As tariffs are reduced, local products are being substituted by imports which generally lowers their world prices. This deterioration in the terms of trade could more than offset any efficiency gains through trade creation [e.g. see Boadway and Treddenick (1978)].

Walras' Law implies that consumers spend their entire incomes on all goods and services, i.e. $Y^h=p^T C^h$. Summing this up across all consumers, adding and subtracting $\sum_{j=1}^{N} \Pi_j$, substituting (3)–(7), and simplifying the

[4]However in chapter 6, Dervis, de Melo and Robinson (1982) discuss the concept of the real exchange rate. They apparently abandon this concept and use the nominal exchange rate (defined as the 'price of a "dollar" in terms of the local currency') in their empirical work. See Srinivasan's (1983) comments on this closure device in the Dervis–de Melo–Robinson model. Also, see Whalley and Yeung (1984) for additional comments and a discussion on external sector closure rules in general.

resulting expression, we obtain the following version of Walras' Law:

$$\sum_{i=1}^{M} w_i(FD_i-\bar{F}\bar{S}_i)+\sum_{j\in NT} p_j(C_j+ID_j-X_j)+r_T(C_T-X_T)+(TR-L)$$

$$+\sum_{j=1}^{N}(\Pi_j-\hat{\Pi}_j)=0. \tag{8}$$

Accordingly, the following sets of equations are the conditions for full general equilibrium:

$$\begin{aligned}
&\text{(i)} && C_j+ID_j-X_j=0, \quad \forall j\in NT;\\
&\text{(ii)} && FD_i-\bar{F}\bar{S}_i=0, \quad \forall \text{ variable factor } i;\\
&\text{(iii)} && C_T-X_T=0; \qquad\qquad\qquad\qquad (9)\\
&\text{(iv)} && TR-L=0;
\end{aligned}$$

and

$$\text{(v)} \quad \Pi_j-\hat{\Pi}_j=0, \quad \forall \text{ good } j.$$

The first two conditions require that all markets of homegoods including factors clear. The third is the trade balance condition. The fourth is the government balanced budget requirement. The last are the non-negativity profit conditions in the economy. All five sets of conditions constitute the simultaneous system of equations that need to be solved to attain full general equilibrium. The system has as many equations as the number of homegoods, sectorally-mobile and sector-specific factors plus two and can theoretically be solved for the prices of homegoods and all types of factors, r_T and L.

Incorporating sector-specific factors expands the dimension of the general equilibrium problem when solving the model. To keep down computing costs, we may use a short cut. We assume that the non-negativity conditions in (3) hold and solve the general equilibrium conditions (i) through (iv) in (9). After a solution is obtained, we check if indeed rents are non-negative. If they are, then the solution satisfies full general equilibrium. This reduces significantly the number of unknowns in the model.

We use OCTASOLV [Broadie (1983)] to calculate equilibrium prices in our Philippine application of the model. OCTASOLV is a general purpose fixed-point program for solving a system of nonlinear equations. One of its many applications is general equilibrium analysis, wherein the fulfillment of the general equilibrium conditions requires the simultaneous solution of the system of nonlinear excess demand equations such as the equation system (i) through (v) above. As in other fixed-point algorithms [Scarf (1973), Merrill (1972)], the search for the equilibrium price vector in OCTASOLV is confined within the unit simplex by an appropriate normalization rule. These algorithms have the advantage of guaranteed convergence provided that the fixed-point problem satisfies a convergence condition that most economic models meet. The computational efficiency of OCTASOLV is enhanced by the additional use of a Newton acceleration procedure before restarting calculations on progressively finer grids.

3. A characterization of the Philippine economy and trade policies

In this section we apply our approach with an analysis of Philippine tariffs. The Philippines may be regarded as a small open economy despite the fact that the country is a major producer and exporter in the world of a few agriculture-based products such as sugar and coconuts. For example, although the Philippines has been the world's largest exporter of copra and coconut oil, the modest share of coconut oil in the world market for oils and fats (roughly less than 10 percent) due to the availability of close substitutes renders the elasticity of world demand for Philippine coconut products extremely high [Clarete and Roumasset (1983)].

We follow the deterministic calibration procedure of numerically specifying an applied general equilibrium model outlined in Mansur and Whalley (1984) and Shoven and Whalley (1984). Table A.1 in the appendix gives a 1978 benchmark general equilibrium data set for the Philippines used in this study. We present some highlights of the data set.[5]

The Philippine economy is represented by seven sectors and two variable factors. The sectors are commercial crops, food industries in agriculture, industrial exportables, industrial importables, import substitutes, the rest of agriculture, and services. The first three are exportables, the next two are importables, and the last two are nontraded goods.

Commercial crops include the traditional export earners of the country such as copra. If these products have been processed before their exportation (e.g. coconut oil or centrifugal sugar), then their processed forms are classified under the third sector consisting of industrial exportables. The food industries in agriculture include food crops, livestock, poultry, and fishery. The third sector consists of processed agricultural products, minerals, and lumber. Major imported inputs such as oil and chemicals are aggregated as

[5]See Clarete (1984) for additional information. In assembling this data set, we left out many features about the Philippine economy that we thought were unnecessary for illustrating a use of our model with Philippine tariffs. We recommend, however, a more detailed calibration process if the model were to be used to actually inform policy-makers.

industrial importables while the remaining industries are grouped under the import-substituting sector.

The two variable factors are labor and capital. The total supply of labor is 63,112 million units while that of capital is 40,483 million units.[6] We assume that capital and labor are homogeneous in the model. There is only one aggregate consumer.[7] The government is assumed to collect only trade taxes and to transfer the revenue to the consumer. Although there are potential interactions of trade taxes with other domestic distortions [see Clarete and Whalley (1985)], we limit our illustration of the model to Philippine tariffs and export taxes. In this static model there are neither savings nor investments.

Production and utility functions are specified as Cobb–Douglas.[8] The share parameters are uniquely derived from the assembled benchmark equilibrium data set in a Cobb–Douglas economy. Table A.2 in the appendix gives the parameters of the model.

For illustrative purposes, we limit the scope of our investigation to the explicit tariff and export tax system.[9] Table 1 gives the average ad valorem export and import tax rates in the Philippines in 1978. The basic rates used to calculate the averages came from the Philippine government's Tariff and

Table 1

Average tariff rates and export taxes, Philippines, 1978 (in percent).

Sector	Average rate	Tax collected (in million pesos)
Exports		
Commercial crops	5	312
Agricultural food industries	3	3
Industrial exportables	3	366
Imports		
Industrial importables	23	3,763
Import substitutes	62	1,356

Note: The rest of agriculture and services, the remaining two sectors of the model, are nontradables.

Source: Tariff and Customs Code of 1978, Republic of the Philippines.

[6]These are units consistent with the Harberger convention of defining prices to be one in the benchmark equilibrium and may not have any real-world counterpart. The convention is used in order to derive quantity and price information from the given factor payments.

[7]The model can analytically accommodate several consumers. We were, however, limited by lack of data.

[8]The model can be readily generalized to a CES formulation. For our illustrative purposes, the Cobb–Douglas specification was deemed sufficient.

[9]A recent systematic study on Philippine tariff policies using effective protection rates was made by Bautista, Power and associates (1979).

Customs Code of 1978. The numbers reported in the table are weighted averages of the respective tax rates on each member industry of a given sector of the model. The weights used were proportions of the industry's contribution to total imports or exports of the sector in 1978. To calculate the industry tax rates, a simple average of the respective tax rates on the different commodities that made up an industry was taken.

4. Economic effects: Resource-pulls, rents, and deadweight loss

A counterfactual equilibrium without tariffs and export taxes was computed with the model for a complete trade liberalization. The changes in selected economic variables such as factor demands by each sector are taken to be the impacts of tariffs and export taxes.

The resource-pulls of tariffs and export taxes are indicated by the changes in shares of the total factor supply going to individual sectors. These are presented in table 2. For example, Philippine tariff policies draw about 1.9 percent of the total labor supply away from commercial crops, and pull an additional 8.1 percent of total capital supply into the production of import substitutes. Note that the changes for each factor add up to zero, i.e. the factor is fully employed with or without the policies.

Exportables (sectors 1, 2 and 3) lose the most resources to importables (sectors 4 and 5) in a protective policy regime. The effect on homegoods (sectors 6 and 7) is mixed. Homegoods gain about 3 percent of labor supply but lose about 2.2 percent of total capital.

Table 2
Economic effects of trade taxes, Philippines, 1978 (in percent).

Sector	Resource-pulls[a] Labor	Capital	Rents[b]
By individual sector:			
Commercial crops	−1.9	−0.6	−15.8
Agricultural food industries (2)	−3.9	−0.5	−9.2
Industrial exportables (3)	−1.5	−4.7	−12.5
Industrial importables (4)	0.2	−0.1	49.6
Import substitutes (5)	4.1	8.1	44.3
Rest of agriculture (6)	0.5	0.0	20.0
Services (7)	2.5	−2.2	16.4
By trade classification:			
Exportables (1, 2 and 3)	−7.3	−5.8	−11.3
Importables (4 and 5)	4.3	8.0	34.6
Homegoods (6 and 7)	3.0	−2.2	16.8

[a]Resource-pulls are measured as a percent of total factor supply.
[b]The figures reported are the percentage changes in rents.

Since factor prices are equalized in all sectors in the model, factors are reallocated according to changes in the domestic price ratios. For example, if the domestic price ratio of exports and imports (P_E/P_M) falls because of tariffs, the corresponding ratio of the marginal products of a factor, say labor, i.e. MP_L^M/MP_L^E, has to fall under the assumption of profit-maximization. Given diminishing marginal productivity of all factors throughout the model, this decline implies that more labor goes to importables and that less labor is demanded by export-oriented industries.

Accordingly, resources move from exportables into importables, following the decline in their relative prices. In the case of homegoods, there are offsetting features. Factors are pulled away from homegood production by falling relative prices of homegoods and importables. At the same time, however, factors from exportables tend to move into the homegood industries because the relative price of homegoods to exportables increases.

There is substitution of labor for capital in homegood production. As the capital-intensive importables expand, capital is drawn from both exportables and homegoods in greater proportion than labor. On the other hand, the labor-intensive exportables release more labor than capital to importables. Since importables absorb less labor than what is released by exportables, the excess labor is absorbed by homegood production. Thus, homegoods lose some amount of capital and gain additional labor.

Table 2 also shows the percentage changes in rents accruing to sector-specific factors induced by tariffs and export taxes. Rents in the exporting sectors go down by 11.3 percent. They increase in the importing and homegood sectors by 34.6 and 16.8 percent, respectively. The biggest gainer is the industrial imports industry and the commercial crops sectors has lost the most in terms of rents.

The deadweight loss of tariffs and export taxes was calculated using the equivalent variation of income. With a homothetic utility function, this amount as a percent of income is simply the percentage change in utility arising from the imposition of these trade distortions. Thus, the estimated economic loss of Philippine tariffs and export taxes was about 3.4 percent of the free-trade income, with tariffs representing about 97 percent of the waste. This result indicates that trade liberalization would tend to significantly improve overall welfare in the Philippines.

Previous studies suggest that the welfare improvement from trade liberalization is small [e.g. Boadway and Treddenick (1978), Harris (1984), Hamilton and Whalley (1985)] relative to the result we get using our model. Several factors explain the comparatively large welfare gains from tariff reduction for small open economies as described in this paper. With fixed world prices and homogeneous products, trade distortions are fully transmitted to domestic agents in economies, without the cushioning effects of the terms-of-trade adjustments and the Armington assumption. In addition, sector specificities of factors induce additional production inefficiencies.

5. Concluding remarks

We have described a static Shoven–Whalley model to be used for analyzing tariff policies in small developing countries. We represent such countries as price-taking economies in both their imports and exports. The model introduces supply elasticities through sector-specific factors to avoid complete specialization. A Hicks composite traded good market is used to attain trade balance in the model instead of a nominal foreign-exchange market. Following the tradition of pure trade models, we regard foreign goods as perfect substitutes for domestic products.

We illustrate a use of the model to examine the economic effects of Philippine tariffs and export taxes. Resources are shifted from exportables to importables. Since importables are relatively capital-intensive, there is substitution of labor for capital in homegood production. The deadweight loss of trade taxes in the Philippines is about 3.4 percent of income, indicating a substantial deterioration of welfare in the Philippines. This relatively large estimate of the welfare effects of trade distortions is due to a combination of several features in our model, namely fixed world prices, homogeneous products, and sector-specific factors.

The small open economy assumption renders general equilibrium models somewhat more useful for applications in developing countries. Considerable work remains to be done to represent additional realities in the developing world. Structural unemployment, wage and price restrictions, financial distortions, foreign-exchange rationing, as well as directly unproductive activities are some of the features that can be introduced formally into this model to enhance its relevance in other applications.

Appendix

Table A.1
The Benchmark general equilibrium data set, Philippines, 1978 (in million pesos).

								INTM/D	FIN/D	FOR/D	Total
1	1,137	21	4,993	0	460	0	100	6,711	684	5,922	13,317
2	0	889	0	17	15,334	0	415	16,655	24,962	107	41,724
3	1	28	2,221	8,009	1,184	3	1,918	13,364	2,554	11,839	27,757
4	73	294	2,868	14,041	74	4,900	6,714	28,964	29,610	−20,124	38,450
5	2,727	15,538	295	793	11,128	370	7,872	38,723	35,744	−3,544	70,923
6	122	475	0	1,419	4,075	590	242	6,923	3,670	0	10,593
7	99	853	2,987	4,615	7,120	111	16,106	31,891	78,626	0	110,517
INT/COST	4,159	18,098	13,364	28,894	44,201	1,148	33,367				
Labor	3,856	10,329	3,329	2,098	7,224	3,473	32,803				
Capital	558	522	4,715	3,410	10,831	73	20,374				
Rent	4,432	12,772	5,983	285	7,311	5,899	23,973				
Taxes	312	3	366	3,763	1,356	0	0				
Value-added	9,158	23,626	77,150	9,556	26,722	14,393	9,445				
Output	13,317	41,724	27,757	38,450	70,923	10,593	110,517				

Legend: Sector 1 – Commercial crops
2 – Agricultural food industries
3 – Industrial exportables
4 – Industrial importables
5 – Import substitutes
6 – Rest of agriculture
7 – Services

Table A.2
Cobb–Douglas parameters of the Philippine model.

Sector	Labor	Capital	Calibration constants	Expenditure shares
1	0.2896	0.0419	935	0.0039
2	0.2476	0.0125	3,915	0.1419
3	0.1199	0.1699	2,494	0.0145
4	0.0546	0.0887	12,312	0.1684
5	0.1019	0.1527	6,943	0.2033
6	0.3279	0.0069	710	0.0209
7	0.2968	0.1844	810	0.4471
Constant term of the utility function =4.01934[a]				

[a]Benchmark utility index is 170,050, the total final demand.
Legend: Sector 1 – Commercial crops
2 – Agricultural food industries
3 – Industrial exportables
4 – Industrial importables
5 – Import substitutes
6 – Rest of agriculture
7 – Services

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