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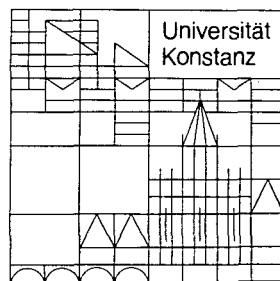
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Sonderforschungsbereich 178
„Internationalisierung der Wirtschaft“

Diskussionsbeiträge



Juristische
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Fakultät für Wirtschafts-
wissenschaften und Statistik

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A Computable General
Equilibrium Comparison**

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Alternative Tax Principles for the European Community: A Computable General Equilibrium Comparison

Andreas Haufler *

October 1991

Abstract

We compare two tax principles for the European Community which can be administered in the internal market: the restricted destination principle and the restricted origin principle. The theoretical analysis indicates that the effects of switching to one or the other alternative are similar in principle. The numerical implementation of a three-country, three-good model shows, however, that national welfare can be quite differently affected depending on which tax principle is chosen. In particular, tax revenue losses in the high-tax country are found to be higher under the restricted origin principle.

*This paper owes much to John Piggott who visited the University of Konstanz in the summer term of 1991. He introduced me to a convenient software package (MPS/GE) and provided a much-needed first orientation in the field. I also wish to thank the participants of the "Workshop on Issues in International Economics: Questions to and Answers from Computable General Equilibrium Analysis" (Konstanz, July 8-9, 1991), organized by Bernd Genser and John Whalley, for very helpful comments and suggestions.

1 Introduction

In the theory of international taxation, it is well known that a general destination principle and a general origin principle are both non-distortive under certain idealized conditions. Despite this theoretical equivalence, policymakers have always favored the destination principle which is currently employed worldwide with only minor exceptions. The destination principle causes a problem to integrating countries, however, because it relies on border tax adjustments which are in turn greatly facilitated by border controls. This point is particularly relevant for the European Community's (EC) internal market program which regards the abolition of intra-EC border controls as an essential element. Without border controls, a *general* destination principle cannot be administered any more.

Given this initial policy problem, two main alternatives have been discussed. The first approach is to *minimize* the role of origin taxation in the internal market, and this is the route that the Community has followed. This approach will be termed a *restricted destination principle (RDP)* in the current paper and encompasses both the so-called 'deferred payment scheme' (which has been adopted by the Council for an interim period until the end of 1996) and an international tax credit method in conjunction with a clearing mechanism (which is envisaged for the period thereafter). In both cases, VAT-registered traders are effectively taxed at the rate of the destination country¹.

The second approach to the problem is to *maximize* the role of origin taxation and extend it to all transactions within the Community. For the case of the European multi-stage value-added tax, the origin principle requires the so-called 'subtraction method' for the taxation of intermediate goods, where the (net-of-tax) value of imported inputs can be deducted from the value of final sales in the destination country². This move will not lead to a general origin taxation, however, if non-EC countries maintain the destination principle for their trade with the Community. In this case (which seems to be a realistic scenario in the present situation), the

¹In the German discussion, the international tax credit method is also known as a *common market principle* – a term introduced by Biehl (1969). Note, however, that an international tax credit method *without* clearing will, in general, have different revenue implications. This last case is not covered by our analysis.

²This proposal has been made, among others, by the Council of Economic Advisers to the West German Ministry of Economics (Wissenschaftlicher Beirat beim Bundesministerium für Wirtschaft, 1986, para. 15).

proposal implies the adoption of a *restricted origin principle (ROP)* from a European perspective.

Thus, none of the feasible tax schemes in the internal market is truly general and only second-best alternatives remain. The theoretical analysis has shown that both the restricted destination principle and the restricted origin principle distort international trade when tax rates differ between countries. In addition, both tax principles redistribute tax revenues between EC member states in a non-desirable way³. Theoretical analysis alone is unable, however, to discriminate between the competing solutions. Furthermore, the limitations of theoretical analysis in higher dimensional models are well known. In our context, the derivation of comparative statics results in three-country, three-good tax models requires strong assumptions, some of which are clearly not realistic in the EC situation⁴.

To overcome these limitations of a purely theoretical analysis, our paper sets up a quantitative assessment of alternative tax principles in the European Community using the techniques of computable general equilibrium (CGE) analysis. It should be emphasized from the outset, however, that we have tried to stick as closely as possible to the simplified theoretical models referred to above. This choice has the advantage that our interpretation of numerical results can draw directly on the insights gained from theoretical analysis. On the other hand, we forgo many of the opportunities that CGE modeling offers in terms of disaggregation by countries and goods, the incorporation of multiple distortions, and other real-world phenomena.

The paper is set up as follows: Section 2 summarizes some of the relevant theoretical and empirical literature. Section 3 provides the theoretical background for our discussion of the restricted destination principle and the restricted origin principle. Section 4 gives the benchmark data set and the elasticity values chosen. Section 5 presents and discusses the results of our numerical analysis. Section 6 evaluates our approach and suggests possible extensions.

³Theoretical studies include Shibata (1967), Whalley (1979), Grossman (1980), Berglas (1981), Sinn (1990), Haufler (1991a,b). See the following section for a more detailed discussion.

⁴In Haufler (1991b), for example, we have to assume that tax rates in the EC are equal in the initial equilibrium and that preferences in all trading countries are identical and homothetic.

2 The Literature

Two basic results have emerged from the theoretical analysis of non-general schemes for taxing international trade. First, trade is distorted and overall efficiency losses are incurred when tax rates differ within the Community. In a two-country, two-good model, Sinn (1990, pp. 493–496) demonstrates that an international tax credit method for investment goods distorts relative prices when consumer goods are taxed in the country of origin. Grossman (1980, pp. 125–127) reaches a similar result in a three-good model which explicitly incorporates intermediate goods. Both of these cases are similar to our analysis of the restricted destination principle. In the analysis of the restricted origin principle, single-stage taxes are usually assumed. Drawing on Shibata (1967) and Whalley (1979), Berglas (1981, pp. 378–382) has shown that a restricted origin principle will distort relative prices when tax rates differ within a tax union.

The second result from the theoretical literature refers to the distributional consequences of international tax differentials: in general, tax revenues will be redistributed from high-tax countries within a tax union to their low-tax partners. For the restricted destination principle, this issue has come to be known as the problem of 'cross-border shopping' but other ways of tax arbitrage (mail ordering, e.g.) have the same redistributive effects⁵. Under the restricted origin principle, a similar redistribution of tax revenues from the high-tax to the low-tax country occurs through changes in the bilateral trade balance of the union countries (Hauffer 1991b, pp. 12–13). This brief summary indicates that the effects of the restricted destination principle and the restricted origin principle are very similar in principle.

Turning to the empirical literature, there are two studies of cross-border shopping from individual EC borders. Using both survey data and time-series analysis, Fitzgerald/Quinn/Whelan/Williams (1987) estimate the 1986 value of purchases in Northern Ireland made by residents of the Republic of Ireland at 200 million Irish pounds (\approx 260 mill. ECU). A similar study by Bygvrå/Hansen/Restad/Soltoft (1987), which relies on survey data only, estimates the 1985 purchases of Danish residents in Germany at about 3.3 billion Danish kroner (\approx 400 mill. ECU). Apart from the limited coverage of these studies in terms of time and space, the more

⁵This distributional argument rather than the overall efficiency loss mentioned above was the reason for the EC Commission to propose a harmonization of tax rates in the internal market. See EC-Commission (1985), para. 173–178. Cf. also Sinn (1990), pp. 500–502.

fundamental problem is that these estimates are based on the functioning of the current destination principle⁶ rather than on the conditions of the internal market. The concern about cross-border shopping in the internal market arises precisely because these figures are expected to rise markedly when private households can legally buy goods of unlimited value in the neighboring low-tax country and commercial smuggling becomes more difficult to control. In short, the opening of intra-EC borders is a policy change whose effects cannot be anticipated by extrapolating current volumes of cross-border shopping.

Therefore, the effects of this policy change have to be simulated using a computable general equilibrium (CGE) approach. There are several CGE studies which focus on indirect taxes. Whalley (1976) presents numerical results for a harmonization of VAT rates in EC member countries under the destination principle. In this model, the initial distortion is due to the fact that VAT rates in each country are differentiated by product. Closer to our analysis is Hamilton/Whalley (1986) who analyse the national welfare effects of a partial or complete switch from the destination principle to the origin principle. However, the focus of this analysis is on the United States, which is modelled as having no general commodity tax. This excludes changes in U.S. tax revenues and only terms of trade effects remain. Thus, despite the similar nature of the tax reform analyzed, the results of the Hamilton/Whalley analysis are not comparable to ours.

The only CGE model which incorporates the cross-border shopping issue and its effects on tax revenues and welfare in EC member states is Fehr/Rosenberg/Wiegard (1991). In fact, the policy change analyzed in their paper is very similar to our switch to the restricted destination principle. Their model is much more detailed than ours in the disaggregation of goods and countries and it incorporates a large number of distortions ranging from an elastic labor supply to the incorporation of various taxes and tariffs. Most importantly, Fehr/Rosenberg/Wiegard model the value-added tax as a multi-stage tax levied at differentiated rates in each country. Nevertheless, their results should be comparable to our computations in principle and it should be possible to trace differences in results back to differences in model assumptions. We will therefore refer to this paper repeatedly. However, Fehr/Rosenberg/Wiegard

⁶Actually, these studies demonstrate that the insulation of markets is less than perfect even under a 'general' destination principle. Legally, individuals shopping abroad can import goods up to a value of ECU 350 (1990) without being subject to border tax adjustments. The general destination principle is further undermined by illegal smuggling. In our analysis, we abstract from these imperfections of the current destination principle.

have not analyzed the switch to full origin taxation within the Community yet (although work along these lines is under way). Thus, a comparison of the restricted destination principle vs. the restricted origin principle, which is the core of our analysis, has not been carried out in the empirical literature to date.

3 The Model

3.1 Basic Assumptions

The set-up of our model is best understood if the well-known Heckscher-Ohlin framework is taken as the point of departure. From this model, we retain the assumption that production takes place under competitive conditions and that each country produces positive amounts of each good in a trade equilibrium. On the consumption side, there is one representative consumer in each country so that redistributive effects within each country are excluded. Factor supply is fixed in each country and factors are assumed to be internationally immobile. The traditional $2 \times 2 \times 2$ dimensions of the Heckscher-Ohlin framework can be easily extended to incorporate a third country and a third tradeable good.

We impose general consumption taxes levied at a uniform ad valorem rate in each country. Tax revenues are redistributed lump sum to the domestic consumer. Due to the assumption of fixed factor supplies, such a tax creates no excess burden in a domestic setting. There are no other taxes or tariffs in our model and transportation costs are assumed to be zero. This setting allows to focus on the distortions introduced by internationally diverging tax rates under non-general tax principles like the restricted destination principle or the restricted origin principle. Since we concentrate on the tax treatment of international transactions, we model the VAT as a one-stage tax whose rate depends on the tax principle in operation⁷.

In addition to the introduction of taxes, we deviate from the standard Heckscher-Ohlin model in three respects which are discussed below. These extensions of the basic theoretical model are driven by the necessity to reconcile our theory with real-world data.

⁷The multi-stage nature of the VAT becomes important in a setting with non-uniform tax rates and exemptions. See Dixit (1990), pp. 279–282, for a theoretical discussion and Fehr/Rosenberg/Wiegard (1991), pp. 3–6, for the modelling of a multi-stage VAT levied at differentiated rates.

1. preferences and production technologies differ across countries,
2. the overall trade balance can be non-zero in each country,
3. there is one specific factor of production in each sector.

ad 1.: standard Heckscher-Ohlin theory emphasizes relative factor endowments as an explanation for international trade; for this reason, other determinants of trade are usually ruled out. There is little empirical support for the assumption of identical and homothetic preferences and technologies, however. Thus, a given data set will usually imply differences in preferences and production technologies, and this has to be incorporated in our model.

ad 2.: in models of international trade in goods, it is analytically convenient to assume international factor immobility and overall balanced trade for each country despite the fact that these assumptions are clearly unrealistic in the modern world economy. It is possible, however, to retain the assumption that factors are internationally immobile and still accommodate multilateral trade imbalances to which our results are highly sensitive⁸. For this purpose, we introduce lump-sum transfers from nations experiencing a trade surplus to countries with a trade deficit. We make the further simplifying assumption that the benchmark volume of these transfers remains unchanged throughout the analysis.

ad 3.: to accommodate real-world data, all countries must produce all goods in a trade equilibrium. It is known from international trade theory that if all factors are sectorally mobile in each country, diversified production of n goods in a trade equilibrium requires at least n factors of production. On the other hand, national accounts data only differentiate two primary factors of production (labor and capital). This dilemma can be solved by assuming that there is one fixed factor of production in each sector which is fully employed. Effectively, we are switching to the production structure of the specific factors model (or Ricardo-Viner model)⁹.

⁸It would, of course, be desirable to analyze the effects of a change in the tax principle for international trade in goods on international flows of capital. This extension of the basic Heckscher-Ohlin model is, however, beyond the scope of the present paper.

⁹This has no qualitative implications for our results since we do not analyze factor markets explicitly. Cf. Dixit's (1985, p. 313) statement that "... the apparatus of special production technologies that underlies much of conventional trade theory is largely unnecessary" for many public finance applications.

Most applied work in this area avoids the problem of specialization by using the so-called 'Armington assumption'. The Armington specification differentiates similar goods by the country in which they are produced. This implies, by way of example, that German consumers will always demand some German *and* some French wine for each set of relative prices. With the Armington assumption, full specialization is thus excluded from the demand side (Whalley 1985, p. 39) while we have excluded it from the supply side. Another frequently stated advantage of the Armington specification is that it is able to accommodate the empirical phenomenon of cross hauling (or intra-industry trade)¹⁰. However, since we focus on aggregate tax revenues from international trade rather than on an exact representation of disaggregate trade flows, there seems to be no fundamental argument against netting out each country's exports and imports for each of our aggregated goods. In line with the general approach of this paper, we will therefore stick to the assumption that similar goods produced in different countries are perfect substitutes. The quantitative implications of using one or the other assumption will be discussed in section 4.2.

3.2 Modelling Alternative Tax Principles

Our model can be described in duality form by specifying three national budget constraints and two market-clearing conditions. Market clearing for the third commodity is implied by Walras' law. In this section, we denote countries by superscript letters $k \in [A, B, C]$ while subscript numbers $i \in [1, 2, 3]$ indicate goods. Countries A and B form an economic union while country C represents the rest of the world.

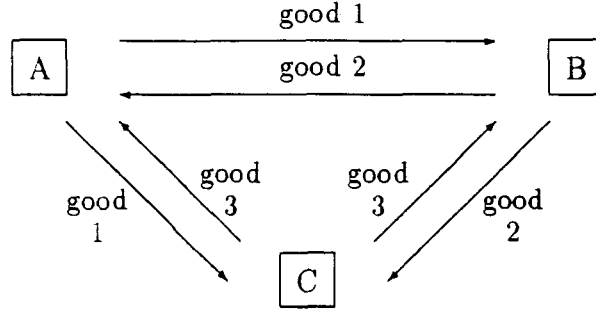
$$\begin{aligned} e^k(q^k, u^k) &= r^k(p^k) + t^k T^k + R^k & \forall \quad k \in [A, B, C], \\ \sum_{k=A,B,C} c_i^k(q^k, u^k) &= \sum_{k=A,B,C} x_i^k(p^k) & \forall \quad i \in [1, 2]. \end{aligned} \quad (1)$$

where

- $e^k(q^k, u^k)$: national expenditure in country k ,
- $r^k(p^k)$: national product in country k ,
- p^k : vector of producer prices in country k ,
- $q^k = p^k(1 + t^k)$: vector of consumer prices in country k ,

¹⁰Cf. Whalley (1985), pp. 35–39, for a discussion of the Armington specification in CGE models.

Figure 1: Trade Flows in the Three-Country Model



- u^k : national utility in country k ,
- t^k : general commodity tax rate in country k ,
- T^k : tax base in country k ,
- R^k : transfer to country k ($R > 0$ for recipient country),
- c_i^k : consumption of good i in country k ,
- x_i^k : production of good i in country k ,

Equation set (1) is not a fully specified model but has to be completed by defining tax bases in each country and by linking producer prices across countries. In our three-country model, international arbitrage conditions depend, in general, on the direction of trade flows. We therefore postulate the initial trade pattern given in Figure 1. Our numerical analysis allows this trade pattern to change following the introduction of distorting taxes. We do, however, exclude triangular tax arbitrage because of its extreme implications in a model without transportation costs¹¹.

¹¹If triangular tax arbitrage is introduced in a model with zero transportation costs, any tax differential in the Community implies that international trade flows are solely based on tax considerations. Furthermore, the high-tax country in the union loses *all* revenues from the taxation of international trade. For a theoretical analysis of this phenomenon of 'trade deflection', cf. Shibata (1967), pp. 212-224, and Georgakopoulos (1989).

General Destination Principle: The general destination principle (DP) serves as our benchmark case and will briefly be reviewed here. International arbitrage is based on producer prices for all goods so that

$$\begin{aligned} p_1^A &= p_1^B = p_1^C, \\ p_2^A &= p_2^B = p_2^C, \\ p_3^A &= p_3^B = p_3^C. \end{aligned} \quad (2)$$

The tax base is composed of domestic consumption in each country. Thus, for the union countries

$$\begin{aligned} T_{DP}^A &= p_1^A c_1^A + p_2^A c_2^A + p_3^A c_3^A, \\ T_{DP}^B &= p_1^B c_1^B + p_2^B c_2^B + p_3^B c_3^B. \end{aligned} \quad (3)$$

The full tax model under the general destination principle is given by substituting equations (2) and (3) into (1). From (2), we know that this benchmark equilibrium must be Pareto optimal even if tax rates differ between countries. Furthermore, it is easily shown that the distribution of tax revenues given in (3) implies that welfare in both countries is unchanged from a no-tax equilibrium. These are the well-known neutrality property of the general destination principle. Since the rest of the world (country C) operates a general destination principle throughout our analysis, its tax rate can be set equal to zero without loss of generality.

Restricted Destination Principle: Under the restricted destination principle, purchases by final consumers in the union countries ('cross border shopping') can only effectively be taxed in the country of origin. On the other hand, the tax rate of the destination country is relevant for VAT-registered traders¹². This is obvious under the deferred payment system, which is really a destination principle applied to VAT-registered traders only. Under the international tax credit method, the recouping effect ensures that the tax rate imposed at the last stage of processing is the relevant one. While VAT-registered traders prepay taxes that are based on the rate of the origin country, their effective tax payment depends solely on the tax rate in the destination country.

¹²In our one-consumer economies, we conceptually differentiate between the individual acting as a trader and acting as a final consumer. The destination principle can be extended to VAT-exempt banks and government agencies by way of special regulations; cf. EG-Kommission (1990), pp. 9–11. Other special regulations aiming to extend the scope of the destination principle in the internal market are discussed below.

For a numerical analysis, this distinction which is based on the identity of the buyer (final consumers vs. VAT-registered traders) must be linked to a distinction which is based on goods (final consumer goods vs. intermediate goods); only for the latter classification does a coherent data set exist. Therefore, we assume that – for a specified bundle of final consumer goods – residents of the high-tax country can fully circumvent border tax adjustments either via cross-border shopping or through mail ordering¹³. While this assumption is certainly extreme, several authors have emphasized the scope for tax arbitrage that exists in the internal market¹⁴. To the extent that one regards the Commission's efforts to minimize the role of origin taxation in the internal market as more effective, our estimates should be interpreted as an upper bound to the redistributive effects of a restricted destination principle.

Given our assumptions, let good 1 be the final consumer good while goods 2 and 3 are intermediate goods purchased by VAT-registered traders. The destination principle continues to apply for all transactions which involve the rest of the world. The destination principle equates producer prices across countries while the origin principle equates international consumer prices. For the trade pattern in Figure 1, the arbitrage conditions are then given by

$$\begin{aligned} p_1^A &= \frac{(1 + t^B)}{(1 + t^A)} p_1^B = p_1^C, \\ p_2^A &= p_2^B = p_2^C, \\ p_3^A &= p_3^B = p_3^C. \end{aligned} \tag{4}$$

It is obvious from equation set (4) that the restricted destination principle distorts international producer prices whenever $t^A \neq t^B$.

For each of the union countries, the tax base under the restricted destination principle is given by the domestic consumption of all goods minus the imports of the final consumer good from the union partner. Introducing m_i^{AB} to denote the imports of good i purchased by country A from country B, we get

¹³According to the draft directive EC-Commission (1990), para. 4b, p. 10, mail order firms are required to charge the tax rate of the destination country if their annual value of sales exceeds one million ECU.

¹⁴Sinn (1990), p. 492, argues that new types of firms offering transport services to import low-tax goods from abroad might emerge in the internal market. Fehr/Wiegand/Rosenberg (1991), pp. 7–8, consider the splitting up of larger mail order firms into legally independent units in order to remain below the threshold specified by the Commission.

$$\begin{aligned}
T_{RDP}^A &= p_1^A(c_1^A - m_1^{AB}) + p_2^A c_2^A + p_3^A c_3^A, \\
T_{RDP}^B &= p_1^B(c_1^B + m_1^{AB}) + p_2^B c_2^B + p_3^B c_3^B.
\end{aligned} \tag{5}$$

The full tax model under the restricted destination principle is given by substituting equations (4) and (5) into (1). The difference between (5) and the tax base under the general destination principle given in (3) is seen to lie in the *bilateral* trade balance for the *final consumer good*.

Restricted Origin Principle: Under the restricted origin principle, the origin principle applies to all trade within the union, no matter whether the purchaser is a final consumer or a VAT-registered trader. For intermediate goods, the tax rate of the origin country becomes effective when the international tax credit method is replaced by an international subtraction method. This excludes the recouping effect of the tax credit while at the same time avoiding international double taxation. Trade with the rest of the world remains to be based on the destination principle. For our specified trade pattern, this yields the following set of arbitrage conditions:

$$\begin{aligned}
p_1^A &= \frac{(1 + t^B)}{(1 + t^A)} p_1^B = p_1^C, \\
\frac{(1 + t^A)}{(1 + t^B)} p_2^A &= p_2^B = p_2^C, \\
p_3^A &= p_3^B = p_3^C.
\end{aligned} \tag{6}$$

Again, relative producer prices will be distorted whenever tax rates differ within the union. Theoretical analysis alone is thus unable to rank the restricted destination principle and the restricted origin principle on grounds of overall allocative efficiency.

Tax bases in each of the union countries are given by overall domestic consumption minus all imports from the union partner. This yields

$$\begin{aligned}
T_{ROP}^A &= p_1^A(c_1^A - m_1^{AB}) + p_2^A(c_2^A - m_2^{AB}) + p_3^A(c_3^A - m_3^{AB}), \\
T_{ROP}^B &= p_1^B(c_1^B + m_1^{AB}) + p_2^B(c_2^B + m_2^{AB}) + p_3^B(c_3^B + m_3^{AB}).
\end{aligned} \tag{7}$$

The full model of the restricted origin principle is given by inserting (6) and (7) into (1). The difference to the general destination principle now lies in the *bilateral* trade balance for *all goods*¹⁵.

¹⁵Cf. the discussion in Berglas (1981), pp. 382–385.

The discussion of the restricted destination principle and the restricted origin principle shows that two changes are involved in a switch in the tax principle:

1. an isolated change in the tax base which occurs when tax rates are equal between the union countries and relative prices remain undistorted. The welfare effects of this isolated change depend on bilateral trade balances in the initial equilibrium. The induced income effects feed back on consumption decisions and trade flows and will, in general, lead to a new set of equilibrium prices¹⁶. There are obvious similarities between this change and the standard transfer analysis in international trade theory.
2. introducing a tax differential in the EC under the new principle distorts relative producer prices and leads to overall efficiency losses. The effects of this isolated change on the international terms of trade are familiar from the standard tariff analysis. In our model, a second redistributive effect occurs as production and consumption responses to changes in relative prices will alter the tax base in each of the union countries.

In section 5, we will base our discussion of numerical results on this analytical decomposition of a switch in the tax principle.

4 The Data

4.1 Deriving the Benchmark Data Set

The numerical implementation of the model is based on 1987 statistics of international trade and national accounting (United Nations 1990a,b,c). We maintain the high level of aggregation in the theoretical model for our empirical analysis and differentiate three regions which trade three homogeneous goods. With respect to the division of countries, Germany (GER) is singled out as an individual region

¹⁶Note the difference between a *distortion* of relative prices introduced by a tax wedge and an *adjustment* of relative prices in response to a change in the international distribution of income. Cf. also the discussion between Berglas (1981) and Whalley (1979, 1981). Whalley (1981, p. 389) uses the term 'trade distortion' for any change in trade flows (and relative prices) induced by a change in the tax principle while Berglas reserves it for a distortion of relative prices due to a tax wedge.

Table 1: Gross Domestic Product by Region

Values in billion U.S.-Dollars.

country	GDP 1987	non- tradeables	tradeables
Germany	1,116.0	748.0	368.0
Rest of EC	3,194.0	2,236.0	958.0
Rest of World	12,955.0	7,514.0	5441.0

Sources: United Nations (1990a), Tables 1, 4, and 7. For ROEC, the division of GDP represents a weighted average of country-specific shares; the weights used are the values of GDP in 1987. For ROW, the production of non-tradeables is based on the worldwide share of services production in GDP in 1980.

while all other countries of the European Community including the 1986 entrants Portugal and Spain are aggregated to the 'Rest of the EC' (ROEC). This division represents partly a 'national bias' of the author but it can also be justified on analytical grounds, as will be seen below. All non-EC countries covered by the U.N. statistics are aggregated to the 'Rest of the World' (ROW).

With respect to the division of goods, gross domestic product is conventionally partitioned into primary goods production, manufacturing, and services. However, the taxation of services under current (pre-1992) arrangements is really a combination of the destination and the origin principle so that a correct incorporation of the service sector would imply a deviation from the general destination principle in the benchmark equilibrium¹⁷. On the other hand, services play only a minor role in the 1987 international trade statistics. Therefore, we assume all services to be non-tradeables and exclude them from our analysis by subtracting the value of services from gross domestic product in each region. Thus, the regional values for 'total' production in our benchmark data set are to be interpreted as the value added in the primary and secondary sectors only (or the value of tradeables). The relevant statistics are summarized in Table 1.

Total value added in tradeables is divided into a primary sector and two manufacturing industries. The subdivision of manufacturing into 'intermediate goods

¹⁷The special role of services is discussed in Fehr/Rosenberg/Wiegard (1991), p. 4.

manufacturing' and 'consumer goods manufacturing' should not be taken literally but attempts to follow the line of division relevant for tax purposes under the restricted destination principle. Cars, e.g., are classified as 'intermediate goods' in order to account for the special tax treatment of new cars in the internal market¹⁸. The choice of the consumer goods bundle is, of course, crucial for the quantitative analysis of the restricted destination principle (and open to criticism). Tables A.1 and A.2 of the appendix show how our division of goods is linked to the categories used in the National Accounting Classification (ISIC) and the Standard International Trade Classification (SITC), respectively. The problems associated with the matching of the commodity-based SITC classification and the sector-based ISIC classification are well known and shall not be repeated here.

To obtain a micro-consistent data set, we employ the following conventions: for each country, an overall trade surplus is matched by a transfer payment of the same amount while an overall trade deficit is balanced by an equivalent transfer receipt. For each good, trade data for the rest of the world are taken as the negative of aggregate EC trade data to eliminate statistical errors. Since regional consumption of each good must equal the sum of regional production and net imports, we take the simplest possible approach and *derive* regional consumption rather than collect independent consumption data¹⁹. This yields the data set given in Table 2.

Several points are worth mentioning: it is seen that the trade pattern in Figure 1 corresponds to actual 1987 data. Each region is a net exporter of one good and a net importer of the other two. Furthermore, the data demonstrate the dominant role of German net exports of intermediate goods. These exports are responsible for a large German trade surplus which is almost exactly matched by a corresponding trade deficit in the rest of the Community. Finally, our model assumptions imply differences in preferences since the composition of domestic consumption in Table 2 differs across regions while relative prices are equal under the general destination principle.

To complete our data set, production technologies must be specified and endow-

¹⁸According to the draft directive EG-Kommission (1990), pp. 9–11, the purchase of new cars will be taxed in the country of destination upon licensing.

¹⁹This procedure eliminates the need to adjust independently collected production, consumption and trade data in order to make them mutually compatible. On the other hand, our approach implies that any errors in either production or trade data enter the benchmark data set without correction.

Table 2: Production, Consumption, and Trade

Values in billion U.S.-Dollars. Imports have positive sign.

country	good	production	plus: imports	equals: consumption
Germany	consumer	55.8	+ 8.4	64.2
	intermediate	256.0	-111.5	144.5
	primary	56.2	+37.4	93.6
	TOTAL	368.0	-65.7	302.3
Rest of EC	consumer	196.7	-14.4	182.3
	intermediate	505.8	+ 17.6	523.4
	primary	255.5	+ 61.6	317.1
	TOTAL	958.0	+ 64.8	1022.8
Rest of World	consumer	685.3	+ 6.0	691.3
	intermediate	2294.2	+93.9	2388.1
	primary	2461.5	-99.0	2362.5
	TOTAL	5441.0	+ 0.9	5441.9

Sources: a) production data: United Nations (1990a), Tables 4 and 7, and United Nations (1990b), Tables 4.1 and 4.3. For ROEC, the division of the value of tradeables represents a weighted average of country-specific shares. For the ROW production of primary goods, the worldwide share of primary goods production in GDP in 1980 is taken as a proxy. The subdivision of manufacturing represents a weighted average of U.S. and South Korean data; the weights used are for developed and developing non-EC market economies, respectively.

b) trade data: United Nations (1990c), Special Table A and country tables. Summary statistics in Eurostat (1989), Tables 6.11 and 6.13 are used which are compatible with the above source. Consumer goods (SITC categories 1 and 8) are singled out from summary statistics by aggregating country-specific data for the EC.

Table 3: Input Coefficients by Sector and Region

country	good	capital	labor
Germany	consumer	0.32	0.68
	intermediate	0.20	0.80
	primary	0.40	0.60
Rest of EC	consumer	0.43	0.57
	intermediate	0.30	0.70
	primary	0.74	0.26
Rest of World	consumer	0.27	0.73
	intermediate	0.20	0.80
	primary	0.64	0.36

Source: United Nations (1990b), Table 4.3. ROEC data are weighted averages of country-specific factor shares. ROW data represent a weighted average of factor shares in the U.S. and South Korea.

ments of primary factors of production must be determined. Production functions were derived from national data on the cost components of value added which isolate wages and a net operating surplus. For a Ricardo-Viner technology, this distinction is sufficient to allow a complete specification of production technologies. Country- and sector-specific input coefficients are given in Table 3. The data exhibit differences in production technologies across countries. To take one example, the production of primary goods is much more capital-intensive in ROEC as compared to Germany. This probably reflects large-scale farming as well as highly capital-intensive mineral oils extraction in several EC member states.

Factor endowments in each region were derived from the output volumes given in Table 2 and the factor input coefficients in Table 3. Again, this is the simplest way to ensure the consistency of the data set used. The derived factor endowments are given in Table A.3 of the appendix.

It remains to adopt a units convention in order to split up value terms – on which national accounts and international trade statistics are based – into quantities and prices which are needed for a microeconomic framework. Following standard practice, we choose physical units such that all factor and commodity prices are equal to one in the benchmark equilibrium. In our commodity tax model, there is

a further choice: we follow Piggott (1988, p. 263) in setting producer rather than consumer prices equal to one. Thus, the national product statistics in the literature correspond to our factor income; nominal income (including tax receipts) in our model is inflated by the general commodity tax rate in each country. We will keep this in mind when we interpret results which depend on the price level.

4.2 Functional Forms and Extraneous Elasticity Estimates

To specify the model fully, we have to adopt functional forms for utility and production functions and choose values for those elasticities which are not obtained in the process of calibration. We assume constant elasticity of substitution (CES) functions in production and consumption; i.e. we assume functional forms which are homogeneous and exhibit constant returns to scale²⁰. CES functions are known to impose two major restrictions on the shape of preferences and production technologies: first, increases in income or production levels will lead to linear increases in demand for goods or factors. Second, in a setting with more than two goods or factors, all partial elasticities of substitution are equal to each other²¹. The latter restriction can be relaxed by introducing nested CES functions; we will, however, confine the analysis to single-stage CES functions.

Elasticities of substitution in production and consumption are taken from estimates in the econometric literature. For our purposes, it is sufficient to rely on the collection of such estimates in Whalley (1985, pp. 97–110). The relevant elasticity estimates are aggregated and reproduced in Table 4. No country-specific elasticity estimates are available so that the reported values hold for each region in our model. With respect to the elasticity of substitution in consumption, Whalley (1985, p. 108) emphasizes that literature estimates are not very robust. He suggests a sensitivity analysis around the 'central case value' of 1.0 (Cobb-Douglas preferences) given in Table 4. We will follow this suggestion and carry out a sensitivity analysis with respect to this parameter in section 5.4.

²⁰The treatment of production functions and utility functions in CGE models is completely analogous. There is, however, no necessity to *interpret* changes in the utility index in a cardinal way. Cf., e.g., Ahlheim/Rose (1984), p. 276, for a critique of a cardinal interpretation of welfare changes.

²¹These are the so-called 'Allen elasticities'. Cf. Silberberg (1978), pp. 313–323, for a detailed discussion of the properties of CES functions.

Table 4: Extraneous Elasticity Estimates

elasticity of substitution in	σ
production: consumer good	0.8
production: intermediate good	0.8
production: primary good	0.7
consumption	1.0

Source: Whalley (1985), p. 100 (Table 5.2) and p. 108. Production elasticities given here represent unweighted averages of the more disaggregated categories in Whalley's Table 5.2: consumer goods (categories 8-12), intermediate goods (categories 13-24), primary goods (categories 1-7).

Finally, our assumption that goods produced in different countries are perfect substitutes implies an infinite elasticity of substitution between imported and domestic goods. Econometric estimates suggest that this elasticity (sometimes called the 'Armington elasticity' because it can only be incorporated in models employing the Armington assumption) is instead in the range of 0.5–2.0 for most sectors (Harrison/Rutherford/Wooton, pp. 100–101). While these estimates are not uncontroversial²², our model assumptions are likely to overestimate the effect of relative price changes on international trade flows. This has to be born in mind when we discuss our results in the following section.

5 The Results

We use the data set and the extraneous elasticity values given in the previous section to calibrate our benchmark equilibrium. In the benchmark equilibrium, a general destination principle is assumed for the taxation of international trade. In section 5.1, we briefly summarize some relevant results from the theoretical discussion of alternative welfare measures. Subsequently, we report our numerical results following the procedure outlined earlier: in section 5.2, we give the results for an isolated switch in the tax base, assuming an equal tax rate of 15 percent in both EC regions while the tax rate in the rest of the world is set equal to zero. In section 5.3, the tax

²²According to Shoven/Whalley (1984), p. 1042, several authors have suspected that most estimates of trade elasticities are too low due to a specification bias.

rate in ROEC is increased to 20 percent and the isolated effects of this change are studied under each of the alternative tax principles²³. The results are 'added up' in section 5.4 to get the overall effects of a switch in the tax principle when tax rates differ within the EC. Our numerical analysis is carried out using the software package MPS/GE, a ready-to-use Fortran program which easily handles 'standard' CGE analyses of the type discussed here (and is, in fact, flexible enough to solve more complex problems).

5.1 Measuring Welfare Change

The most widely used measures of welfare change are the equivalent variation (EV) and the compensating variation (CV). It is well established in the theoretical literature that, in general, only the EV will provide a consistent ranking of individual (or, in our case, regional) preferences when several alternatives are compared to a single benchmark equilibrium²⁴. If preferences are homothetic, however, there is no problem of consistency under either welfare measure. Furthermore, if utility functions are homogeneous of degree one in income (which is the case for the CES functions we are using), changes in the utility index can be transformed into either the EV or the CV measure by²⁵

$$\begin{aligned} EV &= \left(\frac{u_1 - u_0}{u_0} \right) y_0, \\ CV &= \left(\frac{u_1 - u_0}{u_1} \right) y_1, \end{aligned} \tag{8}$$

where u denotes utility, y is nominal income, and indices are 0 for the initial and 1 for the counterfactual equilibrium. These formulae exhibit another advantage of the EV, however. While the EV is based on the initial price level, the CV depends on changes in the price level which will, in general, occur in the counterfactual equilibrium. To

²³The standard VAT rate in Germany will be 15 percent as of 1993. The immediate EC neighbors of Germany excluding Luxemburg had the following standard VAT rates in 1990: Belgium (18%), Netherlands (18.5%), France (18.6%), Denmark (22%). The unweighted average of these rates is close to 20 percent so that the tax rates chosen for our analysis can be taken as a rough approximation of the VAT differential between Germany and its high-tax neighbors.

²⁴Cf., e.g., Ahlheim/Rose (1984), pp. 299–301. Symmetrically, the CV is superior in the case where several benchmark equilibria are compared to a single counterfactual equilibrium. See Johansson (1991), pp. 54–55, for examples of the latter case.

²⁵See Piggott (1988), pp. 274–275, for a more detailed discussion of this special case.

avoid re-normalization, we will therefore use the EV measure of welfare change in our analysis. Initial income in each region will be defined as the factor income given in Table 2 (i.e., net of tax receipts)²⁶.

Another issue which has attracted considerable theoretical attention is the aggregation of individual (or regional) changes in welfare as an indicator of a potential Pareto improvement. Boadway (1974) has shown that a positive sum of individual CVs (or EVs) is neither sufficient nor necessary for a potential Pareto improvement unless preferences are identical and homothetic for all consumers (p. 934). Since our starting point is a Pareto optimum, however, we are secure in the interpretation that a negative sum of EVs goes along with an overall loss in Pareto efficiency.

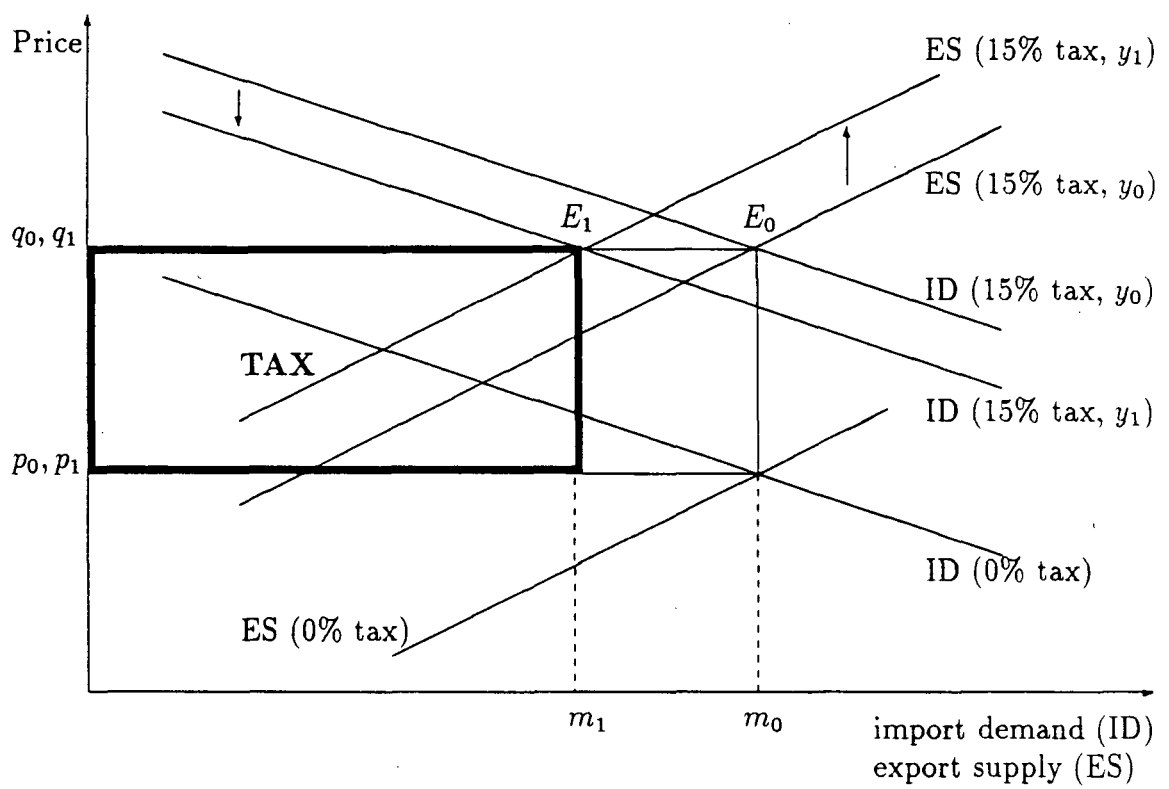
5.2 Analyzing an Isolated Switch in the Tax Base

Our analysis in this and the following section emphasizes the breakdown of the overall welfare change in each region into terms of trade and tax base effects. This decomposition is not provided by a standard software program. The simplicity of our model allows, however, a fairly good approximation of isolated welfare effects using numerically computed general equilibrium prices and quantities on the one hand and simple analytical tools on the other. For this reason, we begin the analysis of each policy change with a brief theoretical discussion. Subsequently, we report selected general equilibrium prices and quantities from our numerical analysis. Using this data input, individual welfare effects in each region are quantified and their sum is compared to the overall regional welfare change computed by the MPS/GE program. In this section, we will base our discussion on the graphical representation of a single market given in Figure 2.

Restricted Destination Principle: The switch from a general to a restricted destination principle alters the tax base in the market for consumer goods only. We will therefore interpret Figure 2 to show the market for the final consumer good. Under the restricted destination principle, revenues from the taxation of intra-EC trade in final consumer goods accrue to the exporting rather than the importing country. Thus, the net exporter within the tax union will benefit from the switch to the restricted destination principle and the net importer will lose. This transfer

²⁶This ensures that our EV values are not inflated relative to actual GDP in each region; cf. the discussion in section 4.1.

Figure 2: Effects of a Switch in the Tax Base



of tax revenues is labelled *TAX* in Figure 2. As is known from international trade theory, a transfer will, in general, change relative prices and thus the terms of trade in response to changes in the international distribution of income²⁷. This secondary effect is not captured in Figure 2.

To quantify the welfare effects involved, we report here the relevant general equilibrium values before and after the switch in the tax principle (indexed by 0 and 1, respectively). The full set of relative prices and bilateral trade flows in the counterfactual equilibrium is given in the appendix (Tables A.4 and A.5).

Data Set 1: Switch in the Tax Base – RDP

good	trade	m_0	m_1	p_0	p_1	q_0	q_1
consumer	ROEC \Rightarrow GER	8.40	8.14	1.000	1.000	1.150	1.150

Since Germany imports the final consumer good from the rest of the EC, it will lose from the isolated switch in the tax base analyzed here. The redistribution of tax revenues can be calculated as the product of the *final* trade volume and the common tax rate

$$8.14 \times 0.15 = 1.22 .$$

Note that a calculation based on the *initial* trade volume would slightly overstate the actual revenue redistribution because the trade volume falls in response to the income effects involved²⁸. This is also shown in Figure 2. The increase in national income experienced by the exporting country (ROEC) will shift the excess supply curve from $ES(y_0)$ to $ES(y_1)$. Likewise, the income loss in the importing country (Germany) shifts the import demand curve from $ID(y_0)$ to $ID(y_1)$. In the new equilibrium, E_1 , the volume of trade in consumer goods will therefore be unambiguously smaller than in the initial equilibrium E_0 .

²⁷This is known as the 'secondary burden' or 'secondary blessing' of a transfer depending on whether the donor country's terms of trade improve or worsen following the transfer. Terms of trade changes will not occur when preferences in the donor and the recipient country are identical and homothetic. Cf., e.g., Caves/Jones (1985), pp. 54–58, for a textbook treatment.

²⁸A calculation based on initial trade volumes is labelled a 'first round effect' in Fehr/Rosenberg/Wiegard (1991), p. 19. Such a calculation underlies, e.g., the EC-Commission's estimates of the payments to be made under the clearing system; see EG-Kommission (1987). Similar to our analysis here, these calculations are based on a full harmonization of tax rates in the Community.

Table 5: Welfare Effects of a Switch in the Tax Base – RDP

Values in billion U.S.-Dollars.

country	TAX	TOT	TOTAL
Germany	-1.22	0.00	-1.22
Rest of EC	+1.22	0.00	+1.22
Rest of World	0.00	0.00	0.00
WORLD	0.00	0.00	0.00

It is seen from the data set given above that relative prices are unchanged in the final equilibrium. Thus, the secondary or terms of trade effects (TOT) are negligible in this case. Table 5 summarizes the regional welfare effects for a switch in the tax base to the restricted destination principle. Our computations have been cross-checked with the change in the utility index calculated by the MPS/GE program; the latter is transformed into EV values using equation (8)²⁹. Table 5 also shows that the rest of the world is not affected by the policy change analyzed here. Finally, EVs sum to zero indicating that the final equilibrium is still Pareto efficient.

Restricted Origin Principle: The switch from a general destination principle to the restricted origin principle alters the tax base in all markets in which intra-EC trade occurs. In our case, these are the two markets for manufacturing goods; the bilateral trade balance in these goods determines the gainers and losers from the switch in the tax principle. Relative prices and bilateral trade flows in the two manufacturing markets are given below. The full data set is found in the appendix (Tables A.4 and A.5).

Data Set 2: Switch in the Tax Base – ROP

good	trade	m_0	m_1	p_0	p_1	q_0
consumer	ROEC \Rightarrow GER	8.40	8.66	1.000	1.000	1
intermed.	GER \Rightarrow ROEC	17.60	16.97	1.000	1.000	

²⁹Since no relative price changes are involved, all welfare measures will yield the same result in this case.

Table 6: Welfare Effects of a Switch in the Tax Base – ROP

Values in billion U.S.-Dollars.

country	TAX	TOT	TOTAL
Germany	+1.25	0.00	+1.25
Rest of EC	-1.25	0.00	-1.25
Rest of World	0.00	0.00	0.00
WORLD	0.00	0.00	0.00

In contrast to the isolated trade balance in final consumer goods, Germany's overall trade balance with the rest of the EC is positive in the benchmark and the counterfactual equilibrium. Thus, Germany will gain from a switch to the restricted origin principle. Multiplying the bilateral trade balance in the final equilibrium with the common tax rate yields

$$(16.97 - 8.66) \times 0.15 = 1.25 .$$

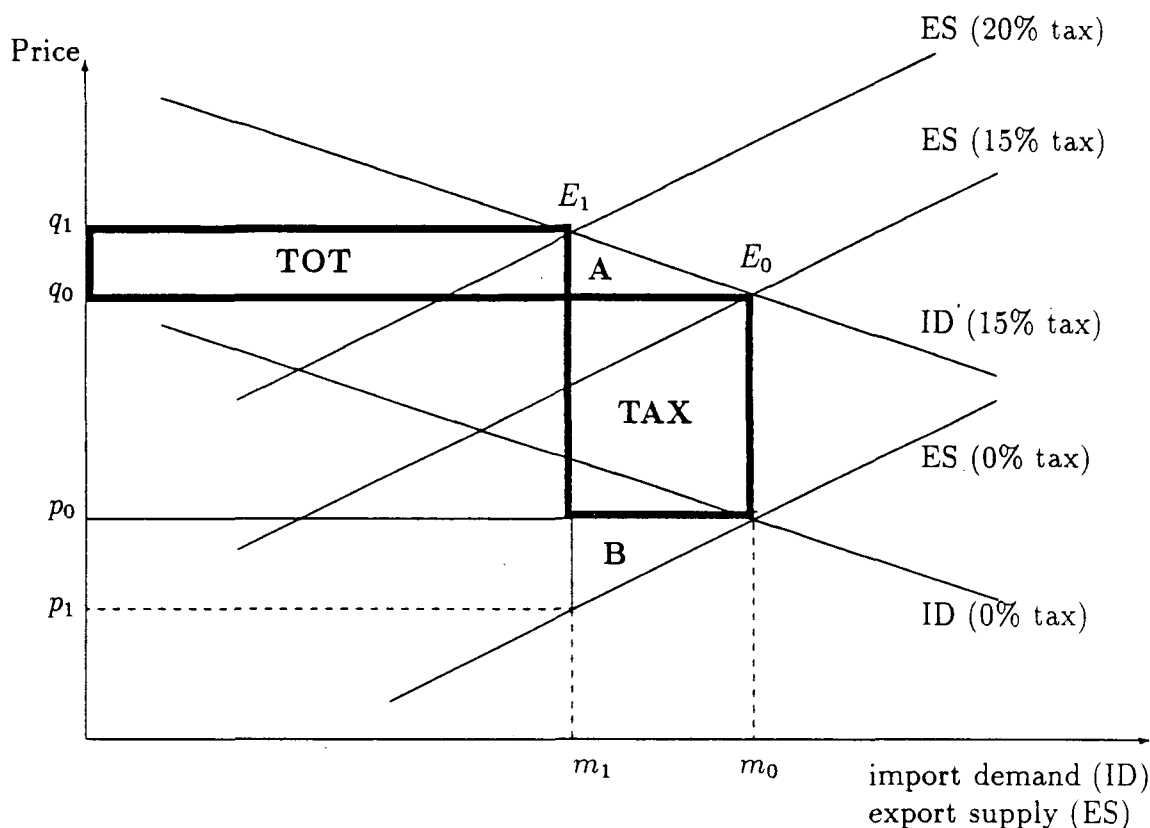
Again, the international terms of trade are unchanged. Regional welfare effects for a switch in the tax base to the restricted origin principle are summarized in Table 6.

So far, we have isolated the role of the initial trade balance as a determinant of redistributive effects between the EC regions. For a switch to the restricted destination principle, only the bilateral trade in final consumer goods matters whereas the overall trade balance between these two regions is relevant for a switch to the restricted origin principle. For our benchmark data set, Germany loses in the first case but gains in the second. General equilibrium repercussions are limited to changes in trade flows induced by income effects. Generally, the region which gains from the switch in the tax base increases its net imports of all goods, thus worsening its bilateral trade balance with the other EC region.

5.3 Introducing a Tax Rate Differential

In this section, we analyze the effects of increasing the tax rate in the rest of the EC to 20 percent under both the restricted destination principle and the restricted origin principle. For each of the alternative tax principles, the counterfactual equilibrium

Figure 3: Effects of a Change in Tax Rates



of the previous section represents the new 'benchmark equilibrium'. We introduce Figure 3 to support our discussion of the welfare effects involved in this isolated policy change³⁰.

Restricted Destination Principle: Under the restricted destination principle, the analysis can again be confined to the market for final consumer goods. Figure 3 demonstrates that two effects must be distinguished here: the (tax-inclusive) price of the final consumer good will, in general, rise following the tax increase. Since the high-tax country (ROEC) is an exporter of this good, the terms of trade effect (TOT) will be positive for ROEC in our case. On the other hand, the tax base effect (TAX) gives the reduction in the export volume and thus the shrinking of ROEC's tax base as a result of induced substitution effects. Thus, the two effects work in opposite

³⁰In Figure 3, we have not shifted demand and supply curves in response to changes in income and other prices for reasons of lucidity. Prices and quantities shown in the graph should be interpreted as general equilibrium values, however.

directions³¹. Finally, total deadweight loss is given by the two triangles labelled *A* and *B*, respectively. Area *A* represents the loss in the importing country's consumer surplus while area *B* shows the loss in producer surplus incurred by the exporting country.

Data set 3 gives the changes in prices and trade volumes in the market for final consumer goods for the isolated policy change discussed here. The full data set for this case is given in the appendix (Tables A.6 and A.7). It is seen there that the second relative price in our three-good model is not affected by a change in tax rates under the restricted destination principle.

Data Set 3: Increase in ROEC's Tax Rate – RDP

good	trade	m_0	m_1	p_0	p_1	q_0	q_1
consumer	ROEC \Rightarrow GER	8.14	2.80	1.000	0.998	1.150	1.197

Using this data input, the individual welfare effects shown in Figure 3 can be calculated. The tax base effect is derived in the same way as in the preceding section and creates no difficulties. Terms of trade effects can be similarly derived as the change in import or export prices weighted by the *final* trade volume. Finally, Figure 3 shows that the total deadweight loss (DWL) can be allocated among the trading countries. To quantify deadweight losses, some simplifying assumptions have to be made, however. First, we will base our calculations on market demand curves while a correct measure of deadweight loss has to be based on compensated demand curves. The error incurred by this procedure is small for moderate changes in income like the ones discussed here³². Second, for ease of computation, we will assume all supply and demand curves to be linear; deadweight losses are then given by the familiar Harberger triangles. This procedure will, however, overestimate deadweight losses when 'true' demand curves are convex.

Our results are summarized in Table 7, detailed calculations are given in the appendix (Table A.8). Our estimates of the total welfare change in each country are compared with the EV values derived from the software output which are given in the final column of Table 7.

Table 7 shows that our calculations slightly overestimate the deadweight loss for the above-mentioned reason. Nevertheless, our breakdown of total regional welfare

³¹Cf. the analytical discussion in Haufler (1991a), section 4.3.

³²See Johannsson (1991), p. 52, for a more detailed discussion and an approximation of the error incurred by using the consumer surplus measure.

Table 7: Welfare Effects of an Increase in ROEC's Tax Rate – RDP

Values in billion U.S.-Dollars.

country	TAX	TOT	DWL	TOTAL	EV
Germany	+0.80	-0.13	-0.12	+0.55	+0.57
Rest of EC	-0.80	+0.11	-0.01	-0.70	-0.70
Rest of World	0.00	+0.02	-0.01	+0.01	+0.01
WORLD	0.00	0.00	-0.14	-0.14	-0.12

is sufficiently precise to determine the relative importance of different effects. Our results show that the tax base effect is substantially larger than terms of trade and efficiency effects in both EC regions so that Germany gains and the rest of the EC loses from the isolated increase in ROEC's tax rate.

Restricted Origin Principle: Under the restricted origin principle, the markets for both final consumer goods and intermediate goods must be considered in our analysis. It is known from the theoretical analysis of this case that tax base effects are negative for the country raising its tax rate (ROEC) and positive for the union partner (Germany). Terms of trade effects are ambiguous for all regions including the rest of the world³³. The relevant equilibrium values from our numerical analysis are reported below; see the appendix (Tables A.6 and A.7) for the full data set.

Data Set 4: Increase in ROEC's Tax Rate – ROP

good	trade	m_0	m_1	p_0	p_1	q_0	q_1
consumer	ROEC \Rightarrow GER	8.66	4.50	1.000	0.996	1.150	1.196
intermediate	GER \Rightarrow ROEC	16.97	32.20	1.000	0.963	1.150	1.155

It is seen that both relative prices are distorted in this case. As is known from second-best welfare theory, deadweight losses can be added over markets if the general equilibrium changes in quantities are used³⁴. Likewise, tax base and terms of

³³Cf. the analytical decomposition of national welfare effects in Haufler (1991b), pp. 12–15.

³⁴Cf. Tresch (1981), pp. 314–318, for an analytical derivation of total deadweight loss in the presence of multiple distortions. Note also that the path-dependency problem usually associated with the consumer surplus measure cannot arise in our analysis because utility functions are homothetic; cf. Johansson (1991), pp. 44.

Table 8: Welfare Effects of an Increase in ROEC's Tax Rate – ROP

Values in billion U.S.-Dollars.

country	TAX	TOT	DWL	TOTAL	EV
Germany	+2.91	+0.32	-0.11	+3.12	+3.14
Rest of EC	-2.91	-0.03	-0.36	-3.30	-3.25
Rest of World	0.00	-0.29	-0.07	-0.36	-0.35
WORLD	0.00	0.00	-0.54	-0.54	-0.46

trade effects in the markets for the two non-numeraire goods can be added. Our results are given in Table 8, detailed calculations are found in the appendix (Table A.8). Again, our approximation of the overall welfare change in each region is cross-checked with the 'correct' EV value given in the last column of Table 8.

The results demonstrate that the error incurred by our approximation of efficiency losses has risen in proportion to the total deadweight loss. Still, the picture that emerges from the breakdown of overall regional welfare is clear-cut: terms of trade effects are relatively small in all regions and are clearly dominated by tax base effects. A comparison with the results in Table 7 demonstrates that the overall redistributive effects of a tax increase in ROEC are much more pronounced under the restricted origin principle as compared to the restricted destination principle. The reason for this last result can be inferred from the changes in trade volumes given in Data Set 4. It is seen that German revenues from the taxation of *intermediate goods* increase under the restricted origin principle at the expense of ROEC. This is an effect which was absent under the restricted destination principle. A fuller discussion of these results and their implications is deferred to the next section.

5.4 Overall Effects of a Switch in the Tax Principle

The overall effects of a switch in the tax principle can now be determined by adding up the regional EV values in Tables 5 and 7 (for the restricted destination principle) and Tables 6 and 8 (for the restricted origin principle), respectively³⁵. This yields

³⁵In principle, an error is incurred by this procedure because initial national income differs in the two analyses. It turns out, however, that this error is of negligible magnitude in our case.

Table 9: Overall Welfare Effects of a Switch in the Tax Principle

country	<i>restricted destin. principle</i>		<i>restricted origin principle</i>	
	EV (bill. \$)	% of GDP	EV (bill. \$)	% of GDP
Germany	-0.65	-0.06	+4.39	+0.39
Rest of EC	+0.52	+0.02	-4.50	-0.14
Rest of World	+0.01	0.00	-0.35	0.00
WORLD	-0.12	0.00	-0.46	0.00

the results given in Table 9.

An evaluation of these results should encompass both the overall efficiency losses and the size of the redistributive effects. For a given tax differential in the Community, our analysis shows that the overall efficiency losses are larger under the restricted origin principle as compared to the restricted destination principle. This result should not be overemphasized, however. Overall efficiency losses are small under both tax principles due to our assumption that the initial equilibrium is Pareto efficient. As is well known from the general theory of the second best, the ranking of the two tax principles with respect to overall efficiency losses may well be reversed if additional distortions are considered.

Our evaluation of redistributive effects draws on the detailed analysis in sections 5.2 and 5.3. Under the restricted destination principle, the overall welfare effect is negative for Germany and positive for the rest of the EC. This result is not incompatible with the general notion that low-tax countries will gain from a switch to the restricted destination principle, as the analysis of an *isolated* tax increase in ROEC has shown. However, this effect is dominated by the loss that Germany incurs from an *isolated* switch in the tax base. Qualitatively, our findings concur with the parallel case in Fehr/Rosenberg/Wiegard (1991)³⁶. In both analyses, Germany loses from the switch to the restricted destination principle, but the loss is smaller than the 'first round effects' indicate³⁷. Quantitatively, the overall German welfare loss

³⁶Fehr/Rosenberg/Wiegard (1991), pp. 18-20, discuss two alternative scenarios. In the case parallel to our analysis, direct consumer purchases are taxed in the country of origin but no switching option is introduced. The results are given in Table 3 of their analysis.

³⁷Note that the isolated switch in the tax base in our analysis is similar to the 'first round effects' discussed by Fehr/Rosenberg/Wiegard; cf. footnote 28.

is approximately 2.5 times higher in the Fehr/Rosenberg/Wiegard analysis as compared to our results (1.3 bill. ECU vs. 0.65 bill. U.S.-\$). Such quantitative differences are to be expected, however, due to year-to-year fluctuations in the bilateral German trade balance with ROEC in final consumer goods. Differences in the base year used for the benchmark data set (1981 in the Fehr/Rosenberg/Wiegard analysis) may well explain most of the divergence in results.

Under the restricted origin principle, the effects of a switch in the tax base and of a change in ROEC's tax rate work in the same direction: Germany gains from both effects while ROEC loses accordingly. This is a partial explanation for the much larger size of redistributive effects in this case. In addition, the analysis of section 5.3 has shown that the redistributive effects of an *isolated* change in ROEC's tax rate are stronger under the restricted origin principle as compared to the restricted destination principle³⁸.

Sensitivity Analysis: Having interpreted our results, it is important to test the robustness of the numerical calculations. Our assumption that comparable goods produced in different countries are perfect substitutes has introduced an extremely elastic response of the tax base to international price differentials. Consequently, our results will tend to overestimate the size of redistributive effects under *both* tax principles. A sensitivity analysis with respect to the infinite trade elasticities implied by our model assumptions would therefore be desirable. This requires, however, a major change in our basic model which is beyond the reach of the present paper. In contrast, a sensitivity analysis can be easily carried out with respect to the elasticity values given in Table 4. We will confine the sensitivity analysis to the elasticity of substitution in consumption since estimates of production elasticities seem to be rather robust. Therefore, we replace the consumption elasticity of 1.0 in the central case by values of 0.5 and 1.5, respectively. The results are given in Table 10.

The sensitivity analysis shows that Germany will gain more (or lose less) under both tax principles when the elasticity of substitution in consumption is raised. A rise in substitution elasticities will increase the size of substitution effects induced by the given tax differential. Our previous discussion has shown that these substitution

³⁸In footnote 20, we have alluded to the problem of interpreting welfare changes in a cardinal way. In our analysis, changes in national welfare derive primarily from international transfers of tax revenues. These transfers clearly have a monetary interpretation so that a quantification of national welfare effects seems appropriate.

Table 10: Sensitivity Analysis

EV values in billion U.S.-Dollars.

country	<i>rest. destin. principle</i>		<i>rest. origin principle</i>	
	$\sigma = 0.5$	$\sigma = 1.5$	$\sigma = 0.5$	$\sigma = 1.5$
Germany	-0.82	-0.48	+3.60	+5.15
Rest of EC	+0.72	+0.34	-3.62	-5.36
Rest of World	0.00	+0.01	-0.33	-0.36
WORLD	-0.10	-0.13	-0.35	-0.57

effects will always benefit the low-tax country. Furthermore, it is intuitive that the overall deadweight loss of a given tax wedge will rise in proportion to the rise in substitution elasticities. Table 10 also shows that the quantitative implications of changing the elasticity of substitution in consumption are substantial in our model. This should serve as a warning not to interpret our quantitative results as estimates of actual revenue redistributions following a switch in the tax principle. While this warning may apply to all CGE models to some extent, it seems especially relevant to our analysis in view of both the highly simplified model we have used and the shortcomings of the data set on which our calculations are based.

Policy Implications: Throughout our analysis, we have emphasized that the overall welfare effects of a switch in the tax principle are determined by bilateral trade balances in the pre-change situation on the one hand, and by the tax differential between the EC regions on the other. This distinction is relevant for policy purposes as well. Under the current general destination principle, national tax policy cannot exert a systematic influence on bilateral trade balances. In contrast, the existence of a tax differential has predictable effects on the distribution of tax revenues between EC member states under both alternative tax principles. Theoretical ambiguities arise from simultaneous terms of trade effects (which may be positive for a country which raises its tax rate) and tax base effects (which are unambiguously negative for the high-tax country). Our numerical analysis suggests that tax base effects will dominate terms of trade effects in the EC context. Thus, low-tax regions in the Community are very likely to gain from the isolated influence of tax

rate differentials.

This leads to the problem of a downward competition of tax rates in the EC internal market. This concern is usually raised in connection with the restricted destination principle³⁹. Our analysis has indicated, however, that for a given tax differential in the Community, the redistribution of tax revenues may be even larger under the restricted origin principle. This result is all the more remarkable when we recall from the discussion in section 3 that our assumptions probably exaggerate the redistribution occurring under the restricted destination principle. Based on this finding, we conclude that the introduction of a restricted origin principle cannot be expected to lower the incentive for strategic tax setting which exists under the restricted destination principle. This conclusion is, of course, subject to the shortcomings of our analysis discussed above.

Finally, we address the important policy issue why the redistribution of tax revenues cannot be compensated via some form of clearing mechanism. The main problem lies in the critical role of reasonably accurate trade statistics, especially with respect to final consumer purchases. Such statistics do not even exist under the current destination principle. In the internal market, the collection of these data will be made impossible by the very nature of the policy change envisaged⁴⁰. It is precisely because an accurate clearing system is infeasible that the choice of a (second-) best tax principle, which minimizes the redistribution of tax revenues between member states, is so important in the EC internal market.

6 Conclusions

Our paper has discussed the regional and overall welfare effects which arise from a switch from the current general destination principle to either a restricted destination principle or a restricted origin principle. We have argued that this comparison should focus on the redistributive effects of these two alternatives rather than on overall efficiency losses. The concern about a redistribution of tax revenues arises not only from a perspective of international equity (or 'fairness'), but also from the

³⁹Cf., e.g., EC-Commission (1985), para. 173-178, or Sinn (1990), pp. 500-501.

⁴⁰For this reason, the EC-Commission has left out trade in final consumer goods from the clearing mechanism which was proposed in the White Paper (EC-Commission, 1985). Even a clearing mechanism for trade between VAT-registered traders, for which trade statistics will continue to exist in the internal market, was politically non-viable as the subsequent developments showed.

incentive that is given to national policymakers to engage in a mutually harmful process of downward tax competition. Isolating the effects of a given tax differential in the Community, we find that the redistribution of tax revenues is larger under the restricted origin principle as compared to the restricted destination principle. This result can be intuitively explained by the fact that induced changes in the tax base are not confined to the limited group of final consumer goods but extend to all intra-EC trade.

Only cautious policy conclusions should be drawn from our analysis, however. The basic approach taken in this paper was to 'put numbers' on a highly simplified theoretical model rather than construct an empirical model which captures as many facets of reality as possible. This approach allowed to determine the net effect of a policy change when counteracting forces are at work. More specifically, tax base effects were seen to be far more important than terms of trade effects under both tax principles – a result which could not be obtained from theoretical work alone. It could also be shown that theoretical results derived under very restrictive assumptions carry over to more realistic settings including overall trade imbalances and regional differences in preferences and technologies. Still, there is a whole range of issues which have been neglected in our analysis.

Among the many possible extensions, two are probably more important than others. A first extension is to differentiate value-added tax rates by product, thus introducing a further (domestic) distortion to our model economy. Secondly, it would be desirable to incorporate more realistic estimates of trade elasticities into our analysis. This, in turn, requires the use of the Armington specification for modelling international trade. From an analytical perspective, the incorporation of these new features may increase the relative importance of terms of trade effects vis-a-vis tax base effects. This, however, is by no means a necessary outcome⁴¹. From a policy viewpoint, these extensions can be regarded as a test to our conclusion that high-tax countries suffer larger revenue losses in the internal market when a restricted origin principle is introduced instead of a restricted destination principle.

⁴¹The analysis of Fehr/Rosenberg/Wiegard (1991) incorporates both of these extensions. Still, the authors find that (p. 18) "on average around ninety percent of total welfare changes are due to tax exports or imports" (these are labelled 'tax base effects' in our analysis).

Appendix

Appendix to Section 4

Table A.1: National Accounting Classification of Goods

good	ISIC	description
primary good	1	agriculture, forestry and fishing
	2	mining and quarrying
manufactured consumer good	3A	food, beverages and tobacco
	3B	textiles, footwear, leather
	3C	wood products incl. furniture
manufactured intermediate good	3D	paper and paper products
	3E	chemicals
	3F/3G	basic industries
	3H	fabricated metal products, machinery and equipment
	3I	other manufacturing

Table A.2: International Trade Classification of Goods

good	SITC	description
primary good	0	food and live animals
	2	crude materials
	3	mineral fuels
	4	oils and fats
manufactured consumer good	1	beverages and tobacco
	8	miscell. manufacturing (textiles & footwear, jewelry, furniture)
manufactured intermediate good	5	chemicals
	6	basic manufacturing
	7	machines and transport equipment

Table A.3: Derived Factor Endowments

Values in billion U.S.-Dollars.

Germany	consumer	intermed.	primary	TOTAL
capital	17.86	51.20	22.48	91.54
labor	37.94	204.80	33.72	276.46
TOTAL	55.80	256.00	56.20	368.00

ROEC	consumer	intermed.	primary	TOTAL
capital	84.58	151.74	189.07	425.39
labor	112.12	354.06	66.43	532.61
TOTAL	196.70	505.80	255.50	958.00

ROW	consumer	intermed.	primary	TOTAL
capital	185.03	458.84	1575.36	2219.23
labor	500.27	1835.36	886.14	3221.77
TOTAL	685.30	2294.20	2461.50	5441.00

Appendix to Section 5.2

Table A.4: Switch in Tax Base: Relative Prices

Restricted Destination and Restricted Origin Principle

good	<i>producers</i>			<i>consumers</i>		
	GER	ROEC	ROW	GER	ROEC	ROW
consumer	1.000	1.000	1.000	1.150	1.150	1.000
intermediate	1.000	1.000	1.000	1.150	1.150	1.000
primary	1.000	1.000	1.000	1.150	1.150	1.000

Table A.5: Switch in Tax Base: Bilateral Trade Flows

good	direction of trade	bench- mark	RDP	ROP
consumer	ROEC \Rightarrow GER	8.40	8.14	8.66
consumer	ROEC \Rightarrow ROW	6.00	6.03	5.97
intermediate	GER \Rightarrow ROEC	17.60	18.22	16.97
intermediate	GER \Rightarrow ROW	93.90	93.87	93.93
primary	ROW \Rightarrow GER	37.40	37.02	37.79
primary	ROW \Rightarrow ROEC	61.60	61.98	61.21

Appendix to Section 5.3

Table A.6: Change in Tax Rates: Relative Prices

Restricted Destination Principle

good	<i>producers</i>			<i>consumers</i>		
	GER	ROEC	ROW	GER	ROEC	ROW
consumer	1.041	0.998	0.998	1.197	1.197	0.998
intermediate	1.000	1.000	1.000	1.150	1.200	1.000
primary	1.000	1.000	1.000	1.150	1.200	1.000

Restricted Origin Principle

good	<i>producers</i>			<i>consumers</i>		
	GER	ROEC	ROW	GER	ROEC	ROW
consumer	1.040	0.996	0.996	1.196	1.196	0.996
intermediate	1.005	0.963	1.005	1.155	1.155	1.005
primary	1.000	1.000	1.000	1.150	1.200	1.000

Table A.7.: Change in Tax Rates: Bilateral Trade Flows

good	direction of trade	<i>rest. dest. principle</i>		<i>rest. orig. principle</i>	
		15 % tax	20 % tax	15 % tax	20 % tax
consumer	ROEC \Rightarrow GER	8.14	2.80	8.66	4.50
consumer	ROEC \Rightarrow ROW	6.03	10.70	5.97	19.19
intermed.	GER \Rightarrow ROEC	18.22	17.19	16.97	32.20
intermed.	GER \Rightarrow ROW	93.87	90.09	93.93	73.76
primary	ROW \Rightarrow GER	37.02	38.25	37.79	40.23
primary	ROW \Rightarrow ROEC	61.98	61.62	61.21	52.10

Table A.8: Decomposition of Welfare Effects

Restricted Destination Principle

country	effect	calculation	result
GER	TAX	$+(8.14 - 2.80) \times 0.15 =$	+0.80
	TOT	$-(1.197 - 1.150) \times 2.8 =$	-0.13
	DWL	$-(1.197 - 1.150) \times (8.14 - 2.80) \times 0.5 =$	-0.12
ROEC	TAX	$-(8.14 - 2.80) \times 0.15 =$	-0.80
	TOT	$+(1.197 - 1.150) \times 2.80$ $-(1.000 - 0.998) \times 10.70 =$	+0.11
	DWL	$-(1.000 - 0.998) \times (14.17 - 13.50) \times 0.5 =$	-0.01
ROW	TOT	$+(1.000 - 0.998) \times 10.70 =$	+0.02
	DWL	$-(1.000 - 0.998) \times (10.70 - 6.03) \times 0.5 =$	-0.01

Restricted Origin Principle

GER	TAX	$+(8.66 - 4.50) \times 0.15$ $+(32.20 - 16.97) \times 0.15 =$	+2.91
	TOT	$-(1.196 - 1.150) \times 4.50$ $+(1.155 - 1.150) \times 32.20$ $+(1.005 - 1.000) \times 73.76 =$	+0.32
	DWL	$-(1.196 - 1.150) \times (8.66 - 4.50) \times 0.5$ $-(1.155 - 1.150) \times (110.90 - 105.96) \times 0.5 =$	-0.11
ROEC	TAX	$-(8.66 - 4.50) \times 0.15$ $-(32.20 - 16.97) \times 0.15 =$	-2.91
	TOT	$+(1.196 - 1.150) \times 4.50$ $-(1.000 - 0.996) \times 19.19$ $-(1.155 - 1.150) \times 32.20 =$	-0.03
	DWL	$-(1.196 - 1.200) \times (23.69 - 14.63) \times 0.5$ $-(1.155 - 1.200) \times (32.20 - 16.97) \times 0.5 =$	-0.36
ROW	TOT	$+(1.000 - 0.996) \times 19.19$ $-(1.005 - 1.000) \times 73.76 =$	-0.29
	DWL	$-(1.000 - 0.996) \times (19.19 - 5.97) \times 0.5$ $-(1.005 - 1.000) \times (93.93 - 73.76) \times 0.5 =$	-0.07

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WORKSHOP ON
ISSUES IN INTERNATIONAL ECONOMICS: QUESTIONS TO AND ANSWERS FROM
COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS

JULY 8-9, 1991
UNIVERSITY OF KONSTANZ

MONDAY, JULY 8, 1991

10.00 Opening Address

Wolfgang Franz (Dean, University of Konstanz)

Bernd Genser (University of Konstanz)

"General Equilibrium Economics: Computation and Application"

John Whalley (University of Western Ontario)

11.00 Session 1: International Taxation

"Value-Added Tax Harmonization in the EC"

Wolfgang Wiegard/Hans Fehr/Christoph Rosenberg (University of Regensburg)

"Commodity Tax Reform under the Restricted Origin Principle"

Andreas Haufler (University of Konstanz)

14.30 Session 2: Factor Supply

"Simulation Models of Labour Supply"

Alan Duncan (Institute for Fiscal Studies, London)

"An Intertemporal General Equilibrium Model for Austria with Application to Foreign Trade"

Christian Keuschnigg (University of Bonn)/Wilhelm Kohler (University of Innsbruck)

17.00 Session 3: Environment

"CGE Modelling of International Public Goods: Air Quality and Global Warming"

John Piggott (University of New South Wales)

TUESDAY, JULY 9, 1991

09.00 Session 4: Imperfect Competition and Growth

"AGE Models in International Economics with Special Reference to Imperfect Competition and Increasing Returns to Scale"

Albert Schweinberger (University of Konstanz)

Growth and International Capital Movement: A Simulation Study

Karl-Josef Koch (University of Konstanz)

(presentation cancelled due to accident)

10.45 Round Table: "The Payoff of Investment in CGE - Modelling"

Chair: Bernd Genser

Introductory Statements:

John Chipman (University of Minnesota)

Friedrich Schneider (University of Linz)

Closing Address: Bernd Genser