# The Costs of Restrictive Trade Policies in the Presence of Factor Tax Distortions

Ian W. H. Parry

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1616 P Street, NW
Washington, DC 20036
Telephone 202-328-5000
Fax 202-939-3460

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**Abstract**

This paper uses a numerical general equilibrium model to examine the quantitative importance of pre-existing factor tax distortions for the welfare effects of restrictive trade policies in economies with and without market power in trade. We analyze tariffs, non-auctioned import quotas (with rents accruing to domestic firms) and voluntary export restraints (with rents accruing to foreign firms). We find that allowing for interactions with pre-existing taxes can greatly magnify the overall costs of these policies – possibly by over several hundred percent! In the case of import tariffs, much of this additional cost can be offset if the tariff revenues are used to reduce other distortionary taxes. Indeed the cost discrepancy between revenue-neutral tariffs and import quotas is dramatic at modest levels of import reduction, but declines to zero as these policies become prohibitive. We find that the optimal tariff for a country with market power in trade is greatly reduced, and possibly to zero, *unless* tariff revenues finance cuts in other distorting taxes. The proportionate increase in costs due to pre-existing taxes is much smaller under voluntary export restraints than under import quotas when costs are measured by domestic welfare losses, but not when measured by world welfare losses.

Key Words: pre-existing tax distortions, tariffs, import quotas, second-best welfare costs

JEL Classification Nos.: F10, H21

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# THE COSTS OF RESTRICTIVE TRADE POLICIES IN THE PRESENCE OF FACTOR TAX DISTORTIONS

Ian W. H. Parry*

## 1. INTRODUCTION

In recent years a literature has emerged that re-evaluates the costs of government policy instruments in a second-best setting that allows for pre-existing sources of distortion in the economy created by the tax system. Most of this work has focussed on the costs of environmental regulations, however the implications apply broadly across a whole range of policy measures, including trade-restricting policies.[1] The key message from this literature is that any regulations that raise the prices of (final) goods in the economy tend to indirectly exacerbate the welfare costs of the tax system. In most models, this occurs through a reduction in labor supply in response to the effect of higher prices on reducing the real household wage. The reduction in labor supply results in a welfare loss, due to the wedge between the gross and net wage created by labor taxes. Taking into account this spillover effect in the labor market can raise the overall costs of regulatory policies by a substantial amount, and sometimes by enough to compromise their ability to improve overall welfare.[2] In this paper we use a numerically solved general equilibrium model to assess the significance of pre-existing taxes in the context of restrictive trade policies.

Second-best considerations are obviously not new to trade economists. There is an extensive literature that examines the welfare impacts of restrictive trade policies in the presence of pre-existing sources of distortion in the economy. However most of this literature focuses on non-tax sources of distortion, such as imperfectly competitive product markets, institutional distortions in labor markets and alleged externalities associated with infant industries.[3]

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[1] For surveys of this literature see Bovenberg and Goulder (1998) and Parry and Oates (1998).

[2] In the context of environmental problems it has been shown that tradable emissions permit programs that fully internalize an environmental externality may actually lead to a reduction in overall social welfare. This is because the partial equilibrium welfare gain can be more than offset by the costs from exacerbating pre-existing tax distortions (see for example Parry et al., 1996). In a somewhat different context, Browning (1997) finds that the costs of monopoly pricing in the U.S. are several times larger when the impact of restricted production on exacerbating tax distortions in the labor market are taken into account.

[3] For reviews of this literature see for example Baldwin (1992) and Bhagwati (1971).

The link between trade policies and the tax system has been studied in the context of optimal tax systems.[4] These studies find that, in the presence of optimal (i.e., Ramsey) commodity taxes, additional taxes on imports and exports are only optimal only if the domestic country has market power in world markets. In other words, for a given amount of revenue raised, these policies involve higher welfare costs than commodity taxes (in the absence of market power). This reflects their narrower base and hence the greater substitution possibilities for firms and households to avoid the tax.[5]

More recently Williams (1998) has used an analytical model to examine the implications of pre-existing factor taxes for the welfare impacts of (revenue-neutral) restrictive trade policies using a specific factors model of an economy with market power in trade. Assuming no retaliation by foreign governments, he shows that the optimal rate of tariff to take advantage of market power is unaffected by pre-existing taxes, unless the net impact of the tariff is to alter the relative burden of taxation born by labor and the specific factors. In contrast, allowing for pre-existing taxes reduces the optimal quantity of (non-auctioned) import quotas, or level of voluntary export restraint (VER).

Two effects underlie these results. First, tariffs, and their non-tariff equivalents, raise the prices of goods in the economy. This reduces the real household wage, (slightly) reduces labor supply and exacerbates the welfare costs of taxes in the labor market. This type of effect has been termed the *tax-interaction effect* in studies of environmental regulations (Goulder, 1995). Second, tariffs generate revenues for the government that can be used to reduce distortionary factor taxes. The welfare gain from using tariff revenues in this manner has been termed the *revenue-recycling effect*. The reduced optimal level of regulation under the import quota or VER in Williams (1998) reflects the inability of these policies to offset the costs of the tax-interaction effect with the welfare gain from the revenue-recycling effect.

This paper extends the work of Williams (1998) by using a numerically solved model to gauge the quantitative importance of pre-existing factor taxes for the welfare effects of restrictive trade policies. We consider the domestic and world welfare impacts of tariffs, (non-auctioned) import quotas (with rents accruing to domestic firms) and VER's (with rents accruing to foreign firms), using a model with industry-specific factors. We examine cases when the domestic country can and cannot affect world prices of traded goods, and we consider the possibility of retaliation by the government of a foreign country. The model is calibrated using U.S. data for labor market parameters.

We find that pre-existing factor taxes can substantially raise both the domestic and world welfare costs of restrictive trade policies. This cost increase can exceed several hundred percent in the case of import quotas, or tariffs when revenues are returned as lump sum transfers. In contrast, the proportionate increase in costs under a revenue-neutral tariff (with revenues used to cut distortionary taxes) is smaller, though still significant (around

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[4] See for example Dixit (1985), Broadway et al. (1973) and Dasgupta and Stiglitz (1972).

[5] Other theoretical studies have examined trade policies in the presence of differential tax treatment of factor inputs across industries (see for example Magee, 1976).

30 percent). The cost discrepancy between import quotas and revenue-neutral tariffs depends importantly on the extent of import reduction. It can be dramatic at modest levels of import reduction, but converges to zero as these policies become prohibitive.

In addition, we find that the traditional case for an optimal tariff (in the absence of retaliation) in economies that can influence world prices is dramatically reduced, if not eliminated altogether, unless tariff revenues are used to reduce other distorting taxes. That is, the tax-interaction effect can easily outweigh the welfare gain to the domestic economy from taking advantage of monopoly power in world markets. In cases where the foreign economy retaliates to domestic trade protection, pre-existing taxes can raise world welfare costs by an amount comparable to that caused by retaliation.

The second-best costs of VER's (with distortionary taxes) are not much greater than the first-best costs (without distortionary taxes) when costs are measured by domestic welfare losses. This is because the first-best costs of VER's include the income loss from the transfer of rents to foreign suppliers, and these costs are much larger than the first-best costs of import quotas. However, if the costs of VER's are measured by world welfare losses, this income transfer is not included. In this case, the second-best costs of VER's can exceed the first-best costs by several hundred percent.

Our results have some potentially significant implications for policy. They suggest that the welfare gains from free trade may be substantially larger than implied by earlier analyses that neglect pre-existing factor tax distortions.[6] They also imply that if, for whatever reasons, imports of a particular product are to be restricted, there is a potentially important efficiency case for using tariffs over quantity restrictions, or alternatively auctioning import quotas, so long as the revenues are used to cut other distorting taxes.[7] In contrast, since the 1970's tariffs in the U.S. have been reduced while (non-auctioned) non-tariff barriers have been expanded (Bhagwati, 1988).

The rest of the paper is organized as follows. We begin in Section 2 by providing a theoretical framework for interpreting the quantitative results. Section 3 describes and presents results from our numerical model, assuming the domestic country has no influence on world product prices. In section 4 we consider an economy that has market power in world markets. Section 5 examines the sensitivity of the results to alternative assumptions about parameter values. Section 6 concludes and discusses some important caveats to the analysis.

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[6] See for example the estimates in USITC (1995) and Feenstra (1992). In the U.S. most trade now takes place with little restriction. However, a number of industries still receive significant protection, including textiles, steel and certain agricultural commodities (particularly sugar, cotton and dairy products). In addition, restrictions on trade with other countries are imposed from time to time to pressurize these countries to change policies related to, for example, the environment, race, and nuclear weapons.

[7] The same policy implication emerges from studies that compare the costs of trade restrictions in the presence of rent-seeking activities. In this case, competition among firms for (non-auctioned) import quotas leads to additional rent-seeking efficiency losses that do not occur under tariffs (see Kreuger, 1974, and Bhagwati, 1982).

## 2. THEORETICAL FRAMEWORK

In this section we sketch out an analytical model that integrates factor taxation into a standard specific factors (Ricardo-Viner) trade model. The model shows, qualitatively, how pre-existing factor taxes affect the welfare impacts of tariffs, import quotas and VER's, and provides a framework for interpreting the subsequent quantitative results. For simplicity, we focus on an economy facing exogenous world prices. Our discussion is fairly brief since the model is similar to that in Williams (1998).

### A. Assumptions

Consider a small, open economy importing goods from, and exporting goods to, a foreign economy at given world prices. A representative household divides its time endowment ($\bar{L}$) between labor supply ($L$) and leisure ($\bar{L} - L$). The household purchases two consumption goods, denoted by subscripts 1 and 2. Both goods are produced and consumed in the domestic economy. Good 1 is also imported and good 2 is exported. Household utility is given by the function:

$$U = U\left(C_1, C_2, \bar{L} - L\right) \tag{2.1}$$

where $U(.)$ is continuous and quasi-concave and $C_i$ denotes a consumption level.

We assume firms behave competitively and the production functions of the representative firms in the domestic economy are:

$$Q_1 = Q_1(L_1); \qquad Q_2 = Q_2(L_2) \tag{2.2}$$

where $Q_i$ denotes output and $L_i$ labor input. We assume that these production functions are concave; that is, production is subject to diminishing returns and domestic supply curves are upward sloping. Implicitly, this represents the effect of a sector-specific factor input that is fixed in supply, such as land, or deposits of natural resources. Section 6 briefly discusses how the inclusion of capital accumulation would affect our results. For the moment, we simplify the analysis by assuming the gross wage is fixed and normalized to unity.[8]

We assume that the trade account balances; that is, expenditure on imports equals revenues from exports, where both are expressed in terms of foreign exchange. The world prices of these goods are determined exogenously in the foreign economy, and are normalized to unity. Therefore:

$$M = C_1 - Q_1 = Q_2 - C_2 = X \tag{2.3}$$

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[8] This assumption implies that the ratio of labor to specific factor input and the elasticity of substitution between factors in the production function is the same in both domestic industries (see for example Harberger, 1962). When these conditions do not hold there is an additional effect that could slightly strengthen or dampen the tax-interaction effect discussed below (see Williams, 1998). We explore the quantitative importance of this generalization in Section 5.

where $M$ and $X$ denote import and export quantities. The trade account is brought into balance via changes in the domestic currency price of imports relative to the price of exports, brought about by changes in the real exchange rate. We normalize the domestic currency price of good 2 to unity and denote the relative price of good 1 (gross of tariffs or tariff-equivalents) by $p$.[9]

The government has an exogenous revenue requirement of $G$ and levies a proportional tax of $t_L$ on labor income.[10] For simplicity we assume that $G$ is returned to households as a lump sum transfer. The government also regulates the quantity of imports using various policy instruments. For the moment, we assume no retaliation by the foreign country in response to trade protection by the home country. In addition we assume the government budget must balance, hence any revenues raised by the trade policies are used to reduce the labor tax (the implications of alternative assumptions are discussed in later sections).[11]

We now discuss the welfare impacts of restrictive trade policies in this setting. Below, we present formulas for the welfare impacts; the derivations of these formulas are provided in Appendix A. Williams (1998) also provides similar derivations.

## B. Comparing the Welfare Impacts of Trade Policies

(i) Import Tariff

Consider an ad valorem tariff of $\tau_t$ levied on the value of imports, where tariff revenues are used to reduce the labor tax. The welfare cost (expressed in monetary terms) of a marginal increase in $\tau_t$ can be expressed (see Appendix A)

$$-\frac{1}{\lambda}\frac{dU}{d\tau_t} = \left(p(\tau_t)-1\right)\left(-\frac{dM}{d\tau_t}\right) + t_L\left(-\frac{dL}{d\tau_t}\right) \qquad (2.4)$$

where $\lambda$ is the marginal utility of income. The first term in (2.4) is the welfare loss from the reduction in imports caused by the incremental increase in the tariff rate. It equals the reduction in imports multiplied by the wedge the tariff creates between the demand price, $p(\tau_t)$ (equal to marginal benefit to domestic consumers) and the world price, 1 (equal to the

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[9] That is, p is the additional units of good 2 that must be exported to pay for one more unit of imports of good 1.

[10] In this section we assume that non-labor income is not taxed. This is relaxed in later sections.

[11] Given our assumptions, in the absence of the trade policy there are no pre-existing distortions in the markets for goods 1 and 2, hence the trade policies necessarily reduce efficiency within these markets. Of course, more generally trade protection policies could conceivably increase welfare in the domestic economy, for example if the domestic economy has some influence over world product prices (see Section 4). On the other hand, we also abstract from a number of considerations that may compound the efficiency costs of trade policies, for example rent-seeking activities, the creation of monopoly power for domestic firms and distortions in the quality of imports caused by quotas.

marginal cost of imports to the domestic economy).[12] The second term in (2.4) is the welfare change in the labor market. This equals the change in aggregate labor supply caused by increasing the tariff, multiplied by the wedge between the gross wage (equal to the value marginal product of labor) and the net wage (equal to the marginal social cost of labor supply in terms of foregone leisure time).

We now explore the welfare impact in the labor market in more detail. To do this it is helpful to define the following term:

$$Z = \frac{-t_L \dfrac{\partial L}{\partial t_L}}{L + t_L \dfrac{\partial L}{\partial t_L}} \qquad (2.5)$$

This is an expression for the (partial equilibrium) marginal excess burden of labor taxation, or efficiency cost of raising an additional dollar of labor tax revenue. The numerator is the welfare loss from an incremental increase in the labor tax and the denominator is the incremental increase in labor tax revenue (from differentiating $t_L L$).

The welfare change in the labor market can be decomposed as follows (see Appendix A):

$$t_L \frac{dL}{d\tau_t} = Z\left\{pM + \tau_t \frac{d(pM)}{d\tau_t}\right\} - (1+Z)t_L\left(-\frac{\partial L}{\partial \tau_t}\right) \qquad (2.6)$$

The first term on the right hand side in this equation is the welfare gain in the labor market from using the additional tariff revenues to reduce the labor tax. This is the (marginal) *revenue-recycling effect*. It equals the product of the marginal tariff revenue and the marginal excess burden of taxation. The second term is the welfare loss from the (marginal) *tax-interaction effect*. Increasing the tariff rate drives up the price of good 1, and hence the price of consumer goods in general. This reduces the real household wage and induces a substitution out of labor supply and into leisure. The reduction in labor supply leads to an efficiency loss because of the wedge between the gross and net wage. In addition, the reduction in labor supply reduces labor tax revenues. The combined welfare loss from these two effects is the tax-interaction effect.

If consumption goods are equal substitutes in demand for leisure then the marginal tax-interaction effect can simply be expressed *ZpM* (see Appendix A). This exceeds the marginal revenue recycling effect in (2.6) (since $d(pM)d\tau_t < 0)$, except when $\tau_t = 0$. Therefore, in this case the net impact of the revenue-recycling and tax-interaction effects is to raise the slope of the marginal cost from reducing imports, but not to affect the intercept. This means that (in general) substituting tariff revenues for labor tax revenues raises the overall

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[12] Using (2.3) the first term can be decomposed into $(p(\tau_t) - 1)(-dC_1 / d\tau_t + dQ_1 / d\tau_t)$. That is, the welfare loss from increasing the tax on consumption of good 1, and increasing the implicit subsidy to domestic producers of good 1.

efficiency costs of the tax system. This is because the import tax has a narrower base and is therefore easier to avoid than a broad-based labor tax.[13] More generally if good 1 is a relatively strong (weak) substitute for leisure, then the tax-interaction effect is larger (smaller), relative to the revenue-recycling effect. We ignore this possibility, since it has been examined at length in the optimal commodity tax literature.[14]

(ii) <u>Import Quota</u>

Now consider a policy that restricts imports by allocating (binding) quotas to domestic consumers of imports. We assume these quotas are given out free, so the rents accrue to domestic households. (In our analysis, an auctioned import quota would be equivalent to a tariff.) We define this policy by its tariff-equivalent $\tau_q$; that is, the (percentage) wedge the quota creates between the domestic and world price of good 1.[15]

The welfare cost of a marginal increase in $\tau_q$ can be decomposed as follows (see Appendix A):

$$-\frac{1}{\lambda}\frac{dU}{d\tau_q} = \tau_q p\left(-\frac{dM}{d\tau_q}\right) + (1+Z)t_L\left(-\frac{dL}{d\tau_q}\right) \qquad (2.7)$$

The first term on the right hand side in (2.7) is the welfare loss from the reduction in imports, and is equivalent to that under the tariff. The quota also produces a welfare loss from the tax-interaction effect, since it increases the price of consumption goods relative to leisure in the same manner as the tariff. However, since it does not raise revenues for the government, it does not produce the benefit from the revenue-recycling effect. In this case, the effect of pre-existing taxes is to shift up the marginal cost curve for reducing imports such that the curve has a positive intercept. This is because the tax-interaction effect results in a first order (or non-incremental) welfare loss, given the tax wedge between the gross and net wage.[16]

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[13] Households can avoid the tariff by substituting into the other consumption good, leisure or purchasing more of good 1 produced by domestic firms. In contrast, a labor tax is equivalent to a uniform tax on both consumption goods, and can only be avoided by substituting into leisure.

[14] As well known, the optimal set of taxes to raise a given amount of revenue would involve taxing goods that are weak substitutes for leisure more heavily, and goods that are strong substitutes for leisure more lightly (see for example Sandmo, 1975).

[15] The effective price of imports exceeds the world price by $\tau_q p$, even to quota holders. If a household uses a quota to increase its own consumption, it forgoes a rent of $\tau_q$ it could have obtained by selling the quota to another household.

[16] The $dL/d\tau_q$ coefficient in (2.7) is approximately equal to the compensated price coefficient (for small $\tau_q$). This is because the income loss from the increase in $\tau_q$ is roughly offset by the income gain from additional quota rents. Thus the reduction in real wage reduces labor supply because the compensated labor supply curve is upward sloping. Under the tariff this offsetting income effect occurs when the revenues are recycled in factor tax reductions.

(iii) VER

We now consider a VER. This policy also limits imports from foreign suppliers, but in this case the quota rents are transferred to foreign suppliers rather than accruing to domestic households. Again we define the policy by its tariff-equivalent, $\tau_v$.

The general equilibrium welfare change from an incremental increase in $\tau_v$ can be expressed (see Appendix A):

$$-\frac{1}{\lambda}\frac{dU}{d\tau_v} = p'(\tau)M + (1+Z)t_L\left(-\frac{\partial L}{\partial \tau_v}\right) \tag{2.8}$$

The marginal welfare loss in the import market is now $p'(\tau)M$, a first-order term reflecting the loss of quota rents to the foreign economy. As with the other policies, the VER drives up the price of consumption relative to leisure and induces a tax-interaction effect.[17]

(iv) Other Policies

We do not explicitly consider export-reducing policies, since the results for these policies can be inferred from those for import policies. An export tax has equivalent efficiency impacts to that of the import tariff in our analysis. That is, despite pre-existing taxes, the Lerner symmetry property still applies: restricting imports by a tax is equivalent to restricting exports by a tax, since trade balance requires that the value of imports always equals the value of exports. Similarly, a domestic export quota has equivalent welfare impacts as the import quota. Export subsidies have symmetrical effects to import tariffs or export taxes. They expand the quantity of exports and reduce the price of consumption goods. This leads to an increase in labor supply and a welfare *gain* from the tax-interaction effect. However, in general this welfare gain is more than offset by the cost of financing the subsidy by raising the rate of factor tax.[18]

## 3. NUMERICAL ANALYSIS: WORLD PRICES EXOGENOUS

In this section we explore the quantitative importance of pre-existing taxes for the welfare cost of restrictive trade policies, assuming these policies have no impact on world prices. To do this we specify functional forms for the previous model and solve by numerical simulation.[19] We also allow for a little more realism by including a non-traded goods sector.

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[17] $\partial L/\partial \tau_v$ in (2.8) is an uncompensated price coefficient, because of the loss of quota rents out of the economy. Since leisure is a normal good, this implies the tax-interaction effect will be weaker under the VER than the import quota.

[18] We ran some simulations for a revenue-neutral export subsidy in our numerical model of Section 3. Pre-existing taxes raise the overall cost of this subsidy policy by around 30 percent – the same result as for a revenue-neutral tariff – for any given increase in the quantity of exports.

[19] This enables us to obtain "exact" solutions for non-marginal policy changes. The analytical model could be solved for non-marginal policy changes by taking second order welfare approximations. However these may be unreliable for "large" policy changes.

Subsections A and B describe the structure and calibration of the empirical model. Appendix B provides more details on how the model is solved. Subsection C presents the numerical results.

### A. Model Assumptions[20]

We assume the following nested CES function for household utility:

$$U = \left\{ \alpha_U C^{\frac{\sigma_U - 1}{\sigma_U}} + (1-\alpha_U)(\overline{L} - L)^{\frac{\sigma_U - 1}{\sigma_U}} \right\}^{\frac{\sigma_U}{\sigma_U - 1}} \tag{3.1a}$$

$$C = \left\{ \alpha_1 C_1^{\frac{\sigma_C - 1}{\sigma_C}} + \alpha_2 C_2^{\frac{\sigma_C - 1}{\sigma_C}} + \alpha_3 C_3^{\frac{\sigma_C - 1}{\sigma_C}} \right\}^{\frac{\sigma_C}{\sigma_C - 1}} \tag{3.1b}$$

where $C_3$ is consumption of non-tradable output produced by a domestic industry and $C$ is sub-utility from consumption goods. $\sigma_U$ and $\sigma_C$ are the elasticities of substitution between aggregate consumption and leisure, and between individual consumption goods, respectively. The $\alpha$'s are distribution parameters. The assumptions embedded in (3.1) imply that all consumption goods are equal substitutes for leisure.[21]

Households receive the rents accruing to the specific factors used in each of the three production sectors. We denote the endowments of these specific factors by $\overline{K}_i$ and prices by $r_i$.[22] The household budget constraint amounts to:

$$(1+\tau)p_1 C_1 + p_2 C_2 + p_3 C_3 = (1-t_L)\left\{ wL + r_1\overline{K}_1 + r_2\overline{K}_2 + r_3\overline{K}_3 + \pi \right\} + G \tag{3.2}$$

where $p_1$ and $p_2$ are the world prices of the two traded goods (expressed in domestic currency), $p_3$ is the domestic price of non-traded consumption, and $(1+\tau)p_1$ is the domestic price of the imported good. $\tau$ is the ad valorem rate of tariff, or tariff-equivalent. $\pi$ is quota rents and is positive only in the case of the import quota. All labor and rent income is taxed at the same rate $t_L$.[23] Households choose consumption and labor supply to maximize utility (3.1) subject to their budget constraint (3.2). This generates the household demand functions for goods and labor supply function.

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[20] Unless otherwise indicated, variables are defined as in Section 2.

[21] This follows from the (weak) separability between individual consumption goods and leisure, and the homothetic preferences over consumption goods implied by (3.1b). For more discussion see Deaton (1981).

[22] We assume these prices are positive in equilibrium; that is, the constraints on the quantities of the specific factors are binding.

[23] The effective tax rates on labor and profit income are roughly the same in the U.S. (see for example Lucas, 1990). Labor is subject to personal income taxes and payroll taxes, and profits are subject to personal and corporate income taxes.

We assume domestic firms produce goods according to the following CES function:

$$Q_i = \left\{ \gamma_i (L_i)^{\frac{\sigma_i - 1}{\sigma_i}} + (1-\gamma_i)(K_i)^{\frac{\sigma_i - 1}{\sigma_i}} \right\}^{\frac{\sigma_i}{\sigma_i - 1}}; \qquad i = 1, 2, 3 \tag{3.3}$$

However the quantity of the specific factors are fixed in equilibrium, therefore increasing output by using additional labor involves diminishing returns. The $\sigma_i$'s are the elasticities of substitution between factors in production and the $\gamma_i$'s are distribution parameters. Firms choose labor and specific factor inputs to maximize profits subject to the production function and taking input and output prices as given. This generates the input demand and output supply functions.

For the moment we maintain the assumption that the domestic economy has no effect on world prices. Therefore the quantity of imports equals the quantity of exports (when world prices are normalized to unity) as in equation (2.3). The tariff, import quota and VER policies we examine are the same as those analyzed in Section 2. However, rents from the import quota are now taxed at rate $t_L$. The government budget constraint is:

$$G = t_L \left\{ wL + r_1 \overline{K}_1 + r_2 \overline{K}_2 + r_3 \overline{K}_3 + \pi \right\} + \tau p_1 M_1 \tag{3.4}$$

This equation equates government spending with government revenues.

In practice it is difficult to predict how the government would use the additional revenues raised by a tariff and from the partial taxation of quota rents. We consider two cases that span the range of possibilities in our model. First, as in Section 2, government spending is held constant and the rate of factor tax is adjusted to maintain budget balance.[24] In this case a tariff generates the full revenue-recycling effect and import quotas an indirect or partial revenue-recycling effect. Second, we consider a case where the additional revenues are used to finance an increase in the lump-sum payment to households. In this case there is no efficiency gain from raising revenue. Thus we illustrate the efficiency gains to be had from using revenues to cut other distortionary taxes.[25]

For a given set of preference, production and government parameters the general equilibrium is calculated by finding the vector of goods and factor prices such that: (a) the demand for all goods and factors equals the relevant supply; (b) the household budget, government budget, and trade balance constraints are satisfied; and (c) imports are reduced to a given level.

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[24] More precisely, real government spending is held constant; that is, nominal spending divided by a consumer price index.

[25] For a public choice perspective on how governments may spend new sources of revenues see Becker and Mulligan (1997).

## B. Model Calibration

Roughly speaking, the $\alpha$ parameters determine input and output quantities and the $\sigma$ parameters the response of variables to changes in policy parameters. The $\sigma$ parameters are most important for determining the *relative* costs of the different trade policies. Below we discuss the parameter values used in the benchmark simulations (the results from alternative parameter values are reported in section 5).

In the absence of trade policies, we assume that the share of imports/exports in the total value of consumption is 10 percent. The share of non-traded consumption in the total value of consumption is 60 percent, and 20 percent for each of the two traded goods (that is, imports account for 50 percent of importable consumption). The relative costs of policy instruments are not sensitive to alternative values for these shares (see Section 5). The shares of labor income, and total specific factor income, in total income are initially 90 percent and 10 percent respectively.[26] The ratio of labor to specific factor input is initially the same in each industry (this is relaxed in section 5).

We use estimates of U.S. labor market parameters – estimates of labor supply elasticities for other countries are much more sparse. The consumption/leisure substitution elasticity $\sigma_U$, along with the labor time endowment, are chosen to imply uncompensated and compensated labor supply elasticities of 0.15 and 0.4 respectively. These are median estimates from the literature, and are meant to capture the effects of changes in the real household wage on average hours worked, the labor force participation rate and effort on the job.[27] However there is uncertainty surrounding these elasticities, and the results are somewhat sensitive to alternative assumptions (see Section 5). Following other studies, we assume a pre-existing factor tax rate of 40 percent.[28] Higher tax rates, which are appropriate in, for example, the European Union, can greatly magnify our results. Our parameter values imply a marginal excess burden of labor taxation of 0.3 which is consistent with other studies (see Browning, 1987; and Ballard et al., 1985).

In our benchmark simulations we assume the elasticity of substitution between consumption goods is unity, implying the (uncompensated) own price elasticity of demand for consumption goods are all unity. We assume production elasticities of 0.5. Our results are not very sensitive to these elasticities.

Below, we refer to our benchmark case with the factor tax as the "second-best" case. We compare this with a "first-best" case in which the pre-existing factor tax is set to zero, and

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[26] All these shares approximately represent the current situation in the U.S. (see the Economic Report of the President).

[27] See for example the survey by Russek (1994). We use a slightly higher value for the compensated elasticity since the studies in his survey do not capture effort effects.

[28] Other studies use similar values (for example Lucas, 1990, and Browning, 1987). The sum of federal income, state income, payroll and consumption taxes amounts to around 36 percent of net national product. This average rate is relevant for the labor force participation decision. The marginal tax rate, which affects average hours worked and effort on the job, is higher because of various deductions.

any revenue consequences from trade policies are neutralized by lump sum transfers from (to) households. We compare the policy instruments on the basis of costs over the entire range of possible reductions in imports.

Since we do not explicitly model the foreign economy in this section we can only calculate changes in domestic welfare. In the case of tariffs and import quotas, changes in domestic welfare equal changes in world welfare, since these policies have no impact on world prices and hence no effect on welfare in the foreign economy. The VER also does not affect world prices, however it transfers income from the domestic to the foreign economy. Thus world welfare losses for the VER are generally much lower than domestic welfare losses.

## C. Results

### (i) Marginal Costs

Figure 1 shows the marginal domestic welfare cost (expressed as a percent of domestic GDP) of the restrictive trade policies over the entire range from 0 to 100 percent reduction in imports. The dashed curve with the triangle legend is the marginal cost under the tariff in the first-best scenario. This curve has a zero intercept. It is also upward sloping reflecting increasing losses in consumer surplus from incremental reductions in consumption, and the increasing marginal cost of (partially) replacing imports with domestic production. The curve also indicates marginal costs under an import quota in the absence of factor taxation.

The solid curve with the triangle legend is the marginal cost under the tariff in the second-best case, with revenues devoted to cutting the factor tax. This curve also has a zero intercept but has a steeper slope than for the first-best tariff. As discussed in Section 2, this is because the tax-interaction effect dominates the revenue-recycling effect for a non-marginal reduction in imports. When tariff revenues finance lump sum transfers marginal costs are shown by the solid curve with the circle legend. This curve has a positive intercept, since there is no revenue-recycling effect to offset the tax-interaction effect. However, marginal costs increase at a slower rate when tariff revenues finance lump sum transfers rather than cuts in distortionary taxes. This is because under the latter policy marginal tariff revenues, and hence the marginal revenue-recycling effect, declines as the quantity of imports – the base of the tariff – is reduced. Marginal tariff revenue becomes zero at around a 50 percent reduction in imports (the peak of the Laffer curve). Beyond this point the marginal revenue-recycling effect is negative and the marginal cost curve under the revenue-neutral tariff lies above that under the tariff with lump sum replacement.[29]

Marginal costs under the revenue-neutral import quota, indicated by the solid curve with the square legend, lie between those for the tariff, with and without the revenue-recycling effect. This is because the government captures a fraction – 40 percent – of the

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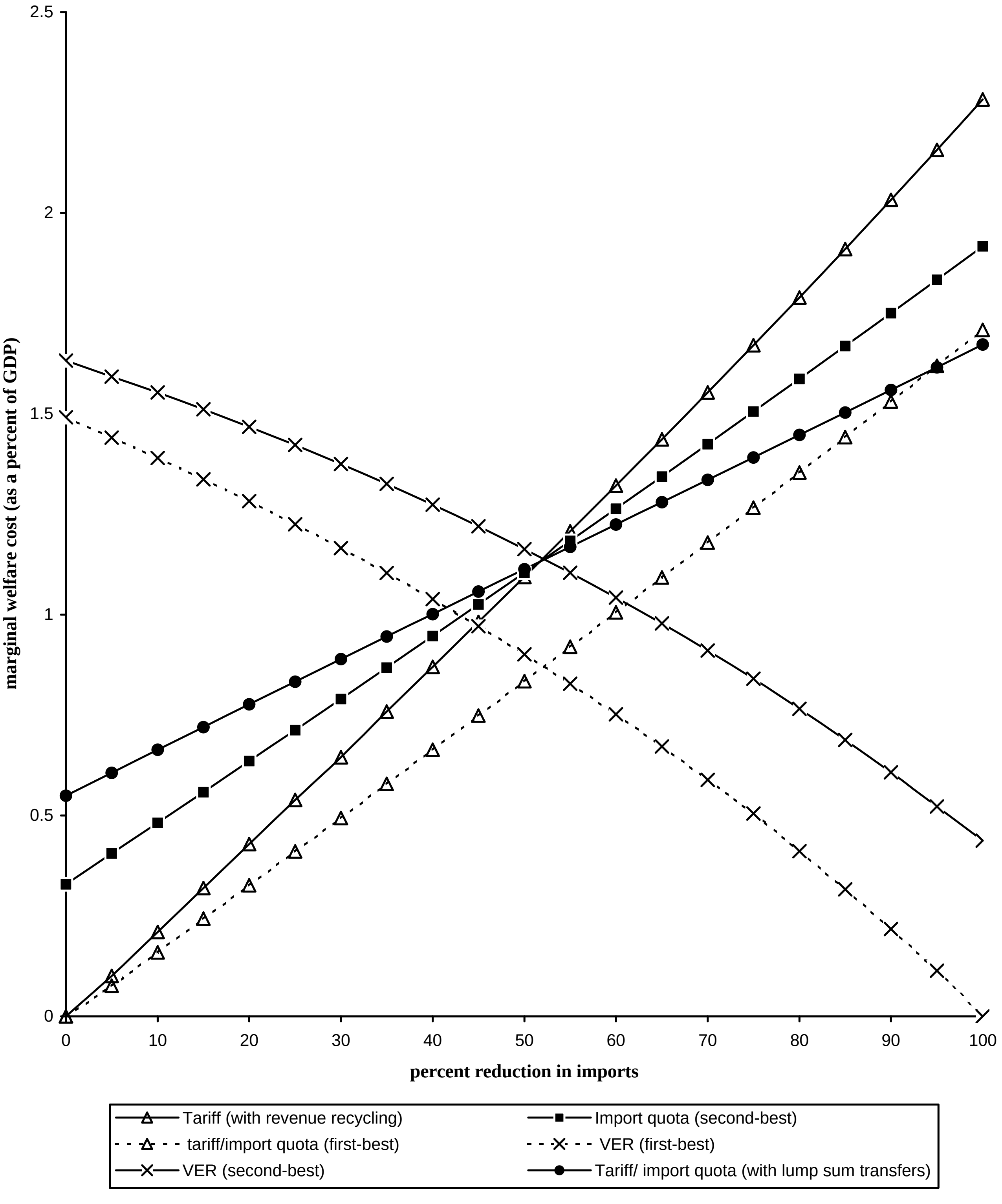
[29] Analogous results were derived by Goulder et al. (1997) in their comparison of pollution abatement policies that do and do not generate the revenue-recycling effect.

**Figure 1. Domestic Marginal Costs from Import Restrictions**
(with exogenous world prices)



quota rents through income taxation, and this produces a revenue-recycling benefit equal to 40 percent of that under the revenue-neutral tariff. If instead these revenues were returned to households as lump sum transfers, marginal costs would be equivalent to those under the tariff with lump sum replacement.

The dashed curve with the "X" legend indicates marginal costs under a VER in the first-best case. The curve has a substantial intercept. This reflects the first order income loss from the transfer of quota rents to the foreign economy (instead of the quota rents being recycled back into the domestic economy). However marginal costs are *decreasing*, rather than increasing as under the other policy instruments. This is because the incremental income loss from the transfer of rents is proportional to the import base, which is falling (see equation (2.8)). Finally, the solid curve with the X legend shows marginal costs under the VER in the second-best case. Marginal costs are higher in this case, due to the efficiency loss from the tax-interaction effect.[30]

(ii) Total Costs

Table 1 shows the total (second-best) costs of the import-restricting policies at import reductions of 5, 20, 50 and 100 percent. These are expressed relative to the total cost of the same import reductions under the tariff in the first-best case. The first row indicates that pre-existing taxes raise the total cost of the revenue-neutral tariff by approximately 30 percent, at all levels of import reduction.

**Table 1. Ratio of Second-Best Total Costs to First-Best Total Costs of a Tariff: Exogenous World Prices**

| | Percent reduction in imports | | | |
|---|---|---|---|---|
| | 5 | 20 | 50 | 100 |
| Tariff (with revenue recycling) | 1.31 | 1.31 | 1.31 | 1.32 |
| Tariff (with lump sum transfers) | 14.0 | 4.02 | 2.00 | 1.32 |
| Import quota (second-best) | 8.97 | 2.93 | 1.72 | 1.32 |
| VER (first-best) | 35.1 | 8.33 | 2.90 | 1.00 |
| VER (second-best) | 38.6 | 9.32 | 3.38 | 1.32 |

The proportionate increase in cost due to pre-existing taxes under the tariff with lump sum replacement is potentially very substantial. For example, the policy is 14 and 4 times as costly in a second-best case than in the first-best case, for import reductions of 5 and 20 percent respectively. Indeed it is infinitely more costly for an incremental reduction in

[30] The gap between the first-best and second-best marginal cost curves under the VER increases somewhat as the quantity of imports is reduced; that is, the marginal tax-interaction effect is smaller at more modest reductions in imports. The marginal tax-interaction effect is partially offset by an income effect: in response to the loss of income to the foreign economy households reduce their demand for leisure, a normal good. However the marginal income loss declines as the quantity of imports is reduced, hence the reduction in the marginal tax-interaction effect is smaller.

imports, reflecting the positive intercept of the marginal cost curve in Figure 1.[31] At higher levels of import restriction the discrepancy between the tariff with and without the revenue-recycling effect is less striking. The total costs of the two policies converge as the tariff becomes prohibitive, since tariff revenues converge to zero.[32] The differences between the import quota and revenue-neutral tariff are similar, though not quite as striking, since the quota creates a partial revenue-recycling effect. For the rest of the paper, we do not explicitly consider the import quota, since the difference in (marginal and total) cost between the import quota and the revenue-neutral tariff is always equal to 60 percent of that between the tariff with and without the revenue-recycling effect.

The VER is the most costly policy, due to the transfer of quota rents to the foreign economy. Comparing the fourth and second rows in Table 1, this welfare loss is generally much larger than the welfare loss from the tax-interaction effect. The ratio of second-best costs to the first-best costs under the VER (the fifth row divided by the fourth row) is generally much smaller than for the other policy instruments. However, if the costs of the VER were measured by world welfare losses, the ratio of first-best to second-best costs would be much more dramatic, since quota rents would not be included in these costs (see below). Note that the costs of all the second-best policies are identical at 100 percent reduction in imports. At this point the entire consumer surplus from imports is eliminated, the increase in price of consumption, and hence tax-interaction effect, is the same across all policies, and there are no revenue-recycling benefits.

We summarize some of the key themes from this section as follows. First, pre-existing taxes can substantially raise the costs of restrictive trade policies. Second, the increase in cost is much larger for policies that do not raise revenues, or do raise revenues but do not use them to cut distortionary taxes. Third, the relative cost discrepancy between policy instruments depends importantly on the level of import reduction.

## 4. NUMERICAL ANALYSIS: WORLD PRICES ENDOGENOUS

We now extend the analysis to allow for market power in trade; that is, the domestic economy can influence world product prices. This introduces the possibility that trade policies can increase domestic welfare, though world welfare necessarily falls. Subsection A describes the extensions to the previous model (again Appendix B provides more detail on how the model is solved). Subsection B presents the empirical results, assuming the foreign government does not retaliate in response to domestic trade protection. Subsection C examines welfare impacts with retaliation by the foreign government.

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[31] Import restrictions are likely to have only minor impacts on the overall level of employment in the economy. However, the resulting welfare loss can still be "large" relative to the first-best costs because taxes drive a substantial wedge between the marginal social benefits and marginal social cost of labor. For a diagrammatic discussion of this, in the context of environmental regulations, see Parry (1997).

[32] In Figure 1 the area between the corresponding marginal cost curves, integrated between 0 and 100 percent import reduction, is zero.

**A. Additional Assumptions**

We now explicitly model two countries that trade with each other (or two trading blocs). For simplicity, we assume each country has the same size (this is relaxed in Section 5). The domestic country is identical in every respect to that described in Section 3, except that it now faces endogenous world prices. Therefore, normalizing the world price of good 2 to unity, the balance of trade constraint is now:

$$p(M_1)M_1 = X_2 \tag{3.1}$$

where $p(M_1)$ is the world price of good 1 and $p'(M_1) > 0$. Thus, the domestic economy has market power in trade; it faces an upward sloping supply curve for imports.

For the moment we assume the foreign economy is identical to the domestic economy in terms of its preference and government parameters, endowments and initial consumption of goods and leisure. The only difference is that it has a superior technology for producing good 1 and an inferior technology for producing good 2. Thus it exports good 1 and imports good 2, and these quantities are initially 10 percent of its total consumption.

We consider the same policy instruments imposed by the domestic economy as before, with initially no response by the foreign government. The model is solved numerically by finding goods and factor prices such that, in both countries, all goods and factor markets are in equilibrium and household budget, government budget and trade balance constraints are satisfied, and domestic imports are reduced to a given level. In cases where we measure world welfare losses, this is simply the sum of domestic and foreign welfare impacts.

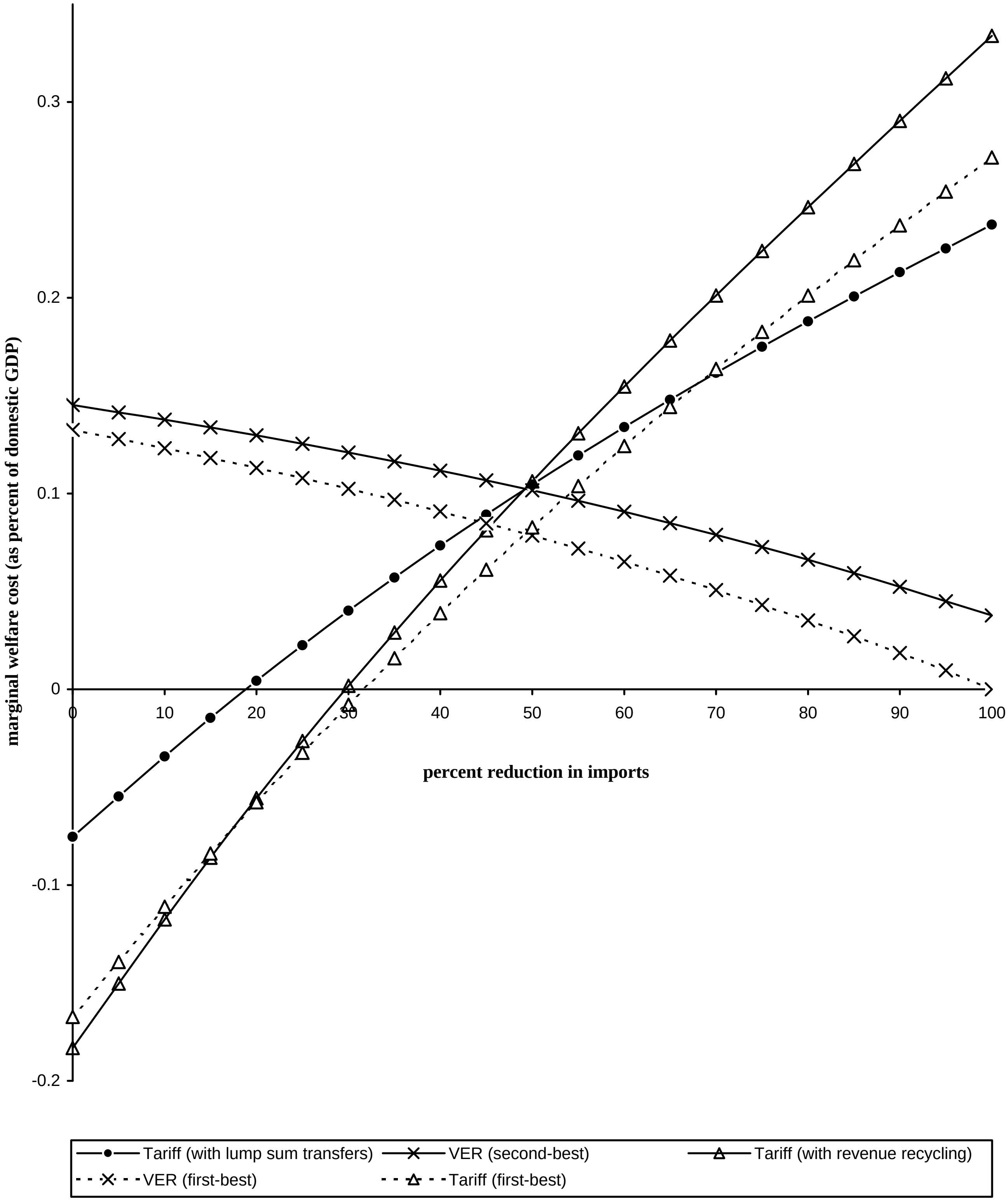
**B. Results: No Retaliation**

(i) Costs to the Domestic Economy

Figure 2a shows the marginal welfare impacts in the domestic economy from restrictive trade policies. The key difference compared with Figure 1 is that the domestic country now faces an upward sloping supply curve for imports. In the first-best case, shown by the dashed curve with the triangle legend, this implies an initial marginal welfare gain (negative marginal cost) for reducing imports under a tariff or import quota. Imposing a tariff (or import quota) leads to a second-order domestic welfare loss by reducing import consumption. However, part of the tariff burden (quota rent) comes at the expense of producer surplus to foreign exporters. That is, the policy enacts a transfer of surplus from the foreign to the domestic economy, and this gain dominates the welfare loss from reduced import consumption, at least for import reductions up to 30 percent.

In the second-best case, the tax-interaction effect substantially reduces the potential welfare gain, and the optimal reduction in imports, under a tariff with lump sum replacement, compared with the first-best tariff. Indeed, as we illustrate below, under alternative assumptions about the degree of market power, it is easily possible that – despite producing a welfare gain in the import market – the overall welfare impact of a tariff with lump sum replacement is necessarily negative, due to the (larger) welfare loss from the tax-interaction effect.

**Figure 2a. Domestic Marginal Costs from Import Restrictions**
(with endogenous world prices)



The difference in marginal welfare impacts between the second-best tariff with revenue recycling and the first-best tariff is somewhat smaller in Figure 2a than in Figure 1. The reason is that some of the tariff revenue now comes at the expense of foreign producer surplus rather than domestic consumer surplus. This implies that not all of the tax-interaction effect occurs in the domestic labor market; a minor part of it occurs in the foreign labor market (see below). The VER reduces domestic welfare in the first-best case. This is because the quota rents go to the foreign rather than the domestic economy.

The first set of rows in Table 2 shows the total (as opposed to marginal) domestic welfare cost of the policies (expressed as a percent of domestic GDP) for various levels of import reduction. A negative cell entry indicates a welfare gain. In the absence of revenue-recycling, pre-existing taxes reduce the welfare gain of a tariff by 58 percent and 70 percent at import reductions of 5 percent and 20 percent respectively (comparing rows 1a and 1c). However, if the tariff generates the revenue-recycling effect, the overall welfare impact of the tariff is similar to that in the first-best case. The welfare cost of all the second-best policies converge as imports become prohibitive. At this point, pre-existing taxes raise the costs of these policies by 24 percent relative to first-best costs.

**Table 2. Total Welfare Cost of Import Restrictions: Endogenous World Prices**
(expressed as a percentage of domestic GDP)

| | Percent reduction in imports | | | |
|---|---|---|---|---|
| | 5 | 20 | 50 | 100 |
| 1. Domestic welfare cost | | | | |
| a. Tariff (first-best) | -0.76 | -2.19 | -1.70 | 7.41 |
| b. Tariff (with revenue recycling) | -0.82 | -2.32 | -1.42 | 9.78 |
| c. Tariff (with lump sum transfers) | -0.32 | -0.66 | 1.06 | 9.78 |
| d. VER (first-best) | 0.65 | 2.45 | 5.33 | 7.41 |
| e. VER (second-best) | 0.71 | 2.75 | 6.22 | 9.78 |
| 2. World welfare cost | | | | |
| a. Tariff (first-best) | 0.04 | 0.69 | 4.06 | 14.82 |
| b. Tariff (with revenue recycling) | 0.06 | 0.92 | 5.35 | 19.56 |
| c. Tariff (with lump sum transfers) | 0.57 | 2.58 | 7.83 | 19.56 |
| d. VER (first-best) | 0.03 | 0.48 | 3.23 | 14.82 |
| e. VER (second-best) | 0.29 | 1.50 | 5.71 | 19.56 |
| 3. Foreign welfare cost | | | | |
| a. Tariff (first-best) | 0.80 | 2.88 | 5.76 | 7.41 |
| b. Tariff (with revenue recycling) | 0.88 | 3.24 | 6.77 | 9.78 |
| c. Tariff (with lump sum transfers) | 0.89 | 3.24 | 6.77 | 9.78 |
| d. VER (first-best) | -0.62 | -1.97 | -2.10 | 7.41 |
| e. VER (second-best) | -0.42 | -1.25 | -0.51 | 9.78 |

(ii) Costs to the World Economy

Figure 2b displays the marginal cost curves corresponding to those in Figure 2a, when costs are measured by world, rather than domestic, welfare losses. In this case the curves never lie below the horizontal axis; that is, trade policies always reduce world welfare. This is because the transfer of surplus from the foreign to the domestic economy effected by a tariff does not constitute a welfare gain from a global perspective.

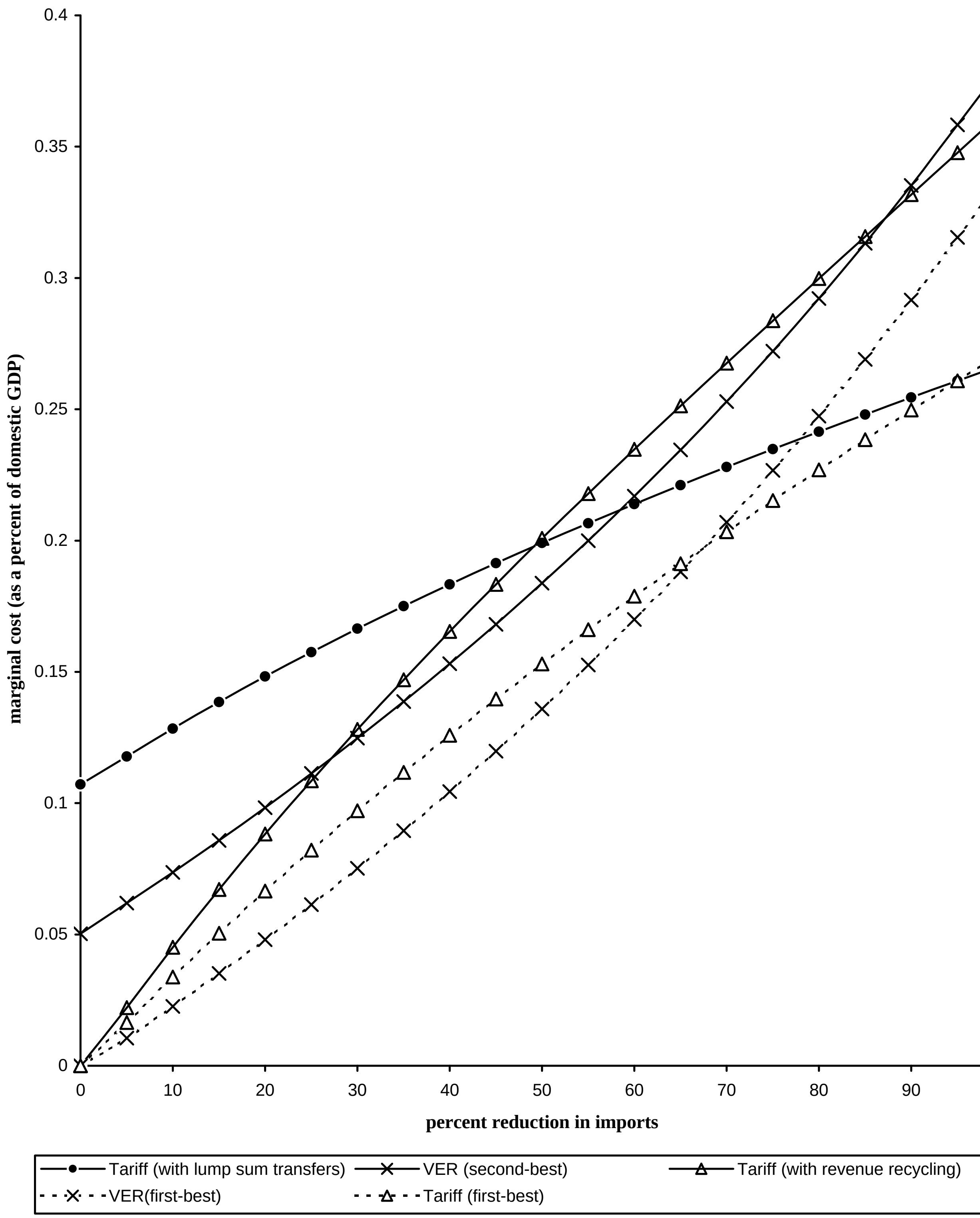
Another noteworthy feature of Figure 2b is that pre-existing taxes now cause a much more significant (proportional) increase in marginal costs under the VER. This is because the first-best costs of the VER are much lower, as they do not include the quota rents. The increase in marginal costs due to pre-existing taxes is a little larger for the import tariff in Figure 2b than in Figure 2a, regardless of whether revenues are used to cut other taxes or to increase lump sum transfers. This is because the world measure of welfare loss now fully captures the tax-interaction effect, which is spread over both domestic and foreign labor markets.

The second set of rows in Table 2 shows total world welfare costs (again expressed as a percent of domestic GDP). These are much larger for tariffs than the domestic welfare losses (or gains), since they include the loss of producer surplus to foreign suppliers and the tax-interaction effect in the foreign labor market. From rows 2a and 2b, the tariff with revenue-recycling is around 30 percent more costly than the first-best tariff. From rows 2a and 2c, the tariff with lump sum replacement is around 14 and 4 times as costly as the first-best tariff, for import reductions of 5 and 20 percent respectively. Thus, pre-existing taxes raise the world welfare costs of tariffs in our model with endogenous world prices, by more-or-less the same proportionate amount as they raise the domestic welfare costs of tariffs in our exogenous world price model. Similarly, from rows 2d and 2e, pre-existing taxes raise the world welfare costs of the VER in roughly the same proportion as they raise the costs of the import quota in Table 1.

(iii) Costs to the Foreign Economy

Subtracting the domestic welfare changes in the first set of rows of Table 2 from the world welfare costs in the second set of rows gives the welfare cost to the foreign economy, shown in the third set of rows. In the case of the first-best tariff (row 3a), the cost to the foreign economy is the reduction in producer surplus to exporters. This exceeds any net welfare gain to the domestic economy (row 1a). In the second-best case, costs to the foreign economy are around 10 – 30 percent higher because of the tax-interaction effect in that economy (comparing rows 3b and 3c with 3a). This effect stems from the increase in the world consumer price of the regulated commodity, and hence reduction in real household wage and labor supply in the foreign economy. These costs are the same, regardless of whether tariff revenues in the domestic economy finance cuts in factor taxes (row 3b) or lump sum transfers (row3c). The VER produces a net welfare gain for the foreign economy in the first-best case (row 3d), if the transfer of surplus from domestic consumers to foreign

**Figure 2b. World Marginal Costs from Import Restrictions (endogenous world prices)**



suppliers exceeds the welfare loss from the reduction in foreign exports. The potential welfare gain is somewhat smaller in the second-best case (row 3e), because the net impact of the VER is to exacerbate the efficiency costs of factor taxes in the foreign economy.[33]

## C. Results: With Retaliation

We now consider retaliation by the foreign government. For simplicity we assume that the foreign economy mimics the trade policy of the domestic country; that is, it imposes the same tariff or VER on domestic country exports, as the domestic country imposes on foreign country exports. In addition, it disposes of revenues from trade policies in the same manner as the domestic country. The resulting domestic and world welfare costs (as a percent of domestic GDP), compared with the situation when neither country restricts imports, are shown in Table 3. These are expressed for given reductions in domestic country imports from its own policy, *prior* to the retaliation by the foreign economy. Therefore, by subtracting row 1a in Table 3 from row 1a in Table 2 we obtain the domestic costs of a retaliatory tariff in a first-best setting. Then subtracting row 1a from rows 1b and 1c in Table 3, we obtain the additional costs due to pre-existing taxes, and so on.

**Table 3. Welfare Impacts of Import Restrictions with Retaliation by Foreign Economy**

(as a percentage of domestic GDP)

| Welfare cost with retaliation | Percent reduction in imports with no retaliation | | |
|---|---|---|---|
| | 5 | 20 | 50 |
| 1. Domestic welfare cost | | | |
| a. Tariff (first-best) | 0.09 | 1.38 | 7.41 |
| b. Tariff (with revenue recycling) | 0.12 | 1.81 | 9.78 |
| c. Tariff (with lump sum transfers) | 0.60 | 3.03 | 9.78 |
| d. VER (first-best) | 0.06 | 0.96 | 6.41 |
| e. VER (second-best) | 0.31 | 1.94 | 8.67 |
| 2. World welfare cost | | | |
| a. Tariff (first-best) | 0.18 | 2.76 | 14.81 |
| b. Tariff (with revenue recycling) | 0.24 | 3.63 | 19.57 |
| c. Tariff (with lump sum transfers) | 1.19 | 6.06 | 19.57 |
| d. VER (first-best) | 0.13 | 2.01 | 12.82 |
| e. VER (second-best) | 0.63 | 3.88 | 17.34 |

[33] When tariffs and VER's become prohibitive, the costs are born equally by the domestic and foreign economies. This stems from our assumption that the two economies are symmetrical.

For the tariff policies, the domestic welfare losses caused by retaliation are significantly larger than the additional costs due to pre-exiting taxes. For example, under the tariff with lump sum replacement, the additional welfare costs due to pre-existing taxes are 26-59 percent of the additional costs due to retaliation. This is because retaliation effects a first-order income transfer from the domestic to the foreign economy. When viewed from a global perspective however, pre-existing taxes can have a larger impact on increasing welfare costs than retaliation. For example, under the tariff with lump sum replacement the additional costs due to pre-existing taxes are 7.2 and 1.6 times as large as those due to retaliation, when the domestic tariff initially reduces imports by 5 and 20 percent respectively. Even when tariffs produce the revenue-recycling benefit, the additional costs from pre-existing taxes are 50 percent of those from retaliation. Similarly for VER's, the increase in world welfare losses due to pre-existing taxes can be significantly larger than the costs of retaliation, at least for more modest levels of import reduction.

## 5. SENSITIVITY ANALYSIS

In this section we examine how the previous results are affected by alternative assumptions about parameter values.

### A. Degree of Market Power

In Table 4 we indicate how pre-existing taxes affect the optimal reduction in imports for the domestic economy – assuming no retaliation by the foreign economy – under different assumptions about the share of the domestic economy's GDP in world GDP (or the combined GDP of countries within a trading bloc).[34] In the first-best case, when this share is relatively small the domestic economy has relatively little market power hence the optimal level of import restriction is relatively small. For example, when the share in world trade is 5 percent the optimal reduction in imports is 4.7 percent. In contrast when the share is 50 percent, the optimal import reduction is 31.5 percent (this is where the marginal cost curve intersects the horizontal axis in Figure 2a).

**Table 4. Optimal Import Reduction**
(expressed as a percentage)

| | Share in world GDP | | | | |
|---|---|---|---|---|---|
| | .05 | .2 | .35 | .5 | .65 |
| Tariff (first-best) | 4.7 | 16.2 | 24.0 | 31.5 | 31.2 |
| Tariff (with revenue recycling) | 3.8 | 14.5 | 21.9 | 29.8 | 31.3 |
| Tariff (with lump sum transfers) | 0 | 0 | 2.2 | 17.8 | 28.7 |

[34] To do this we simply scale up and down endowments, and initial quantities of consumption, imports and leisure, in the domestic economy, keeping foreign country exports and imports equal to domestic country imports and exports.

In a second-best setting, the tax-interaction effect dramatically reduces the optimal amount of import restriction under a tariff with lump sum replacement, compared with the first-best case. For example, when the domestic economy's share in world trade is 35 percent, pre-existing taxes reduce the optimal level of import reduction from 24.0 percent to just 2.2 percent. When the trade share is 5 percent or 20 percent, the optimal import reduction is zero. In contrast, when the tariff generates the revenue-recycling effect, the optimal level of import reduction is very similar to that in the first-best case.[35] Thus, pre-existing taxes substantially reduce, if not eliminate, the case for an optimal tariff, *unless* the tariff revenues are used to cut other distortionary taxes.

For the rest of this section we consider how alternative model specifications and parameter values affect the proportionate increase in costs of tariffs caused by pre-existing taxes.[36] To do this we use the model of Section 3 with fixed world prices. The cell entries in Table 5 show ranges for the ratio of second-best costs to first-best costs for the tariff with and without the revenue-recycling effect, for import reductions of 5 and 50 percent.

**B. Relative Size of the Traded Goods Sector**

In the first set of rows in Table 5 we vary the share of the traded goods sector in domestic GDP. First, we hold importable consumption at 20 percent of GDP, but vary the share of imports between 10 and 90 percent of importable consumption. Second, we vary the share of importable consumption in GDP between 5 and 40 percent (keeping the ratio of imports to importable consumption at 50 percent). In either case, this has virtually no impact on the ratio of second-best to first-best costs. In other words the tax-interaction and revenue-recycling effects are proportional to the first-best costs of the tariff.

**C. Factor Input Ratios**

When factor input ratios differ across industries, trade policies have an additional impact on the labor market. Suppose import-competing production is labor intensive relative to that in the exporting industry. Import restrictions lead to additional production in the first industry and reduced production in the second. Thus they raise the demand for labor, and this serves to mitigate the tax-interaction effect. Conversely, if import-competing production is relatively intensive in the specific factor, the tax-interaction effect is larger.

In the second row of Table 5 we halve and double the ratio of specific factor to labor input in import-competing production (adjusting that in the export industry to keep total factor shares the same). This reduces and increases the tax-interaction effect by approximately 40 percent respectively. Indeed a modest, revenue-neutral tariff can produce an overall welfare gain if import-competing production is labor intensive (even though the country has no

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[35] These empirical findings are (approximately) consistent with the qualitative results in Williams (1998).

[36] Of course different assumptions and parameterizations imply different absolute welfare costs from trade policies.

market power in trade). Effectively, the policy shifts the overall burden of taxation away from labor and onto the specific factors.[37]

**Table 5. Sensitivity Analysis: Ratio of Second-Best Costs to First-Best Costs**
(exogenous world prices)

| | Percent reduction in imports | |
|---|---|---|
| | 5 | 50 |
| Benchmark estimates | | |
| Tariff (revenue recycling) | 1.31 | 1.31 |
| Tariff (lump sum transfers) | 14.0 | 2.00 |
| 1. Size of traded goods sector in total consumption | | |
| a. imports 10 - 90% of importable consumption | | |
| Tariff (revenue recycling) | 1.35 – 1.35 | 1.39 – 1.39 |
| Tariff (lump sum transfers) | 13.2 – 13.1 | 1.98 – 2.22 |
| b. importable consumption 5-40% of total consumption | | |
| Tariff (revenue recycling) | 1.34 – 1.33 | 1.31 – 1.31 |
| Tariff (lump sum transfers) | 14.1 – 13.8 | 2.00 – 2.01 |
| 2. Factor input ratios | | |
| Specific factor to labor ratio halved and doubled | | |
| Tariff (revenue recycling) | -4.47 – 7.78 | 0.72 – 1.95 |
| Tariff (lump sum transfers) | 8.15 – 19.9 | 1.41 – 2.64 |
| 3. Specific factor income 20 – 5% of GDP | | |
| Tariff (revenue recycling) | 1.24 – 1.37 | 1.22 – 1.37 |
| Tariff (lump sum transfers) | 11.1 – 16.4 | 1.76 – 2.15 |
| 4. Labor market parameters | | |
| a. Tax rate 20 – 60% | | |
| Tariff (revenue recycling) | 1.09 – 3.12 | 1.07 – 3.22 |
| Tariff (lump sum transfers) | 4.44 – 78.2 | 1.25 – 8.90 |
| b. Uncompensated labor supply elasticity 0 – 0.3 | | |
| Tariff (revenue recycling) | 1.08 – 1.57 | 1.10 – 1.56 |
| Tariff (lump sum transfers) | 8.40 – 20.5 | 1.50 – 2.61 |
| 5. Consumption and production elasticities | | |
| a. Consumption elasticity halved and doubled | | |
| Tariff (revenue recycling) | 1.31 –1.31 | 1.32 – 1.30 |
| Tariff (lump sum transfers) | 13.8 – 14.0 | 2.01 – 1.99 |
| b. Production elasticities halved and doubled | | |
| Tariff (revenue recycling) | 1.28 – 1.34 | 1.28 – 1.34 |
| Tariff (lump sum transfers) | 12.8 – 14.6 | 2.14 – 1.84 |

[37] For more discussion of these types of effects see Williams (1998).

### D. Share of Fixed Factor Income in Total Income

Reducing the share of labor endowment in total factor endowment reduces the tax-interaction and revenue-recycling effects. However the quantitative importance of this is limited; doubling the share of specific factor endowment in the total value of endowments has a relatively modest impact on reducing the net efficiency loss from interactions with the tax system (see row 3 of Table 5).

### E. Labor Market Parameters

The fourth set of rows in Table 5 varies the labor market parameters. We vary the initial factor tax rate between 20 and 60 percent. This has a disproportionate effect on the relative size of the revenue-recycling and tax-interaction effects. For example the proportionate increase in costs due to pre-existing taxes under the revenue-neutral tariff varies between 7 and 200 percent. The costs of the tariff with lump sum replacement in the presence of a 60 percent factor tax are 78 times as large as the first-best costs, for an import reduction of 5 percent!

Our results are also sensitive to alternative assumptions about labor supply elasticities. Based on the recent survey by Russek (1994), a plausible range for the economy-wide, uncompensated labor supply elasticity is 0 – 0.3. Using these values leads to a reduction and an increase in the tax-interaction effect of roughly 40 percent.

### F. Consumption and Production Elasticities

In the final set of rows in Table 5 we halve and double the consumption goods and production elasticities. This has little effect on the ratio of second-best to first-best costs. For a given reduction in imports, the more elastic the demand for imports (that is, the larger the consumption and production elasticities) the smaller the first-best welfare loss. However this also implies a proportionately smaller tax-interaction effect, since the increase in price of imported consumption is lower. It also implies a proportionately lower rate of tariff to induce the import reduction, and hence a smaller revenue-recycling effect.

## 6. CONCLUSION

This paper examines the quantitative importance of pre-existing factor tax distortions for the welfare effects of restrictive trade policies in small and large open economies. Using U.S. labor market parameters, we find that pre-existing taxes can substantially raise the costs of such policies, sometimes by over several hundred percent. This reflects the adverse impact on labor supply stemming from the effect of trade restrictions on driving up domestic consumer prices and hence reducing the real household wage. However, much of this added cost may be offset if the trade policy raises revenues for the government and these revenues are used to reduce other distortionary taxes. Thus, there is a potentially large discrepancy between the costs of revenue-neutral tariffs and (non-auctioned) import quotas. This is particularly the case for modest levels of import reduction. In addition, the case for an optimal tariff in an economy with market power in trade is dramatically reduced, if not eliminated, unless the revenues from the tariff finance cuts in other distortionary taxes. Pre-existing taxes generally have much less effect on raising the relative domestic costs of VER's compared with import quotas or tariffs with lump sum replacement. This is because these costs include the loss of rents to foreign suppliers. However, when measured in terms of world welfare losses, pre-existing taxes have a much more striking effect on raising the relative costs of VER's.

There are a number of potentially important caveats to the above results. Our model incorporates only one imported good. More realistically countries import a variety of different goods and these may be subject to varying rates of tariffs or non-tariff barriers. Introducing a new tariff may affect the efficiency impacts of existing trade restrictions both directly through shifts in demand and supply and indirectly through changes in the real exchange rate, required to maintain trade balance equilibrium.[38] A more comprehensive second-best evaluation of particular trade restrictions would take into account these types of spillover effects, in addition to the spillover effects in distorted factor markets.

Another important assumption in our analysis is perfect competition. Over the last two decades many trade models have been developed that incorporate imperfect competition and increasing returns at the industry level due to, for example, R&D spillovers and learning by doing. In these models trade protection can enhance domestic welfare (in the absence of retaliation) by, for example, inducing domestic firms to develop new products before foreign rivals, thereby capturing rents from a first-mover advantage.[39] A useful extension to the above analysis would be to weigh the potential efficiency gains from trade policies in these types of situations against their costs, in terms of exacerbating factor market distortions.

We also assume the only source of distortion in the labor market is that created by the tax system. In many countries, non-tax factors such as trade unions, minimum wage laws and employment protection legislation may importantly affect the level of the distortion in the labor market.[40] Taking into account these factors may significantly magnify the efficiency impacts of trade policies in factor markets.

Finally, we use a static analysis that abstracts from interactions with the capital market. In a more general setting, to the extent that trade policies discourage investment rather than consumption they will tend to exacerbate the efficiency costs of taxes in the capital market rather than taxes in the labor market. Incorporating the capital market requires a more sophisticated dynamic analysis that allows for capital accumulation over time. These types of dynamic models are difficult to implement empirically because of uncertainty over the

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38 See for example Harberger (1989).

39 For a survey of these models and their implications see for example Baldwin (1992) and Dixit (1983).

40 For a recent discussion of labor market rigidities in European countries see Siebert (1997). Even in the U.S., which is thought to have a relatively flexible labor market, non-tax factors may significantly add to the distortions created by taxes (see Browning, 1994).

consumption/savings elasticity. In any case we would expect our results to be reasonably robust in a dynamic setting because the capital market is only around one third the size of the labor market (in the U.S.). Thus our static model does capture the most important market in the economy that is distorted by taxes.

## APPENDIX A: ANALYTICAL DERIVATIONS

### Deriving Equation (2.4)

The household budget constraint is given by:

$$p(\tau_t)C_1 + C_2 = (1 - t_L)L + R + G \tag{A1}$$

where $R$ is rent income from specific factors. Households choose consumption and labor supply to maximize utility (2.1) subject to (A1). This gives the first order conditions:

$$\frac{\partial U}{\partial C_1} = \lambda\, p(\tau_t)\,; \qquad \frac{\partial U}{\partial C_2} = \lambda\,; \qquad \frac{\partial U}{\partial L} = -\lambda\,(1 - t_L) \tag{A2}$$

From these we obtain the uncompensated demand and labor supply functions:

$$C_1 = C_1(\tau_t, t_L)\,; \qquad C_2 = C_2(\tau_t, t_L)\,; \qquad L = L(\tau_t, t_L) \tag{A3}$$

Firms choose labor input to maximize revenues net of gross payments to labor (and payments to fixed factors). Using (2.2) this gives the first order conditions:

$$p(\tau_t)\frac{dQ_1}{dL_1} = 1; \qquad \frac{dQ_2}{dL_2} = 1 \tag{A4}$$

From these equations we obtain the input demand functions:

$$L_1 = L_1(\tau_t)\,; \qquad L_2 = L_2(\tau_t) \tag{A5}$$

Substituting (2.2) and (2.3) into (2.1) and totally differentiating gives:

$$dU = \frac{\partial U}{\partial C_1}\left\{\frac{dQ_1}{dL_1}dL_1 + dM\right\} + \frac{\partial U}{\partial C_2}\left\{\frac{dQ_2}{dL_2}dL_2 - dX\right\} + \frac{\partial U}{\partial L}dL \tag{A6}$$

Substituting (A2) and (A4) in (A6) and dividing by $\lambda\, d\tau_t$ gives:

$$\frac{1}{\lambda}\frac{dU}{d\tau_t} = p\frac{dM}{d\tau_t} - \frac{dX}{d\tau_t} + \frac{dL_1}{d\tau_t} + \frac{dL_2}{d\tau_t} - (1 - t_L)\frac{dL}{d\tau_t} \tag{A7}$$

Differentiating (2.3) and the constraint that total labor input equals labor supply gives:

$$\frac{dM}{d\tau_t} = \frac{dX}{d\tau_t} \qquad \text{and} \qquad \frac{dL_1}{d\tau_t} + \frac{dL_2}{d\tau_t} = \frac{dL}{d\tau_t} \tag{A8}$$

Substituting (A8) in (A7) gives (2.4).

### Deriving Equation (2.6)

The government budget constraint is given by:

$$G = \tau_t\, pM(\tau_t, t_L) + t_L L(\tau_t, t_L) \tag{A9}$$

that is, government spending equals the sum of tariff revenue and labor tax revenues. Totally differentiating with respect to $\tau_t$ and $t_L$ we can obtain:

$$\frac{dt_L}{d\tau_t} = -\frac{pM + \tau \dfrac{d(pM)}{d\tau} + t_L \dfrac{\partial L}{\partial \tau_t}}{L + t_L \dfrac{\partial L}{\partial t_L}} \tag{A10}$$

(where we have separated out the partial derivatives for *L* but not for *M*). From (2.5) and (A10) we can obtain:

$$\frac{dt_L}{d\tau_t} = \frac{Z\left\{pM + \tau \dfrac{d(pM)}{d\tau} + t_L \dfrac{\partial L}{\partial \tau_t}\right\}}{t_L \dfrac{\partial L}{\partial t_L}} \tag{A11}$$

Using (A3) the effect on labor supply can be decomposed as follows:

$$\frac{dL}{d\tau_t} = \frac{\partial L}{\partial \tau_t} + \frac{\partial L}{\partial t_L}\frac{dt_L}{d\tau_t} \tag{A12}$$

Substituting (A11) in (A12) we can easily obtain (2.6).

**Deriving an Alternative Formula for the Tax-Interaction Effect**

From (2.5) and (2.6) the tax-interaction effect can be expressed:

$$TI = (1+Z)t_L\left(-\frac{\partial L}{\partial \tau_t}\right) = ZL\frac{\partial L/\partial \tau_t}{\partial L/\partial t_L} \tag{A13}$$

From the Slutsky equations:

$$\frac{\partial L}{\partial \tau_t} = \frac{\partial L^h}{\partial \tau_t} - \frac{\partial L}{\partial I}\frac{dp}{d\tau_t}C_1; \qquad \frac{\partial L}{\partial t_L} = \frac{\partial L^h}{\partial t_L} - \frac{\partial L}{\partial I}L \tag{A14}$$

where "*h*" denotes a compensated coefficient. From the Slutsky symmetry property

$$\frac{\partial L^h}{\partial \tau_t} = \frac{\partial L^h}{\partial p}\frac{dp}{d\tau_t} = \frac{\partial C_1}{\partial(1-t_L)}\frac{dp}{d\tau_t} \tag{A15}$$

Also, from differentiating the household budget constraint (2.4) for a compensated price change:

$$\frac{\partial L^h}{\partial t_L} = -\frac{\partial L^h}{\partial(1-t_L)} = -\frac{\partial C_1}{\partial(1-t_L)} - \frac{\partial C_2}{\partial(1-t_L)} \tag{A16}$$

since the change in labor tax revenues is returned to households and *p* is (initially) unity. Substituting (A14) – (A16) in (A13) gives

$$TI = \frac{ZC_1 \dfrac{dp}{d\tau_t}\left\{\dfrac{\partial C_1}{\partial(1-t_L)}\dfrac{1}{C_1}+\dfrac{\partial L}{\partial I}\right\}}{\dfrac{\partial C_1}{\partial(1-t_L)}\dfrac{1}{L}+\dfrac{\partial C_2}{\partial(1-t_L)}\dfrac{1}{L}+\dfrac{\partial L}{\partial I}}$$

This can be manipulated to give:

$$TI = ZC_1 \frac{dp}{d\tau_t}\left\{\frac{\eta_{1l}^h+\eta^I}{s_1\eta_{1l}^h+s_2\eta_{2l}^h+\eta^I}\right\} \tag{A18}$$

where

$$\eta_{1l}^h = \frac{\partial C_1}{\partial(1-t_L)}\frac{1-t_L}{C_1}; \qquad \eta_{2l}^h = \frac{\partial C_2}{\partial(1-t_L)}\frac{1-t_L}{C_2}; \qquad \eta^I = \frac{\partial L}{\partial I}\frac{(1-t_L)L}{L};$$

$$s_1 = \frac{C_1}{L}; \qquad s_2 = \frac{C_2}{L}$$

$s_1$ and $s_2$ are the shares of the two consumption goods in GDP and they sum to unity. $\eta^I$ is the income elasticity of labor supply. $\eta_{1l}^h$ and $\eta_{2l}^h$ are the compensated elasticity of demand for $C_1$ and $C_2$ respectively, with respect to the price of leisure. When $C_1$ and $C_2$ are equal substitutes for leisure, $\eta_{1l}^h = \eta_{2l}^h$ and the term in brackets in (A17) is unity. Finally, $dp/d\tau_t = pM/C_1$; that is, an incremental increase in the tariff rate increases the price of importable consumption by the share of imports in importable consumption. Hence we obtain $TI = ZpM$ .

**Deriving Equations (2.7) and (2.8)**

Under the import quota the government budget constraint is:

$$G = t_L L(\tau_q, t_L, \pi) \tag{A18}$$

Labor supply now depends on quota rents π, which appear in the household budget constraint. Totally differentiating with respect to $\tau_q$ and $t_L$ gives:

$$\frac{dt_L}{d\tau_q} = \frac{t_L \dfrac{dL}{d\tau_q}}{L + t_L \dfrac{\partial L}{\partial t_L}} \tag{A19}$$

where

$$\frac{dL}{d\tau_q} = \frac{\partial L}{\partial \tau_q} + \frac{\partial L}{\partial \pi}\frac{d\pi}{d\tau_q}$$

Following the same procedure for deriving equation (2.6), but using (A19) instead of (A11), we can obtain (2.7).

For the VER, quota rents do not appear in the household budget constraint and the labor supply function. Hence the numerator in equation (A19) is $t_L(\partial L/\partial t_v)$. This explains the difference in price coefficients between (2.7) and (2.8).

## APPENDIX B: SOLVING THE NUMERICAL MODELS

The model in Section 3 is straightforward to solve. We used GAMS with MPSGE. Essentially this involves specifying preference, production and policy parameters and initial consumption shares and factor ratios. The package then calculates the general equilibrium and any welfare changes between different equilibria. For information on how to solve these types of models, and numerous examples, see the GAMS website:

`gams.com/solvers/mpsge/index.htm`

Our model essentially combines models m4-1s (small open economy) and m1-4s (labor leisure choice), which are at website:

`ike.gams.com/solvers/mpsge/markusen.htm`

and adds labor taxes. For a discussion of how to model revenue neutral policies see website gams.com/solvers/mpsge/syntax.htm (section 3).

For the endogenous price model of Section 4 we use an exchange model. There are two representative agents (domestic and foreign) who trade with each other. Each agent owns and works in three industries producing non-tradable consumption, importable consumption and exportable consumption (that is, there are six industries). The domestic government taxes income to the domestic agent and the foreign government taxes income to the foreign agent. The domestic government also regulates the amount of imports from the foreign agent. Again, these types of exchange models are relatively straightforward to solve with GAMS/MPSGE (see gams.com/solvers/mpsge/gentle.htm, section 6).

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