“Trade Taxes Are Better ?!?
Short Answer: No”

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Abstract: This paper examines the welfare implications of trade reforms with a government budget constraint. A general equilibrium approach is employed to analyze the welfare implications of a revenue-neutral trade reform by expanding the study of Anderson (1999). Unlike the applications in standard trade theory, the tariff revenue cuts due to the tariff reform must be compensated with increases in indirect taxes and not simply by assuming lump sum transfers. The concept of “Marginal Cost of Funds” (MCF) from the public finance literature is utilized to discover whether the prospective change is welfare improving or not. The paper generates MCF figures for 34 countries. The results suggest that there are significant welfare gains to be exploited through further trade liberalization, especially for the developing countries. Replacing trade taxes with indirect domestic taxes is beneficial for the majority (27 out of 34) of the countries in the sample. The results are of special interest to developing countries, which rely on trade taxes as a significant source of their government revenue, as well as for organizations such as the WTO, World Bank or the IMF.

OUTLINE

I. Introduction

In recent years, many countries have followed the path of trade liberalization, eliminating or lowering their trade barriers, and opening their economies to international competition[1]. The growth performance of early liberalizers, such as Hong Kong, Singapore and South Korea, have motivated the rest of the developing world to acknowledge trade liberalization as a powerful policy tool to improve their economic performance and raise standards of living. On November 14th, 2001, the World Trade Organization (WTO)'s 142 members agreed to launch a new round of trade talks in Doha, Qatar, promising to liberalize trade further. There are many expectations from this liberalization process. Robert Zoellick, the US Trade Representative, stated that the new trade round would deliver "growth, development and prosperity". Indeed, trade theory provides us with the insight that eliminating trade barriers enhances economic efficiency, promotes growth and helps correct domestic market failures.

Although gains from trade are indisputable in theory, barriers to trade are still widespread in practice[2]. According to Kubota (2000), there are three main reasons that explain why trade barriers are so prevalent: restricting trade can be an optimal policy (infant industry, strategic trade policy, etc...), interest group politics to intervene in trade, and finally there is the revenue-raising aspect of trade barriers. The last one is the most relevant for developing countries[3].

This paper focuses on the welfare implications of trade reforms and compensating taxation, while taking into account the importance of the revenue-

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[1] In Latin America, trade policy reforms started in countries like Chile and Mexico in themid-1980s, followed by Argentina, Brazil, Peru and Venezuela. In Asia, around the same time, China, the Philippines, Taiwan and Vietnam employed openness policies. Even in Africa, where trade taxes are still higher compared to the rest of the world, countries like Ghana, Nigeria, Tanzania and Zaire recently started to liberalize their trade policies.

[2] Uruguay Round 1994, from WTO sources.

[3] The cost of raising revenue through domestic resources is very high in developing countries (such as African countries). The lack of necessary infrastructure to monitor, administer and collect domestic taxes makes it easier to rely on tariffs.

raising aspect of trade barriers. It investigates a direct cost: loss of tax revenue from trade, which must be made up from increases in other distortionary taxes or cuts in government spending. Since this loss can be substantial for developing countries, the welfare implications of trade liberalization become an important issue. The net effect can be a loss.

This paper builds on Anderson's (1999) study by investigating in more depth the Marginal Cost of Funds --- MCF --- calculations for distortionary taxation. MCF for any tax increase is given by the ratio of the incremental compensation, required to maintain real income to the incremental tax revenue. After finding the MCF for each of the two taxes, a revenue neutral shift from the tax with high MCF to the tax with low MCF is welfare improving. More generally, the MCF of any tax can be compared to the marginal benefit of the funds raised.

In particular, this paper aims to shed light on the following questions; "What is the MCF for trade taxes versus output taxes?", "Are revenue neutral trade reforms welfare improving for the case of distortionary taxes?" and finally "Are there "cheaper" distortionary taxes that we can replace the trade taxes with?" The application to real life follows through the "marginal cost of funds - marginal benefit of revenue" analysis, which provides a metric to evaluate the welfare implications of the compensating taxation. The net benefit of tax reform which switches from trade to production taxes is given by MCF(trade)-MCF(production).

The empirical part of this paper illustrates the welfare costs of trade taxes versus output taxes for 34 countries. For 27 of them, trade taxes are the more "expensive" distortion, hence a trade liberalization compensated with an output tax policy is welfare improving. The empirical determinants of this pattern in terms of tax rates and structural characteristics of countries are also investigated. The results of this paper might be of special interest for developing countries and for organizations like the WTO, the World Bank and IMF, which advise developing countries on their economic policies.

This study contributes to the growing research program on welfare implications of trade liberalization in several dimensions. The first is the utilization of an increasingly popular and very intuitive welfare measurement tool, the marginal cost of funds (MCF). In contrast to much of the theoretical and applied literature, it uses the *compensated* MCF for reasons explained below. The second is the large number of countries[4] that this measurement tool is applied to in the context of a computable general equilibrium (CGE) model, to answer the question posed in the title. In contrast to the small number of existing MCF calculations, a *common* CGE structure is used for the set of countries. Third, the explicit usage of intermediate imported inputs to make the model employed in this study more realistic (especially for the developing countries). And finally, the large quantity of countries investigated in this paper provides the sufficient number of observations for an econometric analysis that sheds light on the determinants of the MCF of both import and output taxes.

The current literature on trade liberalization acknowledges that trade taxes constitute an important part of government revenue in developing countries and can also be substantial in some cases for developed countries. In low income countries trade taxes account for approximately a quarter of the total tax revenues.[5, 6] Ebrill, Stotsky and Gropp (1999) report that in a group of selected developing countries in Africa, trade taxes account for about 5.5 percent of GDP on average in 1995. Keen and Lightart (1999) reveal that tariff revenue accounts for approximately 27 percent of the total tax revenue in Africa, and Matusz and Tarr (1999) report that explicit trade taxes account for 38 percent (19 percent) of

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[4] Partially due to complexity of modeling and setting up the SAM (Social Accounting Matrix), most CGE models are built to run for only one country. One of the most recent and most comprehensive studies involving MCF figures and CGE modeling was done by Devarajan, Thierfelder and Suthiwart-Narueput (2000) and covers only 3 countries (Cameroon, Bangladesh and Indonesia).

[5] For OECD countries the same ratio is only 0.5%

[6] from Government Finance Statistics, 1997

total revenues in low (middle) income countries. As a consequence of this heavy reliance on trade taxation, "certain developing countries have postponed, slowed or reversed trade liberalization measures on the grounds that losses in trade tax revenues undermine their government's budget constraint.[7]"

A recent evaluation of IMF-approved Structural Adjustment Facility (SAF) and Extended Structural Adjustment Facility (ESAF) programs[8] reveals that some countries targeted an increased reliance on international trade taxes as the source of government revenue. They attained higher ratios of trade tax revenue to GDP at the end of the SAF/ESAF-supported adjustment period. In an environment where a new trade round is in progress and the prominent international organizations such as the World Trade Organization (WTO), the World Bank and the International Monetary Fund (IMF) strongly advocate for trade liberalization, attention is placed on the consequences of compensating for the revenue loss due to the liberalization, and whether the whole operation, including recapturing the foregone tariff revenue, will be welfare improving.

The literature offers little guidance on coordinated tariff-tax reforms, which take into account the binding budget constraint of many developing countries. The literature on the welfare effects of piecemeal trade reform typically employs lump-sum transfers to compensate for the revenue consequences of the tariff reform. Thus, most of the literature simply assumes no distortionary taxes other than tariffs[9].

Recently, research in the area of coordinating tariff reductions with

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[7] Evenett and Madani (2000).

[8] External Evaluation of the ESAF Report by a Group of Independent Experts, June 1998. Available at IMF website: http://www.imf.org/external/pubs/ft/extev/index.htm.

[9] The theoretical results of piecemeal policy reform, obtained under the assumption that all distortions are tariffs, may not hold if there are other distortions such as a production subsidy/tax, Beghin and Karp (1992).

domestic tax reforms has gained momentum[10]. According to the theoretical paper of Keen and Lightart (1999), combining any tariff cut with a consumption tax reform which leaves the consumer prices unchanged increases both welfare and public revenue. Their compensating policy tool, domestic consumption taxes, differs from the one used in this paper, output taxes, and their experiment is not revenue-neutral. But their findings are consistent with ours: tariff reforms are favorable in the context of coordinated tariff-tax packages. Rajaram (1994) examines whether the revenue effects of tariff reform proposals of the World Bank were anticipated and complemented by other tax measures. He finds out that in many cases they are neither anticipated, nor complemented. Abed (1998) stresses the link between trade liberalization and domestic tax reform and details the types of tax reforms that would support trade reform by generating the compensatory revenue and, in the long run, reduce the distortionary effects of tax and tariff systems[11]. Findings in outcome of these studies suggest the necessity for further investigation.

The significance of imported intermediates in trade policy and welfare analysis is repeatedly acknowledged in the literature[12]. The inclusion of intermediate imported inputs to the production structure (see Figure 3.1) is one of the innovations to the model. For the 34 countries investigated in this paper, the share of imported intermediates to total imports is very high (especially for developing countries)[13]. In fact, most of the MCF estimates that were calculated with a "simple model" treating all imports as final goods have changed when switching to the "advanced model" with intermediate imported inputs (see Section III for the model layout). In the "simple model", imports are treated as final goods,

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[10] Greenaway and Milner (1991), Mitra (1992), Rajaram (1994), Datta-Mitra (1997), Abed (1998), Kubota (1999), Keen and Lightart (1999), Ebrill et al (1999).

[11] Abed (1998) focuses on trade liberalization between the Southern Mediterranean Region and the European Union by reviewing comparative data.

[12] Markusen (1989), Lopez and Panagariya (1992), Lopez-de-Silanes, Markusen and Rutherford (1992) and Goulder and Williams III (1999).

[13] It is about 70% for most of the developing countries.

and high trade taxes shift the consumption away from imported goods towards domestically produced goods. In the "advanced model", trade taxes impose distortion not only on the consumption side but also on the production side. High trade taxes distort the production by causing a shift away from imported intermediates toward domestic intermediates. Therefore, it is intuitive that in the "advanced model" trade taxes generate more distortion and become relatively "more expensive" for most of the countries in the sample.

The starting point for this paper is a study by Anderson (1999), where he determines that a revenue neutral trade reform may not always improve welfare. He introduces a government budget constraint where a change in tariff revenue due to trade reforms is offset by public good decreases or other tax increases. To measure welfare effects, Anderson uses the concept of the compensated Marginal Cost of Funds (MCF)[14] from the public finance literature and generates sufficient conditions for the revenue-neutral trade reform to be welfare increasing. He analyzes an example of a simple efficient tax by using a uniform radial change in the consumer tax vector to compensate uniform radial reductions in tariffs, in other words, taxing all the consumption at the same rate[15]. Anderson asks a basic question: "Is replacing trade taxes with distortionary[16] consumption taxes always beneficial?" In the empirical part of his paper, Anderson presents a small-scale CGE model of the Korean economy in 1963, and provides an example of welfare-decreasing replacement, despite higher average trade taxes than consumption taxes. His result shows that no presumption is obtained. There is a need to investigate under which circumstances Anderson's result is likely, and to study welfare implications for further cases of compensation with distortionary taxation.

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[14] Explained in detail on the next page.

[15] According to Hatta (1977), uniform radial tariff cuts with lump sum taxes are always welfare improving. According to Dixit (1985), it is optimal for a small open economy to raise any revenue it needs by setting all tariffs to zero and relying entirely on consumption taxes (which is a straight forward application of the Diamond-Mirrlees (1971) theorem that consumption taxes dominate trade taxes at the optimum).

[16] Note that although it is extremely convenient to implement, there is no application of "lump sum" taxation into the real economy.

It is important to point out that the MCF used in this study is the compensated version of MCF. A crucial property of the compensated MCF concept is that it is comparable across economies, model specifications and parameterizations. This allows an investigation into the determinants of differing MCFs. Its use in this research stands in contrast to prevailing usage in the public economics and relevant trade or tax reform literature (Snow and Warren, 1996) where the uncompensated, or money metric utility, version of MCF is widely employed. The uncompensated MCF is inherently non-comparable across models or countries because it is a money metric measure of utility. A more detailed intuition, a formal derivation and a simple example of MCF will follow in section II.

A summary of a literature survey on MCF reveals its differing definitions and widespread usage. Ahmad and Stern (1990) contribute to the public finance literature by using the comparison of "marginal social costs" to evaluate "shadow" revenue neutral marginal shifts from one tax to another. The difference between their approach and the one used in this paper, is that they focus on the role of shadow prices and distributional values whereas our results use the compensated MCFs to compare policy reforms across countries. Devarajan, Squire and Suthiwart-Narueput (1995) stress the usefulness of MCF, especially for projects that are characterized by public costs and private benefits. Other papers by Mayshar (1991) and Allgood and Snow (1998) try to define the different methods of calculating MCF estimates and explain the wide discrepancy between the estimates in the literature. Devarajan, Thierfelder and Suthiwart-Narueput (2000) argue, "if the MCF across different tax instruments varies greatly, directions for revenue-neutral tax reform are readily apparent". They provide MCF estimates for three developing countries – Cameroon, Bangladesh and Indonesia, and conclude that "the potential for revenue-neutral (or even revenue-increasing) tax reforms in developing countries is enormous." They claim that MCF analysis provides the necessary groundwork for tax reform efforts. Slemrod and Yitzhaki (2001) use the MCF as the main concept to evaluate distortionary cost of fund raising. Rutherford (2001) uses MCF for 5 different tax instruments for Columbia to assess possibilities of tax reform. His analysis is undertaken with the Columbian National Department of Planning, proving the policy makers' increased attention towards MCF estimates.

The layout of the paper is as follows. Section II sets out the intuition of the compensated MCF, the formal derivation and a small example with specific functional forms. Section III lays out the model. Section IV examines the empirical work by investigating the Social Accounting Matrix (SAM), the elasticities employed in the study, the calibration procedure and the mechanics of the CGE model. Section V reports the empirical results. Section VI lays out the conclusion of the paper, and Section VII discusses some potential extensions and implications for future research.

II. Marginal Cost of Funds (MCF) – Intuition and Derivation in a Simple Model

i) Basic Intuition

An increase in taxes will decrease the real income of the consumer and raise tax revenue for the government at the same time. The Marginal Cost of Funds (MCF) for any tax increase gives the ratio of the marginal compensation required to maintain real income to the marginal tax revenue raised by this tax increase. In other words, it is the marginal cost of raising another dollar of tax revenue.

Below is the simplest formula of the MCF, where we assume a single imported good.

Consider a small open economy with an imported good at international price p^*, which is selling domestically for p due to a tariff[17]. Assume that all goods are tradable, and there are no other distortions in the economy. Denoting the quantity of imports by m, MCF after a small perturbation in the tariff can be defined as follows:

$$MCF = \frac{mdp}{[m + (p - p^*)m_p]dp}, \qquad (2.1)$$

where mdp is the marginal compensation and $[m + (p - p^*)m_p]dp$ is the marginal tax revenue change. Here and for the remainder of the paper, a subscript denotes partial differentiation. For a single import, due to the substitution effect the scalar excess demand slope m_p<0, hence, MCF>1. Intuitively, it takes more than one dollar of compensation to maintain real income, when $1 of added tariff revenue is raised.

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[17] Note that "p" here is the domestic price of a single import, whereas "p" in the formal derivation, on the next page, will denote the relative price vector of private goods.

ii) Formal Derivation

The formal derivation uses a simplified version of the model laid out in Section III and serves mainly to verify the intuition.

The framework of the model is built on the representative consumer's expenditure function, $e(p,u)$, and the gross domestic product function, $g(p,v)$.

The expenditure function, $e(p,u)$ gives the minimum expenditure on private goods needed to reach a utility of u, where p is the relative price vector for private goods.

The gross domestic product function, $g(p,v)$ gives the maximized value of private production at prices p, where v represents the vector of primary factors of production in a convex technology with constant returns to scale (CRS) and perfect competition. By the exhaustion of product theorem, the gross domestic product function measures the total payments to factors.

The following set up gives the simplest case where the public goods are not included in the equations to simplify the analysis[18]. Moreover, the prices of the non-distorted goods are suppressed.

The net expenditure on private goods at domestic prices can be defined as

$$E(p,u,v) = e(p,u) - g(p,v) \,, \qquad (2.2)$$ [19]

The private budget constraint is as follows:

$$E(p,u,v) = 0 \qquad (2.3)$$ [20]

denoting the net expenditure on the private goods.

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[18] Including an exogenously determined G, and hence using dG=0 would bring us to the same result.

[19] Note that all goods are assumed to be tradable. Otherwise, we must solve for the non-traded goods prices. Non-traded goods are formally handled by $E(p,u,v) \equiv \max_h [e(p,h,u) - g(p,h,v)]$.

[20] Note that (2.3) implies that there are no direct transfers to the representative consumer.

The government budget constraint is:

$$(p-p^*)' E_p(p,u,v)-\beta=0 \qquad (2.4)$$

The first term gives the tariff revenue of the government where $(p-p^*)$ denotes the price wedge (tariff) and E_p gives the vector of excess demands. The second term, β, denotes external transfer. Eventually, β will pay for a reduction in revenue from other taxes.

Now we can introduce a package of tariff changes by perturbing the domestic price vector p. Changes in domestic prices can be denoted as $dp^i = W^i p \cdot d\tau$, where W^i is a diagonal matrix of weights (i standing for a member of an index set[21]) and $d\tau$ is a scalar.

Next step is discussing the effect of an exogenous change in the external transfer, $d\beta$, solved for the exogenous change in dp and in welfare du. Totally differentiating the government budget constraint:

$$E_p' Wp \cdot d\tau + (p-p^*)' E_{pp} Wp \cdot d\tau + (p-p^*)' E_{pu} \cdot du = d\beta \qquad (2.5)$$

and the private budget constraint:

$$E_p' Wp \cdot d\tau = -E_u du \qquad (2.6)$$

The endogenous tax reduction, $dp^i = W^i p d\tau$, is financed by this external transfer. In other words, government budget constraint is first altered by an external transfer, $d\beta$, then balanced by an endogenous change in taxes, $d\tau$, where $d\tau$ is given by:

$$d\tau = -\frac{1}{E_p' Wp + (p-p^*)' E_{pp} Wp} d\beta - \frac{1}{E_p' Wp + (p-p^*)' E_{pp} Wp} (p-p^*) E_{pu} du \qquad (2.7)$$

[21] For notational convenience, this index will be suppressed in the remainder of the derivation.

(2.7) is obtained using the government budget constraint only. Solving for $d\tau$ from the private budget constraint (2.6), we obtain:

$$\frac{-E_u du}{E_p' Wp} = d\tau \qquad (2.8)$$

Substituting (2.7) into (2.8) we end up with (2.9):

$$\frac{E_u du}{E_p' Wp} = \frac{1}{E_p' Wp + (p - p^*)' E_{pp} Wp} d\beta + \frac{1}{E_p' Wp + (p - p^*)' E_{pp} Wp} (p - p^*) E_{pu} du$$

Multiplying both sides by $\frac{E_p' Wp}{d\beta}$, and rearranging terms, we find (2.10):

$$\frac{E_u du}{d\beta} = \frac{E_p' Wp}{E_p' Wp + (p - p^*)' E_{pp} Wp} + \frac{E_p' Wp}{E_p' Wp + (p - p^*)' E_{pp} Wp} (p - p^*) \frac{E_{pu}}{E_u} \frac{E_u du}{d\beta}$$

Rewriting 2.10 we end up with a term that includes MCF,

$$\frac{E_u du}{d\beta} (1 - MCF (p - p^*) \frac{E_{pu}}{E_u}) = MCF \, , \qquad (2.11)$$

where $MCF \equiv \frac{E_p' Wp}{E_p' Wp + (p - p^*)' E_{pp} Wp}$, and (2.12)

E_p denotes the vector of excess demand,

E_{pp} is the matrix of compensated price derivatives of excess demand,

E_u is the change in excess demand with respect to change in utility,

$(p - p^*)' E_{pu} du$ is the income effect on tax revenues, and

$1/[1 - MCF(p - p^*)' E_{pu} / E_u]$ gives the price of an additional unit of money metric utility in terms of external compensation, the shadow price of foreign exchange or the fiscal multiplier.

The intuition behind the right hand side of (2.12) is straightforward; the nominator stands for the private marginal cost of the tariff change or in other words, it is the magnitude effect of a unit tariff change on the representative agent. The denominator gives the net revenue raised by the tariff change. All changes are at constant utility (u). Going back to the scalar case introduced in the introduction of this section, we can see that (2.1) and (2.12) give the same intuition. The MCF in the scalar case can be reduced to:

$$MCF = \frac{1}{1 + (p - p^*) m_p / m} \tag{2.13}$$

The nominator reports one unit of external transfers, and the denominator gives the revenue raised due to tariff reductions financed by this external transfer.

Equation (2.11) also gives us the direct relationship between the money metric (or the uncompensated) and compensated MCF. The difference between these two measures is captured by μ in (2.14) below, known as the "shadow price of foreign exchange" in the international trade literature, also called the "fiscal multiplier" by Anderson and Martin (1995):

$$\mu = \frac{1}{1 - MCF(p - p^*) \frac{E_{pu}}{E_u}} \tag{2.14}$$

The fiscal multiplier describes the price of an additional unit of money metric[22] utility in terms of external compensation[23].

The compensated MCF is simply the money metric MCF (MMCF) divided by this "fiscal multiplier":

$$MCF = MMCF / \mu \tag{2.15}$$

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[22] Money metric utility measures transform utils into expenditure units.

[23] The fiscal multiplier is generally positive and greater than one (Hatta, 1997), but may be also less than one under some circumstances (Fullerton, 1991).

MCF, as described in (2.12), is the compensated (utility constant) marginal cost of raising another dollar for external transfer by using tariffs. The fiscal experiment is donating an external dollar to the government and inducing a one dollar reduction in tax revenue generated from tariffs. This experiment gives us the compensated benefit of MCF, the willingness to pay for a dollar of external transfer to finance a tax reduction. The important difference between the money metric version of MCF and the compensated MCF is that the money metric version of MCF does not have the "willingness to pay" interpretation; hence it doesn't allow international or interregional comparisons.

This experiment can be extended to two sets of taxes[24]. One group of taxes is altered exogenously, and another group of taxes change endogenously to maintain the tax revenue at a constant level. For this analysis, we need to calculate MCF^i and MCF^j for two group of goods i and j, respectively. Let p^j denote the vector of prices of the subset of goods whose tax rates are varied exogenously, and p^i denote the vector of prices of the subset of goods whose tax rates are varied endogenously. Defining the exogenous change in taxes for the j set of goods as $dp^j = W^j p^j d\tau^j$, we solve the differential of the government budget constraint for the endogenous change, $dp^i = W^i p^i \cdot d\tau^i$.

The solution for $d\tau^i / d\tau^j$ is (2.16)

$$\frac{d\tau^i}{d\tau^j} = \frac{-1}{E_{p^i}'W^i p^i + (p - p^*)' E_{\bullet i} W^i p^i} + \frac{-1}{E_{p^i}'W^i p^i + (p - p^*)' E_{\bullet i} W^i p^i}(p - p^*)' E_{pu} \frac{du}{d\tau^j}$$

where $E_{\bullet i}$ is the matrix $\begin{pmatrix} E_{ii} \\ E_{ji} \end{pmatrix}$, which captures the substitution effect.

Solving $d\tau^i / d\tau^j$ together with the differential of the private budget constraint we

[24] This section closely follows the setup of the differential tax case by Anderson and Martin (1995).

obtain:

$$(1 - MCF^i (p - p^*)' \frac{E_{pu}}{E_u}) E_u \frac{du}{d\tau^j} = \left(\frac{MCF^i}{MCF^j} - 1 \right) E_{p^j}' p^j \tag{2.17}$$

where MCF^i is defined as:

$MCF^i = \dfrac{E_{p^i}' W^i p^i d\tau^i}{E_{p^i}' W^i p^i d\tau^i + (p - p^*)' E_{\bullet i} W^i p^i d\tau^i}$ and MCF^j is also defined similarly.

$(1 - MCF^i (p - p^*)' \dfrac{E_{pu}}{E_u})$ is the fiscal multiplier for endogenous taxes.

The intuition tells us that if the taxes for group i goods are more costly, in other words if $MCF^i > MCF^j$ (which indicates that the term in the brackets, $\left(\dfrac{MCF^i}{MCF^j} - 1 \right)$, is positive), an increase in taxes for group j goods accompanied by a revenue neutral cut in taxes for group j goods will be welfare improving.

iii) A Cobb-Douglas Experiment

In the model employed in this paper, the two different kinds of taxes are, trade taxes and output taxes[25]. Below, we will demonstrate a simple derivation of the MCF for trade taxes versus production taxes using the Cobb-Douglas functional form[26].

Consider two classes of goods being taxed: imported goods and domestically produced goods. As in the previous part, the production structure assumes constant returns to scale and perfect competition. The small country assumption fixes the foreign prices for imports to p*. Tariffs cause the domestic price for the imports, p, to differ from the world price, p*. Let q be the producer

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[25] Output taxes are collected from the domestic producers and increase the price of domestic production. See Section III for further explanation of the tax structure of the model.

[26] Note that the setup of this C-D example is independent from the previous part (formal derivation).

price of the domestic goods, and q* differs from q by the production taxes. There is in the background a third untaxed class of goods, here made explicit as an exportable good (see footnote 10).

Focusing on

$$MCF^{p} = \frac{1}{1+[(p-p^*)E_{pp}(p-p^*)+(q-q^*)E_{qp}(p-p^*)]/(p-p^*)E_{p}} \qquad (2.18)^{27}$$

we need to find E_p, E_{pp} and E_{qp}.

The starting point is a Cobb-Douglas utility function:

$$u(x_1, x_2) = x_1^{\beta_1} x_2^{\beta_2}, \qquad (2.19)$$

where x_1 stands for imports and x_2 for domestic goods, and β_1 and β_2 for their shares in total consumption[28].

We maximize the utility function subject to the budget constraint of the households,

$$px_1 + qx_2 \leq I, \qquad (2.20)$$

where I stands for income[29], and obtain the Marshallian demand functions:

$$x_1 = \beta_1 I / p \qquad (2.21)$$

and

$$x_2 = \beta_2 I / q \qquad (2.22)$$

Next, using the indirect utility function, we can derive the expenditure function:

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27 (2.15) assumes endogeneity of producer prices.

28 $\beta_1 + \beta_2 < 1$, which implies that there is an untaxed good in the background. The reason for this assumption is that if we had the power to tax all goods, then Ramsey's optimal taxation rule should be followed.

29 Note that in the previous section we adopted the convention of treating the factor supplies as negative factor demand. Here we are defining I to be the income.

$$e(p,q,u)=\frac{p^{\beta_1}q^{\beta_2}}{\beta_1{}^{\beta_1}\beta_2{}^{\beta_2}}\cdot u \qquad (2.23)$$

Taking partial derivatives with respect to p and q, respectively, we find

$$e_p=\beta_1\frac{e}{p} \qquad (2.24)$$

and

$$e_q=\beta_2\frac{e}{q}, \qquad (2.25)$$

and taking their derivatives with respect to p, we obtain the second derivatives of the expenditure function:

$$e_{qp}=\beta_1\beta_2\frac{e}{pq} \qquad (2.26)$$

and

$$e_{pp}=\beta_1{}^2\frac{e}{p^2}-\beta_1\frac{e}{p^2} \qquad (2.27)$$

Now, dividing (2.24) by (2.21), we obtain:

$$e_{pp}/e_p=(\beta_1-1)/p\ , \qquad (2.28)$$

and similarly dividing (2.23) by (2.21), we find

$$e_{qp}/e_p=\beta_2/q \qquad (2.29)$$

The next step is defining g as a fixed endowment GDP function:[30]

$$g=q\overline{Y}+Z, \qquad (2.30)$$

where Z is the endowment of the third untaxed good.

The first and second derivatives of this simple GDP function give us:

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[30] With this definition, conveniently, $e_{pp}/e_p=E_{pp}/E_p$.

$$g_q = \overline{Y} \tag{2.31}$$

and

$$g_{qq} = g_{qp} = 0 \tag{2.32}$$

Using (2.28) and (2.29), we can show that

$$E_{pp} / E_p = e_{pp} / e_p \tag{2.33}$$

and

$$E_{qp} / E_p = e_{qp} / e_p \,. \tag{2.34}$$

We also assume that q* is fixed, so that $\overline{Y}$ is exported[31]. Taxation of imports means p>p* while taxation of the exportable means q<q*.

Substituting (2.30) and (2.31) into (2.15), we obtain the following equations for the MCF^p and MCF^q, the marginal cost of funds for trade taxes and for production taxes, respectively:

$$MCF^p = \frac{1}{1-[(1-\beta_1)\frac{p-p^*}{p} - \beta_2 \frac{q-q^*}{q}]} \text{ and} \tag{2.35}$$

$$MCF^q = \frac{1}{1-[\beta_1 \frac{p-p^*}{p} - (1-\beta_2)\frac{q-q^*}{q}]} \tag{2.36}$$

In both cases, the MCF figure is greater than one. This is consistent with intuition. It is also important to note that the ranking between MCF^p and MCF^q depends on the price wedges (the size of the distortion) and on shares of imported versus domestically produced goods in the expenditure function of the consumer. Depending on the restrictiveness of the country and the preferences of the consumer, MCF^p could be greater or smaller than MCF^q. Hence, a tariff reform

[31] Small country assumption fixes the world prices of exports.

could potentially be more costly than initially thought if the revenue lost has to be recaptured using the "expensive" output taxes.

For more complex production, preference and tax structures it need not be true that MCF for a given tax is always greater than one. Devarajan et al. (2000) report that MCF figures come out to be less than one for indirect taxes in Bangladesh and Cameroon and tariffs in Indonesia when the lowest tax is raised. They argue that "in developing countries with large distortions, a tax whose substitution effect lowers that large distortion could have a very low or negative welfare cost. A policy which increases the lowest tax rate, in the absence of other distortions, will reduce the marginal cost of funds as the tax structure becomes more uniform"[32]

While the intuition behind the MCF calculations are as illustrated above, the mechanics of the CGE application will be explained in Section IV.

[32] Furthermore, recent literature on the so-called double dividend from a green tax reform investigates the substitution of green (or Pigouvian) taxes for standard distortionary taxes, holding the government revenue constant. The green taxes apply to commodities of factors of production generating negative external effects. The MCF from this experiment turns out to be less than one, since there is an efficiency gain from tax finance.

III. The Model

The simple computable general equilibrium (CGE) model used in this paper simulates the working of a small open market economy. It assumes perfect competition and constant returns to scale (CRTS) in production. There are three sectors: agriculture, manufacturing and services. Labor and capital are the two primary factors used in the production of each sectoral output. They are not sector specific, and are perfectly mobile across sectors. Other inputs into the production structure are the domestic and imported intermediates, which are also imperfectly substitutable for each other. A multi-level nesting of all the factors of production (see Figure 3.1) constructs the sectoral output. Each sector then decides how much of the sectoral output will be produced as exports or domestic products for domestic consumption, which are imperfect substitutes in supply (Figure 3.2). The households and the government consume composite consumption goods, which are combinations of domestic and imported consumption goods. The Armington specification between imports and domestic goods indicates imperfect substitution in demand (Figure 3.3). The representative consumer has a Cobb-Douglas utility function in the three aggregates. Expenditure functions arise from these Cobb-Douglas preferences and their CES subutility functions. The household revenue comes from factor payments to capital and labor and transfers from the government. Government consumption equals its revenue from different types of taxation (including trade taxes) plus foreign transfers (remittances) minus transfers to households. In this simple model, the government does not supply a public good. The world price of exports and imports is assumed to be exogenous due to the small country assumption. Trade is taxed via tariffs on imports. The other distortion is the output tax that applies to all domestic production. The social accounting matrix for the benchmark year, the calibration process and the magnitude and sources of the elasticities used in CES and CET aggregation functions are discussed in the next section (Section IV).

Below is the equation by equation mathematical model statement[33].

A) Production Block, Factor Markets and Intermediate Inputs

The domestic production process combines value added (VA) from labor (L) and capital (K) and composite intermediate input (V) from domestic (X) and imported intermediate inputs (XI) to produce goods and services on a sectoral basis according to the nested constant elasticity of substitution (CES) production structure below:

$$Y_i = TOP_i[h_i VA_i^{\frac{\tau_i - 1}{\tau_i}} + (1-h_i)V_i^{\frac{\tau_i - 1}{\tau_i}}]^{\frac{\tau_i}{\tau_i - 1}} \text{, SECTORAL OUTPUT} \quad (3.1)$$

relates output to value added (VA) and composite intermediates (V).

$$VA_i = AD_i[\gamma_i L_i^{\frac{\sigma_i - 1}{\sigma_i}} + (1-\gamma_i)K_i^{\frac{\sigma_i - 1}{\sigma_i}}]^{\frac{\sigma_i}{\sigma_i - 1}} \text{, VALUE-ADDED} \quad (3.2)$$

relates value-added to labor (L) and capital (K).

$$V_i = AVD_i[k_i X_i^{\frac{\vartheta_i - 1}{\vartheta_i}} + (1-k_i)XI_i^{\frac{\vartheta_i - 1}{\vartheta_i}}]^{\frac{\vartheta_i}{\vartheta_i - 1}} \text{, COMPOSITE INTERMEDIATE} \quad (3.3)$$

relates the composite intermediate to imported (XI_i) and domestic intermediate inputs (X_i). The subscript "i" stands for the 3 different sectors of the model, where i=agriculture, industry or services.

- Y_i denotes the sectoral output,
- VA_i is the value-added,
- V_i is the composite intermediate input
- L_i and K_i are the two factors of production, labor and capital,
- X_i and XI_i are domestic and imported intermediate goods used in production,
- TOP_i, AD_i and AVD_i are shift parameters,

[33] The model presented here is in concordance with most of the standard CGE models in GAMS and it follows the neoclassical-structuralist modeling tradition that is presented in Dervis, de Melo, and Robinson (1981). A more detailed discussion on the choice of the structure of the model and functional forms can be found in, "A Standard CGE Model in GAMS," by Löfgren, Lee Harris and Robinson (2001) and "CGE Modeling for Regional Analysis," by Schreiner, Marcouiller, Tembo and Vargas (1999).

- h_i,γ_i and k_i are share parameters (also known as the distribution parameters)

- τ_i, σ_i and υ_i are the elasticities of substitution between VA_i and V_i, L_i and K_i, and X_i and XI_i respectively[34].

In setting out (3.3) as it is, substitution between sectoral domestic intermediates is suppressed, and the same is true for sectoral imported intermediates.

The marginal products of factors of production, wage and rent, are derived from the value-added function using the MV=MP principle of perfect competition:

$$WAGE_i = \frac{\partial VA_i}{\partial L_i} = (\frac{1}{AD^{\frac{\sigma_i - 1}{\sigma_i}}})\gamma_i PVA_i (VA_i / L_i)^{1/\sigma_i} \text{, WAGES} \quad (3.4)$$

$$RENT_i == \frac{\partial VA_i}{\partial K_i} = (\frac{1}{AD^{\frac{\sigma_i - 1}{\sigma_i}}})(1-\gamma)_i PVA_i (VA_i / K_i)^{1/\sigma_i} \text{, RENTS} \quad (3.5)$$

where PVA_i stands for the price of the value-added good.

In other words, at the sectoral level, value added consists of payments to both labor and capital:

$$PVA_i \cdot VA_i = WAGE_i L_i + RENT_i K_i \quad (3.6)$$

The sectoral demand for labor and capital are determined by equations (3.4) and (3.5) respectively:

$$L_i = VA_i [(\frac{1}{AD^{\frac{\sigma_i - 1}{\sigma_i}}})\gamma_i (PVA_i / WAGE_i)]^{\sigma_i} \quad (3.7)$$

$$K_i = VA_i [(\frac{1}{AD^{\frac{\sigma_i - 1}{\sigma_i}}})(1-\gamma_i)(PVA_i / RENT_i)]^{\sigma_i} \quad (3.8)$$

The total supply of labor and capital are assumed to be invariant with

[34] Section IV looks into elasticities in more detail.

respect to the wage rate and rent. Both of the factors of production are assumed to be perfectly mobile across all three sectors[35], therefore their returns are the same across all sectors, and the labor market and capital market equilibrium conditions are given by:

$$\sum_i L_i = L \text{ and } \sum_i K_i = K , \qquad \text{(3.9) and (3.10)}$$

where L and K represent the fixed amounts of endowments obtained from the SAM (social accounting matrix) of the benchmark year.

Similarly, the prices of intermediate inputs, PX_i and PXI_i, can be derived from the composite intermediate inputs function:

$$PX_i = \frac{\partial V_i}{\partial X_i} = \left(\frac{1}{AVD^{\frac{\vartheta_i - 1}{\vartheta_i}}}\right) k_i PXV_i (V_i / X_i)^{1/\vartheta_i} \qquad (3.11)$$

$$PXI_i == \frac{\partial V_i}{\partial XI_i} = \left(\frac{1}{AVD^{\frac{\vartheta_i - 1}{\vartheta_i}}}\right)(1-k)_i PXV_i (V_i / XI_i)^{1/\vartheta_i} \qquad (3.12)$$

where PXV is the price of the composite intermediate good.

At the sectoral level, value of the composite intermediate inputs consists of payments to both domestic and imported intermediate inputs.

$$PXV_i \cdot V_i = PX_i \cdot X_i + PXI_i \cdot XI_i \qquad (3.13)$$

where is the price of the composite intermediate good.

The sectoral demand for domestic and imported intermediates are determined by equations 3.14 and 3.15 respectively:

$$X_i = V_i \left[\left(\frac{1}{AVD^{\frac{\vartheta_i - 1}{\vartheta_i}}}\right) k_i (PXV_i / PX_i)\right]^{\vartheta_i} \qquad (3.14)$$

---

[35] Alternatively, capital could be assumed sector specific $K_i = \overline{K_i}$, where $\overline{K_i}$ is the fixed stock of capital by sector. In that case, the return of capital (RENT) would be determined as a residual from equation (3.5) after labor is paid the value of its marginal product.

$$XI_i = V_i[(\frac{1}{AVD^{\frac{\vartheta_i - 1}{\vartheta_i}}})(1-k_i)(PXV_i / PXI_i)]^{\vartheta_i} \tag{3.15}$$

Figure 3.1 on the next page lays out the production structure.

B) Supply Behavior

Above, we laid out the choice of the producer between factors of production and intermediate inputs. After the producer decides on the combination of inputs, the next choice he faces is either to produce for the domestic market or for the export market. At this stage, sectoral domestic output is allocated between exports and domestic sales on the assumption that suppliers minimize cost (or maximize sales revenue) for any aggregate output level. The CET (constant returns to transformation) joint production (or also referred as output transformation) function marks this choice, which makes the domestic products and exports imperfect substitutes in supply. The CET function, which applies to commodities that are both exported and sold domestically, is identical to a CES function except for negative elasticities of substitution.

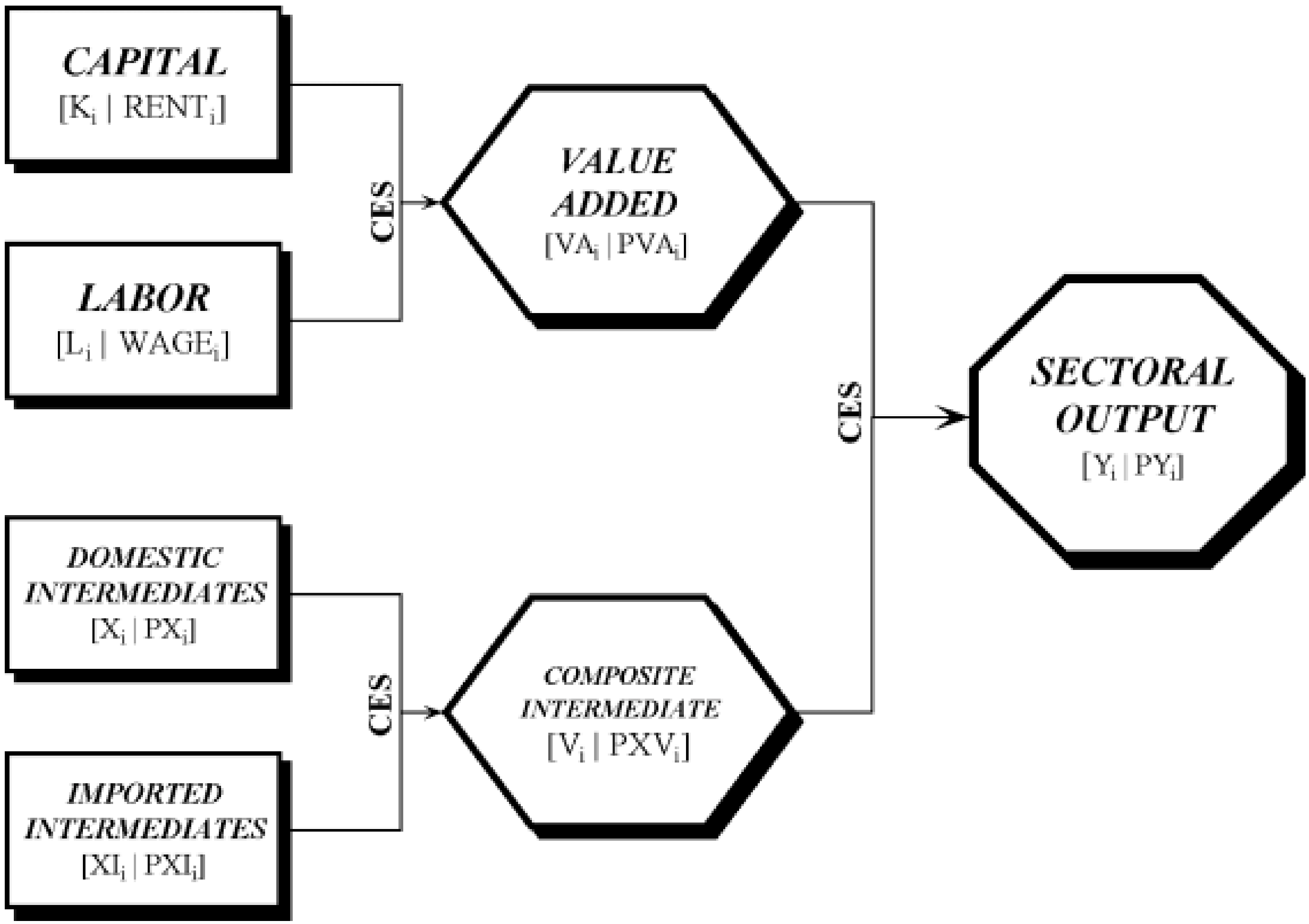
$$Y_i = CETS_i(\alpha_i \cdot E_i^{\frac{ELA+1}{ELA}} + (1-\alpha_i)DO_i^{\frac{ELA+1}{ELA}})^{\frac{EL1}{ELA+1}} \text{, CET Function} \tag{3.16}$$

relates exports to domestic products in production

- Y_i denotes the sectoral output,
- E_i is the exported good,
- DO_i is the domestic good,
- $CETS_i$ is the shift parameter,
- α_i is the share parameter (also known as the distribution parameter)
- ELA is the CET elasticity of substitution between E_i and DO_i.

The export supply and the supply of domestic products are determined by solving the optimization problem of the producer (the least cost procedure):

Figure 3.1: <u>Production Structure</u>



Using $\frac{\partial Y_i / \partial E_i}{\partial Y_i / \partial DO_i} = \frac{PWE_i}{PD_i}$, → $\left(\frac{(1-\alpha_i)PWE_i}{\alpha_i \cdot PD_i}\right)^{ELA} = \frac{E_i}{DO_i}$ (3.17) and (3.18)

where PWE_i is the world price of the exports (exogenous due to the small country assumption) and PD_i stands for the price of the domestic good. Equation (3.18) defines the optimal mix between exports and domestic sales. It is derived from the first-order conditions for cost minimization (or revenue maximization) of the producer (3.17) and assures that an increase in export price-domestic price ratio will generate an increase in the export-domestic demand ratio (a shift towards the higher price).

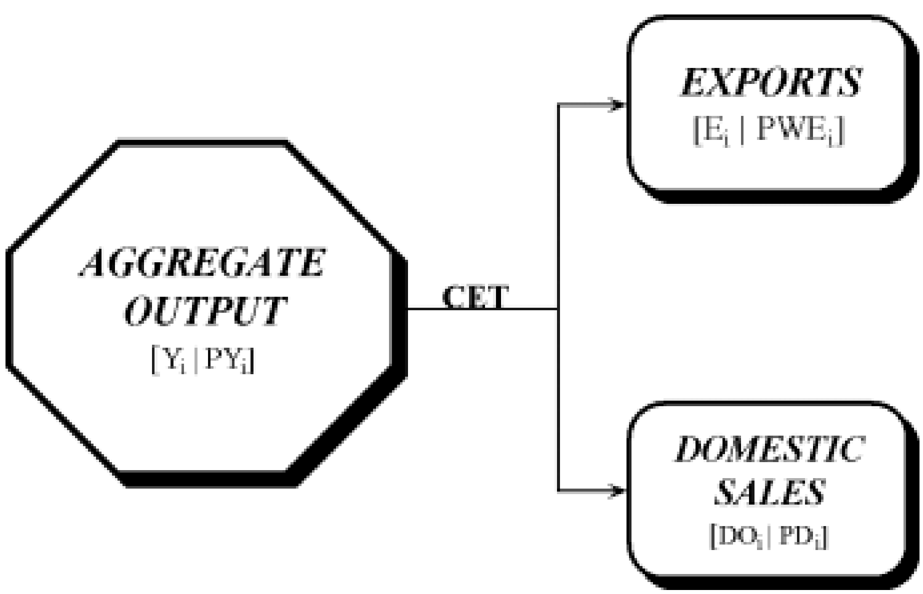
At the sectoral level, value of the gross output is equal to the value of exports plus the value of domestic products.

$$PY_i \cdot Y_i = PWE_i \cdot E_i + PD_i \cdot DO_i \quad (3.19)$$

PY_i is the price of the sectoral output.

Figure 3.2, below, lays out the supply behavior in the model.

Figure 3.2: Supply Behavior



C) Demand Behavior

Imperfect substitutability between imports and domestic outputs sold domestically is captured by a two CES (constant elasticity of substitution) aggregation functions, one for the households and the other for the government:

$$QHH_i = ARMI_i[\beta^h{}_i HCIMP_i^{\frac{EPSI_i-1}{EPSI_i}} + (1-\beta^h{}_i)HCDOM_i^{\frac{EPSI_i-1}{EPSI_i}}]^{\frac{EPSI_i}{EPSI_i-1}} \quad (3.20)$$

$$QGOV_i = ARMII_i[\beta^g{}_i GCIMP_i^{\frac{EPSI_i-1}{EPSI_i}} + (1-\beta^g{}_i)GCDOM_i^{\frac{EPSI_i-1}{EPSI_i}}]^{\frac{EPSI_i}{EPSI_i-1}} \quad (3.21)$$

where,

- QHH_i denotes the household composite good,
- $QGOV_i$ denotes the government composite good,
- $HCIMP_i$ is the household consumption of the imported goods,
- $HCDOM_i$ is the household consumption of the domestic good
- $GCIMP_i$ is the government consumption of the imported goods,
- $GCDOM_i$ is the government consumption of the domestic good
- $ARMI_i$ and $ARMII_i$ are the shift parameters,
- β_i^h, β_i^g, are the Armington share parameters between imports and domestic goods for households and the government, respectively,
- EPSI is the CES elasticity of substitution between imports and domestic products.

These functions are often referred to as "Armington" functions[36]. The prices and the substitution elasticities that the consumers and government face are the same, and the domestic demands by the households and the government are for composite commodities that are made up of imports and domestic outputs. The household and government Armington functions, (3.22) and (3.23) above, relate imported goods to domestic products in consumption, for the households and the

[36] Named after Paul Armington who introduced imperfect substitutability between imports and domestic commodities in economic models (Armington 1969).

government, respectively.

At the sectoral level, imports are equal to the sum of the household demand for imported goods, the government demand for imported goods and the demand for intermediate imported inputs:

$$IMP_i = HCIMP_i + GOVIMP_i + XI_i \quad (3.22)$$

where IMP is the sectoral import.

Similarly, domestic sales are equal to the sum of the household demand for domestic goods, the government demand for domestic goods and the demand for intermediate domestic inputs:

$$DO_i = HCDOM_i + GOVDOM_i + X_i \quad (3.23)$$

Figure 3.3, on the next page, describes the demand behavior.

D) Households

The household revenue is the sum of received payments to factors of productions and transfers from the government:

$$HR = WAGE \cdot L + RENT \cdot K + THG \quad (3.24)$$

THG is the lump-sum transfer from government to the households (or vice versa), determined residually to clear the market.

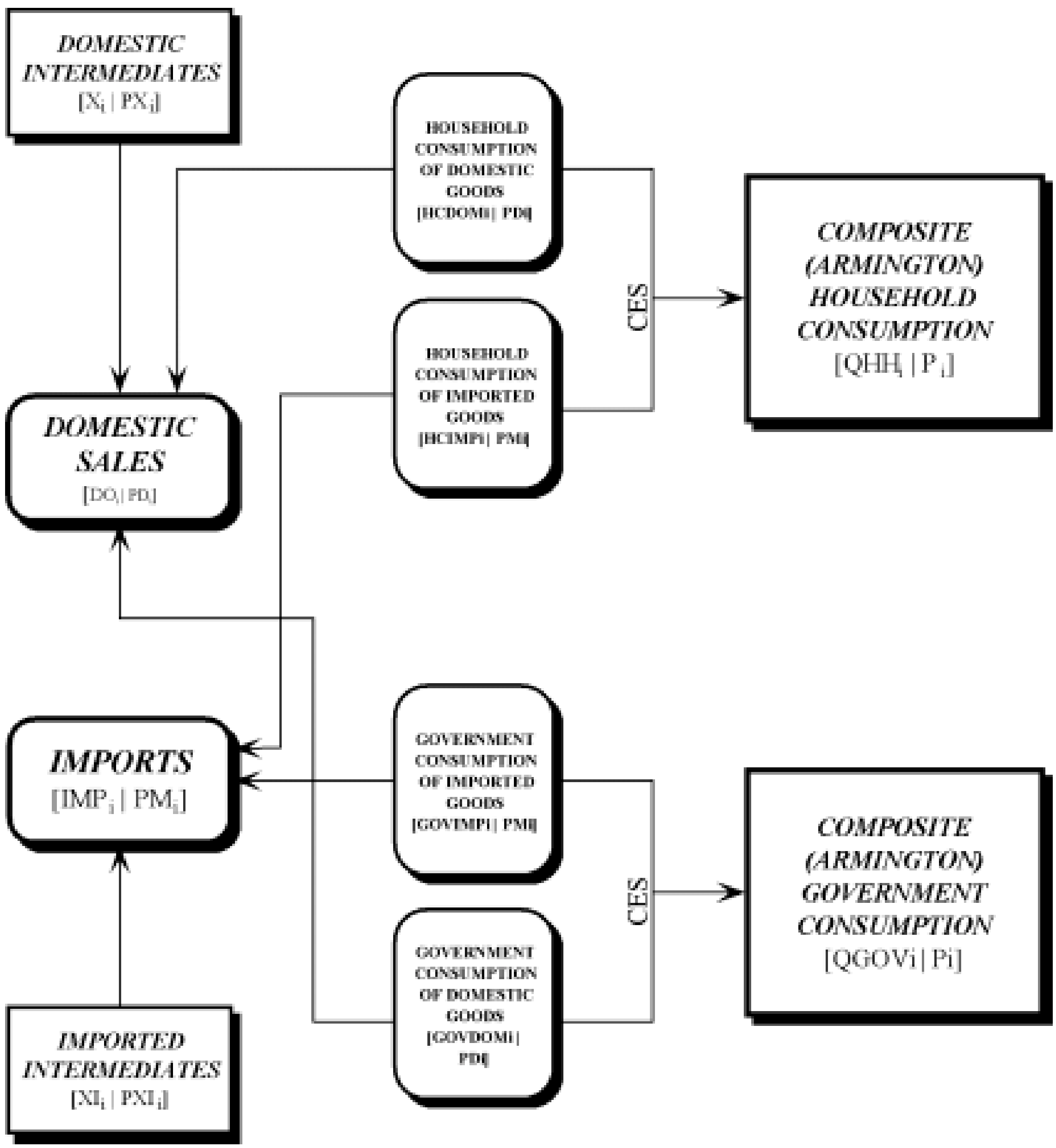
The utility of the consumer is modeled as a Cobb-Douglas function:

$$UTILITY = \prod_i QHH_i^{HBS_i} \quad (3.25)$$

The consumer derives utility from consuming the household composite good, a mix of household consumption of domestic and imported goods from all three sectors.

The Marshallian consumer demand functions are derived maximizing the

Figure 3.3: __Demand Behavior__



utility function subject to the household budget constraint:

$$\max UTILITY = \prod_i QHH_i^{HBS_i}$$
$$subject\ to\ HR = \sum_i QHH_i \cdot P_i \qquad (3.26)$$

which leads to

$$QHH_i = HBS_i * HR / P_i , \qquad (3.27)$$

where $HBS_i = QHH_i / HR$, is the household budget share (3.28)

Starting with the Cobb-Douglas utility function of the consumer from (3.26), the expenditure function (EFCT) is derived:

$$EFCT = \prod_i \frac{P_i^{HBS_i}}{HBS_i^{HBS_i}} * UTILITY \qquad (3.29)$$

The money metric version of marginal cost of funds (MCF) is then calculated by using the utility and expenditure functions:

$$MMCF = ECOEFF_0 * [UTILITY_1 - UTILITY_0] , \text{ where} \qquad (3.30)$$[37]

$$ECOEFF = \prod_i \frac{P_i^{HBS_i}}{HBS_i^{HBS_i}}$$ is the price part of the expenditure function (3.31)

E) Government Sector and the Tax Structure

The model has two tax instruments; tariffs on imports and output taxes on domestically produced goods. Government revenues are determined by:

$$GR = INTAX + TARIFF + REMIT - THG , \qquad (3.32)$$

where INTAX is the indirect tax revenue, TARIFF stands for the tariff revenue, REMIT for remittances from abroad and THG is a lump-sum transfer from government to the households (or vice versa).

---

[37] Equation 3.25 calculates the familiar money metric utility (using old prices as base): $MO = E(p^0, U^0) - E(p^0, U_1)$, and it is equal to $\frac{E_u du}{d\beta}$ in equation (2.15).

The market clearing condition in the government sector is:

$$GR = \sum_i QGOV_i , \qquad (3.33)$$

where $QGOV_i$ represents the government consumption (see (3.23)).

Both REMIT and THG are aggregates over all three sectors and are determined residually to clear the balance of payments and the government equilibria, respectively. REMIT balances the differences between the exports and imports of the economy, and THG makes sure that the government revenue is equal to the total government consumption.

i) Tariffs

$$PM_i = PWM_i(1 + PROPTM_i) \qquad (3.34)$$

is the domestic price of imported goods. PWM_i stands for the world price of imports.

$TM_i = TARIFF_i /(IMP_i - TARIFF_i)$ is the tariff rate, and (3.35)

$$PROPTM_i = TM_i DTM \qquad (3.36)$$

gives the change in the tariff rate, where DTM depicts the radial cut (same across all three sectors) in the tariff rate[38]. Modeling the radial tax cut across the sectors is essential for the calculation of the marginal cost of funds[39].

Rearranging (3.35) and (3.36):

$$TARIFF_i = \sum_i PROPTM_i \cdot PWM_i \cdot IMP_i \qquad (3.37)$$

Tariffs also apply to imported intermediate inputs:

$$PXI_i = PXIT_i(1 + PROPTM_i), \qquad (3.38)$$

where $PXIT_i$ is the price for intermediate imported inputs net of tariffs.

[38] The radial cut in the tariff rate implies that the change in all three sectors are the same percentage (for example, a 5% cut in tariffs for agricultural and industrial products and services).
[39] The radial cut is explained in Section II, and built in the formal derivation of the MCF.

ii) Output Taxes

Similarly,

$$PYT_i = PY_i(1 + PROPTY_i) \tag{3.39}$$

stands for the domestic price of sectoral output gross of taxes, where PY_i is the price of output net of taxes.

$$PROPTY_i = TY_i DTY \tag{3.40}$$

gives the change in the output tax rate, where

$TY_i = INDTAX_i /(Y_i - INDTAX_i)$ is the output tax rate, (3.41)

and DTY depicts the radial cut (same across the three sectors) in the tariff rate. Rearranging (3.41) and (3.42), we obtain:

$$INDTAX_i = \sum_i PROPTY_i \cdot PYT_i \cdot Y_i \tag{3.42}$$

F) Closure Rules

The model includes four macroeconomic balances:

the government balance, $GR = \sum_i QGOV_i + THG$, stated in (3.31),

the external balance,

$$\sum_i PWE_i \cdot E_i + WS = \sum_i PWM_i \cdot IMP_i \tag{3.43}$$

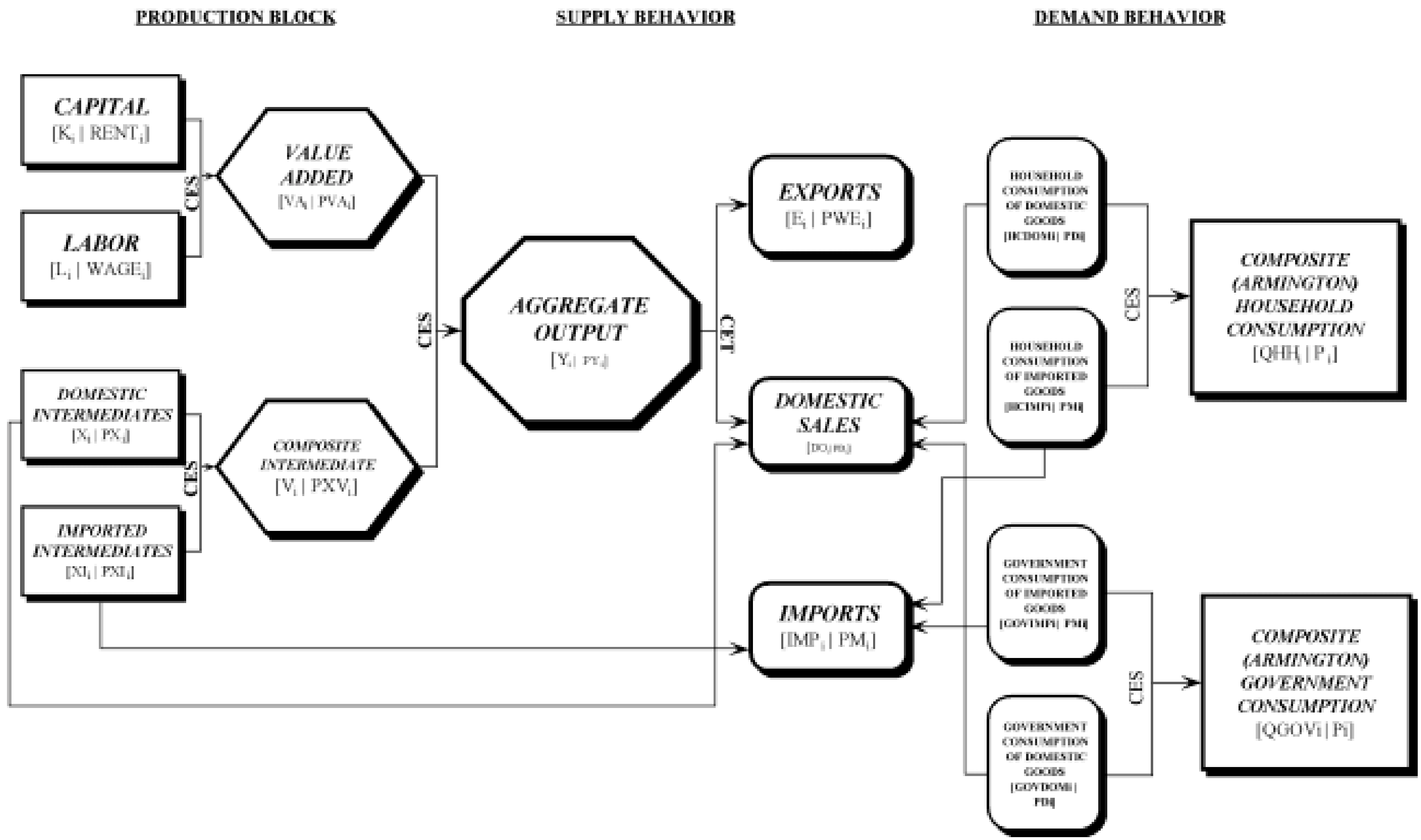
and the two factor market equilibrium conditions, $\sum_i L_i = L$ and $\sum_i K_i = K$, stated in (3.9) and (3.10).

In addition, the government consumption is set fixed to its initial value to mark the binding budget constraint of the government.

Both, world prices of imports and exports, PWM_i and PWE_i, are exogenous due to the small country assumption.

Figure 3.4, on the next page, puts the production block, supply behavior and demand behavior together and gives the sectoral flow of commodities in the economy.

***Figure 3.4**: __Flow of Commodities__*



IV. Empirical Work

A) Data Sources

The data set used in the empirical analysis comes primarily from GTAP (Global Trade Analysis Project) database. Both, versions GTAP 4 and GTAP 5 were utilized.

GTAP 4 database, released in Fall 1998, covers 31 countries. All monetary values of the data are in $US millions and the base year for Version 4 is 1995. Most of its tariff information comes from UNCTAD TRAINS database. The majority of the macro data on trade is compiled from the United Nation's COMTRADE database. A large number of GTAP 4's input-output (I/O) tables were initially inherited from the Australian Industry Commission's SALTER project, the rest is compiled from the national government (such as departments of statistics) and academic sources for each country. Other data sources utilized in GTAP4 are, OECD's PSE (producer subsidy equivalent) database, Development Economics Analytical Data Base (DAD) maintained by the Development Economics Prospects Group of the World Bank, various GATT/IDB sources and individual contributors[40].

GTAP 5 database was released in July 2001[41], and its regional coverage has been expanded from 31 to 54 countries. All monetary values of the data are in $US millions and the base year for Version 4 is 1997. Most of the data resources of GTAP 5 are identical to its previous version. One of the additions is the inclusion of IEA (International Energy Agency) – based energy use data.

An aggregation-constrained software package, GTAPAgg, allows any number of 10x10 (or smaller) aggregations of the GTAP Data Package. A 3x3 aggregation has been used to construct the data for the social accounting matrix

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[40] A detailed documentation for GTAP 4 and GTAP 5 databases can be found at www.gtap.org.

[41] Still being debugged as of November 28, 2001.

(SAM) of this paper.

B) Social Accounting Matrix (SAM)

A Social Accounting Matrix (SAM) is a comprehensive, economy wide data framework, typically presenting the economy of a nation. Table 4.1 shows the SAM employed in the empirical part of this paper.

Table 4.1: Basic SAM structure used in the CGE model

	Agr	***Ind***	***Serv***
Agr	domestic intermediates	domestic intermediates	domestic intermediates
Ind	domestic intermediates	domestic intermediates	domestic intermediates
Serv	domestic intermediates	domestic intermediates	domestic intermediates
AgrImpInp	imported intermediates	imported intermediates	imported intermediates
IndImpInp	imported intermediates	imported intermediates	imported intermediates
ServImpInp	imported intermediates	imported intermediates	imported intermediates
Labor	factor payments	factor payments	factor payments
Capital	factor payments	factor payments	factor payments
Ind-tax	output taxes	output taxes	output taxes
Duties	tariffs	tariffs	tariffs
Imports	imports	imports	imports
Exports	exports	exports	exports
Hous-Con	household consumption of domestic goods	household consumption of domestic goods	household consumption of domestic goods
Imp.Hous-Con	household consumption of imported goods	household consumption of imported goods	household consumption of imported goods
Gov-Cons	household consumption of domestic goods	household consumption of domestic goods	household consumption of domestic goods
Imp.Gov-Con	household consumption of imported goods	household consumption of imported goods	household consumption of imported goods
DomesOut	domestic sales of domestic output	domestic sales of domestic output	domestic sales of domestic output

Note that the SAM used in this paper doesn't follow the principle of double-entry, and hence is not a square matrix. The first 3x6 submatrix (3 columns, 6 rows) builds the I-O (input-output) matrix for domestic and imported intermediate inputs which enter into the production structure[42]. The rows "*Labor*" and "*Capital*" are factor payments from the three different sectors in the economy. The indirect tax (Ind-tax) used in the empirical analysis is the output tax that the government collects from the producers. "*Duties*" report the import taxes, "*Imports*" and "*Exports*" are the values of trade outflow and inflow. The household consumption is detailed in "*Hous-Con*", household consumption of domestic goods, and "*Imp.Hous-Con*", household consumption of imported goods. The same separation holds for the government sector. "*DomesOut*" gives the domestic sales of domestic output. The total domestic output is the sum of "*Export*" and "*DomesOut*". Output taxes apply to total domestic output. All entries are in $US millions.

The calibration is done with the benchmark data presented in the SAM. All the shift and share parameters for the CES and CET functions are calculated using the benchmark values.

In the production block, TOP_i, AD_i and AVD_i are the shift parameters and h_i,γ_i and k_i are the share parameters for the CES functions, stated in (3.1), (3.2) and (3.3).

$CETS_i$ is the shift parameter for the CET function in (3.16), and α_i is the share parameter indicating the share of exports in the sectoral output.

In the demand block, $ARMI_i$ and $ARMII_i$ are the shift parameters and β_i^h, and β_i^g, are the share parameters for the Armington functions in (3.20) and (3.21).

The shift parameters are also known as the efficiency parameters or the parameters indicating the state of technology. After they are calibrated from the benchmark data, they stay constant throughout the analysis. The share parameters, also known as the distribution parameters, give the relative shares of the inputs

[42] See Section III for the production structure.

into the corresponding CES/CET functions (e.g: γ_i is the relative share of labor in production). After the calibration is complete the model is solved for the benchmark year.

C) Elasticities

Table 4.2 reports the different elasticity values used in the CES and CET functions to mark the production, supply and demand choices in the model, and compares them with elasticities used in similar CGE models of small open economies.

Table 4.2: Elasticities used in the paper and a comparison with the relevant literature:

ELASTICITIES	Erbil	Literature and GTAP
σ_i elasticity of substitution between capital and labor (production - CES) [43]	**1.2**	**0.9-1.8**
υ_i elasticity of substitution between domestic and imported inputs (production - CES) [44]	**2**	**0.4-3.55**
τ_i, elasticity of substitution between value added and composite intermediate (production - CES) [45]	**0.1**	**0-1.68**
ELA_i, elasticity of substitution between exports and domestically consumed domestic products (supply – CET) [46]	**3**	**2.9-3.9**
$EPSI_i$, elasticity of substitution between imports and domestic products (demand – CES) [47]	**2**	**0.4-3.55**

The second column shows the elasticities used in this paper, whereas the third column reports the range of estimates from various sources (listed in the

[43] Griliches (1967), Dhrymes and Zarembka (1970), Zarembka (1970), Fishelson (1979), and Moroney (1972).
[44] De Melo and Tarr (1992).
[45] Close to Leontief function (perfectly inelastic).
[46] De Melo and Tarr (1992).
[47] De Melo and Tarr (1992), Anderson (1999).

footnotes) and the substitution elasticities reported in the GTAP documentations. All the elasticities of substitution are constant across all three sectors of the economy for all the countries explored in the model[48]. This simplifying assumption does not change the results of the paper. The sensitivity analysis utilized in the next section shows that the empirical MCF estimates are not very sensitive to the elasticities of substitution.

D) Calculating MCFs in the Computable General Equilibrium (CGE) Model

To understand the mechanics of the empirical work, it is essential to mention once again that the MCF figures calculated here stem from a "compensated equilibrium". In CGE models, such as the one employed in this study, more than one step is required to obtain the compensated MCF.

Below, the procedure of calculating MCF of trade taxes is laid out:

- In the first step, the model is perturbed with a transfer of a small external exogenous amount, $d\beta$, into the government budget. This amount is offset by an endogenous proportionate change in the trade tax vector, $dp_i = W^i p_i d\tau_i$, where $d\tau_i$, is the endogenous scalar. The simulation calculates the change in money metric utility, $\frac{E_u du}{d\beta}$, in equation (2.15). This is the uncompensated MCF (MMCF) for trade taxes.

- Second step starts with the injection of the same small external exogenous amount, $d\beta$, into the government budget. However, this time it is offset by a lump sum transfer, $d\theta$, from the government to the private sector. Running the CGE model, the change in money metric utility, μ, is calculated. μ, the shadow price of foreign exchange, is equal to:

[48] This simplification is mostly due to limitations of availability of elasticity estimates for the countries in the sample.

$$\mu = \frac{1}{1 - MCF(p - p^*)\dfrac{E_{pu}}{E_u}} \tag{4.1}$$[49]

There is a direct relationship between the money metric MCF (MMCF), μ and the compensated MCF:

$$\begin{aligned} MMCF &= \frac{MCF}{1 - MCF(p - p^*)\dfrac{E_{pu}}{E_u}} \\ &= \frac{\text{MCF}}{1 - \text{MCF}(1/\mu - 1)} \\ &= \text{MCF} * \mu \end{aligned} \tag{4.2}$$

- Third step is simply dividing the result of step1 by the result of step2;

$$\frac{\dfrac{E_u du}{d\beta}(= step1)}{\mu(= step2)} = MCF = \frac{MMCF}{\mu} \tag{4.3}$$

In (4.3), (4.2) is solved for MCF given the calculations of μ and MMCF.

The calculation of MCF of indirect taxes follows the same structure.

GAMS (General Algebraic Modeling System) system is employed to solve the CGE model and to calculate the MCFs.

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[49] μ is derived by subbing $\frac{d\theta}{d\beta} = \tau + (p - p^*)' E_{pu} / d\beta$ (government budget constraint) into the private government budget constraint, and solving for the rate of change in money metric utility.

V. Empirical Analysis and Results

Before laying out the empirical results of this paper, it is beneficial to take a look at the empirical magnitudes of the MCF estimates from previous studies. The table below includes MCF figures obtained by using either analytical formulae or numerical simulation.

Table 5.1: MCF Estimates from Previous Studies

Country	*Tax Type*	*Estimate*	*Source*
United States	*Surcharge*	1.17-1.56	*Ballard, Shoven and Whalley (1985)*
	Labor	1.21-1.24	*Stuart (1984)*
	Labor	1.32-1.47	*Browning (1987)*
	Labor	1.08-1.14	*Ahmed and Croushore (1994)*
Sweden	*Surcharge*	0.67-4.51	*Hansson and Stuart (1995)*
New Zealand	*Labor*	1.18	*Diewert and Lawrence (1994)*
India	*Excise*	1.66-2.15	*Ahmed and Stern (1987)*
	Sales	1.59-2.17	*Ahmed and Stern (1987)*
	Import	1.54-2.17	*Ahmed and Stern (1987)*
Bangladesh	*Import*	0.82-2.18	*Devarajan, Thierfelder and Suthiwart-Narueput (2000)*
Cameroon	*Indirect Taxes*	0.48-1.32	*Devarajan, Thierfelder and Suthiwart-Narueput (2000)*
Indonesia	*Imports*	0.70-1.91	*Devarajan, Thierfelder and Suthiwart-Narueput (2000)*

These empirical results from previous studies present a wide range for MCF figures. It is important to note that the MCFs reported above are the money metric or uncompensated version of the MCF. As explained in Sections II and IV, the uncompensated and compensated MCF concepts are linked to each other with the "fiscal multiplier": the compensated MCF is simply the uncompensated MCF divided by the "fiscal multiplier". Since the "fiscal multiplier" is generally positive and greater than one[50], the compensated MCFs are smaller in absolute value than their money metric versions. The results presented below are for the compensated version of MCF, and have a narrower range (0.915-1.558) for 34 countries than the uncompensated MCF figures reported in Table 5.1.

A) Simple Model (without intermediate imported inputs)

i) Testing Operationality: Case of Turkey, 1990

The CGE model has proved useful for studying the welfare effects of trade reforms in the presence of binding government budget constraints. This section reports estimates of MCF^{TY} and MCF^{TM}, the marginal cost of funds, of indirect taxes, and tariffs, respectively. The results are obtained from the simple CGE model of the Turkish economy in 1990, explained in Section III above. The simulation of the model runs following the procedure explained in Section IV, and produces the MCF for tariffs of around 1.53, and the MCF for indirect taxes of around 1.13. These estimates are reasonable since their magnitudes are similar to the figures presented in Table 5.1.

The results show that the MCF for indirect taxes is significantly lower than the MCF for tariffs for Turkey. These findings are in the expected direction, since the indirect taxes in the model are low (between zero and 5.8%), whereas the tariffs are relatively higher (they go up to 21%). The comparison of MCF^{TY} and MCF^{TM} gives us the answer to the original question: "are trade taxes better?"

In the simplest sense, we can say that to raise \$1, while keeping the government budget constraint constant[51], one has to spend \$1.53 when using tariffs as the policy tool, and only \$1.13 when using the indirect taxes. Hence, indirect taxes are the "cheaper" distortion, and therefore replacing trade taxes with

[50] See Hatta (1977).
[51] Government consumption is fixed, and equal to government revenue.

indirect taxes is beneficial.

Due to the three-step calculation procedure of the CGE experiment, explained in Section IV, we also obtain some "additional results" along the way to compute MCF:

- Step 1, in Section IV, generates uncompensated or money metric MCF (MMCF)[52] figures for trade and indirect taxes. For the Turkish economy in 1990, MMCF for tariffs is 1.67, and MMCF for indirect taxes is 1.23.

- The shadow price of foreign exchange, μ, is 1.09. As explained in Section II, μ gives the price of an additional unit of money metric utility in terms of external compensation.

It is important to look at the sensitivity of these results for changes in elasticity of substitution between home and imported goods. The table below shows how the MCF figures are affected by the change in substitution elasticity.

Table 5.2:

% increase in substitution elasticity	$MMCF^{TM}$ Tariffs	$MMCF^{TY}$ Indirect Taxes	MU Shadow Price	MCF^{TM}	MCF^{TY}
0%	1.669	1.230	1.092	1.528	1.126
10%	1.689	1.259	1.101	1.534	1.144
20%	1.706	1.287	1.109	1.538	1.161
30%	1.721	1.312	1.116	1.542	1.176
40%	1.733	1.336	1.122	1.545	1.191
50%	1.744	1.359	1.128	1.546	1.205

The results are not sensitive to changes in substitution elasticity. The MCF for indirect taxes is still smaller than MCF for trade taxes, indicating that the indirect taxes are still the cheaper distortion for a wide range of elasticity of substitution between domestic and imported goods.

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[52] These money metric measures report the money required by the consumer to purchase the change in equilibrium utility due to switching from an old to a new policy. For distorted economies, money metric adds to compensated measures a tax revenue change due to the shift in equilibrium utility.

Furthermore, the results suggest that the MCF figures are increasing as the elasticity of substitution rises. The intuition behind this direction is that; the own terms have greater responsiveness with respect to changes in elasticity of substitution than cross-effect terms.

ii) Multi-country Study: 15 Countries

After proving operationality in the previous part, this section expands the empirical analysis to a set of 15 countries[53]. The MCF figures are given in Table 5.3 below:

Table 5.3:

COUNTRY	MCF^{TM}	MCF^{TY}
Chile	1.007	1.026
Mexico	1.019	1.023
Japan	1.034	2.195
Morocco	1.069	1.950
Korea	1.088	1.151
Uruguay	1.089	1.526
USA	1.098	1.232
Malaysia	1.159	3.627
China	1.254	1.838
Viet Nam	1.307	2.089
Colombia	1.478	3.109
	$MCF^{TM}<MCF^{TY}$	
Turkey	1.169	1.121
India	1.232	1.072
Thailand	1.296	1.128
Philippines	2.008	1.066
	$MCF^{TM}>MCF^{TY}$	

As seen from Table 5.3 above, for the majority of countries (11 out of 15), the MCF for indirect taxes (MCF^{TY}) is significantly higher than the MCF for tariffs (MCF^{TM}). This comparison tells us, that for the first eleven countries reported in Table 5.3, the trade taxes are the "cheaper" distortion, and therefore replacing indirect taxes with trade taxes is beneficial. This finding implies that a

[53] The sample selection was due to data availability.

trade liberalization package, where the tariff loss will be compensated with an increase in indirect taxes, will be too costly (in welfare terms) for the consumer in the first 11 countries in Table 5.3. The main direction of the results is consistent with Anderson (1999)'s findings for the Korean economy in 1963, and there is also consistency in the case of Turkey for the two different years, 1990[54] and 1995.

The main difference between the four countries with higher MCF^{TM} figures and the remaining eleven countries is that the former group is subject to very high tariff taxes (more than 25% on average), whereas the later group has average tariff taxes around 11%. This finding supports the intuition, since in countries with higher trade taxes, a trade liberalization package would be less costly.

However, there are exceptions in both groups: China (32%), Vietnam (21%) and Malaysia (16%) have high trade taxes although they fall in the first group where $MCF^{TM}<MCF^{TY}$, and Turkey (with 8% tariff rate) is in the second group along with three other countries with relatively higher tariffs.

This brings us to the issue that a more detailed look into the CGE model that generates the MCF figures is necessary. In part D, Cross-Country Econometric Analysis, the determinants of MCF will be investigated.

B) Advanced Model (with intermediate imported inputs)

Below are the cross-country results for the compensated MCF figures generated by using the "advanced model" which explicitly takes into account the presence of "intermediate imported inputs": The advanced model is laid out in detail in Chapter 3. The nested domestic and imported intermediate inputs in the production structure marks the difference between the "simple" and the

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[54] Data for 1990 is used only for Turkey in the "Testing Operationality: Case of Turkey, 1990" section. The MCF estimates reported for Turkey in Table 5.2 are for 1990, whereas the MCF estimates reported for Turkey in Table 5.3 are for 1995.

“advanced” model. The introduction of intermediate imported inputs changes the results considerably.

As shown in Table 5.4 on the next page, for a majority of countries, indirect taxes are the cheaper distortion, which hints that replacing trade taxes with indirect taxes would be beneficial. This opens up the debate that there is still room for further trade liberalizations.

This time, in the majority of countries (27 out of 34), the MCF for indirect taxes (MCF^{TY}) is lower than the MCF for tariffs (MCF^{TM}). This comparison tells us, that for the first seven countries reported in Table 5.4, the trade taxes are the “cheaper” distortion, and therefore replacing indirect taxes with trade taxes is beneficial. This finding implies that a trade liberalization package, where the tariff loss will be compensated with an increase in indirect taxes, will be too costly (in welfare terms) for the consumer in the first 7 countries in Table 5.4, but the preferred policy tool for the remainder of the 34 countries.

It is interesting to note that 8 countries which belonged to the first group from Table 5.2 (results generated with the “simple model”), now belong to the second group where the MCF for indirect taxes (MCF^{TY}) is higher than the MCF for tariffs (MCF^{TM}), hence trade taxes are the “more expensive” distortion. The addition of intermediate imported inputs to the “simple model” has a very significant effect on the results.

In the “simple model”, imports are treated as final goods, and high trade taxes shift the consumption away from imported goods towards domestically produced goods. In the “advanced model”, trade taxes impose distortion not only on the consumption side but also on the production side. High trade taxes distort the production by causing a shift away from imported intermediates toward

Table 5.4: Multi-Country MCF Results

	COUNTRY	MCF^{TM}	MCF^{TY}	Comparison with the "Basic" Model[55]
1	JAPAN	1.125	1.442	SAME
2	MEXICO	1.024	1.340	SAME
3	SRI LANKA	1.241	1.337	NEW
4	SWEDEN	1.176	1.200	NEW
5	GREAT BRITAIN	1.016	1.173	NEW
6	DENMARK	1.013	1.029	NEW
7	CANADA	0.915	1.000	NEW
		$MCF^{TM}<MCF^{TY}$		
1	CHINA	1.556	1.268	REVERSAL
2	KOREA	1.488	1.134	REVERSAL
3	SINGAPORE	1.372	1.333	NEW
4	INDIA	1.311	1.155	SAME
5	VENEZUELA	1.295	1.273	NEW
6	VIETNAM	1.281	1.078	REVERSAL
7	TURKEY	1.270	1.041	SAME
8	GERMANY	1.262	1.207	NEW
9	ZAMBIA	1.255	1.062	NEW
10	POLAND	1.252	1.001	NEW
11	PHILLIPINES	1.241	1.001	SAME
12	FINLAND	1.241	1.008	NEW
13	THAILAND	1.206	1.122	SAME
14	URUGUAY	1.200	1.026	REVERSAL
15	TANZANIA	1.196	1.010	NEW
16	PERU	1.176	1.003	NEW
17	MOROCCO	1.153	1.002	REVERSAL
18	UGANDA	1.148	1.000	NEW
19	ZIMBABWE	1.139	1.001	NEW
20	USA	1.112	0.995	REVERSAL
21	HUNGARY	1.106	1.005	NEW
22	MOZAMBIQUE	1.105	1.052	NEW
23	BOTSWANA	1.099	1.001	NEW
24	MALAYSIA	1.092	1.037	REVERSAL
25	CHILE	1.083	0.995	REVERSAL
26	INDONESIA	1.060	1.001	NEW
27	ARGENTINA	1.057	1.035	NEW
TOTAL: 34		$MCF^{TM}>MCF^{TY}$		

[55] ***SAME:*** Results indicate the same direction as in the previous "simple model".
REVERSAL: Results indicate the opposite direction as in the previous "simple model".
NEW: New countries that were not solved for in the simple model due to data unavailability.

domestic intermediates. Therefore, it is intuitively appealing that in the "advanced model" trade taxes generate more distortion and become relatively "more expensive" for most of the countries in the sample.

As explained in Section II, the MCF figures in Table 5.4 reflect each country's willingness to pay for a dollar of external transfer to finance a tax reduction. The net benefit of tax reform which switches from trade to production taxes can be extracted from Table 5.4. It is simply given by MCF(trade) - MCF(production). Korea, China, Poland and the Philippines have the highest potential welfare gains. Their welfare gain would be \$0.354, \$0.288, \$0.251 and \$0.24, respectively, for each dollar raised, if they switched from tariffs to output taxes as the revenue collecting policy instrument. Finland, Turkey, Vietnam, Zambia and Tanzania also gain significantly from a tax reform, whereas Argentina, Venezuela and Singapore gain only \$0.022, \$0.022 and \$0.039, respectively.

C) Sensitivity Analysis

As seen in Table 5.5 below, the MCF figures are not very sensitive to changes in the elasticity of substitution between imported goods and domestic products (Armington elasticity). Elasticities up to 25% above and below the benchmark year elasticity (EPSI=2) do not affect the direction of the results. In other words, MCF^{TM} remains higher than MCF^{TY} over the entire range, indicating that replacing trade taxes with output taxes would be welfare improving for the economy in question.

Table 5.5:

% increase in substitution elasticity	**POLAND**	
	MCF^{TM}	*MCF^{TY}*
-25%(EPSI=1.5)	1.239416	1.00073
0% (EPSI=2)	1.252193	1.000731
25%(EPSI=2.5)	1.26335	1.000732

% increase in substitution elasticity	MOZAMBIQUE	
	MCF^{TM}	*MCF^{TY}*
-25%(EPSI=1.5)	1.10244	1.05041
0% (EPSI=2)	1.10582	1.0517
25%(EPSI=2.5)	1.11013	1.05466

% increase in substitution elasticity	SWEDEN	
	MCF^{TM}	*MCF^{TY}*
-25%(EPSI=1.5)	1.16517	1.19403
0% (EPSI=2)	1.17577	1.1996
25%(EPSI=2.5)	1.18452	1.20337

From the sample countries presented above, we can calculate the empirically determined elasticity of the MCF with respect to the elasticity of substitution. For MCF^{TM} (tariffs) the elasticity is within the range of 0.0122 and 0.0408, and for MCF^{TY} (output taxes), it is even smaller, between 0.000004 and 0.0186. Intuitively, MCFs rise as elasticity of substitution increases, showing that the own terms have greater responsiveness with respect to changes in elasticity of substitution than cross-effect terms.

D. Cross-Country Econometric Analysis

The next step is to try to identify the determinants of MCF, and to provide insight into the likelihood of welfare decreasing tariff cuts. Can we understand from the underlying data (such as data on tariffs and taxes, on the consumption patterns of the economy, on the propensity to import, on the share of the government sector in consumption and production and on elasticities of substitution) and the model specifications which direction the MCF figures will point to? Can we shed light in the black box of the CGE experiment and understand better where these MCF estimates come from?

It is important to note the relative simplicity of the regression analysis with respect to the CGE process employed in this paper. Essentially, it provides some descriptive statistics with conditioning variables suggested by the MCF formula and economic intuition.

Previous studies by Devarajan et al. generated results against the common belief that developing countries with high distortions also have high MCF figures. However, the number of countries studied was too small for more elaborate analysis (and as argued here the uncompensated MCF is not suitable for cross country comparison). The section below focuses only on regression analysis with results from the advanced model. The results from the advance model are more realistic (and also significantly different from the basic model) since they capture the presence of intermediate imported inputs.

i) Regression Analysis for Marginal Cost of Funds of Tariffs

Table 5.5, below, presents the results of the regression[56] of natural logarithm of marginal cost of funds of tariffs, log (MCF^{TM}), denoted as (log Y), on:

- natural logarithm of tariff rates, log(tariff), denoted as (log X_1),
- natural logarithm of indirect tax rates, log(indtax), denoted as (log X_2),
- natural logarithm of imports to GDP ratio, log(imp/gdp), denoted as (log X_3),
- intermediate imports to total imports ratio, (intimp/imp), denoted as (X_4),
- share of imports in domestic consumption, (hhimp/cons), denoted as (X_5), and
- two dummy variables (D_1 and D_2) for the size of GDP (countries with a GDP more than 1.000.000 million US$ are denoted as D_1, “largegdp”, between 1.000.000 US$ and 200.000 million US$ as D_2, “midgdp” and less than 200.000 million US$ as “smallgdp”[57]).

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[56] The regression is corrected for heteroscedasticity using the “robust” option of STATA. In regression with robust standard errors, the estimates of the regression coefficients are the same as in the standard OLS linear regression, but the estimates of the standard errors are more robust to failure to meet assumptions concerning normality and homogeneity of variance of the residuals. The robust option in STATA computes Huber-White robust estimates of the standard errors.

[57] Omitted in the regression to avoid perfect collinearity.

Table 5.5:

$logY = constant + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 D_1 + \beta_7 D_2$

Number of obs	=	34
F(7, 26)	=	2.19
Prob > F	=	0.07
R-squared	=	0.33
Root MSE	=	0.12

log Y=log(MCF^{TM})	***Coef.***	***Std. Err.***	***t***	***P>|t|***	***[95% Conf.***	***Interval]***
log X_1=log(tariff)	0.05	0.02	2.12	0.04	0.001	0.10
log X_2=log(indtax)	0.002	0.003	0.52	0.60	-0.01	0.01
log X_3=log(imp/gdp)	0.01	0.07	0.14	0.89	-0.14	0.16
X_4=intimp/imp	0.38	0.37	1.03	0.31	-0.38	1.14
X_5=hhimp/cons	0.66	1.11	0.59	0.56	-1.63	2.94
D_1=largegdp{dummy}	0.14	0.07	2.04	0.05	0.00	0.28
D_2=midgdp{dummy}	0.07	0.04	1.68	0.11	-0.01	0.15
constant	-0.06	0.34	-0.17	0.86	-0.75	0.64

The regression specification is determined by trying to find a good fit while keeping all the theoretically relevant variables in the analysis. Although some of the variables are not statistically significant, their presence in the formulas for MCF meant that they belong in the regression analysis. The R^2 for the regression presented above in Table 5.1 is 0.33, which indicates a good fit for a cross-sectional analysis.

β_1 gives the elasticity of MCF^{TM} with respect to a change in the tariff rate. A one percentage point rise in the tariff, say from 10 to 11%, will raise MCF^{TM} by 0.05%. Tariff rate is the most significant explanatory variable of this regression (significant even at more than 96% confidence level). This finding supports the conventional wisdom that the MCF^{TM} is positively related to tariff rates. Intuitively, the higher the distortion, the more “expensive” the policy tool gets. Hence, countries with high tariff rates have a bigger potential to gain from trade reforms. Indeed, the data shows that countries with higher tariff rates like India, China, the Philippines and Vietnam (trade weighted tariff rates between 54% and 21%) end up with relatively higher MCF^{TM} numbers (between 1.55 and 1.24).

The second explanatory variable, log X_2, also affects the MCF^{TM} positively. β_2, the elasticity coefficient between MCF^{TM} and indirect taxes is positive, but very small, 0.002. This suggests an increase in indirect taxes would make tariffs more expensive as a policy tool. An increase in output taxes would induce a shift away from domestic products toward imports, and as X_3, X_4 and X_5 show (below), MCF^{TM} tends to raise with an increase in imports. However, this coefficient is not statistically significant.

The third explanatory variable, log X_3, is the natural logarithm of imports to GDP ratio, log (imp/gdp). X_3, the (imp/gdp) ratio stands for the share of imports in GDP. The interpretation is that a one percentage point rise in the log (imp/gdp) ratio, say from 10 to 11%, translates to a ten percent rise in the imports/GDP ratio, and the coefficient estimate informs us that this would increase the MCF by 0.1%. For larger initial trade shares the effect is damped but not trivial. This positive relationship is also intuitive, in that a higher import dependence increases the MCF^{TM}, hence tariffs as the policy tool become more expensive. Although the sign is correct, this coefficient also does not pass the significance test.

The fourth explanatory variable, X_4, is the ratio of intermediate imported inputs to total imports. This ratio reports how much of the imports are used in the production as intermediate inputs as opposed to being consumed as final goods. A one percentage point increase in this ratio increases the MCF^{TM} by 0.38%. Once again the sign is consistent with the intuition, but the coefficient turns out to be statistically insignificant.

Next explanatory variable, describes what percentage of the households consumption is made of imports as opposed to domestic products. A one percentage point increase in the share of imports in the domestic consumption increases the value of MCF^{TM} by 0.66 percent. Households' increasing preference for imported goods over domestically produced goods, makes tariffs more expensive as a policy tool. While the sign is as expected, the coefficient does not pass the significance test.

The last two explanatory variables are dummy variables for the size of the GDP. Countries with GDPs more than 1.000.000 million US$ are denoted as "large", countries with GDPs between 1.000.000 million US$ and 200.000 million US$ as "mid" and countries with GDPs less than 200.000 million US$ as "small". The dummy variable "large", D_1, is positively related to MCF^{TM}. It indicates that tariffs would be less desirable as a policy tool to raise revenue for larger countries. It holds for developing countries such as China and Korea (MCF^{TM} 1.56 and 1.49 respectively), whereas the data do not support this hypothesis for large developed countries like USA, Canada or Great Britain (MCF^{TM} 1.11, 0.92 and 1.02, respectively).[58] One explanation is that USA, Canada and Great Britain have very low levels of tariffs. We can say that tariffs appear to be even less desirable for large developing countries. D_1 is statistically significant (at 95% confidence level).

ii) Regression Analysis for Marginal Cost of Funds of Indirect Taxes

Table 5.6, on the next page, gives the output for regression[59] of natural logarithm of marginal cost of funds of indirect taxes, $\log(MCF^{TY})$, denoted as (log Y), on:

- indirect taxes, indtax, denoted as (X_1) interacted with three slope dummy variables (D_1X_1, D_2X_1, D_3X_1),
- natural logarithm of tariff rates, log(tariff), denoted as (log X_2),
- natural logarithm of total imports to GDP ratio, log(imp/gdp), denoted as (log X_3),
- natural logarithm of consumption of domestic products to total consumption

[58] As a matter of fact, when another regression is run with a subset of only developing countries in the dataset (26 countries), the coefficient of the size dummy "large" increases (0.295), and it becomes much more significant (0.998 significance level). For the entire dataset, there is some multicollinearity between the size dummy and dummy for development (developed = 0, developing = 1), but it is not at a critical level (correlation coefficient of "dev" and "large" = -0.47, meaning the developing countries' GDP in the dataset tends to be small).

[59] The regression is corrected for heteroscedasticity using the "robust" option of STATA.

ratio, log(dom/cons), denoted as (log X_4),

- the three dummy variables (D_1, D_2 and D_3) for the size of GDP (countries with a GDP more than 1.000.000 million US$ are denoted as D_1, "largegdp", between 1.000.000 US$ and 200.000 million US$ as D_2, "midgdp" and less than 200.000 million US$ as D_3, "smallgdp").

Note that interactive dummies, allow different parts of the data to have different slopes. For example, for large countries, D_1=1 and D_2=0, D_3=0, and the coefficient for X_1 takes the value (D_1X_1). For small countries D_3=1 and D_1=0 and D_2=0, and the coefficient of X_1 is (D_3X_1). Hence, the regression specification allows indirect taxes to affect MCFTY differently for large and small countries.

Table 5.6:

$\log Y = constant + (\beta_1 D_1)X_1 + (\beta_2 D_2) X_1 + (\beta_3 D_3) X_1 + \beta_4 \log X_2 + \beta_5 \log X_3 + \beta_6 \log X_4$

Number of obs	=	34
F(6, 26)	=	4.64
Prob > F	=	0.00
R-squared	=	0.44
Root MSE	=	0.09

log Y=log(MCF^{TY})	*Coef.*	*Std. Err.*	*t*	*P>|t|*	*[95% Conf.*	*Interval]*
X_1D_1=indtaxlarge	3.25	1.26	2.57	0.02	0.65	5.84
X_1D_2=indtaxmid	1.32	1.47	0.90	0.38	-1.70	4.34
X_1D_3=indtaxsmall	-3.44	1.92	-1.80	0.08	-7.39	0.50
log X_2=log(tariff)	0.004	0.02	0.18	0.86	-0.04	0.05
log X_3=log(imp/gdp)	-0.03	0.06	-0.43	0.67	-0.15	0.10
log X_4=log(dom/cons)	0.02	0.09	0.20	0.84	-0.17	0.21
constant	0.05	0.18	0.26	0.80	-0.32	0.42

As in the previous analysis, the regression specification is chosen by keeping the theoretically relevant variables in the regression and trying different forms to get a good fit. A relatively High R^2 (0.44), reported in Table 5.6 indicates a good fit of the regression to the data.

The results for indirect taxes interacting with the three dummy variables show that the presence of high indirect taxes (in this case, output taxes) along with the size of the economy (high GDP) affect the magnitude of MCF^{TY}.

The interpretation of these interactive dummy variables provides a rather interesting invention: the presence of high output taxes increase the magnitude of MCF^{TY} significantly for large countries, while they decrease its magnitude for small countries. China and Japan, two large countries with relatively higher output taxes (5.4% and 3.9%), have also high MCF^{TY} values (1.27 and 1.44), hence they fit the implication of the results that emerge from the interactive slope dummies. Zimbabwe, Zambia, the Philippines and Uruguay are all small countries with relatively high output taxes and relatively low MCF^{TY} values, which also fit to the above interpretation of the interactive slope dummies. β_1 is statistically significant (at 98% confidence level).

The intuition is less straightforward than in the case for MCF^{TM}. The regression results imply that output taxes are a "less expensive" revenue raising policy tool for smaller countries compared with larger countries. Another regression analysis run with a subset of only developing countries in the dataset (26 countries) does not change the result for smaller countries. A small country with a highly inefficient domestic production might illustrate the correct explanation. Higher output taxes would shift the domestic consumption of domestic goods towards imported goods and the usage of domestic intermediate inputs towards imported intermediates. This shift would potentially decrease the domestic inefficiency. Along with relatively cheaper factors of production and a high ratio of intermediate imported inputs in production, the description fits to most of the small developing countries. This result points clearly to a welfare improving policy reform for the small countries. The presence of alternative indirect taxes with relatively lower costs mean that a revenue neutral tariff reform would be beneficial for most of the small countries[60].

β_4 gives the elasticity of MCF^{TY} with respect to a change in the tariff rate. A one percentage point rise in the tariff, say from 10 to 11%, will raise MCF^{TY} by 0.004%. The intuition is symmetric to the impact of indirect taxes on MCF^{TM}. An increase in tariffs would shift demand in production toward domestic intermediates, and make output taxes more distortionary. The sign of the coefficient is correct, but the tariff rate turns out to be not statistically significant.

The next explanatory variable, log X_3, is the natural logarithm of imports to GDP ratio, log (imp/gdp). X_3, the (imp/gdp) ratio gives the share of imports in GDP. A one percentage point rise in the log (imp/gdp) ratio, say from 10 to 11%, translates to a ten percent rise in the "imports/GDP" ratio, and the coefficient estimate tells us that this would decrease the MCF^{TY} by 0.3%. This negative relation is intuitive, in that a higher ratio of imports in GDP means that a smaller part of the economy is affected by domestic production. Therefore, MCF^{TY} goes down and, output taxes as the policy tool become less expensive. The coefficient, β_5, is not statistically significant.

The last explanatory variable of the regression analysis, log X_4, is the natural logarithm of consumption of domestic products to total consumption ratio, log (dom/cons). The interpretation of the regression results for this explanatory variable is that a one percentage point rise in the log (dom/cons) ratio, say from 10 to 11%, translates to a ten percent rise in the "consumption of domestic products/total consumption" ratio, and the coefficient estimate tells us that this would increase the MCF^{TY} by 0.2%. A higher share of domestic products in the total consumption makes output taxes a more expensive policy tool. β_6 has the sign supported by the intuition, but it is not statistically significant.

60 As a matter of fact, Sri Lanka is the only small country in the dataset to have a higher MCF^{TY} than its MCF^{TM}.

Summarizing the basic results of econometric analysis:

- The conventional wisdom that ***higher distortions imply higher MCF estimates*** is confirmed.

- High share of imports in production and consumption makes MCF of tariffs more costly. This finding supports trade liberalization recommendations for developing countries with a high demand for imported intermediate inputs.

- Effects of distortions on MCF estimates seem to change with the size of the economy (determined by GDP). However, a larger sample with enough degrees of freedom in each size category is necessary to investigate this relationship.

VI. Conclusion

Trade taxes constitute an important source of revenue for most developing countries. In many cases, a tariff reform can considerably decrease government revenue and pose a serious fiscal challenge. The fiscal impact of the tariff reduction depends directly on the size of the tariff cut, the responsiveness of imports to the tax change, relative importance of import tariffs as a source of government revenue, and indirectly on what happens to the other tax bases. In theory, many studies conveniently offset the revenue loss of the government by a hypothetical lump-sum transfer. However, in practice lump-sum transfers do not exist. Lately, the importance of the revenue implications of trade liberalization has been widely acknowledged among economists, especially in international organizations such as the World Bank and the IMF. Recent policy recommendations that have evolved from their research on the interaction of trade liberalization and domestic tax systems suggest that for developing countries with binding government budget constraints, it is a priority to implement comprehensive reform packages of the domestic tax system to accompany trade liberalization[61].

This paper investigates whether trade taxes or indirect taxes will be more costly in welfare terms. A CGE model for a small open economy is employed to investigate a sample of 34 countries. The production structure assumes perfect competition and constant returns to scale. Intermediate imported inputs are nested within the production structure. To raise the same amount of revenue for the government, trade taxes and indirect taxes are used as policy tools. They each impact the welfare of the consumer differently. A comparison is made by using the compensated marginal cost of funds as the measurement tool for these welfare

[61] See Ebrill, Stotsky and Gropp (1999).

implications. Switching from the “more expensive” distortion (in welfare terms) to the “cheaper” one would be welfare increasing. Countries with higher marginal cost of funds estimates for tariffs than for other revenue raising tools, such as the output taxes, will be better off at the end of a tariff reform.

The results of the empirical part of this paper indicate that for 27 out of 34 countries investigated in this study, trade taxes are the “more expensive” distortion. In other words, a tariff cut, financed by raising the indirect taxes to compensate the government for the lost tariff revenue, would be welfare increasing. The relevant policy recommendation that emerges from these results is that there is still a strong potential for many countries to liberalize their trade. This would not only satisfy international organizations, that advocate for freer trade, but also be welfare improving for the country. The fact that 24 of these 27 countries are developing countries makes this recommendation even more encouraging.

Basically, the short answer to the question posed in the title: “Trade Taxes Are Better?!?” is “No”. The presence of imports in both the production and the consumption side increases the amount of distortions that are imposed by a tariff, thereby making the taxes on imports an “expensive” policy tool[62]. The model employed in this paper allows for a realistic presentation of the distortions in the economy, which is crucial for making the correct policy recommendations.

The empirical results for MCF estimates appear reasonable based on the range of the estimates obtained from the literature (Table 5.1). They are also not sensitive to the choice of elasticity of substitution (Table 5.5). The results are promising in that they offer an opportunity of welfare gain for many countries in

[62] Earlier results of this paper, reported from a smaller sample (only 15 countries) and a simpler model (treating imports only as final goods, and omitting imported intermediate inputs in production), suggest that trade taxes are actually the “cheaper” distortion for 11 out of 15 countries.

the sample[63].

These results encourage further research with different policy tools and different model specifications. The next section will briefly look into different ways of expanding this paper. Introduction of distortionary income taxation, taxes on private domestic consumption, value-added taxes or other distortions, such as quotas, along with making the model dynamic, would provide new marginal cost of funds estimates, which could help shape policy recommendations for developing countries.

[63] Korea, China, Poland and the Philippines have the highest potential welfare gains. Their welfare gain would be $0.354, $0.288, $0.251 and $0.24, respectively, for each dollar raised, if they switched from tariffs to output taxes as the revenue collecting policy instrument.

VII. Potential Extensions

While the results of this paper provide an answer to the question posed in the title, there are several new research directions one can take by extending the framework used here. This section briefly summarize some of these extensions:

Keeping the same welfare measurement tool (MCF), the question posed in this paper, whether trade reforms are always welfare improving or not, could be answered by making the following potential modifications and additions.

A. Distortionary Income Taxation

An interesting extension to the paper would be to replace distortionary income taxation with output taxes. The required substantial change in the model would be to include leisure choice in the utility function to end up with a non-zero uncompensated elasticity of labor supply[64]. The time endowment would be treated as exogenous and a unit of leisure would be produced with a unit of time. The elasticity of labor supply varies for different groups of individuals in the society. For example, the supply curve for non-student males is close to vertical, whereas for households and students it is more elastic. Averaging it to the whole population could give an inelastic labor supply curve, rather than a perfectly inelastic one. This extension would allow for the evaluation of trade reform paid for with realistic distortionary income taxation.

B. Other Types of Taxation

The indirect taxes for all the MCFs calculated in this paper were output taxes. Table 7.1 demonstrates a quick look at two other distortions for a sample country (Turkey). MCF^{TC} is the MCF for private domestic consumption taxes and MCF^{TX} is the MCF for export taxes.

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[64] Assumed to be 0.1 in MobiDK Project, a general equilibrium model for Denmark, directed by Glenn W. Harrison and Thomas F. Rutherford, see www.mobidk.dk.

Table 7.1 Output, Trade, Consumption and Export Taxes for Turkey (1997)

COUNTRY	MCF^{TY}	MCF^{TM}	MCF^{TC}	MCF^{TX}
Turkey	1.042	1.270	1.272	1.287

All MCFs are calculated for 1997 using GTAP5.

Introducing other distortions (such as private domestic consumption taxes or export taxes) into the model would offer a wider spectrum of policy tools, providing a larger set of alternatives for policy makers to use when compensating for the revenue lost due to trade reforms. Studies like Rutherford (2001), where he employs five different sets of tax instruments (value-added taxes, import tariffs, direct taxes on capital, direct taxes on formal labor and indirect taxes and substitutions on production) to calculate MCF estimates for Columbia, are gaining popularity among governments and international organizations like the World Bank, IMF and the WTO. By finding MCFs for other distortions, it could be shown that even the 7 countries, for which the trade taxes are cheaper than output taxes in this study, could potentially benefit from further trade liberalization (if the MCF of the new distortion is lower than the MCF of tariffs).

C. Other Distortions (Non-tariff Barriers)

Another attractive extension to the paper would be to define the trade reform in terms of reductions in quantitative restrictions, such as quotas, instead of cuts in tariffs. The intuition would remain the same. One interesting aspect of this approach is that the model becomes sensitive to rent sharing between the government and private sector due to the nature of the quantitative restrictions. The results can indicate that targeting quotas might be a better tool for a trade reform. The comparison of MCF figures between quotas and tariffs can give new insight for some policy decisions.

D. Dynamic Model

Another potential enhancement would be to make the model dynamic by introducing savings and investment and allowing dynamic capital accumulation. This addition would make it possible to investigate the long term effects of a policy change.

There is, however, evidence that results do not necessarily need to change with a dynamic model. Recent research by Rutherford and Tarr (1999) indicates that a dynamic small open economy (SOE) computable general equilibrium model does not produce welfare estimates significantly different from the static SOE model. They evaluate the impact of Chile forming free trade agreements with either NAFTA or MERCOSOUR for two different models (one static and one dynamic), and find out that the results for both scenarios are similar[65].

E. Sensitivity Analysis in a Broader Sense

Looking at the simple CGE model applied in this paper, we can ask more general questions about the credibility of CGE models. Can we find a goodness of fit criteria for CGE models in the international trade literature? Can we correctly predict the trade flows with the "right" CGE model? If both, econometric and CGE approaches, are "false", can we make a comparison and find out which one is less desirable?

Sensitivity analysis can provide a better understanding of the usefulness and reliability of a CGE model. A brief literature survey about sensitivity analysis is presented below.

Leamer (1984) runs cross country regressions of net trade divided by domestic consumption in a particular good on the vector of factor endowments. He

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[65] In an earlier paper, Rutherford and Tarr (1998) show that an endogenous growth model can result in significantly larger estimated welfare gains.

claims that by using the residuals from the cross sectional regression, ‘hidden’ trade barriers can be identified. Leamer (1988) also looked at the residuals from Heckscher-Ohlin equations to measure the restrictiveness of trade policy. The econometric approach used by Leamer has the drawback that misspecifications of the model will alter the residuals and hence affect the trade policy.

Another approach to measure openness is the “Trade Restrictiveness Index (TRI)” of Anderson and Neary (1993), a computable general equilibrium application. It represents the initial protective structure of an economy in terms of a uniform set of trade restrictions (in welfare terms). Choosing a benchmark year in the TRI model and generating indexes by going back and forth in time, would allow us to use the CGE model as an alternative to the econometric approach to forecast trade parameters. Using the CGE model for forecasting purposes would not only enable us to compare different approaches in the international trade literature, but also measures of fit of “Real Business Cycle” and “International Trade” CGEs.

Canova (1995) mentions the increasing usage of simulation techniques to derive the time series properties of nonlinear general equilibrium models in the applied macroeconomic literature. The “Real Business Cycle” literature has evaluated “goodness of fit measures”, procedures to formally measure the fit of calibrated models (see e.g. Sims (1989) and Canova, Finn, and Pagan (1993)).

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