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This paper investigates whether developed countries export taxes to developing countries, contributing to the deterioration of their terms of trade and welfare; that is to what extent the distribution of gains from trade is being affected not by existing tariffs in developed countries, which are already at low levels, but by their domestic taxation. An eight-region CGE model for the world economy is used. The results indicate that developed regions export capital taxes to developing regions. However, the effects of import tariffs on welfare and terms of trade are larger than those of domestic taxes.

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I. INTRODUCTION

The purpose of this paper is to evaluate whether developed countries export taxes to developing countries, contributing to the deterioration of their terms of trade and welfare. Developing countries have become increasingly integrated into world commerce. Since the beginning of the 1990's most developing countries have undertaken radical changes in their trade regimes. Trade negotiations have mainly concentrated on multilateral tariff reductions and in giving preferential treatment to developing countries, and hence helping them to improve their welfare. However, so far the role of domestic taxation in affecting the distribution of gains from trade has been overlooked. Hence, the purpose of this paper is to investigate whether the distribution of gains from trade is being affected not by existing tariffs in developed countries, which are already at low levels, but by their domestic taxation.

Toward this end, a computable general equilibrium (*CGE*) model for the world economy is built in which existing domestic taxes and import tariffs are eliminated and replaced by an equal yield non-distorting tax. The model consists of eight regions: the United States (*USA*), Japan (*JAP*), the European Union (*EU*), other developed countries (*ODC*), developing America (*DAM*), developing Africa (*DAF*), developing Asia (*DAS*), and developing Europe (*DE*). Regions have a production and a demand structure, and they are linked through trade. Further, the model explicitly includes domestic taxation and commercial policy. Domestic taxation comprises taxes such as corporate tax, property tax, payroll tax, social security contributions, income tax, and a tax on final expenditure. Commercial policy is represented by import tariffs.

To our knowledge, the issue of tax exporting among countries has not been analysed empirically, although Mutti and Morgan (1986), and Morgan et al. (1996) have looked at tax exporting among regions within the United States. One of the few analyses in this area is Whalley (1980), who investigates the strength of relative price effects in international trade caused by the different domestic factor taxes which operate in the United States, the European Union, and Japan. Whalley uses a four-region general equilibrium model (the fourth region being the rest of the world), which incorporates tariffs, non-tariff barriers and domestic taxation policies of major trading blocks, using data for 1973. This author finds that domestic factor taxes can induce very strong terms of trade effects and that, for some trading areas, domestic taxation can be more important in distorting international trade than traditional instruments of commercial policy, such as import tariffs.[1]

[1] See Whalley (1984) for an analysis of the role of trade protection policies on the North-South terms of trade.

This paper differs in one important respect from Whalley (1980). There is a distinction between developed and developing regions, and more importantly both groups have been divided further into four sub-groups. The advantage of this additional disaggregation is that it helps to identify from which region(s) developing sub-groups are likely to import taxes. Developed regions have more commercial ties with some particular developing regions than with others, and so their domestic tax policies may affect one developing region more than another. It is worth mentioning that developed countries main trading partners are developed countries themselves, and this inter-developed regions trade may weaken tax exporting effects. In 1990, for example, 65% of the United States exports were destined to Japan, the European Union and other developed countries, whereas less than 16% were destined to developing America and developing Africa (these figures are taken from the benchmark data set).

According to the results, the replacement of capital taxes by an equal yield non-distorting tax in developed regions generates welfare gains and terms of trade improvement in developing countries, when capital is internationally mobile. In this case, the replacement of this tax reduces the return to capital, as this factor moves into developed regions, and this in turn reduces the cost of producing exports (i.e. developing countries imports are cheaper). This result suggests that developed countries were exporting capital taxes to developing regions. In addition, it is found that *JAP* exports income taxes to developing regions, although the effects on welfare and terms of trade are small. The effects of import tariffs on welfare and terms of trade are larger than those of domestic taxes.

The paper proceeds as follows. Section 2 briefly presents the theoretical underpinnings of the study. Section 3 describes the basic structure of the multiregional computable general equilibrium model. Section 4 presents the empirical implementation, including the description of the benchmark data set and the calibration of the model. Section 5 presents the results of the model as well as the sensitivity analysis. Section 6 offers some concluding remarks.

II. THEORETICAL UNDERPINNINGS OF THE STUDY

Tax exporting refers to the shifting of tax burdens from domestic residents to non-residents of the taxing jurisdiction; it is also known in the theory of international trade as the terms of trade effect (see e.g. Dixit and Norman, 1980; Woodland, 1982; Bhagwati et al. 1998).

The existing literature on tax exporting has concentrated in the exportation of state and local taxes to other regions within the same country. This literature has also focused on issues such as foreign tax credits (e.g. Damus et al., 1991) and deductibility of state and local taxes with multilevel governments (e.g. Wildasin, 1987a).

McLure (1969) is one of the first authors that analysed tax exporting in the context of a general equilibrium framework.[2] McLure addressed the question of the extent to which the burden of taxes levied by state and local governments is borne by non-residents of the taxing jurisdiction. In order to do this, he presented a theoretical general equilibrium analysis of interstate incidence of several types of general taxes levied in one state in a larger nation.[3] The key assumption in McLure's analysis is that labour is completely immobile between states; also, capital is assumed to be perfectly mobile in response to interstate differentials in rates of return, and the geographic site of residence of both workers and capitalists is assumed to be fixed. McLure concludes that, under the restrictive assumptions of his model, "...the degree of net tax exporting on the side of sources of income depends upon the change in the return to capital resulting from the tax in question and the extent to which the non-taxing state is a net debtor or creditor" (p. 481). On the uses side, "...interstate tax exporting depends upon how the tax alters the terms or trade of the non-taxing state and the amount of the product of the taxing state bought by non-residents" (p. 482).

This kind of tax exporting can be significant when the regions' producers and/or consumers are non-negligible in size relative to the market for some particular commodity (a good or a factor). In this case, the government will have an incentive to tax exports or imports in order to restrict trade and to achieve improvements in the region's terms of trade. Oates (1972) points out that a common form of tax exporting could be the imposition of a tax on restaurants and hotel bills in tourist centres.

One implication of tax exporting is that it is commonly believed that the presence of tax exporting reduces the effective cost of public services, by pushing some of the burden on to non-residents, and thus creating an incentive to increase public

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2 In this case, the general equilibrium framework matters because the author is considering interstate mobility of factors, and this assumption is likely to be of considerable importance in determining interstate tax incidence.

3 These general taxes include: taxes on all labour employed in the taxing state, on all capital invested in the state, on all production of the state, on the consumption of all domestically produced goods, on all imports, and on all exports.

expenditure. This issue has been analysed by Wildasin (1987b), who shows that the additional revenues could be collected from exported or non-exported taxes without affecting the marginal cost of public funds. Furthermore, Wildasin (1987a) points out that if tax exporting affects spending, it will do so by creating an income effect and by affecting the marginal excess burden of non-exported taxes.

In a paper evaluating the literature on interregional exporting and importing of state and local taxes within the United States, Mutti and Morgan (1986) indicate that tax exporting may result in lower tax rates since public services could be partly financed by non-residents. In the long run tax exporting can also have effects on the levels of income and employment within the taxing region, in the patterns of resource use and on the location of economic activity across regions, since the lower tax rates may attract footloose industries and other mobile factors to the region. The inflow of factors can result in rapid growth of the tax-exporting region (see e.g. Oates, 1972, 1991; Mutti and Morgan, 1986).

Little empirical work has been done on tax exporting among countries. Damus et al. (1991) evaluate tax exporting between Canada and the rest of the world. They develop a numerical general equilibrium model in order to highlight the importance of tax exporting in determining the welfare effects of tax changes in open economies. In their model the authors emphasise the importance of including foreign tax credits when modelling the supply of foreign capital.[4] In this context, tax exporting occurs either through a change in the terms of trade or through a change in the net return paid to foreign-owned capital employed in Canada. Damus' et al. measure of the aggregate welfare change (*DW*) resulting from a given tax change includes a tax exporting effect (*TEE*) and an efficiency effect (*DWL*), that is,

$$(1) \qquad \Delta W = TEE + DWL,$$

where D*W* is calculated as the sum of equivalent variations across income groups; *TEE* captures the possibility of exporting tax burdens to non-residents (foreigners); and *DWL* is the efficiency effect (dead-weight loss or gain) associated with a given tax change, which captures the impact on resource allocation resulting from any change in the overall pattern of taxation in the economy.

The results of Damus et al. (1991) indicate that tax exporting effects may be as significant as efficiency effects in evaluating potential reforms. Furthermore, efficiency effects may be influenced by the way foreign capital flows are modelled.

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4 In this paper foreign tax credits are not considered.

More recently, Morgan et al. (1996) analyse long-run exporting and importing of regional taxes using a six-region general equilibrium model of the United States. They conclude that the ability of states to export taxes does not necessarily promote economic growth or welfare. In addition, factor tax exporting depends on regional ownership patterns and the determinants of factor prices, such as factor mobility, factor intensities, and elasticities of substitution in production.

As indicated above, the literature we have reviewed mainly focuses on the exportation of state and local taxes to other regions within the same country, with the exception of Damus et al. (1991). In what follows, we investigate whether developed countries export factor taxes to developing countries, contributing to the deterioration of their terms of trade and welfare.

III. THE MODEL

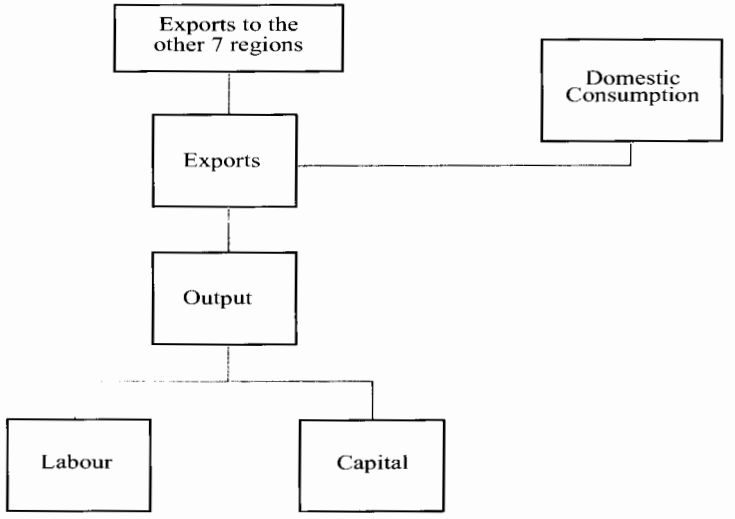
The general equilibrium model used to analyse tax exporting is a standard multicountry model that incorporates domestic tax structures in each region. The model is static and consists of eight regions, each one with a demand and production structures. The regions are linked through trade. Each region has three industries, each of which produces a single output. There are two factors of production (namely labour and capital) which are used as primary inputs. There is a representative consumer in each region and, for simplicity, intermediate production is not considered.

Commodities are considered to be qualitatively different from similar commodities produced abroad. This is the Armington assumption (Armington, 1969), widely used in international trade applied general equilibrium analysis, to account for the presence of cross hauling in international trade data. In addition, the use of the Armington assumption rules out complete specialisation, and allows us to establish the strength of the terms of trade effect by introducing estimates of trade elasticities (Whalley, 1985).

Production in the model exhibits constant returns to scale and firms are perfectly competitive, so that prices equal marginal costs of output. In each region each industry uses labour (L) and capital (K) as inputs. The production structure in each industry is summarised in Figure 1 and the formal equations and notation used in the model are presented in Appendix 1.

A constant elasticity of substitution (*CES*) production function describes the substitutability between L and K into value added for each industry in each region. More formally, the value added function for industry i, in region r, is given by,

Figure 1
Production structure in each sector



$$(2) \qquad Q_i^r = \gamma_i^r \left[\delta_i^r L_i^{r(\sigma_i^r - 1)/\sigma_i^r} + (1-\delta_i^r) K_i^{r(\sigma_i^r - 1)/\sigma_i^r} \right]^{\sigma_i^r/(\sigma_i^r - 1)} \quad \text{for } i = 1,...,N;\ r = 1,...,R,$$

where Q_i^r is the value added in industry i in region r; γ_i^r is a constant defining units of measurement; δ_i^r is a share parameter; σ_i^r is the elasticity of substitution between labour and capital in the production of good i.

Each industry selects an optimal level of inputs that minimises the cost of producing Q units of output. Further, each industry in each region produces a commodity that can be transformed either into a commodity sold on the domestic market, or into an export according to a constant elasticity of transformation (*CET*) function. In a second stage, exports are allocated across regions according to a sub *CET* function.

Factors are non-produced commodities in fixed supply in each region. It is assumed that both factors are mobile across industries within the region. Regarding international factor mobility, labour is assumed to be internationally immobile because of restrictions to international labour mobility. As to capital, in global models international mobility is usually ignored (e.g. Whalley, 1985; Shoven and Whalley,

1992). However, in their analysis of domestic tax policies and the foreign sector, Goulder et al. (1983) point out that the incorporation of international capital mobility can substantially affect the results of the model.[5] In addition, capital markets are becoming more integrated internationally. Hence, it seems appropriate to assume that capital is internationally mobile.[6]

Turning to the demand side of the model, consumers within a region are assumed to have identical homothetic preferences. This assumption allows us to consider a representative consumer, endowed with all the labour and capital in the region. The consumer maximises a nested *CES* utility function subject to the regional budget constraint. The nesting structure used for each region in the *CES* final demand function is summarised in Figure 2, and the complete set of equations and notation that defines the demand side of the model is presented in Appendix 1.

At the top level, consumers decide how much to spend on goods from each sector given the regional budget constraint. Consumers demand a composite of similar imported and domestically produced goods. At the second level, the consumer determines domestic and aggregate import expenditure in each sector according to a *CES* function.[7] At the third level, purchases of imports from each region are selected in each sector, according to a *CES* function.[8]

The budget constraint in each region is given by income equal expenditure ($I^r = E^r$), where income is derived from factor ownership, government transfers and the region's trade surplus (or deficit). On the other hand, the region's expenditure includes the amount spent on the goods as well as taxes paid.

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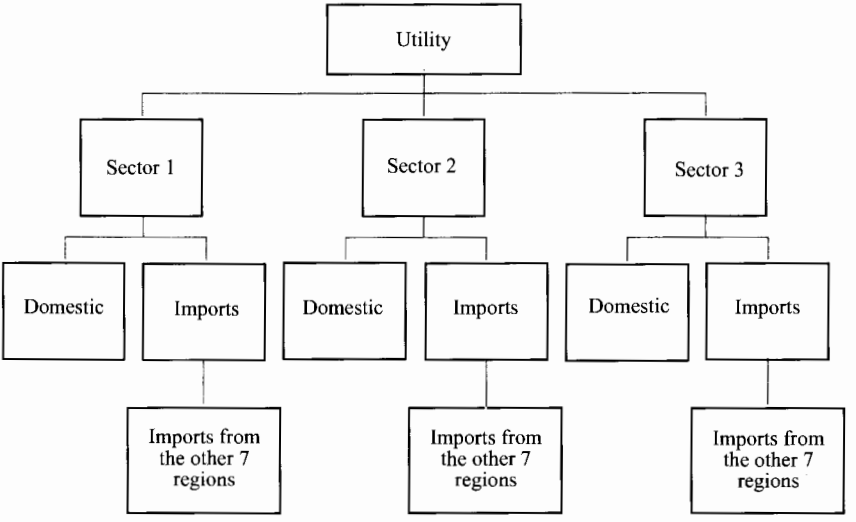
5 See Gasiorek et al. (1992) for a presentation of a multicountry computable general equilibrium model with perfect international capital mobility.

6 Whalley (1985) mentions that the absence of international factor mobility follows the tradition of the Heckscher-Ohlin literature. This assumption can be crucial for model results, since factor mobility can be a substitute for trade. Moreover, "...factor flows in a Heckscher-Ohlin framework can equalise relative factor endowments across countries, removing the source of trade. Global gains from liberalised factor mobility, ..., can thus be just as important as global trade liberalisation" (Whalley 1985, p. 36).

7 The substitution between comparable domestic and composite imports determines the price elasticity of demand for imports.

8 The substitution among imports from the other 7 regions determines export-price elasticities faced by the region.

Figure 2
Nested utility structure



The model also incorporates some policy elements that may have regional effects, such as factor, income and consumption taxes, as well as import tariffs. Domestic taxes, especially factor taxes, affect the cost structure of domestic output. Since part of this output is exported, the degree of tax exporting will depend on how much the price of the exported output is increased by the domestic tax, and the fraction of output purchased by non-residents.[9]

Factor taxes are modelled as ad valorem taxes on the use of factors of production, and so will affect the price paid by producers. These taxes are exported mainly due to intersectoral effects.

Income taxes are modelled as an ad valorem tax on taxable income. This tax is paid by residents and cannot be exported. However, it seems appropriate to consider this tax in the formulation of the model, since in some countries there is double taxation of corporate income, that is, at the firm and shareholders levels.

[9] This is what McLure (1969) refers to as tax exporting from the uses side.

Consumption taxes are modelled as *ad valorem* taxes on final consumption, and therefore affect the price paid by consumers. Consumption taxes cannot be exported since the possibility of commuting is not considered; that is, in the model workers purchase goods in the region where they live. These taxes are included because in the counterfactual experiments, domestic taxes are eliminated and replaced by an equal yield non-distorting tax on final expenditure.

Import tariffs are modelled as an ad valorem tax on imports, with rates varying across commodities. Import tariffs are not exported, but are used to alter the terms of trade of a country with respect to its trading partners. Finally, all tax revenues raised are assumed to be transferred back to consumers.

Once the model has been specified, it can be solved for an equilibrium solution. A general equilibrium in the model can be interpreted in the usual Walrasian sense as a set of goods and factor prices for which all markets clear. That is demand-supply equalities hold in each goods and factors markets; zero profit conditions hold for each industry in each region; and each region is in external-sector balance.[10] Appendix 1 formally presents the full set of equilibrium conditions of the model. Next, we calculate the parameters of the model that are consistent with the benchmark data set; these parameters allow us to reproduce the data set as an equilibrium solution of the model. Then, we compare counterfactual equilibria with the benchmark equilibrium generated by the data.

IV. EMPIRICAL IMPLEMENTATION

The model consists of eight regions, each of which engages in both domestic and foreign trade activities. No internal trade among the countries of any region is included. These regions were chosen to reflect world trade. Instead of having two big regions called "developed countries" and "developing countries", it was decided to split each group into four sub-groups. The advantage of this additional classification is that it allows us to consider from which region(s) developing sub-groups are likely to "import" taxes. Developed regions were chosen to represent the main trading areas in the developed world, that is the United States (*USA*), Japan (*JAP*), the European Union (12-member-*EU*), and the remaining developed countries were grouped in other development countries (*ODC*). Developing regions comprise a heterogeneous group of countries, and were chosen according to their geographical location, that is

[10] In this model, this condition states that the value of exports minus the value of imports, that is, the trade surplus (or deficit) remains fixed in real terms. The trade balance is not equal to zero, since this involves adjusting the data.

developing America (*DAM*), developing Africa (*DAF*), developing Asia (*DAS*), and developing Europe (*DE*).[11] Table 1 presents the grouping of individual countries.

The regional classification described above is important since domestic tax policy in developed regions may affect one developing region more than another. Also, developing regions have more commercial ties with one developed region than with others. For example, the *USA* is the main market for developing America due to its proximity, as it is the case between Japan and developing Asia. The European Union is the main market for African products, not only because of their proximity but also because there are still colonial ties and institutional agreements (e.g. *EU-ACP*). Lastly, developing Europe is increasingly trading with the European Union mainly as a result of the opening up of the countries in Eastern Europe, and the possibility of enlargement of the European Union.

In the model, each region is assumed to produce three commodities: primary commodities (including fuels), manufactured goods, and services. It is also assumed that each region's domestically produced and imported goods are qualitatively different (i.e. the Armington assumption).

A. BENCHMARK DATA SET

The benchmark data set involves data on value added by component by industry, domestic taxes, foreign trade and import tariffs. Given that the model considers a representative consumer in each region, the final demand for domestic products is equal to gross output minus exports, whereas the final demand for imported products equals imports.

The size of the eight regions is given by their respective *GDP*, in 1990 US dollars, as reported in the World Tables (World Bank, 1995). The benchmark data set satisfies the equilibrium conditions of the model in the presence of the existing policies. Data from National Accounts as compiled by the United Nations, World Tables produced by the World Bank, and the Government Finance Statistics Yearbook of the International Monetary Fund were used. Regarding foreign trade statistics, we use information from *UNCTAD* (1995) and the *GATT*-trade policy review.[12]

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[11] Initially, developing Oceania (which included Fiji, Kiribati, Papua New Guinea, Samoa, Solomon Islands, and Vanuatu) was included as a ninth region. At the time of solving the model numerical problems were encountered because this region was very small compared to the others (in 1990 its *GDP* accounted for only 0.2% of world *GDP*). Hence, it was excluded from the analysis.

[12] An appendix with the sources and the procedure followed to assemble the data set is available from the author upon request.

Table 1
Regional classification

Region 1: ***USA***	United States			
Region 2: ***JAP***	Japan			
Region 3: ***EU***	Belgium	Denmark	France	Germany
	Greece	Ireland	Italy	Luxembourg
	Netherlands	Portugal	Spain	United Kingdom
Region 4: ***ODC***	Australia	Austria	Canada	Finland
	Iceland	Israel	New Zealand	Norway
	South Africa	Sweden	Switzerland	
Region 5: ***DAM***	Antigua & Barbuda	Argentina	Barbados	Belize
	Bolivia	Brazil	Chile	Colombia
	Costa Rica	Dominica	Dominican Rep.	Ecuador
	El Salvador	Grenada	Guatemala	Guyana
	Haiti	Honduras	Jamaica	Mexico
	Nicaragua	Panama	Paraguay	Peru
	St. Lucia	St.Kits & Nevis	Suriname	Uruguay
	Trinidad & Tobago	St. Vincent & the Grenadines	Venezuela	
Region 6: ***DAF***	Algeria	Angola	Benin	Botswana
	Burkina Faso	Burundi	Cameroon	Cape Verde
	Central African Rep.	Chad	Comoros	Congo
	Cote d'Ivoire	Djibouti	Egypt	Equatorial Guinea
	Ethiopia	Gabon	Gambia	Ghana
	Guinea	Guinea-Bissau	Kenya	Lesotho
	Madagascar	Malawi	Mali	Mauritania
	Mauritius	Morocco	Mozambique	Namibia
	Niger	Nigeria	Reunion	Rwanda
	Sao Tome & Principe	Senegal	Seychelles	Sierra Leone
	Sudan	Swaziland	Togo	Tunisia
	Uganda	Tanzania	Zambia	Zimbabwe
Region 7: ***DAS***	Bahrain	Bhutan	Bangladesh	China
	Hong Kong	India	Indonesia	Iran (Islamic Rep.)
	Jordan	Kuwait	Laos	Lebanon
	Malaysia	Mongolia	Myanmar	Nepal
	Oman	Pakistan	Philippines	Qatar
	Rep. of Korea	Saudi Arabia	Singapore	Sri Lanka
	Syrian Arab Rep.	Taiwan	Thailand	United Arab Emirates
	Yemen			
Region 8: ***DE***	Bulgaria	Croatia	Cyprus	Czech Rep.
	Estonia	Hungary	Malta	Poland
	Romania	Slovenia	Turkey	USSR (former)
	Yugoslavia (former)			

In the model, both commercial and domestic tax policies are considered. Commercial policy is represented by import tariffs, applied in ad valorem form; tariff collections are part of the government's revenues.[13] As to domestic taxation, factor, income and consumption taxes are incorporated in the domestic transactions of each region. Factor taxes include corporate and property taxes, treated as taxes on the use of capital by industry, and payroll taxes and social security contributions, treated as taxes on the use of labour by industry.[14] Income taxes are treated as taxes on consumer's taxable income. Consumption taxes include value added tax, sales tax and some specific taxes on consumption. All taxes are in ad valorem form. Lastly, foreign tax credits are not included in the model.

Tax rates are calculated by dividing tax revenues (as taken from the benchmark data set) by the model tax base, obtaining an average effective tax rate. For simplicity, in applied general equilibrium models it is assumed that marginal tax rates equal the observed average tax rates. Table 2 shows the tax rates used in the model. As can be seen, the resulting tax rates are quite low; in addition, income tax rates, factor taxes and taxes on domestic goods and services are higher in developed regions than in developing regions. The collection of tax revenue in developing countries is often limited by their administrative capacity and political constraints. One consequence of this is that direct taxation plays a much more limited role in developing than in developed regions. Hence, developing regions exhibit a heavier reliance on indirect taxation, especially taxes on international trade.

During the nineties there have been some changes in tax policy (International Bureau of Fiscal Documentation, various years). The general trend has been towards reduced rates of personal income tax and corporate tax. There has also been a shift towards indirect taxation as a mean of collecting revenue. Some countries with fiscal difficulties (e.g., Japan, Thailand, Pakistan, the Middle East countries) have chosen to rely on indirect taxation either by increasing the tax rate or by broadening the tax base. Other countries (e.g., Mongolia, Nepal, Sri Lanka, Zambia, Ghana) have introduced *VAT*, and in some other cases (e.g., Japan, Pakistan, Thailand, Ivory Coast, Niger) *VAT* systems have been simplified by reducing the number or rates. The general trend among Latin American countries has been the increase of *VAT*.

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[13] Import tariffs were included because of their effect on both regional terms of trade and welfare.

[14] From the available data it was only possible to calculate one tax rate by factor tax in each region. Since intersectoral effects play an important role in the model, the data set was also modified to include differential tax rates by industry in order to assess the sensibility of the results (An appendix with the procedure followed to calculate the differential tax rates is available from the author upon request).

Table 2

Model-equivalent ad valorem tax rates used in the model (%)

	Regions							
	USA	*JAP*	*EU*	*ODC*	*DAM*	*DAF*	*DAS*	*DE*
1. Taxes on the use of capital								
Corporate tax	5.3	11.3	6.3	6.3	5.0	6.0	7.6	3.3
Property tax	0.7	1.7	2.1	1.6	1.5	0.4	1.0	0.1
2. Taxes on the use of labour								
Payroll tax	0.0	0.0	0.2	0.9	0.5	0.5	0.3	2.1
Social security contributions	11.3	16.7	24.9	10.5	8.5	8.0	1.5	3.6
3. Taxes on domestic goods and services (*)								
Primary commodities	3.0	1.1	5.2	3.4	5.3	0.5	0.4	3.9
Manufactured goods	4.4	14.3	11.2	3.6	7.2	6.5	11.8	4.2
Services	8.1	5.0	10.4	11.8	4.1	0.1	7.5	0.7
4. Income tax	9.2	6.2	8.3	9.2	0.2	1.6	1.4	3.0
5. Import tariffs								
Primary commodities	13.5	9.3	15.0	9.3	20.2	53.6	33.2	15.7
Manufactured goods	5.2	4.9	5.4	7.7	21.6	30.2	30.0	11.3
Services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(*) Includes mainly commodity excise taxes, and retail sales taxes.
Source: Iregui (1999), Table 3.2.

In Central Europe changes have also been made in with a view to harmonising corporate taxation and *VAT* with the European Union.

Regarding direct taxation, the general trend has been to protect the tax base, often accompanied by reduced or at least stable tax rates. Also, anti-avoidance/anti-evasion measures have been strengthened in order to deal with international tax avoidance and new business practices. Perhaps as a result of the increased competition brought about by globalisation, one of the main features world-wide has been the enactment of measures design to attract investment (exemptions and other tax concessions), sometimes limited to specific sectors (e.g. the oil sector in Nigeria). The Netherlands have introduced tax incentives in order to make the investment climate more attractive: these include the extension of incentives to

research and development activities, by allowing accelerated or free depreciation for certain new assets, and relaxing significantly its ruling policy.

Virtually all countries in the world continued to expand their tax treaty networks, particularly in Africa and the Middle East, and several countries have been reducing their import tariffs in the continuing move towards freer markets.

B. CALIBRATION AND ELASTICITIES

Once the data set has been assembled, some parameter values, such as share parameters and scale parameters, can be directly calculated from the equilibrium conditions of the model, following the procedure described in Mansur and Whalley (1984). Because of the *CES/CET* functional forms used in the model, some parameter values for the elasticities of substitution and the elasticities of transformation need to be specified. Then, on the demand side, share parameters can be obtained from demand functions. On the supply side, share and scale parameters can be obtained from cost functions.

The results of the model are dependent on the values selected for the elasticities of substitution. Trade elasticities determine the strength of the terms of trade effects associated with trade policies. These terms of trade effects, together with production and consumption effects, which also depend on the elasticities chosen, determine the welfare effects of any policy change. Sensitivity analysis is performed around the values chosen.

On the demand side, the model involves elasticities of substitution in consumption between composite goods; elasticities of substitution between comparable imported and domestically produced goods; and elasticities of substitution between imported products. In this case, the elasticities used are based on price elasticity estimates, since it was not possible to find econometric estimates of elasticities of substitution for *CES* demand functions. The elasticity of substitution between composite commodities was set equal to one in all regions; these elasticities imply Cobb-Douglas demand functions.

The elasticity of substitution between comparable imported and domestically produced goods (υ) was set equal to literature estimates of import price elasticities (Table 3). Within each region the same value was assumed for all commodity-substitution possibilities. Lastly, since substitution between import types forming import composites determines the export price elasticity faced by the region, the

Table 3
Elasticities in the model

Elasticity		Regions							
		USA	*JAP*	*EU*	*ODC*	*DAM*	*DAF*	*DAS*	*DE*
σ	Primary Commodities	0.70	0.62	0.64	0.70	0.77	0.70	0.70	0.70
	Manufactured goods	0.78	0.79	0.81	0.81	0.90	0.81	0.81	0.81
	Services	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ρ	Primary Commodities	(0.77)	(0.77)	(0.77)	(0.77)	(0.77)	(0.77)	(0.77)	(0.77)
	Manufactured goods	(0.75)	(0.75)	(0.75)	(0.75)	(0.75)	(0.75)	(0.75)	(0.75)
	Services	(0.95)	(0.95)	(0.95)	(0.95)	(0.95)	(0.95)	(0.95)	(0.95)
ε	Primary Commodities	(1.17)	(1.17)	(1.17)	(1.17)	(1.17)	(1.17)	(1.17)	(1.17)
	Manufactured goods	(1.17)	(1.17)	(1.17)	(1.17)	(1.17)	(1.17)	(1.17)	(1.17)
	Services	(1.17)	(1.17)	(1.17)	(1.17)	(1.17)	(1.17)	(1.17)	(1.17)
υ	Primary Commodities	0.92	0.93	0.86	0.95	1.26	1.02	1.55	2.72
	Manufactured goods	0.92	0.93	0.86	0.95	1.26	1.02	1.55	2.72
	Services	0.92	0.93	0.86	0.95	1.26	1.02	1.55	2.72
ζ	Primary Commodities	0.99	0.93	0.92	1.13	0.54	0.57	1.23	1.41
	Manufactured goods	0.99	0.93	0.92	1.13	0.54	0.57	1.23	1.41
	Services	0.99	0.93	0.92	1.13	0.54	0.57	1.23	1.41

σ Is the elasticity of substitution between capital and labour; based on estimates presented in Whalley (1985).
ρ Is the elasticity of transformation for domestic output; taken from de Janvry et al. (1991).
ε Is the elasticity of transformation for exports. These elasticities appear to be identical when the figures are rounded to two decimal places.
υ Is the elasticity of substitution between domestic and imported goods. This elasticity was set equal to literature-survey import price elasticities. Within any region, the same value is used for all commodity-substitution possibilities.
ζ Is the elasticity of substitution between regional imports. This elasticity was set equal to literature-survey export price elasticities. Within any region, the same value is used for all commodity-substitution possibilities.
Source: See Appendix 2.

elasticity of substitution between imports forming import composites (ζ) was set equal to estimates of export price elasticities obtained from the literature (Table 3).

Shiells and Reinert (1993) point out that estimated Armington elasticities are low; thus, there are large terms of trade effects losses associated with trade liberalisation. They also state that the value chosen for the elasticity of substitution among imports from different sources clearly affects trade, terms of trade and the welfare effects of bilateral tariff reductions.

The Armington assumption has been criticised by Brown (1987), in the sense that it may imply large terms of trade effects regardless of the size of the country. Brown also shows that the terms of trade effect would increase in magnitude, the larger the elasticity of substitution between comparable imported and domestically produced goods, and the smaller the elasticity of substitution between import types.

Regarding the supply side, the elasticity of substitution between labour and capital (σ) is the key parameter of the value added functions. Elasticities of factor substitution by industry based on those used by Whalley (1985) are used. With regard to the elasticities of transformation for domestic output (ρ), it was not possible to find econometric estimates, so that the elasticities of transformation estimated for Ecuador by de Janvry et al. (1991) were used. The strong assumption adopted here is that the same elasticity values apply by industry for all the regions in the model. Finally, it was not possible to find econometric estimates of the elasticity of transformation for exports (ε); hence, these parameters were calculated such that the elasticity of supply was equal to one. Once all parameters have been specified, the model can be solved for counterfactual experiments. The model was solved using a routine we wrote in *GAMS*.

V. MODEL RESULTS

In this section a set of simulations is performed to investigate whether developed countries export taxes to developing countries. Seven counterfactual experiments are carried out in which existing taxes and import tariffs are eliminated and replaced by an equal yield non-distorting tax. These experiments involve the elimination an replacement of: i) capital taxes; ii) labour taxes; iii) all factor taxes; iv) import tariffs; v) all factor taxes and import tariffs vi) income taxes; and vii) all factor taxes, import tariffs, and income taxes. The equal yield non-distorting tax is a destination-based tax on final expenditure within the region.[15] Whalley (1980) points out that the introduction of an equal yield non-distorting tax may not be very realistic. However, it allows us to appraise the effect domestic taxes may have on both welfare and terms of trade of the region's trading partners.

The counterfactual experiments were performed individually for *USA*, *JAP*, and *EU*, and for all developed regions simultaneously.[16]

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15 The possibility of using an origin-based tax was not considered because the introduction of this kind of tax may increase the price of domestic output, and in consequence the price of exports.

16 Counterfactual experiments were also performed for the region comprising other developed countries (*ODC*). These results are not reported since we are interested in tax exporting from developed to developing regions, and the replacement of taxes in the *ODC* region mainly affects *USA*, *JAP* and *EU*.

After each change was introduced, a new equilibrium was calculated and the results were compared with the benchmark equilibrium. We are mainly interested in the impact of each policy change on the regional terms of trade and on welfare. The terms of trade were calculated for each region in its trade with all other regions, and correspond to a quantity weighted price index giving the relative price of exports and imports. The quantity weights used correspond to those associated with the benchmark equilibrium. A reduction in the price of a region's exports relative to that of its imports implies a deterioration in the terms of trade of the region, whereas an increase in this relative price implies a terms of trade improvement.

The welfare effects of the policy changes are measured by the Hicksian Equivalent Variation (*EV*) for each region, where a positive *EV* refers to a welfare improving change and vice versa. A positive *EV* could be the result of the removal of domestic distortions that affect producer and/or consumer decisions. Distortions to producer decisions are caused by the effects of taxes on producer prices whereas distortions to consumer decisions are caused by the effect differential factor taxation can have on output prices.

The welfare effects will be decomposed according to equation (1) into a tax exporting effect (*TEE*) and an efficiency effect (*DWL*) (Damus et al., 1991). *TEE* is measured as:

$$TEE = V_E \hat{P}_E - V_M \hat{P}_M ,$$

where V_E and V_M correspond to the initial values of exports and imports, respectively; and $\hat{P}_E$ and $\hat{P}_M$ denote tax-induced percentage changes in the producer prices of exports and imports, respectively. Then, from (1) it follows that efficiency gains (losses) are given by the difference between the aggregate welfare change and the tax exporting effect, that is:

$$DWL = \Delta W - TEE$$

DWL captures the impact a change on the overall pattern of taxation in the economy has on resource allocation.

If a region is exporting domestic taxes to another region, one would expect that an increase in such taxes will cause deterioration in the terms of trade of the importing region as well as a welfare loss. For the exporting region an improvement in the terms of trade is expected, but the welfare effects could go either way. That is, the exporting region could experience a welfare gain or loss, because with the

increase in the tax an additional distortion is introduced. The final result will depend on whether the terms of trade effect or the efficiency effect dominates.

A priori one might expect that the *USA* is mainly exporting taxes to *DAM*, since the former is the main trading partner of the latter; similarly, *JAP* is expected to export taxes to *DAS*, while *EU* is expected to export taxes to *DAF* and to a lesser extent to *DE*. As it was mentioned earlier, the degree of tax exporting will depend on how much the price of the exported output is increased by the domestic tax, and the fraction of the output exported. Table 4 presents the trade flows among the regions of the model.

Tables 5 and 6 present the results. In these experiments, capital will move in response to changes in its rate of return.

When labour taxes are replaced (Table 5), the price of labour falls so that producers in *USA*, *JAP*, and *EU* demand more of it. However, labour is in fixed supply in each region, so that the price of labour goes up again in order to eliminate the excess demand. When labour taxes are unilaterally replaced in *USA* and *EU* the welfare gains in these regions account for US$0.7 and US$0.4 billion, respectively, that is approximately 0.01% of *GDP*; the terms of trade improve by 0.1% in *USA* and 0.04% in *EU*. These gains are comprised of US$2.5 and US$0.3 billion tax exporting effects (gains for the regions) and US$1.8 and $0.2 billion efficiency losses. These two regions attract capital from the other regions, leading to an increase in total output; exports in both regions reduce, being the increased output destined for domestic consumption. In the other regions there is less capital available, and this leads to a reduction in domestic production and exports. As a result, *USA* and *EU* imports reduce; the reduction in imports is more than compensated by the increase in output for domestic consumption, leading to an increase in aggregate consumption.

When labour taxes are unilaterally replaced in *JAP*, the region's terms of trade deteriorate 0.2% due to the reduction in manufacture export prices, and obtains losses of US$0.3 billion (0.01% of *GDP*). This loss is comprised of a reduction in tax exporting of US$0.5 billion, and an efficiency gain of US$0.2 billion. Capital leaves the region, and hence there is a reduction in total output; exports increase since factors of production reallocate towards manufactured goods (which are its main exports). Imports also increase but this is not enough to compensate the reduction in output for domestic consumption, leading to a fall in aggregate consumption. In the other regions, both production and exports increase because there is more capital available. Also these regions are better off as a result of the improvement in their terms of trade.

Table 4

Trade Flows

(Billons US dollars)

			Imports					
			USA			*JAP*		
			PC	*MG*	*S*	*PC*	*MG*	*S*
Exports	*USA*	*PC*	0.0	0.0	0.0	21.2	0.0	0.0
		MG	0.0	0.0	0.0	0.0	29.1	0.0
		S	0.0	0.0	0.0	0.0	0.0	19.0
	JAP	*PC*	1.1	0.0	0.0	0.0	0.0	0.0
		MG	0.0	87.8	0.0	0.0	0.0	0.0
		S	0.0	0.0	11.5	0.0	0.0	0.0
	EU	*PC*	13.0	0.0	0.0	4.1	0.0	0.0
		MG	0.0	84.5	0.0	0.0	24.9	0.0
		S	0.0	0.0	33.3	0.0	0.0	9.9
	ODC	*PC*	37.1	0.0	0.0	19.3	0.0	0.0
		MG	0.0	88.9	0.0	0.0	8.3	0.0
		S	0.0	0.0	30.6	0.0	0.0	6.7
	DAM	*PC*	23.6	0.0	0.0	5.5	0.0	0.0
		MG	0.0	16.5	0.0	0.0	1.1	0.0
		S	0.0	0.0	12.8	0.0	0.0	2.1
	DAF	*PC*	16.5	0.0	0.0	2.0	0.0	0.0
		MG	0.0	0.8	0.0	0.0	0.1	0.0
		S	0.0	0.0	4.0	0.0	0.0	0.5
	DAS	*PC*	12.8	0.0	0.0	42.7	0.0	0.0
		MG	0.0	73.1	0.0	0.0	25.9	0.0
		S	0.0	0.0	15.6	0.0	0.0	12.4
	DE	*PC*	1.5	0.0	0.0	1.9	0.0	0.0
		MG	0.0	2.3	0.0	0.0	0.7	0.0
		S	0.0	0.0	1.2	0.0	0.0	0.8

PC: Primary commodities. *MG*: Manufactured goods. *S*: Services. *USA*: United States. *JAP*: Japan. *EU*: European Union. *ODC*: Other Developed Countries. *DAM*: Developing America. *DAF*: Developing Africa. *DAS*: Developing Asia. *DE*: Developing Europe.

Source: Benchmark data set.

Table 4 (continued)
Trade Flows
(Billons US dollars)

			Imports					
			EU			*ODC*		
			PC	*MG*	*S*	*PC*	*MG*	*S*
Exports	*USA*	*PC*	19.2	0.0	0.0	14.8	0.0	0.0
		MG	0.0	79.5	0.0	0.0	95.2	0.0
		S	0.0	0.0	37.4	0.0	0.0	41.6
	JAP	*PC*	0.6	0.0	0.0	0.3	0.0	0.0
		MG	0.0	52.2	0.0	0.0	24.9	0.0
		S	0.0	0.0	6.8	0.0	0.0	3.3
	EU	*PC*	0.0	0.0	0.0	30.2	0.0	0.0
		MG	0.0	0.0	0.0	0.0	171.4	0.0
		S	0.0	0.0	0.0	0.0	0.0	68.8
	ODC	*PC*	56.1	0.0	0.0	0.0	0.0	0.0
		MG	0.0	119.6	0.0	0.0	0.0	0.0
		S	0.0	0.0	42.7	0.0	0.0	0.0
	DAM	*PC*	19.7	0.0	0.0	16.1	0.0	0.0
		MG	0.0	6.0	0.0	0.0	1.8	0.0
		S	0.0	0.0	8.2	0.0	0.0	5.7
	DAF	*PC*	46.8	0.0	0.0	4.0	0.0	0.0
		MG	0.0	8.5	0.0	0.0	0.7	0.0
		S	0.0	0.0	12.7	0.0	0.0	1.1
	DAS	*PC*	22.0	0.0	0.0	6.1	0.0	0.0
		MG	0.0	50.1	0.0	0.0	21.1	0.0
		S	0.0	0.0	13.1	0.0	0.0	4.9
	DE	*PC*	30.9	0.0	0.0	12.6	0.0	0.0
		MG	0.0	26.9	0.0	0,0	9.3	0.0
		S	0.0	0.0	17.6	0.0	0.0	6.7

PC: Primary commodities. *MG*: Manufactured goods. *S*: Services. *USA*: United States. *JAP*: Japan. *EU*: European Union. *ODC*: Other Developed Countries. *DAM*: Developing America. *DAF*: Developing Africa. *DAS*: Developing Asia. *DE*: Developing Europe.
Source: Benchmark data set.

Table 4 (continued)
Trade Flows
(Billons US dollars)

			Imports					
			DAM			*DAF*		
			PC	*MG*	*S*	*PC*	*MG*	*S*
Exports	*USA*	*PC*	10.7	0.0	0.0	2.4	0.0	0.0
		MG	0.0	44.1	0.0	0.0	4.1	0.0
		S	0.0	0.0	20.7	0.0	0.0	2.5
	JAP	*PC*	0.1	0.0	0.0	0.0	0.0	0.0
		MG	0.0	9.5	0.0	0.0	3.8	0.0
		S	0.0	0.0	1.2	0.0	0.0	0.5
	EU	*PC*	3.5	0.0	0.0	8.3	0.0	0.0
		MG	0.0	22.5	0.0	0.0	35.1	0.0
		S	0.0	0.0	8.9	0.0	0.0	14.8
	ODC	*PC*	1.9	0.0	0.0	2.3	0.0	0.0
		MG	0.0	6.1	0.0	0.0	4.5	0.0
		S	0.0	0.0	1.9	0.0	0.0	1.7
	DAM	*PC*	0.0	0.0	0.0	1.0	0.0	0.0
		MG	0.0	0.0	0.0	0.0	0.8	0.0
		S	0.0	0.0	0.0	0.0	0.0	0.6
	DAF	*PC*	0.9	0.0	0.0	0.0	0.0	0.0
		MG	0.0	0.1	0.0	0.0	0.0	0.0
		S	0.0	0.0	0.2	0.0	0.0	0.0
	DAS	*PC*	2.8	0.0	0.0	5.1	0.0	0.0
		MG	0.0	4.9	0.0	0.0	4.7	0.0
		S	0.0	0.0	1.4	0.0	0.0	1.8
	DE	*PC*	3.0	0.0	0.0	1.7	0.0	0.0
		MG	0.0	4.5	0.0	0.0	3.2	0.0
		S	0.0	0.0	2.3	0.0	0.0	1.5

PC: Primary commodities. *MG*: Manufactured goods. *S*: Services. *USA*: United States. *JAP*: Japan. *EU*: European Union. *ODC*: Other Developed Countries. *DAM*: Developing America. *DAF*: Developing Africa. *DAS*: Developing Asia. *DE*: Developing Europe.
Source: Benchmark data set.

Table 4 (continued)
Trade Flows
(Billons US dollars)

			Imports					
			DAS			*DE*		
			PC	*MG*	*S*	*PC*	*MG*	*S*
Exports	*USA*	*PC*	19.2	0.0	0.0	3.2	0.0	0.0
		MG	0.0	53.9	0.0	0.0	1.4	0.0
		S	0.0	0.0	27.6	0.0	0.0	1.7
	JAP	*PC*	4.8	0.0	0.0	0.1	0.0	0.0
		MG	0.0	91.8	0.0	0.0	3.0	0.0
		S	0.0	0.0	12.5	0.0	0.0	0.4
	EU	*PC*	12.2	0.0	0.0	4.8	0.0	0.0
		MG	0.0	86.8	0.0	0.0	25.4	0.0
		S	0.0	0.0	33.8	0.0	0.0	10.3
	ODC	*PC*	16.0	0.0	0.0	3.2	0.0	0.0
		MG	0.0	24.2	0.0	0.0	10.1	0.0
		S	0.0	0.0	9.8	0.0	0.0	3.2
	DAM	*PC*	4.4	0.0	0.0	5.6	0.0	0.0
		MG	0.0	3.1	0.0	0.0	0.4	0.0
		S	0.0	0.0	2.4	0.0	0.0	1.9
	DAF	*PC*	3.4	0.0	0.0	2.5	0.0	0.0
		MG	0.0	1.8	0.0	0.0	0.6	0.0
		S	0.0	0.0	1.2	0.0	0.0	0.7
	DAS	*PC*	0.0	0.0	0.0	4.7	0.0	0.0
		MG	0.0	0.0	0.0	0.0	6.7	0.0
		S	0.0	0.0	0.0	0.0	0.0	2.1
	DE	*PC*	5.3	0.0	0.0	0.0	0.0	0.0
		MG	0.0	12.8	0.0	0.0	0.0	0.0
		S	0.0	0.0	5.5	0.0	0.0	0.0

PC: Primary commodities. *MG*: Manufactured goods. *S*: Services. *USA*: United States. *JAP*: Japan. *EU*: European Union. *ODC*: Other Developed Countries. *DAM*: Developing America. *DAF*: Developing Africa. *DAS*: Developing Asia. *DE*: Developing Europe.
Source: Benchmark data set.

In the scenario in which capital taxes are replaced there are stronger terms of trade and welfare effects (Table 5). In this case, capital moves out of the regions where capital taxes are in place, in order to avoid the tax and into the region(s) eliminating the tax(es). This is accompanied by a reduction in the marginal product of capital in the receiving region relative to that of labour, since labour is in fixed supply.

When capital taxes are unilaterally replaced by *USA* and *EU*, the welfare losses in these regions account for US$5.1 and US$6.6 billions, respectively, that is approximately 0.1% of *GDP*; the terms of trade worsen by 0.9% in *USA* and 1.2% in *EU*. These losses are comprised of US$5.3 and US$8.7 billion tax exporting effects (losses for the regions) and US$0.3 and US$2.2 billion efficiency gains. When capital taxes are replaced, the price of capital falls so that producers in *USA* and *EU* demand more of it. Hence, production increases as well as exports. In the other regions there is less capital available, and this leads to a reduction in domestic production and exports. As a result of this, *USA* and *EU* imports reduce, so that there is a reduction in aggregate consumption. As to the other regions, *DAM* benefits more when *USA* replaces its capital taxes than when *EU* does it; on the contrary, *DAF* benefits more when *EU* replaces its capital taxes (in fact, when USA replaces its taxes *DAF* loses US$0.1 billion).

The terms of trade of *USA* and *EU* deteriorate since the price of their exports is lower after the replacement of capital taxes, and the price of their imports has gone up (due to the reduction in production for exports in the other regions). Also, the improvement of *DAM*'s terms of trade is greater when *USA* replaces its taxes rather than *EU* (0.6% compared to 0.2%). The improvement of *DAF*'s terms of trade is more significant when *EU* replaces its taxes (i.e. 1.1% compared to -0.01%).

When *JAP* replaces capital taxes it obtains a welfare gain of 0.01% of *GDP*, despite the fact that the terms of trade of this region deteriorate by 1.9% (because its imports are now more expensive). These gains are comprised of a reduction in tax exporting of US$8.9 billions (loss for the region) and US$9.2 billions efficiency gain. *JAP* also attracts capital, hence there is an increase in production and an increase in exports. In the other regions, both production and exports reduce because there is less capital available. Also these regions (except *DE*) are better off as a result of the improvement in their terms of trade (especially *DAS* whose terms of trade improve 0.8%).

When *USA*, *JAP*, *EU* and *ODC* simultaneously replace capital taxes, capital moves into *JAP*, *EU* and *ODC*; this result can be explained by the fact that these regions

Tabe 5

Welfare and terms of trade effects of an equal-yield tax replacement of existing factor taxes

Replacement of taxes in:	Taxes on labour				Taxes on capital				All factor taxes			
	EV	*TEE*	*DWL*	*TOT*	*EV*	*TEE*	*DWL*	*TOT*	*EV*	*TEE*	*DWL*	*TOT*
	(US$ billions)			%	(US$ billions)			%	(US$ billions)			%
1. *USA*												
USA	0,72	2,55	(1,83)	0,10	(5,07)	(5,33)	0,26	(0,87)	(4,37)	(2,23)	(2,15)	(0,77)
JAP	(0,12)	(8.08)	7,96	(0,04)	(0,79)	3,16	(3,95)	0,12	(0,91)	(5,24)	4,34	0,09
EU	(0.20)	(3,18)	2,98	(0,03)	(0,53)	1,27	(1,80)	0,01	(0,72)	(2,04)	1,32	(0,01)
ODC	(0.13)	4,62	(4,76)	(0,02)	1,78	0,41	1,37	0,37	1,66	4,99	(3,34)	0,35
DAM	(0.07)	1.15	(1,22)	(0,04)	0,80	0,48	0,32	0,57	0,73	1,58	(0,85)	0,53
DAF	(0.02)	(0.91)	0.89	(0,01)	(0.09)	0,35	(0,44)	(0,01)	(0,11)	(0,59)	0,48	(0,03)
DAS	(0.10)	10.00	(10,10)	(0,02)	1,06	(2,57)	3,63	0,29	0,96	7,69	(6,73)	0,26
DE	(0.01)	(6.15)	6,14	(0,01)	(0,15)	2,49	(2,64)	(0,05)	(0,16)	(3,91)	3,76	(0,06)
Total	0.06	0.00	0,06		(2,98)	0,27	(3,25)		(2,92)	0.24	(3,17)	
2. *JAP*												
USA	0.22	0.21	0.01	0,04	2,52	2,98	(0,46)	0,48	2,73	3,18	(0,44)	0,51
JAP	(0.31)	(0.54)	0.23	(0,17)	0,34	(8,86)	9,20	(1,90)	(0,03)	(9,35)	9,32	(2,06)
EU	0.18	0.15	0.03	0,02	1,01	1,34	(0,34)	0,17	1,17	1,48	(0,31)	0,19
ODC	0.04	0.05	(0.01)	0,01	0,71	0,83	(0,12)	0,16	0,75	0,88	(0,12)	0,16
DAM	0.01	0.01	0.00	0,01	0,22	0,23	(0,01)	0,15	0,23	0,24	(0,01)	0,16
DAF	0.01	0.00	0.00	0,01	0,15	0,21	(0,06)	0,16	0,16	0,21	(0,05)	0,16
DAS	0.12	0.12	0.00	0,02	3,78	3,84	(0,07)	0,75	3,90	3,96	(0,06)	0,77
DE	0.00	0.00	0.01	0,00	(0,18)	0,16	(0,33)	(0,07)	(0,17)	0,15	(0,33)	(0,06)
Total	0.27	0.00	0.27		8,55	0,73	7,82		8,74	0,75	7,99	
3. *EU*												
USA	(0.03)	(0.03)	0.00	0,00	(0,55)	(0,08)	(0,48)	(0,05)	(0,58)	(0,10)	(0,48)	(0,06)
JAP	0.01	0.01	0.01	0,00	(1,24)	(0,38)	(0,86)	(0,10)	(1,23)	(0,37)	(0,85)	(0,10)
EU	0.43	0.28	0,15	0,04	(6,58)	(8,74)	2,16	(1,17)	(6,19)	(8,46)	2,27	(1,13)
ODC	(0.05)	(0.04)	(0.01)	(0,01)	6,00	6,69	(0,69)	1,17	5,95	6,65	(0,70)	1,16
DAM	(0.03)	(0.03)	(0.01)	(0,02)	0,18	0,30	(0,12)	0,16	0,14	0,27	(0,13)	0,14
DAF	(0.08)	(0.07)	(0.01)	(0,06)	0,91	1,03	(0,13)	1,09	0,83	0,97	(0,14)	1,03
DAS	(0.06)	(0.07)	0.01	(0,02)	2,81	2,98	(0,17)	0,65	2,76	2,92	(0,16)	0,63
DE	(0.06)	(0.06)	0.00	(0,04)	(1,39)	(1,30)	(0,09)	(0,55)	(1,45)	(1,36)	(0,09)	(0,59)
Total	0.13	0.00	0.13		0,14	0,50	(0,37)		0,23	0,51	(0,28)	
4. *USA, JAP, EU, ODC*												
USA	0.58	2,65	(2,06)	0,13	1,11	0,97	0,15	0,13	1,75	3,37	(1,62)	0,22
JAP	(0.46)	(8.39)	7.93	(0,21)	(0,22)	(5,18)	4,96	(1,44)	(0,73)	(13,22)	12,49	(1,65)
EU	1.01	(2,27)	3,28	0,11	(1,12)	(1,96)	0,83	(0,33)	(1,16)	(4,86)	3,71	(0,34)
ODC	0.99	5.31	(4.32)	0,15	(1,89)	(1,45)	(0,44)	(0,37)	(1,04)	4,01	(5,05)	(0,24)
DAM	(0.07)	1.13	(1,20)	(0,04)	1,20	0,99	0,21	0,90	1,09	2,00	(0,92)	0,83
DAF	4.56	(2,28)	6.84	(1,50)	6,01	5,58	0,44	0,10	5,91	(0,58)	6,49	0,01
DAS	0.03	9.87	(9.84)	0,00	9,44	3,53	5,90	2,16	9,33	15,27	(5,94)	2,13
DE	(0.02)	(6.01)	5.99	(0,02)	(1,84)	(3,14)	1,30	(0,60)	(1,95)	(5,07)	3,12	(0,68)
Total	6.62	0.01	6.61		12,69	(0,66)	13,35		13,20	0,92	12,27	

Note: Totals may not add up due to rounding.
EV: Equivalent Variation; *TEE*: Tax Exporting Effect; *DWL*: Deadweight gain (or loss); *TOT*: Percentage change Terms of Trade.

had higher taxes on the use of capital than *USA*. *DAM*, *DAF* and *DAS* benefit from the replacement of capital taxes in the developed regions, and there is an improvement in their terms of trade.

Let us now consider the replacement of all factor taxes (Table 5). In this case, the results are dominated by what happens when capital taxes are replaced. When *USA*, *JAP* and *EU* unilaterally replace factor taxes, there is a welfare loss for these regions, accompanied by terms of trade deterioration (0.8%, 2.1% and 1.1%, respectively). These gains are comprised of a reduction in tax exporting of US$2.2, US$9.3, and US$8.5 billions respectively, and US$2.1 billions efficiency losses for *USA* whereas *JAP* and *EU* obtain US$9.3 and US$2.3 billions efficiency gains. These regions attract capital from all other regions. As to developing regions, *DAM* and *DAS* benefit from the replacement of the factor taxes in *USA* (their terms of trade improve 0.5% and 0.3%, respectively). When *JAP* replaces factor taxes, *DAM*, *DAF* and *DAS* obtain welfare gains of US$0.2 billion (0.02% of *GDP*), US$0.2 billion (0.05% of *GDP*), and US$3.9 billions (0.26% of *GDP*) respectively; the terms of trade of these developing regions also improve, especially for *DAS* (0.8%). When *EU* replaces factor taxes, *DAF* benefits the most (welfare gains of US$0.8 billion, and terms of trade improvement of 1%), followed by *DAS* and *DAM*.

When all developed regions simultaneously replace factor taxes, the developing regions that benefit the most are *DAF* and *DAS*. *DAF* obtains a welfare gain of 1.8% of *GDP* (US$5.9 billions) with a very small improvement in terms of trade (0.01%). *DAS* obtains a welfare gain of US$9.3 billions (0.6% of *GDP*) and an improvement of 2.1% in terms of trade. *DAM* is also better off, but *DE* is worse off as a result of the deterioration in its terms of trade (0.7%).

In conclusion, the results indicate that developed regions export factor taxes (especially on the use of capital) to developing regions, and that the magnitude of the effects depends upon commercial ties; that is *USA* mainly affects *DAM*, *JAP* mainly affects *DAS*, and *EU* mainly affect *DAF*.

Table 6 reports the case when import tariffs are replaced by a non distorting tax on final consumption. The regions replacing the tariffs suffer welfare losses and terms of trade worsening. A tariff lowers foreign export prices; the gain depends on the ability of the tariff-imposing country to drive down foreign export prices. Also notice that the effects of the replacement of import tariffs on welfare and terms of trade are larger than when factor taxes are replaced.

When *USA*, *JAP*, and *EU* unilaterally eliminate and replace import tariffs, they suffer welfare losses and terms of trade deterioration. The welfare losses in these

regions are due to efficiency losses that more than compensate for the positive tax exporting effect. In this scenario, capital moves out of these regions since this factor is cheaper elsewhere. There is an increase in exports, an increase in imports, a reduction in output for domestic consumption, and a reduction in aggregate consumption. All other regions benefit from the replacement of tariffs, both in terms of welfare and terms of trade improvement. In particular, when *USA* replaces tariffs *DAM*'s terms of trade improve by 0.8%; when tariffs are replaced in *JAP*, *DAS*'s terms of trade improve by 0.6%; and, *DE* and *DAF*'s terms of trade improve by 1.6% and 1.4%, respectively, when *EU* replaces its tariffs.

When all developed regions replace tariffs simultaneously, all developing regions benefit both in terms of welfare and terms of trade improvement.

The last four columns of Table 6 show the joint effects of the replacement of import tariffs and factor taxes. As can be seen, the results are qualitatively the same as when only import tariffs are replaced. Larger welfare losses are observed for developed regions when they unilaterally replace both import tariffs and factor taxes; there are also stronger terms of trade effects. The results are tariff dominated.

The effects of the replacement of income taxes were also calculated. Results not reported here indicate that in this case there are small welfare gains (losses) and small terms of trade effects. When *USA* and *EU* eliminate income taxes, their welfare improves because of the elimination of a distortion in the economy, and there is also terms of trade improvement. These regions attract capital from the other regions. All other regions are worse off and their terms of trade deteriorate. In the case of *JAP*, it obtains losses of US$0.2 billion (0.006% of *GDP*) as a result of the terms of trade deterioration (0.1%); capital leaves this region. All other regions benefit, although there are small effects on both welfare and terms of trade. When all developed regions simultaneously replace income taxes, capital moves out of *USA*, *JAP*, *DAM* and *DAS*. All developing regions and *JAP* suffer terms of trade deterioration. *DAM*, *DAS* and *DE* also suffer a welfare loss.

The joint effects of the replacement of factor taxes, import tariffs and income taxes were also computed. Results not reported here indicate that the results are dominated by the effects of import tariffs. When *USA*, *JAP* and *EU* replace unilaterally all taxes, the region eliminating the taxes suffers terms of trade deterioration and welfare loss. When all developed regions eliminate all taxes, developing regions benefit. Lastly, when all regions simultaneously replace all taxes, developed regions benefit since imports tariffs are higher in developing regions; *DAF* and *DE* obtain welfare gains.

Tabe 6

Welfare and terms of trade effects of an equal-yield tax replacement of existing import tariffs and factor taxes

Replacement of taxes in:	Import tariffs				Import tariffs and factor taxes			
	EV	*TEE*	*DWL*	*TOT*	*EV*	*TEE*	*DWL*	*TOT*
	(US$ billions)			%	(US$ billions)			%
1. ***USA***								
USA	(13.11)	20.28	(33.40)	(1.81)	(71.72)	16.28	(88.00)	(2.58)
JAP	2.35	2.88	(0.53)	0.61	1.37	(2.64)	4.01	0.69
EU	4.40	4.14	0.26	0.53	3.54	1.71	1.83	0.51
ODC	2.22	1.02	1.20	0.32	3.80	5.96	(2.16)	0.67
DAM	1.48	1.04	0.44	0.82	2.17	2.55	(0.38)	1.35
DAF	0.66	0.64	0.02	0.46	0.52	(0.01)	0.54	0.43
DAS	1.83	0.16	1.68	0.41	2.73	7.87	(5.14)	0.67
DE	0.34	1.12	(0.78)	0.23	0.17	(2.92)	3.08	0.17
Total	0.17	31.28	(31.12)		(57.42)	28.80	(86.23)	
2. ***JAP***								
USA	1.59	1.41	0.18	0.25	4.25	4.51	(0.26)	0.76
JAP	(5.88)	7.66	(13.54)	(2.03)	(5.55)	(2.05)	(3.49)	(4.08)
EU	1.28	1.05	0.23	0.15	2.36	2.45	(0.09)	0.34
ODC	0.51	0.39	0.13	0.07	1.22	1.25	(0.03)	0.23
DAM	0.24	0.20	0.04	0.13	0.45	0.43	0.02	0.29
DAF	0.09	0.07	0.02	0.07	0.27	0.27	0.00	0.23
DAS	2.23	1.94	0.28	0.55	5.96	5.82	0.13	1.31
DE	0.15	0.10	0.05	0.10	(0.04)	0.22	(0.26)	0.03
Total	0.20	12.82	(12.62)		8.93	12.90	(3.98)	
3. ***EU***								
USA	4.05	3.61	0.44	0.64	3.40	3.41	(0.01)	0.57
JAP	1.85	1.30	0.55	0.52	0.56	0.83	(0.27)	0.41
EU	(18.08)	30.13	(48.21)	(2.06)	(23.66)	20.80	(44.47)	(3.19)
ODC	3.23	2.43	0.80	0.46	9.04	9.03	0.01	1.64
DAM	1.16	0.93	0.22	0.63	1.24	1.18	0.06	0.77
DAF	2.00	1.52	0.49	1.39	2.76	2.47	0.29	2.48
DAS	2.57	2.41	0.16	0.61	5.21	5.31	(0.10)	1.24
DE	2.49	2.28	0.20	1.55	0.91	0.79	0.12	0.95
Total	(0.73)	44.62	(45.35)		(0.54)	43.83	(44.37)	
4. ***USA. JAP. EU. ODC***								
USA	(4.05)	28.09	(32.14)	(0.41)	(1.86)	28.38	(30.24)	(0.25)
JAP	(0.59)	12.68	(13.26)	(0.66)	(1.39)	(2.43)	1.05	(2.36)
EU	(5.36)	40.95	(46.31)	(0.62)	(6.98)	30.75	(37.73)	(1.13)
ODC	(8.20)	25.01	(33.21)	(1.02)	(9.66)	26.27	(35.93)	(1.28)
DAM	3.31	2.50	0.81	1.83	4.23	4.36	(0.13)	2.69
DAF	7.63	0.90	6.72	0.66	8.79	1.68	7.11	2.20
DAS	7.62	5.29	2.33	1.79	16.52	20.45	(3.93)	3.93
DE	3.69	4.23	(0.54)	2.37	1.43	(1.48)	2.91	1.63
Total	4.05	119.65	(115.60)		11.08	107.98	(96.90)	

Note: Totals may not add up due to rounding.
EV: Equivalent Variation; *TEE*: Tax Exporting Effect; *DWL*: Deadweight gain (or loss); *TOT*: Percentage change Terms of Trade.

In summary, the results suggest that *USA*, *JAP* and EU export capital taxes to some particular developing regions. In the case of taxes on the use of labour and income taxes, the results appear to suggest that there is tax exporting from *JAP* to developing regions, although the effects on both welfare and terms of trade are small. Import tariffs are more important than domestic taxes in their effects on both welfare and terms of trade.

We also performed a sensitivity analysis on the key elasticities of the model.[17] In particular, we look at the effects of a change in trade elasticities, since they determine the strength of the terms of trade effects associated with policy changes. In particular, the elasticity of substitution between import types and the elasticity of substitution between comparable imported and domestically produced goods are considered. It has been argued that the terms of trade effects increase when the elasticities of substitution between import types are smaller and the elasticities of substitution between comparable imported and domestically produced goods are larger. In addition, we report on the sensitivity of the results to changes in the elasticity of export transformation.

In the model, the elasticities of substitution used are based on price elasticity estimates, since it was not possible to find econometric estimates of elasticities of substitution for *CES* demand functions. In the case of the elasticities of export transformation it was not possible to find econometric estimates; hence these parameters were calculated such that the elasticity of supply was equal to one. The elasticity of transformation indicates the difference among the goods exported to the other seven regions; the larger the elasticity, the more similar are the exported goods and viceversa. Uniform values for these elasticities of 0.5, 1.5 and 3.0 are used in the sensitivity analysis; the first value is smaller than the one used in the model, whereas the last two values are larger. These elasticity values were chosen in order to consider extreme possibilities, that is very little substitution (or transformation) and almost infinite substitution (or transformation). We focus on the replacement of factor taxes and import tariffs, since these experiments have larger effects on both terms of trade and welfare. We conclude that the results are robust to the elasticity choice, in the sense that there is evidence that *USA*, *JAP* and *EU* export factor taxes to the developing regions with which they have closer commercial ties.[18]

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17 The results ore nor reported here, but are available from the author upon request.

18 Since manufactured goods are imported from developed regions and these goods usually have low elasticity of substitution with domestic production, the referee suggested that the sensitivity of the results should be tested using lower elasticities for manufactured goods in developing regions. Then, sensitivity analysis was performed, changing only the elasticity of substitution between imported and domestically produced manufactures in developing regions. Uniform values between 0.2 and 1.2 were used. We conclude that the results are robust to the elasticity choice. The results are not reported here but are available upon request.

A. DIFFERENTIAL FACTOR TAX RATES

From the available data it was not possible to calculate differential tax rates by industry. In reality, in each country there are differential tax rates for each sector in the economy. Hence, given that intersectoral effects may play an important role in tax exporting, it seems interesting to investigate whether the results of the model are altered when there are differential factor tax rates by industry. Table 7 presents the new ad valorem tax rates by industries.[19] As an illustration, three counterfactual experiments were carried out: i) elimination and replacement of labour taxes; ii) elimination and replacement of capital taxes; and iii) elimination and replacement of all factor taxes. Each experiment is performed for *USA*, *JAP*, and *EU* individually, and for all developed regions simultaneously (i.e. *USA*, *JAP*, *EU*, and *ODC*). Similar to the previous experiments, existing factor taxes were replaced by an equal yield non-distorting tax on final expenditure within each region. Table 8 presents the results.

The unilateral replacement of labour taxes generates welfare gains for the region replacing the taxes. As to developing regions, there are small losses as a result of the small terms of trade deterioration. However, when all developed regions simultaneously replace labour taxes, *EU* and *ODC* obtain welfare losses; developing countries also obtain welfare losses (all but *DAF*) ranging from 0.1% of *GDP* in the case of *DAM*, to 0.3% of *GDP* in the case of *DAS*; terms of trade deteriorate 0.9% and 1.0% respectively. In this case there is no tax exporting of labour taxes.

If these results are compared with those obtained in the central case, differential taxation generates larger welfare gains (losses) and stronger terms of trade effects. For example, when *USA* replaces labour taxes, the region obtains welfare gains of 0.2% of *GDP* compared with 0.01% of *GDP* without differential taxation, and the region's terms of trade improve 1.6% compared to 0.1%. As to developing countries, the deterioration in *DAM*'s terms of trade increases from 0.04%, without differential taxation, to 0.8%.

When taxes on the use of capital are replaced, the region replacing the tax obtains welfare losses as a result of terms of trade deterioration. The region also attracts capital because this factor is now cheaper relative to labour. *USA* appears to be exporting capital taxes to *DAM* and *DAS*; *JAP* and *EU* export capital taxes to all

[19] An appendix with the procedure followed to colculate these differential tax rates is available from the author upon request.

Table 7

New *ad valorem* factor tax rates by industry (%)

	Regions							
	USA	*JAP*	*EU*	*ODC*	*DAM*	*DAF*	*DAS*	*DE*
1. Taxes on the use of capital								
Primary commodities	2.8	9.5	4.4	4.3	3.5	4.3	5.4	1.9
Manufactured goods	7.8	21.7	19.2	18.8	9.8	12.1	14.9	5.3
Services	6.0	10.0	6.2	6.0	6.1	7.5	9.3	3.3
2. Taxes on the use of labour								
Primary commodities	14.0	21.2	32.7	14.8	10.2	9.7	2.0	6.3
Manufactured goods	6.7	10.2	24.6	11.1	8.9	8.4	1.7	5.5
Services	12.5	19.0	25.1	11.4	8.9	8.4	1.7	5.5

Source: Iregui (1999), Table A3.9.

developing regions but *DE*. When all developed regions simultaneously replace capital taxes, *DAM*, *DAF* and *DAS* obtain welfare gains of 0.2%, 2.1% and 1% of *GDP*, respectively, as a result of the terms of trade improvement. Comparing these results with those obtained without differential taxation, little change is observed in the case of *USA* but for the other regions there are larger welfare gains (losses) and stronger terms of trade effects. For example, in the case of *JAP* the replacement of capital taxes generates welfare losses of 0.2% of *GDP* whereas in the central case this region obtained welfare gains of 0.01% of *GDP*. *JAP* has the highest tax rates on the use of capital, and as a result of the elimination of these taxes this country attracts capital from all other regions, increasing the production of manufactured goods and in turn of exports. At the same time, imports from all other regions are reduced; hence the supply of goods for domestic consumption is reduced. There is also a deterioration of *JAP*'s terms of trade (4.4% compared with 1.9% without differential taxation) brought about by the reduction in the price of exports as a result of the reduction in the price of capital.

Lastly, in the presence of differential tax rates, the welfare and terms of trade effects of the elimination of all factor taxes in *USA* are dominated by labour taxes (which are higher than capital taxes) whereas with uniform tax rates the results are dominated by capital taxes. In the case of *JAP* and *EU* the results are dominated by capital taxes, as it was the case with uniform tax rates.

Tabe 8

Welfare and terms of trade effects of an equal-yield tax replacement of factor taxes in the presence of differential tax rates

Replacement of taxes in:	Taxes on labour		Taxes on capital		All factor taxes	
	EV (US$ billions)	*TOT* (%)	*EV* (US$ billions)	*TOT* (%)	*EV* (US$ billions)	*TOT* (%)
1. *USA*						
USA	10.55	1.55	(5.01)	(0.81)	5.95	0.72
JAP	(0.86)	(0.29)	(1.00)	0.02	(1.84)	(0.27)
EU	(2.50)	(0.33)	(0.58)	0.01	(3.07)	(0.31)
ODC	(2.63)	(0.49)	1.90	0.40	(0.73)	(0.08)
DAM	(1.18)	(0.76)	0.79	0.56	(0.38)	(0.19)
DAF	(0.12)	(0.11)	(0.12)	(0.05)	(0.24)	(0.16)
DAS	(1.61)	(0.37)	0.86	0.25	(0.76)	(0.11)
DE	(0.02)	(0.14)	(0.21)	(0.10)	(0.22)	(0.11)
Total	1.64		(3.36)		(1.29)	
2. *JAP*						
USA	(2.67)	(0.44)	5.36	0.91	2.70	0.50
JAP	7.94	2.55	(6.91)	(4.39)	2.11	(1.98)
EU	(1.55)	(0.21)	2.61	0.37	1.08	0.18
ODC	(0.69)	(0.13)	1.45	0.28	0.75	0.16
DAM	(0.27)	(0.17)	0.48	0.30	0.23	0.15
DAF	(0.13)	(0.12)	2.76	0.26	0.16	0.16
DAS	(2.96)	(0.69)	6.75	1.40	3.71	0.74
DE	(0.05)	(0.05)	(0.12)	(0.02)	(0.17)	(0.06)
Total	(0.36)		12.39		10.56	
3. *EU*						
USA	(0.02)	0.00	1.62	0.26	1.61	0.26
JAP	(0.01)	0.00	(0.51)	0.12	(0.51)	0.12
EU	0.06	0.00	(14.28)	(2.47)	(14.26)	(2.47)
ODC	0.09	0.02	9.42	1.80	9.50	1.82
DAM	(0.02)	(0.01)	0.65	0.44	0.63	0.43
DAF	0.01	0.03	1.71	1.75	1.72	1.78
DAS	(0.09)	(0.02)	4.86	1.11	4.77	1.10
DE	(0.04)	(0.02)	(0.90)	(0.14)	(0.95)	(0.16)
Total	(0.02)		2.56		2.50	
4. *USA, JAP, EU, ODC*						
USA	7.71	1.11	7.99	1.27	16.00	2.38
JAP	7.18	2.30	(6.90)	(3.93)	1.06	(1.75)
EU	(3.17)	(0.43)	(4.41)	(1.11)	(8.59)	(1.64)
ODC	(2.84)	(0.57)	(2.14)	(0.48)	(5.11)	(1.07)
DAM	(1.42)	(0.92)	2.08	1.41	0.58	0.46
DAF	4.45	(1.61)	7.05	0.89	6.81	0.71
DAS	(4.51)	(1.03)	14.71	3.35	9.92	2.28
DE	(0.04)	(0.05)	(1.16)	(0.03)	(1.30)	(0.13)
Total	7.36		17.22		19.37	

Note: Totals may not add up due to rounding.
EV: Equivalent Variation; *TEE*: Tax Exporting Effect; *DWL*: Deadweight gain (or loss); *TOT*: Percentage change Terms of Trade.

VI. CONCLUDING REMARKS

This paper has presented numerical results on the possibility that developed regions export domestic taxes to developing regions, particularly to those regions with which they have close commercial ties. We have used a general equilibrium model that incorporates domestic taxation and import tariffs of eight regions, chosen to represent world trade.

The results of the model support the existence of tax exporting of capital taxes by *USA*, *JAP* and *EU* to some particular developing regions. In the case of taxes on the use of labour and income taxes, the results indicate that there is tax exporting from *JAP* to developing regions, although the effects on both welfare and terms of trade are small. In this case, once again, import tariffs are more important than domestic taxes in their effects on both welfare and terms of trade.

The effects that differential factor tax rates might have on the results of the model were also considered. Stronger terms of trade effects and larger welfare gains (losses) were found, and this confirms that intersectoral effects are very important for tax exporting. In particular, more taxes could be exported if a region taxes more heavily those industries that constitute their main exports, as appear to be the case of capital taxes in *JAP* and *EU*.

It is not possible to say that policies in developed regions affect all developing regions in the same way. Policies will have stronger effects on those regions with which there are close commercial ties; for example, *USA* will mainly affect *DAM*, *JAP* will mainly affect *DAS*, and *EU* will mainly affect *DAF* and to a lesser extent *DE*.

In the light of these results, it could be suggested that the possibility of tax exporting of domestic taxes will become a more important part in trade negotiations as international markets become more integrated. Capital markets are becoming more international in scope; international migration is highly constraint and very selective; hence it will still take considerable time to reduce restrictions to labour mobility. At the moment, tariffs are low in developed countries and the benefits of any further reductions could be dampened by higher domestic factor taxes, which can be exported to developing countries.

APPENDIX 1

MODEL EQUATIONS AND NOTATION

Production side of the model

-Value-added function

$$(A.1) \qquad Q_i^r = \gamma_i^r \left[\delta_i^r L_i^{r(\sigma_i^r-1)/\sigma_i^r} + (1-\delta_i^r) K_i^{r(\sigma_i^r-1)/\sigma_i^r} \right]^{\sigma_i^r/(\sigma_i^r-1)}$$

-Domestic and foreign sales

$$(A.2) \qquad Q_i^r = \varphi_i^r \left[\beta_i^r DC_i^{r(\rho_i^r-1)/\rho_i^r} + (1-\beta_i^r) EXP_i^{r(\rho_i^r-1)/\rho_i^r} \right]^{\rho_i^r/(\rho_i^r-1)}$$

-Export allocation

$$(A.3) \qquad EXP_i^r = v_i^r \left(\sum_s \theta_i^r RX_i^{r,s\,(\varepsilon_i^r-1)/\varepsilon_i^r} \right)^{\varepsilon_i^r/(\varepsilon_i^r-1)}, \; s \neq r$$

Demand side of the model

-Utility function

$$(A.4) \qquad U^r = \left(\sum_{i=1}^{3} (\alpha_i^r)^{1/\mu^r} (X_i^r)^{(\mu^r-1)/\mu^r} \right)^{\mu^r/(\mu^r-1)}$$

-Domestic and import consumption

$$(A.5) \qquad CMP_i^r = \Omega_i^r \left(\omega_i^r IMP_i^{r(v_i^r-1)/v_i^r} + (1-\omega_i^r) DOM_i^{r(v_i^r-1)/v_i^r} \right)^{v_i^r/(v_i^r-1)}$$

-Import allocation

$$(A.6) \qquad IMP_i^r = \Psi_i^r \left(\sum_s \chi_i^r DIMP_i^{r,s\zeta_i^r-1/\zeta_i^r} \right)^{\zeta_i^r/(\zeta_i^r-1)}, \; s \neq r$$

Constraints

-Consumer budget constraint $(I^r = E^r)$

$$(A.7) \qquad P_{L,r}\overline{L}_r + P_{K,r}\overline{K}_r + TR^r + TB^r = \sum_{i=1}^{3} P_i^r X_i^r + T^r$$

-Government budget constraint

$$(A.8) \qquad TR^r = t^r \left(P_{L,r}\overline{L^r} + P_{K,r}\overline{K^r} \right) + \sum_{i=1}^{3} \tau_i^r P_{M,i}^r IMP_i^r +$$

$$t_{C,i}^r \sum_{i=1}^{3} P_{i,r} X_i^r + t_{K,i}^r \sum_{i=1}^{3} P_{K,r} K_i^r + t_{L,i}^r \sum_{i=1}^{3} P_{L,r} L_i^r$$

-Trade balance equation

$$(A.9) \qquad \sum_{i=1}^{3} P_{M,i}^{r,s} IMP_i^r + TB^r = \sum_{i=1}^{3} P_{X,i}^r EXP_i^r, \text{ where}$$

$$TB^r = TB_0^r \left(\sum_{i=1}^{3} P_{i,r} X_i^r \right) \left(\sum_{i=1}^{3} P_{i,r}^0 X_i^r \right)^{-1}$$

Zero profit conditions

In each region the value of domestic output in sector i must be equal to the capital and labour costs of producing good *i*. At the same time, the value of domestic output in sector *i* equals the value of commodities sold in the domestic market plus the value of commodities sold as exports. Combining these two zero profit conditions, the following expression is obtained:

$$(A.10) \qquad P_{D,C,i}^r DC_i^r, \; EXP_i^r = P_{K,i}^r K_i^r + P_{L,i}^r L_i^r$$

The value of commodities sold as exports must equal the value of the sum of exports to the other 7 regions:

$$(A.11) \qquad P_{X,i}^r EXP_i^r = \sum_s P_{RX,i}^{r,s} RX_i^{r,s}, \; s \neq r$$

The value of total imports must equal the value of the sum of imports from the other 7 regions:

(A.12) $$P^{r}_{M,i} IMP^{r}_{i} = \sum_{s} P^{r,s}_{DIMP,i} DIMP^{r,s}_{i}, \; s \neq r$$

The value of the composite commodity *i* demanded by consumers must equal the value of aggregate imports plus the value of domestically produced goods:

(A.13) $$P_{i,r} CMP^{r}_{i} = P^{r^{*}}_{M,i} IMP^{r}_{i} + P^{r}_{DOM,i} DOM^{r}_{i}$$

The value of goods sold for domestic consumption must be equal to the value of the demand for domestically produced goods; *i.e.*,

$$P^{r}_{DC,i} DC^{r}_{i} = P^{r}_{DOM,i} DOM^{r}_{i} .$$

Hence:

(A.14) $$P^{r}_{DC,i} = P^{r}_{DOM,i}$$

The value of exports from region *r* to region *s* must be equal to the value of imports of region *s* from region *r*; *i.e.*,

$$P^{r,s}_{RX,i} RX^{r,s}_{i} = P^{s,r}_{DIMP,i} DIMP^{s,r}_{i} .$$

Hence:

(A.15) $$P^{r,s}_{RX,i} = P^{s,r}_{DIM,i}$$

Market clearing conditions

-Goods markets

The supply of goods for domestic consumption must equal the demand for domestically produced goods:

(A.16) $$DC^{r}_{i} = DOM^{r}_{i}$$

Exports from region *r* to region *s* must equal imports of region *s* from region *r* because there are assumed to be no transfer (*e.g.* transport) costs in shipping goods from one region to another:

(A.17) $$RX^{r,s}_{i} = DIMP^{s,r}_{i}$$

Total supply of composite commodities, which consists of the composite of similar domestic products and aggregate imports, must equal consumer's demand in each region:

(A.18) $$CMP_i^r = X_i^r$$

-Factor markets
For labour:

(A.19) $$\sum_{i=1}^{3} L_i^r = \overline{L}_r$$

For capital, assuming that it is internationally immobile, the market clearing condition is:

(A.20) $$\sum_{i=1}^{3} K_i^r = \overline{K}_r$$

When capital is internationally mobile, the market clearing condition becomes:

(A.20a) $$\sum_{i=1}^{3} \sum_{r=1}^{8} K_i^r = \sum_{r=1}^{8} \overline{K}_r$$

Equations for price relationships

-Import prices

(A.21) $$P_{M,i}^{r*} = P_{M,i}^r \left(1 + \tau_i^r\right)$$

-Factor prices

(A.22) $$P_{K,i}^r = P_{K,r} \left(1 + t_{K,i}^r\right)$$

(A.23) $$P_{L,i}^r = P_{L,r} \left(1 + t_{L,i}^r\right)$$

-Consumer prices

(A.24) $$P_i^r = P_{i,r} \left(1 + t_{C,i}^r\right)$$

List of variables

Q_i^r	Value added good *i* region *r*.
L_i^r	Labour input good *i* region *r*.
K_i^r	Capital input good *i* region *r*.
DC_i^r	Output for domestic consumption good *i* region *r*.
EXP_i^r	Output for exports good *i* region *r*.
$RX_i^{r,s}$	Exports of good *i* from region *r* to region *s*.
U^r	Consumer utility region *r*.
X_i^r	Consumer demand good *i* region *r*.
CMP_i^r	Total supply of good *i* region *r*.
IMP_i^r	Total imports good *i* region *r*.
DOM_i^r	Domestic output for domestic for consumption good *i* region *r*.
$DIMP_i^{r,s}$	Imports good *i* region *r* from to region *s*.
I^r	Income region *r*.
E^r	Expenditure region *r*
TR^r	Government transfers region *r*.
TB^r	Trade surplus or deficit region *r*.
T^r	Income tax paid by consumers region *r*.
$P_{L,r}$	Selling prices of labour region *r*.
P_L^r	Producer price labour input good *i* region *r*.
$P_{K,r}$	Selling prices of capital region *r*.
P_K^r	Producer price capital input good *i* region *r*.
$P_{i,r}$	Gross price of consumer good *i* region *r*.
P_i^r	Price paid by consumers for good *i* region *r*.
$P_{M,i}^{r*}$	Domestic price of imports good *i* region *r*.
$P_{M,i}^r$	Gross price of imports good *i* region *r*.
$P_{X,i}^r$	Price of exports good *i* region *r*.
$P_{DC,i}^r$	Price goods sold for domestic consumption good *i* region *r*.
$P_{RX,i}^{r,s}$	Price of good *i* exported from region *r* to region *s*.
$P_{DOM,i}^r$	Price good *i* for domestic consumption region *r*.
$P_{DIMP,i}^{r,s}$	Price of good *i* imported by region *r* from region *s*.

List of parameters

γ_i^r	Scale parameter value added function, good *i* region *r*.
δ_i^r	Share parameter value added function, good *i* region *r*.
σ_i^r	Elasticity of substitution between labour and capital, good *i* region *r*.
φ_i^r	Scale parameter exports and domestic sales function, good *i* region *r*.
β_i^r	Share parameter exports and domestic sales function, good i region *r*.
ρ_i^r	Elasticity of transformation between domestic output, good i region *r*.

v_i^r	Scale parameter export allocation function, good *i* region *r*.
θ_i^r	Share parameter export allocation function, good *i* region r.
ε_i^r	Elasticity of transformation between regional exports, good *i* region *r*.
α_i^r	Share parameter utility function, good *i* region *r*.
μ^r	Elasticity of substitution in consumption region *r*.
Ω_i^r	Scale parameter domestic and import consumption function, good *i* region *r*.
ω_i^r	Share parameter domestic and import consumption function, good *i* region *r*.
v_i^r	Elasticity of substitution between domestic and imported consumption, good *i* region *r*.
ψ_i^r	Scale parameter import allocation function, good *i* region *r*.
X_i^r	Share parameter import allocation function, good *i* region *r*.
ζ_i^r	Elasticity of substitution between regional imports, good *i* region *r*.
$\overline{L}_r$	Endowment of labour region *r*.
K_r	Endowment of capital region *r*.
t^r	Tax rate on income region *r*.
τ_i^r	Tax rate on imports good *i* region *r*.
$t_{C,i}^r$	Tax rate on consumption good *i* region *r*.
$t_{K,i}^r$	Tax rate on capital (*i. e.* corporate and property taxes) region *r*.
$t_{L,i}^r$	Tax rate on labour (*i. e.* payroll tax and social security contributions) region *r*.
TB_0^r	Benchmark region's trade surplus or deficit region *r*.

APPENDIX 2

ARMINGTON ELASTICITIES IN THE MODEL

These elasticities are the elasticity of substitution between comparable imported and domestically produced goods (u), and the elasticity of substitution between imports forming import composites (z). The former was set equal to literature estimates of import price elasticities. The latter was set equal to literature estimates of export price elasticities. Within each region the same values are assumed for all commodity-substitution possibilities.

-For *USA* and *JAP* these elasticities were obtained from Marquez (1990).

-For *EU* these elasticities correspond to the averages of the elasticities of the following countries (sources in parentheses): Belgium-Luxembourg, Denmark, France, Ireland, Italy and the Netherlands (Stern et al., 1976); Germany and the United Kingdom (Marquez, 1990); and Portugal (Houthakker and Magee, 1969).

-For *ODC* these elasticities correspond to the averages of the elasticities of the following countries (sources in parentheses): Canada (Marquez, 1990); Austria, Finland, Norway, Sweden, Switzerland, Australia, and New Zealand (Stern et. al., 1976).

-For *DAM* these elasticities correspond to the averages of the elasticities of Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Peru and Uruguay, as taken from Khan (1974).[20]

-For *DAF* these elasticities correspond to the averages of the elasticities of Ghana and Morocco, as taken from Khan (1974).

-For *DAS* these elasticities correspond to the averages of the elasticities of the following countries (sources in parentheses): India, the Philippines and Sri Lanka (Khan, 1974); and Pakistan and Bangladesh (Nguyen and Bhuyan, 1977).[21]

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[20] The export price elasticity of Uruguay is not included in the computation of the average elasticity for *DAM* since it was not available.

[21] The export price elasticity of the Philippines is not included in the computation of the average elasticity for *DAS* since it was not available.

-Lastly, for *DE* I use the elasticities for Turkey estimated by Khan (1974).

The elasticities used in the model are presented in Table 3 in the text.

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