Chapter 6

TAX POLICY IN OPEN ECONOMIES

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1. Introduction

The main subject of this paper is the theory of optimum taxation in an economy open to international trade. This is not a topic that lacks surveys. Bhagwati (1964, sec. VI; 1971) and Corden (1974, 1982) are particularly noteworthy. The distinctive feature of this review will be its perspective. I shall approach the subject as a branch of public economics, with the concerns and techniques of modern public finance theory as exemplified by Atkinson and Stiglitz (1980), or earlier chapters of this volume, rather than neoclassical trade theory as recently surveyed by Jones and Neary (1983) and used in the Bhagwati and Corden surveys cited above. Both approaches ultimately derive from the Walrasian general equilibrium model, and therefore have large overlaps, but the apparatus of special production technologies that underlies much of conventional trade theory will be largely unnecessary for my present purpose.

Most formal models of optimum taxation assume away international trade. Its presence does not alter any basic issues or methods. The economic objectives of the policy remain the same, and can be broadly classified as (i) correcting externalities and distortions, (ii) raising revenue for government expenditure, and (iii) redistributing income. There may also be other "non-economic" objectives or constraints. The policy instruments to pursue these aims are taxes or subsidies on the activities and transactions in the economy, within limitations imposed by observability of the actions and enforceability of the policies. International trade introduces a new set of possible externalities and distortions, and a new set of transactions to tax or subsidize.

There are some potentially new features. The objective function of policy in one country normally excludes the welfare of consumers in other countries. Formally this presents no difficulty so long as we are analyzing policy-making in one country only. We can then regard its net trade with the rest of the world as just

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another transformation possibility, without explicitly accounting for consumption or production in other countries. However, when policies are being made simultaneously in several countries, their mutual interaction presents more complex considerations than are familiar from closed-economy public finance. Some aspects of international interaction of policies are considered in Section 5. Elsewhere, the focus is on policy-making in one country, called the home country.

The most important point to remember is that the general equilibrium interdependence of the system, typical in public economics, applies equally to an open economy. Tariffs, which are taxes levied on transactions with the rest of the world, affect the domestic resource allocation and income distribution, while taxes on domestic transactions affect the trade pattern. Any compartmentalization of activities and policies must be proved, not assumed. Two such separation results are in fact available, and deserve special mention at the outset. One is the Bhagwati–Johnson principle of targeting, which states that a distortion is best countered, or conversely, deliberately introduced if desired as a non-economic objective, by a tax instrument that acts directly on the relevant margin. Thus the first-best policy response to an external economy in production is an appropriate Pigovian subsidy; it is only if this is impossible that the indirect effect of a tariff to stimulate domestic production can be useful as a second-best (or worse) policy. The second result is that income distribution policy is better pursued by use of domestic goods and factor taxes or subsidies than through tariffs. This has important implications for policies to compensate groups that are hurt by trade.

One other result worth highlighting is an application of the Diamond–Mirrlees aggregate production efficiency theorem (see the chapter in this volume by Auerbach, Section 5.3). In this context, it says that marginal rates of transformation should be equalized between domestic production activities and foreign trade. The former equal domestic producer prices, but the latter can differ from the world prices, i.e., the average rates of transformation through trade, if this country has any monopoly power in trade. The optimum policy from this country's point of view will involve trade taxes to achieve the desired equality. This is just the classical optimum tariff. Another implication of production efficiency is that there should be no producer taxation of intermediate goods, i.e., outputs purchased as inputs for other production activities. This has a bearing on the subject of effective protection.

1.1. Outline of the chapter

In the rest of this section, I shall discuss the merits and limits of the approach, and set up the notation. The following three sections take up different aspects of tax and tariff policies. The techniques most suited to the analysis of each also differ, although there are some overlaps. Section 2 considers discrete comparisons of two equilibria, with the object of designing policies that yield a Pareto improvement over the status quo. This deals with the classic questions of gains from trade, optimality of free trade, etc. In Section 3 the optimum tax and tariff policies are characterized for a variety of contexts; in particular, the issues of income distribution and distortion mentioned above are analyzed and the targeting results are derived. Section 4 considers the effects of a small policy change from an arbitrary initial position. This yields some rules for partial reform, including the second-best use of policies when the optimum targeting is not possible.

In Section 5 some aspects of international coordination and competition in trade policy are considered. Section 6 takes up some further topics including effective protection, quotas, and the emerging positive theory of trade policy. Section 7 gives a brief review of some empirical work on the welfare effects of trade policies.

1.2. Scope and limitations

The strengths as well as the weaknesses of the approach followed here stem from its use of the Walrasian equilibrium model. On the plus side, the commodities can be given a wide interpretation, thus giving a unified treatment of disparate topics. There is no need to analyze goods trade and factor trade separately. The basic distinction is between tradeable and non-tradeable commodities; there is no need to begin with the conventional trade model where this coincides with the goods – factors split and then generalize gradually. Similarly, by distinguishing commodities according to the date of availability, the model can be interpreted as treating international borrowing and lending, and taxes thereon. I shall make specific mention of such interpretations only in passing.

One other restriction I shall impose is that of constant returns to scale in all production activities. The Walrasian setting of course rules out increasing returns. Any diminishing returns can be accommodated by defining an artificial factor called "ownership" which receives the pure profit of that activity, and then there will be constant returns to scale when all factors (including the artificial one) are considered. This is a standard trick dating back to McKenzie (1955). The only demand it imposes on the normative theory being considered here is that of the range of tax instruments. The full set of commodity taxes will involve separate taxes on each commodity including the artificial factors. This requires the ability to tax each firm's pure profit at a different rate; a single profits tax will not suffice. However, constant returns to scale are commonly assumed in trade theory, and no special apology is necessary here.

More serious limitations arise from the competitive equilibrium setting. Trade policy in relation to involuntary unemployment or inflation cannot be considered.

That is the province of quite a different branch of public economics, in conjunction with monetary economics. For surveys, see Mundell (1968, ch. 14–18) and Dornbusch (1980, ch. 4, 10, 11). Secondly, trade in imperfectly competitive markets is not considered. Governments may recognize national monopoly power in trade and levy optimum tariffs, but all individual consumers and producers are assumed to be price-takers. Research in recent years has belatedly recognized the practical importance of trade under scale economies and monopolistic competition, and Helpman (1983) has surveyed this work. But the public finance aspects are yet to be developed systematically. Trade policy under monopolistic competition is examined by Venables (1982). Some recent work on oligopoly is reviewed in Dixit (1984). Several contributions in Kierzkowski (1984) consider issues arising from trade with imperfect competition.

Non-linear tariff schedules, sometimes called tariff-quotas, are beginning to receive proper attention; see Saidi and Srinagesh (1981) and Anderson and Young (1982). But a more thorough public finance treatment and survey must wait.

Finally, I should mention a minor omission in the literature, which my survey will share. The government's expenditure on goods and services is taken to be constant and exogenous. However, it is not clear whether any interesting additions to the theory on the expenditure side arise from the openness of an economy per se.

1.3. Model structure and notation

The underlying model is the standard Walrasian or competitive, flex-price equilibrium involving consumption, production and international trade in commodities. These have the usual wide interpretation; in particular, factors supplied by consumers appear as components of the general commodity vector which happen to be consumed in amounts less than the endowments. Distinction by the location and date of availability, and states of the world, can also be made as appropriate.

For our purpose, it is useful to highlight another distinction, namely tradeable and non-tradeable commodities. In principle, one should specify a technology of trade, e.g., transport costs, and determine endogenously which goods will be traded in equilibrium. However, such a model quickly becomes too complex to yield useful results, and it is customary to suppose as an extreme case that transport costs are zero for one set of commodities and infinite for another.

I shall now set out the notation that will be employed throughout this survey. The vector of aggregate home-country consumption quantities will be denoted by c. Its component corresponding to commodity k will be the subscripted scalar c_k. When commodities need to be classified into tradeables and non-tradeables, the vector will be partitioned, with the superscript t for tradeables and n for non-tradeables, i.e., $c = (c^{\mathrm{t}}, c^{\mathrm{n}})$. When different consumers are distinguished, they will be denoted by the superscript i; thus c^i is the consumption vector for consumer i. The vector of consumer prices will be p, and the vector of commodity endowments held by consumers will be e, with the superscripts, partitions, subscripts, etc. as above and when necessary.

If commodity k is labor, e_k is the total time available, c_k is the consumption of leisure, and $(e_k - c_k)$ the labor supply. Some, even most, components of e will be zero in practice. Some components of c may also be zero, e.g., for pure intermediate goods, and for resources that do not affect consumer utility directly, but only through the income generated when they are inelastically supplied to the limit of the endowment. Consumer prices of produced pure intermediate goods are of course irrelevant, and may be set at any arbitrary level, e.g., zero, without harm.

The budget constraint of consumer i can be written as $p \cdot (c^i - e^i) \leq b_i$, where b_i is transfer income, if any. Consumption taxes can only be levied on net trades $(c^i - e^i)$ with the rest of the economy.

Production quantities in the home country will be denoted by x (inputs appearing as components with negative signs) and the prices facing home producers by q. The set of technologically feasible production vectors can be described in various ways. It can be written as X, a closed convex cone with vertex at the origin, or by means of an inequality $F(x) \leq 0$, where the function F is convex and homogeneous of degree 1. The technical assumptions reflect the properties of constant returns to scale and diminishing marginal rates of transformation. Where different firms or production activities are distinguished, the superscript j will be employed; thus x^j is in the set X^j, or $F^j(x^j) \leq 0$. Other labels or partitions will be as for consumption.

The vector of net imports from the rest of the world will be m. Of course its partitioning gives $(m^{\mathrm{t}}, 0)$. Commodities that are exported appear as components with negative signs. The vector r will denote trading prices just outside the home country's borders, namely c.i.f. (inclusive of cost, insurance and freight) before tariffs or subsidies for imports, and f.o.b. (free on board) after any taxes or subsidies for exports are applied. The sub-vector r^{n} is irrelevant. When forming the value $r \cdot m$, the only contribution comes from tradeables since $m^{\mathrm{n}} \equiv 0$. Therefore r^{n} can be set at any arbitrary level, e.g., zero, without harm.

The set of feasible net trades is governed by behavior in the rest of the world. For our purpose, this can be summarized in a set M. With just two tradeable goods, its typical appearance is as shown in Figure 1.1. The origin lies on its boundary to the north-east, reflecting the absence of unrequited transfers. Over the range that will concern us most, the boundary is negatively sloped and convex, reflecting a diminishing marginal rate of transformation through trade. In the usual language of trade theory, the boundary is the rest of the world's *offer surface*. At extreme relative prices, income effects in the rest of world may cause the offer surface to bend backwards. Further exports of one good from the home country will then yield negative marginal returns in terms of imports of the other good. Of course a country pursuing an optimal trade policy will not choose such a point, and for simplicity of exposition I shall ignore the problem. But for an arbitrary trade policy, and even in free trade, such an outcome cannot be ruled out, and is the source of many fond paradoxes in the "positive" theory of international trade.

An alternative description of the set M is by means of an inequality $G(m^t) \leq 0$, for a function G satisfying $G(0) = 0$. We can also describe the offer surface by a supply function $m^t = S(r^t)$, which is homogeneous of degree zero. Or, after choosing some normalization for prices in the rest of the world, we can use an inverse supply function $r^t = R(m^t)$, and then let $G(m^t) = R(m^t) \cdot m^t$. If the country is small in world markets, it will face a constant trade price vector r^t (within normalization), and then the offer surface will be a hyperplane $r^t \cdot m^t = 0$.

The home-country government will be assumed to consume a vector g of commodities, and levy a variety of taxes or subsidies. These could be lump sum transfers to consumers, denoted by b, or commodity taxes expressed in specific rates.

Begin with the vector of trade taxes, τ^t. Since r^t is the vector of prices of tradeables just outside our borders, $\pi^t \equiv r^t + \tau^t$ is that just inside, and will be

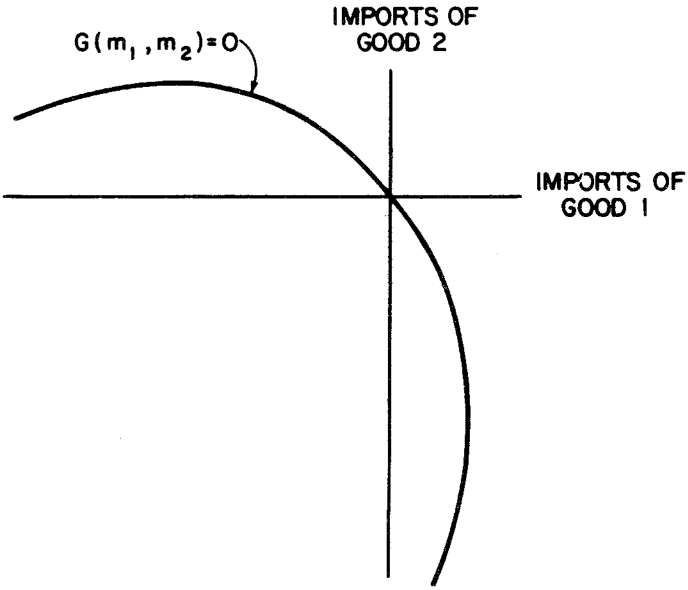


Figure 1.1

called the vector of domestic prices of tradeables. Note that whether a particular commodity k is taxed or subsidized depends on whether it is imported or exported, i.e., $\tau_k > 0$ corresponds to a tax if $m_k > 0$ and a subsidy if $m_k < 0$, and the other way around for $\tau_k < 0$. Thus the sign of the product $\tau_k m_k$ tells us whether we have a tax or a subsidy.

The vector π^{t} will be supplemented by π^{n} for non-tradeables to form the complete domestic price vector $\pi \equiv (\pi^{\mathrm{t}}, \pi^{\mathrm{n}})$. Then there may be taxes or subsidies on domestic consumption and production activities. Writing α for the vector of consumption taxes, $p \equiv \pi + \alpha$ will be the vector of home consumer prices, applicable to their net trades. Writing β for the vector of production subsidies, $q \equiv \pi + \beta$ will be the vector of home producer prices. These are sign conventions similar to those for tariffs, e.g., $\alpha_k > 0$ corresponds to a tax if commodity k is bought by consumers, but a subsidy if it is sold by them as is the case with labor.

The prices facing various agents can differ on account of market distortions as well as taxes. Where there is no risk of confusion, I shall use the same symbols, τ, α, and β, to indicate such price wedges no matter how they arise.

It will be noted that, for the present, the domestic price vector π is something of a fiction. No trader actually pays or receives π. Correspondingly, there is a degree of arbitrariness in defining the various taxes. If k is a non-tradeable good, only the overall tax $(\alpha_k - \beta_k)$ matters. If k is tradeable, only $(\tau_k + \alpha_k)$ and $(\tau_k + \beta_k)$ matter; thus a tariff can be thought of as a combination of a consumption tax and a production subsidy at equal rates.

However, it turns out to be very useful to introduce a separate domestic price vector. When the optimum tax policy is considered, we obtain Lagrange multipliers that are shadow prices of commodities, and it is economically most transparent to express the optimum tax formulae as the differences between various other prices and these shadow prices. Then π can play the part of the shadow prices.

There is further indeterminacy arising from normalization. With constant returns in private production, the consumers have lump sum incomes of zero, or else optimally controlled by a government that can choose lump-sum transfers. In either case, p and q can be normalized independently (see Auerbach's chapter in this volume, Section 5.1). Next, with no cross-country transfers, r can be normalized independently of either. As an example, consider the special case where there is no taxation of domestic activities, and write $p = q = \pi$. Suppose there are just two traded commodities, 1 and 2, the former being imported and the latter exported. We can set $r_2 = \pi_2$ and $r_1 < \pi_1$ (an import tax), or $r_1 = \pi_1$ and $r_2 > \pi_2$ (an export tax). So long as r_1/r_2 and π_1/π_2 are unchanged, the two policies are fully equivalent. This is the famous symmetry theorem of Lerner (1936).

To conclude the construction of the model, let us check the government's budget balance. We know $q \cdot x = 0$ because of constant returns to scale in production, and $r \cdot m = 0$ in absence of international transfers. Next, $p \cdot (c - e) = b$, the net lump sum transfer, if any, from the government. Finally, $c + g = x + m + e$ for equilibrium. Then the government's revenue T is given by

$$\begin{aligned} T &= \alpha \cdot (c - e) - \beta \cdot x + \tau \cdot m - b \\ &= (p - \pi) \cdot (c - e) - (q - \pi) \cdot x + (\pi - r) \cdot m - b \\ &= p \cdot (c - e) - b - q \cdot x - r \cdot m + \pi \cdot (x + m + e - c) \\ &= \pi \cdot g. \end{aligned}$$

This is the usual result: so long as the government's tax and expenditure policies are compatible with general equilibrium, its budget must be balanced. This calculation was done at shadow prices. Any other tax treatment of g, e.g., transaction at consumer prices, with the purchase branch paying the consumption tax to the treasury, will yield balance at the appropriate prices.

2. Discrete comparisons of alternative equilibria

The earliest discussions of normative aspects of international trade, such as Samuelson (1939, 1962) and Kemp (1962), focussed on two questions: is trade better than autarky? and is free trade better than restricted trade? Each was answered by comparing two equilibria under the alternative policies, and finding conditions under which one was revealed preferred. Subsequently, the method was used for comparisons of equilibria involving distortions with the attendant problems of the second best; Bhagwati (1971) and Ohyama (1972) are the most notable syntheses. Comparisons involving the distribution of gains to all consumers were made by Dixit and Norman (1980a). The treatment of this section will broadly follow the development of the subject.

2.1. Potential gains from trade

The basic reason for gains from trade is very simple: trade enlarges the set of consumption possibilities. For a country in autarky, its aggregate consumption vector net of the endowments ($c + g - e$ in our context) must lie in its own aggregate production possibility set (X). When the rest of the world offers net trades from a set M, this set of aggregate net consumption possibilities is the sum of X and M, i.e., the set of vectors $x + m$ as x ranges over X and m over M. The efficient frontier of consumption possibilities can be traced by taking an x on the production possibility frontier, adding on the rest of world's offer surface with the origin at x, and taking the outer envelope as x varies. For a small economy, this is simply the tangent to the production possibility curve corresponding to the world prices. For an economy with monopoly power in trade, this is the Baldwin Envelope. Figure 2.1 shows these cases schematically in two dimensions.

Therefore the consumption possibility frontier (CPF) lies wholly outside the production possibility frontier (PPF), touching the latter where the marginal rates

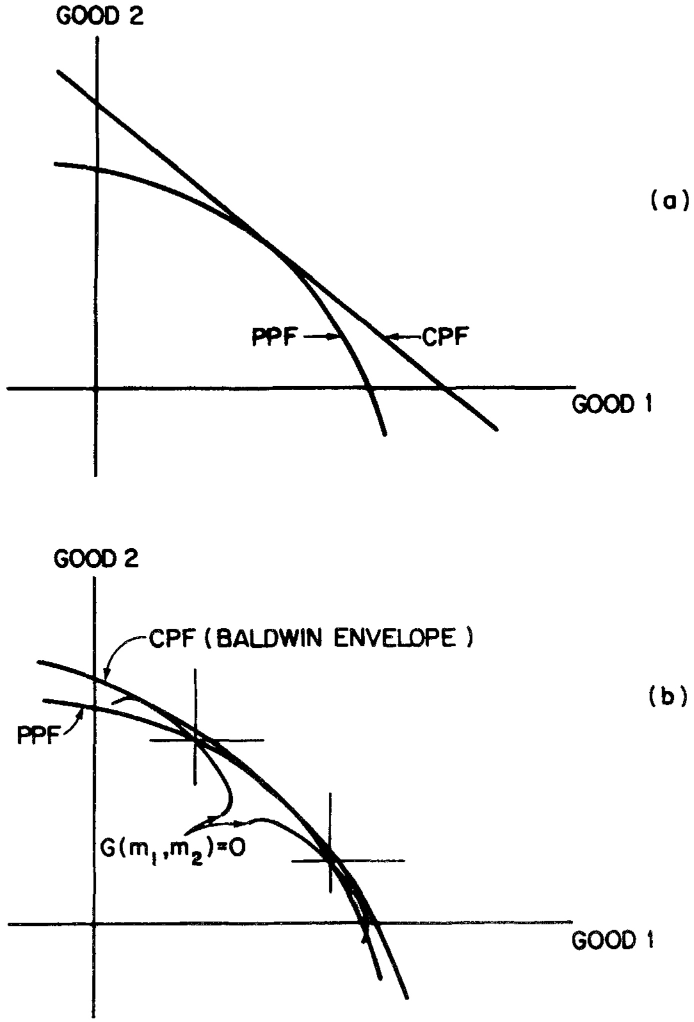


Figure 2.1

of transformation in domestic production happen to equal those attainable by means of a small amount of trade. Thus any feasible autarkic consumption vector can be dominated by a suitable combination of domestic production and foreign trade. Moreover, the sense of domination is strong, i.e., with strictly greater consumption of every good, except where the CPF touches the PPF. On the other hand, no efficient trading outcome can be dominated, even the weak sense of having more consumption of at least one good and no less of any, by an autarkic one.

These gains are still only potential ones, since it does not automatically follow that they can always be realized in equilibria of decentralized markets. The obstacles are familiar ones. First, consider distortions. These can be market failures (externalities, monopolies, etc.) or policy failures (regulation or taxes other than ones that are optimum responses to market failures), and they may affect domestic activities or international trade. If these are present, a laissez-faire equilibrium with trade may be Pareto-inefficient. The general problem of the second-best suggests that adding another distortion or restriction, such as prohibition or taxation of trade, may be beneficial in some such cases. Secondly, the existence of aggregate gains does not guarantee that all consumers will share them. In fact, in the well known two-good two-factor Heckscher–Ohlin model that served as the paradigm of trade theory for many years, it is necessarily the case that any change in the relative product price is unambiguously beneficial to owners of one factor and harmful to those owning the other; see Jones (1965).

For the rest of this section and the next two, we will examine these problems in detail. The findings generally dissipate any pessimism concerning realization of gains from trade. The optimum policies to tackle most of these problems are taxes or subsidies on domestic transactions; no interference with international trade is required except when the distortions arise in trade itself.

2.2. *Aggregate gains and revealed preference*

To begin in a relatively simple way, I shall set aside issues that require explicit recognition of consumer heterogeneity, namely consumption externalities and income distribution, and examine how aggregate gains can be achieved. Inter-consumer externalities are simply assumed to be absent. Neglect of distributional considerations is allowed in any one of the following circumstances. (1) There is only one aggregate consumer. (2) Lump sum transfers are employed to maximize a Bergson–Samuelson social welfare function, as in Samuelson (1956). This is formally just like a one-consumer case, with the social indifference map representing his preferences. (3) All individuals have identical homothetic preferences, and fixed shares in total income, as in Chipman and Moore (1980). Again we can formally regard the economy as having one consumer with the same homothetic preferences and all the income.

In all of these cases, we have a utility function defined over aggregate consumption, and it serves both to generate demands and to measure welfare. Therefore we can use revealed preference tests to compare two equilibria. If these are labelled A and B, we can say that B is revealed preferred if the actual budget in B would suffice to purchase the A quantities at B prices. Using the notation developed in Section 1.3, the criterion is

$$p^{\mathrm{B}} \cdot c^{\mathrm{B}} \geq p^{\mathrm{B}} \cdot c^{\mathrm{A}}. \tag{2.1a}$$

This is sufficient, but not necessary, for B to be at least as good as A. Likewise, a strict inequality is sufficient for B to be strictly better so long as there is no satiation. The rest consists of applying this criterion in specific contexts.

Let us begin with the classical comparisons of alternative trade regimes. Here we fix the endowments and production possibilities. We also assume that domestic distortions (market failures or tax wedges) are absent. The fixed vector of government purchases (if any) is financed by lump sum taxes.

With $c = e + x + m - g$ in each of A, B, and $e^{\mathrm{A}} = e^{\mathrm{B}}$, $g^{\mathrm{A}} = g^{\mathrm{B}}$, (2.1a) becomes

$$p^{\mathrm{B}} \cdot (x^{\mathrm{B}} - x^{\mathrm{A}}) + p^{\mathrm{B}} \cdot (m^{\mathrm{B}} - m^{\mathrm{A}}) \geq 0. \tag{2.1b}$$

Next note that, with no domestic distortions, $p^{\mathrm{B}} = q^{\mathrm{B}}$. The set X of production possibilities is unchanged, so x^{A} remains feasible when x^{B} is chosen. Therefore $(0 =) q^{\mathrm{B}} \cdot x^{\mathrm{B}} \geq q^{\mathrm{B}} \cdot x^{\mathrm{A}}$. This is the familiar production effect of better adaption to the B prices. We cannot assert a strict inequality in general, since there may be no possibility of substitution among outputs in the relevant range along the transformation surface. However, there is gain in a weak sense, and it works towards (2.1b) being satisfied.

Thus a sufficient condition for (2.1b), and hence in turn for the B equilibrium being at least as good as A, is

$$p^{\mathrm{B}} \cdot (m^{\mathrm{B}} - m^{\mathrm{A}}) \geq 0. \tag{2.2}$$

This can formally be thought of as revealed preference between the two import vectors.

When B is identified with the free-trade regime and A with autarky, we have $p^{\mathrm{B}} = r^{\mathrm{B}}$ and $r^{\mathrm{B}} \cdot m^{\mathrm{B}} = 0$, while $m^{\mathrm{A}} = 0$. Thus (2.2) is satisfied, and free trade is revealed superior to autarky for this economy. This result was long in the folklore of the subject, but was rigorously established by Samuelson (1962) and Kemp (1962).

A simple generalization is due to Ohyama (1972). Let A be autarky, and B a regime with trade taxes or subsidies. Then $p^{\mathrm{B}} = r^{\mathrm{B}} + \tau^{\mathrm{B}}$, with $r^{\mathrm{B}} \cdot m^{\mathrm{B}} = 0$, so (2.2) becomes

$$\tau^{\mathrm{B}} \cdot m^{\mathrm{B}} \geq 0.$$

Provided the trade taxes or subsidies are net self-financing, such trade is not worse than autarky. If the trade taxes make a loss (met by lump sum taxation), this is a kind of subsidy to the rest of the world that could leave the home country worse off.

Next consider the other classical question of whether free trade is the best policy. Here is helps to interpret (2.2) in a different way. If B is free trade, and A is any other feasible regime, $p^{\mathrm{B}} = r^{\mathrm{B}}$ and $r^{\mathrm{B}} \cdot m^{\mathrm{B}} = 0$, so (2.2) becomes $0 \geq r^{\mathrm{B}} \cdot m^{\mathrm{A}}$. Using $r^{\mathrm{A}} \cdot m^{\mathrm{A}} = 0$, this can be written

$$(r^{\mathrm{B}} - r^{\mathrm{A}}) \cdot m^{\mathrm{A}} \leq 0. \tag{2.3}$$

This says that the move to free trade will be beneficial if "on the average" the prices of imported commodities ($m_k^{\mathrm{A}} > 0$) fall ($r_k^{\mathrm{B}} < r_k^{\mathrm{A}}$). More precisely, the A-quantity weighted index of world prices should fall. This is an improvement in the home country's terms of trade.

Conversely, a move to free trade can fail to be beneficial only if the terms of trade worsen. This is the monopoly argument for interfering with trade. Like any monopolist who can affect his terms of trade, a country can benefit by doing so to some extent. Beyond a point, the contraction of volume of trade becomes too serious, and a marginal condition defines the optimum restriction, or the Mill–Bickerdike optimum tariff. Like any monopoly pricing, this is desirable only from the home country's selfish point of view, and not for Pareto efficiency in the world as a whole.

This discussion has two immediate corollaries. For a country too small to affect its terms of trade, $r^{\mathrm{A}} = r^{\mathrm{B}}$, to within an arbitrary normalization, and (2.3) holds. So free trade is optimum for a small country. Next we consider the optimum regime in general. If B is such that

$$m^{\mathrm{B}} \text{ maximizes } p^{\mathrm{B}} \cdot m \text{ over } M, \tag{2.4}$$

then (2.2) holds for any comparison A. This property implicitly defines the optimum tariffs. A simpler interpretation comes from the first-order condition for the maximization: $p^{\mathrm{B}} \cdot \mathrm{d}m = 0$ for any feasible deviation $\mathrm{d}m$ along the rest of the world's offer surface. Thus the domestic price vector is normal to this surface, and the marginal rates of transformation in domestic production and international trade are equalized. With two goods this is just the familiar tangency between the home country's trade indifference curve and the rest of the world's offer curve. In Sections 3 and 4 we shall consider the optimum tariff problem in more general settings where domestic distortions and distributional considerations are present, and obtain generalizations of this rule.

We can use the same method to pose questions of gain from a general increase in trade possibilities. Let A and B be free-trade equilibria, differing only in that more commodities become tradeable in B. The revealed preference sufficient condition for B to be superior to A is formally identical to (2.3). Of course m^A has fewer non-zero components, corresponding to the smaller set of tradeables in A, and only these contribute to the inner product.

Thus an enlargement of the set of tradeables can be welfare-worsening only if it leads to a worsening of the terms of trade of the previously tradeable commodities. Even then, some worsening may be tolerable since (2.3) is only sufficient for B to be better.

For a small country, this is not an issue, and any relaxation of trade is beneficial. A large country that is imposing optimum tariffs in the B regime is also assured of gain. It does not matter whether there are any tariffs in A, optimum or otherwise.

As an example, consider Grossman's (1984) model of gains from factor trade. Starting from complete autarky, the opening of free trade (or even suitably restricted trade) in goods yields gains in the usual way. Does the introduction of factor trade yield further gain? Our sufficient conditions for free trade in goods and factors to be superior to free trade in goods alone apply in either of the following cases: (1) The economy is small. (2) The opening of factor trade does not worsen the terms of trade for goods. A special case is where free trade in goods equalizes factor prices, when the introduction of free trade in factors makes no difference; see Dixit and Norman (1980, pp. 106–125) for a recent statement.

The issue of gains from trade under uncertainty is examined by Helpman and Razin (1978). They find that trade in goods in each state of the world is better than total autarky, and a small country is assured of further gain through the opening up of trade "across states of the world", i.e., trade in securities. Similarly, Smith (1979) considers intertemporal trade, and shows that trade in goods with balance at each date is superior to complete autarky; a small country gains further when international borrowing and lending is introduced so that trade need only be balanced over time in discounted present values.

2.3. *Distortions and growth*

The next step is to extend comparisons based on (2.1a) to a wider class of equilibria, in the manner of Ohyama (1972) and Smith (1982). Here we allow distortions, whether from market failure or taxes, which drive wedges between prices faced by different categories of agents: consumers, producers and foreigners. For expositional simplicity, distortions within each such sector are not recognized, but their introduction is only a matter of algebra. The wedges are most conveniently expressed as departures from the domestic shadow price vector π. The appropriate interpretation of this shadow price vector depends on the specific context, in particular the range of policy instruments available. Some cases will be considered in detail in Section 3 and 4, but the discussion here will be couched in general terms.

Using the notation introduced in Section 1.3, we write

$$\begin{aligned} p^{\mathrm{B}}\cdot(c^{\mathrm{B}}-c^{\mathrm{A}}) &= (\pi^{\mathrm{B}}+\alpha^{\mathrm{B}})\cdot(c^{\mathrm{B}}-c^{\mathrm{A}}) \\ &= \alpha^{\mathrm{B}}\cdot(c^{\mathrm{B}}-c^{\mathrm{A}})+\pi^{\mathrm{B}}\cdot(e^{\mathrm{B}}-e^{\mathrm{A}})-\pi^{\mathrm{B}}\cdot(g^{\mathrm{B}}-g^{\mathrm{A}}) \\ &\quad +(q^{\mathrm{B}}-\beta^{\mathrm{B}})\cdot(x^{\mathrm{B}}-x^{\mathrm{A}})+(r^{\mathrm{B}}+\tau^{\mathrm{B}})\cdot(m^{\mathrm{B}}-m^{\mathrm{A}}). \end{aligned}$$

Hence condition (2.1a) becomes

$$\begin{aligned} &\pi^{\mathrm{B}}\cdot(e^{\mathrm{B}}-e^{\mathrm{A}})-\pi^{\mathrm{B}}\cdot(g^{\mathrm{B}}-g^{\mathrm{A}}) \\ &+q^{\mathrm{B}}\cdot(x^{\mathrm{B}}-x^{\mathrm{A}})+r^{\mathrm{B}}\cdot(m^{\mathrm{B}}-m^{\mathrm{A}}) \\ &+\alpha^{\mathrm{B}}\cdot(c^{\mathrm{B}}-c^{\mathrm{A}})-\beta^{\mathrm{B}}\cdot(x^{\mathrm{B}}-x^{\mathrm{A}})+\tau^{\mathrm{B}}\cdot(m^{\mathrm{B}}-m^{\mathrm{A}})\geq 0. \end{aligned} \tag{2.5}$$

Using the fact that $r^{\mathrm{B}}\cdot m^{\mathrm{B}}=0=r^{\mathrm{A}}\cdot m^{\mathrm{A}}$, we could also write the term $r^{\mathrm{B}}\cdot(m^{\mathrm{B}}-m^{\mathrm{A}})$ as $-(r^{\mathrm{B}}-r^{\mathrm{A}})\cdot m^{\mathrm{A}}$.

As the first application, let us consider the effect of a change in the trade policy pursued by a given distorted small economy. Now $e^{\mathrm{B}}=e^{\mathrm{A}}$, $g^{\mathrm{B}}=g^{\mathrm{A}}$, $r^{\mathrm{B}}=r^{\mathrm{A}}$, and producer behavior ensures $q^{\mathrm{B}}\cdot(x^{\mathrm{B}}-x^{\mathrm{A}})\geq 0$. Therefore our sufficient condition for the B equilibrium to be better is

$$\alpha^{\mathrm{B}}\cdot(c^{\mathrm{B}}-c^{\mathrm{A}})-\beta^{\mathrm{B}}\cdot(x^{\mathrm{B}}-x^{\mathrm{A}})+\tau^{\mathrm{B}}\cdot(m^{\mathrm{B}}-m^{\mathrm{A}})\geq 0. \tag{2.6}$$

This can be interpreted as follows. Suppose for commodity k the distortion α_k^{B} is positive. Then the consumer price, reflecting its marginal value in consumption, is above the shadow price, and there is some net benefit to increasing its consumption. If $(c_k^{\mathrm{B}}-c_k^{\mathrm{A}})$ is positive, this is what happens in B relative to A. The overall benefit criterion is simply the sum of such components over all commodities and distortions. Thus $\beta_k^{\mathrm{B}}>0$ indicates the producer price, i.e., marginal cost, above the shadow price, and therefore the desirability of reducing production, while $\tau_k^{\mathrm{B}}>0$ indicates a domestic shadow price in excess of the world price, and therefore the desirability of expanding imports or reducing exports.

How the various quantities change in the course of the move from A to B depends on the full general equilibrium comparative statics of the system. This is much better done using calculus methods, and Section 4 will examine some cases of this kind. However, no restrictions can be placed on the changes without making specific assumptions about the functional forms of the preferences and technologies. Therefore it is always possible to find cases where the criterion fails to hold. The condition is only sufficient for B to be superior, but it is equally easy to construct examples where B is worse than A. In particular, it is possible to find models of distorted small economies for which free trade is not optimum, and even autarky may be preferable to free trade. This is just an instance of the general problem of the second best.

This discussion assumes that the distortions are unavoidable. If they can be eliminated, it is always better to do so. For example, a consumption externality distortion α_k should be offset by a Pigovian tax of $-\alpha_k$. Where the distortion results from a policy itself, it should be reversed. Call the resulting equilibrium B, with $\alpha^B = \beta^B = \tau^B = 0$. Let A be the equilibrium which accepts the distortions and arranges other policies optimally around them. The comparison of equation (2.6) immediately shows B to be superior. In other words, interference with trade may be a desirable second-best policy for a distorted small economy, but the first-best is to get rid of the distortion and keep trade free. This will be elaborated upon in Sections 3 and 4; see Bhagwati (1971) for a survey.

Next consider an undistorted economy that experiences growth, either in the sense of an endowment increase or an enlargement of the production possibility set X. By (2.5), the new equilibrium is better if

$$\pi^B \cdot (e^B - e^A) + q^B \cdot (x^B - x^A) - (r^B - r^A) \cdot m^A \geq 0. \tag{2.7}$$

The first two terms are the direct effects of the change, and are bound to be non-negative. With non-negative shadow prices π^B, and no decrease in any endowment, the first term is non-negative. Even when some endowments increase and others decrease, it is natural to take an increase in the value of the physical change as our definition of a net increase. As for the second term, the enlargement of X leaves x^A feasible, while x^B maximizes profit at the B producer prices, so $q^B \cdot x^B \geq q^B \cdot x^A$.

The third term is the induced change in the terms of trade, and can be of either sign. In particular, the terms of trade can worsen sufficiently to violate (2.7), and then growth may be welfare-worsening. This possibility was called "economic damnification" by Edgeworth (1894) and "immiserizing growth" by Bhagwati (1958). This is once again a second-best possibility. A country that can affect its terms of trade can levy an optimum tariff τ^B. With $p^B = r^B + \tau^B$, and $p^B \cdot (m^B - m^A) \geq 0$ from (2.4), condition (2.5) is satisfied, and immiserizing growth cannot occur.

Recall that our concept of a commodity encompasses factors as well as goods. Therefore the result can be applied to trade in factors. For example, consider the model of Brecher and Bhagwati (1981), where foreigners own some of the factors of production in the home country. Here the optimum tariff vector must be computed simultaneously for goods trade and foreign factor income. Otherwise immiserizing growth and similar paradoxes can arise.

Finally, similar analysis applies to a small economy with distortions. Growth can be immiserizing if in the new equilibrium the distortions are worse in the sense that the last three terms in (2.5) are affected adversely; see Johnson (1967). Again, the first-best remedy is to act directly on the distortions.

The general conceptual framework has been applied to many kinds of distortions, growth and other comparative static changes. These are too numerous to list here; see Bhagwati and Srinivasan (1983, ch. 16–25) for an exhaustive account. Their formal methods are somewhat different (revealed preference is studied in two-dimensional diagrams, and comparative statics is carried out using production functions), but readers can easily relate them to the approach used here.

2.4. Distributions for Pareto superiority

Finally, I shall consider binary comparisons of equilibria when there are several consumers. It was emphasized earlier that any change in relative prices of traded goods typically favors some factors and harms others. The question is whether tax or subsidy policies can be used to achieve a desirable distribution of aggregate gains. Thus we start with an equilibrium A, and attempt, by a simultaneous change of the trade regime and distributive policies, to produce a superior equilibrium B.

The test of superiority will be relatively stringent, namely a Pareto improvement. Note that we require an actually superior outcome B, not a mere potential improvement through hypothetical compensations. Note also that Pareto superiority is sufficient, but not necessary, for an increase in the value of any Bergson–Samuelson welfare function.

The achievable outcomes depend, of course, on the policy instruments that are available. Lump-sum transfers are the most powerful redistributive tools; in effect they reduce the problem to the one-consumer case already analysed. But such transfers are thought to be impractical for several reasons. Perhaps the most important is the problem of incentive compatibility, discussed by Hammond (1979). To calculate the optimal lump sum transfers, the policy-maker needs information about the characteristics (endowments and preferences) of individuals. When such information must be inferred from observed behavior, each individual has the incentive to alter the behavior so as to secure a larger net transfer receipt. Hammond's conclusion is that incentive compatibility requires that the same set of net trades be available to each individual. The calculation of the optimal set requires information only about the distribution of individuals' characteristics in the population, which is not susceptible to manipulation by any one of them. In our context, commodity taxes or subsidies, and a uniform poll tax or subsidy, satisfy this requirement. These tools, especially the former, are the ones considered below.

The method of analysis comes from Dixit and Norman (1980a, 1980b). The idea is as follows. Let the initial equilibrium A, with its trade regime and any other taxes or subsidies, be specified. Suppose that some move away from it yields aggregate production or terms-of-trade gains. Construct an intermediate equilibrium B where such gains are realised, but all consumers are kept at their A utility levels. This equilibrium involves some slack or waste. We then move to the final position C by disposing of the slack in such a way as to raise some consumers' utilities without lowering any.

Let us examine the process in more detail. Commodity taxation allows us to de-link the prices consumers face, both for commodities they buy (typically goods) and those they sell (typically factors), from the corresponding prices for producers. Thus we can ensure that consumers face the same prices in B as in A; $p^{\mathrm{B}} = p^{\mathrm{A}}$. Uniform poll subsidies (if any) are also unchanged; $b^{\mathrm{B}} = b^{\mathrm{A}}$. Thus each consumer i faces an unchanged budget set $p^{\mathrm{A}} \cdot (c - e^i) \leq b^{\mathrm{A}}$. Therefore his choice is unchanged, i.e., $c^{\mathrm{B}i} = c^{\mathrm{A}i}$, and so is his utility.

The producer prices change to q^{B}, and the trade prices to r^{B}, to achieve equilibrium. This implicitly defines the tariff rates $(q^{\mathrm{B}} - r^{\mathrm{B}})$, and domestic commodity tax rates $(p^{\mathrm{B}} - q^{\mathrm{B}})$, with producer prices q^{B} playing the role of shadow prices π^{B}.

In this process the government's tax revenue T will change, and so must its purchases. For expository simplicity, suppose they change according to the rule $g^{\mathrm{B}} = g^{\mathrm{A}} + \lambda g^0$, where g^0 is a strictly positive vector, and the scalar λ accomodates to achieve equilibrium. For budget balance, we need

$$T^{\mathrm{B}} = q^{\mathrm{B}} \cdot g^{\mathrm{B}} = q^{\mathrm{B}} \cdot g^{\mathrm{A}} + \lambda q^{\mathrm{B}} \cdot g^0.$$

On the revenue side, writing n for the number of consumers, we have

$$T^{\mathrm{B}} = \left(p^{\mathrm{B}} - q^{\mathrm{B}}\right) \cdot \left(c^{\mathrm{B}} - e\right) + \left(q^{\mathrm{B}} - r^{\mathrm{B}}\right) \cdot m^{\mathrm{B}} - nb^{\mathrm{B}}.$$

But $p^{\mathrm{B}} \cdot (c^{\mathrm{B}} - e) = nb^{\mathrm{B}}$ on adding the consumers budgets, and $r^{\mathrm{B}} \cdot m^{\mathrm{B}} = 0$ for trade balance. Finally, substituting for $c^{\mathrm{B}} = c^{\mathrm{A}}$, we have

$$\begin{aligned} T^{\mathrm{B}} &= -q^{\mathrm{B}} \cdot \left(x^{\mathrm{A}} + m^{\mathrm{A}} - g^{\mathrm{A}}\right) + q^{\mathrm{B}} \cdot m^{\mathrm{B}} \\ &= q^{\mathrm{B}} \cdot g^{\mathrm{A}} + q^{\mathrm{B}} \cdot \left(x^{\mathrm{B}} - x^{\mathrm{A}}\right) + q^{\mathrm{B}} \cdot \left(m^{\mathrm{B}} - m^{\mathrm{A}}\right), \end{aligned}$$

where we have used $q^{\mathrm{B}} \cdot x^{\mathrm{B}} = 0$. Comparing the two expressions for T^{B}, we have

$$q^{\mathrm{B}} \cdot \left(x^{\mathrm{B}} - x^{\mathrm{A}}\right) + q^{\mathrm{B}} \cdot \left(m^{\mathrm{B}} - m^{\mathrm{A}}\right) = \lambda q^{\mathrm{B}} \cdot g^0. \tag{2.8}$$

The left-hand side of (2.8) is the same as that of (2.1b). In the one-consumer case, we had no commodity taxes, i.e., $p^{\mathrm{B}} = q^{\mathrm{B}}$. Here we see that it is the producer price vector which is relevant with such taxation. But the sources of aggregate gains are the same in the two cases, and are captured in the values of the physical changes in production and imports.

As before, profit-maximization ensures that the production effect is non-negative. The trade effect can be verified to be non-negative for the same comparisons and in the same way as in the one-consumer case: (i) where A is autarky and B is either free trade or self-financing restricted trade, (ii) where B is optimally restricted trade, defined as maximizing the value of net imports at domestic producer prices, and (iii) where B is free trade for a small economy.

If the left-hand side of (2.8) is strictly positive, we have $\lambda > 0$. Since the government's use of goods is not explicitly valued, the excess λg^0 over the requirement g^{A} is a slack that occurs solely to dispose of the revenue. It would be better to change the policies and use this slack in a way that benefits the consumers. Let us see when and how this can be done. If consumers' demands are continuous functions of the policy instruments, then a sufficiently small change will not increase the total demand by more than λg^0 in any component, and can be absorbed by a reduction in the waste. So the change will be feasible. If the instruments can be adjusted in a direction that benefits some consumers without harming any, the change will be a Pareto improvement. This will be the final position C that we adopt in preference to A.

A uniform poll subsidy clearly does the job. More interestingly, so can commodity taxation on its own, provided there is a commodity, single as in Diamond and Mirrlees (1971) or composite as in Weymark (1979), in the market for which no two consumers are on opposite sides. Thus if some consumers are net buyers and none are net sellers of this commodity, we lower its consumer price; in the opposite case we raise it. The condition invoked is a familiar and basic one in much of public finance; for example, it lies behind the production efficiency property of a commodity tax optimum. Therefore the result seems a robust one: aggregate gains in production or trade can be distributed so as to achieve a Pareto improvement using commodity taxation, and arguments about the distribution of gains do not provide a case for intervention in trade. This point will receive further support when jointly optimal tax and tariff policies are considered in the next section.

Extension of the results of Section 2.3 to many-consumer contexts can be problematic if we want Pareto improvement using commodity taxation alone. The case of endowment growth is considered by Smith (1982). If some consumers experience an endowment increase and none a decrease, the above method applies. But an aggregate increase can occur while some suffer a decrease; in such a case transfers are typically required if a Pareto improvement is to result.

Other problems can arise if gains from the removal of distortions are to be distributed. For example, if there are consumption externalities, the appropriate policy response is an adjustment of consumer prices. This may be incompatible with the approach used above, where all consumers were given unchanged prices at the intermediate step, and more favorable ones at the final equilibrium. However, we shall soon see that if Pareto superiority is not required and interpersonal comparisons are made using a welfare function, commodity taxation has a useful role for tackling such situations.

3. Optimum taxation and tariffs

Here I shall characterize the optimum mix of tax policies with regard to domestic production and consumption activities and international trade. In contrast to the previous section, the focus is on the best deployment of the available instruments, and not on improvement relative to some status quo. Interpersonal comparisons are made by means of a given Bergson–Samuelson welfare function. Therefore the optimum may not be Pareto-superior to some alternative; there may be uncompensated losers if the value judgements so dictate.

This approach comes closest to the modern theory of public finance. In fact, if we regard international trade as just another transformation activity, the model is a special case of the Ramsey–Diamond–Mirrlees framework, and the resulting tax formulae can be obtained from those in Auerbach's chapter in this volume, Sections 5 and 6. Alternatively, we can regard the rest of the world's net supply as that coming from an uncontrolled firm, and obtain optimum tax and price rules as in Guesnerie (1975).

3.1. The first-best optimum

To set the stage, consider the case of a fully controlled economy, i.e., let the vectors of consumption, production and trade be objects of direct choice, subject only to the constraints of technical feasibility and resource availability. The shadow prices associated with such an optimum tell us how it might be decentralized through tax and price policies, and provide a basis for comparison with later cases where policy instruments are more restricted.

First consider a case without external economies or diseconomies. Let $u_i = U^i(c^i)$ be the utility of consumer i, and $W(u_1, u_2, \dots)$ the social welfare function. Let $F^j(x^j) \leq 0$ be the set of feasible net outputs of production activity j, and $G(m^{\mathrm{t}}) \leq 0$ the set of feasible net imports. Then we are to maximize

$$W(U^1(c^1), U^2(c^2), \dots),$$

subject to

$$\sum_i c^i \leq \sum_i e^i + \sum_j x^j + m - g, \tag{3.1}$$

$$F^j(x^j) \leq 0 \quad \text{for} \quad j = 1,2,\ldots, \tag{3.2}$$

$$G(m^{\mathrm{t}}) \leq 0. \tag{3.3}$$

Let π be the non-negative vector of multipliers for the material balance constraint (3.1), and ϕ_j ($j = 1,2,\ldots$) and γ the non-negative scalar multipliers for (3.2) and (3.3). Formulate the Lagrangean

$$L = W(U^1(c^1), U^2(c^2), \ldots) + \pi \cdot \left(\sum_i e^i + \sum_j x^j + m - g - \sum_i c^i \right)$$
$$- \sum_j \phi_j F^j(x^j) - \gamma G(m^{\mathrm{t}}). \tag{3.4}$$

For expositional simplicity I shall leave out corner solutions; interested readers can easily extend the method to allow them. Then the first-order conditions are

$$(\partial W/\partial u_i)(\partial U^i/\partial c^i_k) - \pi_k = 0, \tag{3.5}$$

$$\pi_k - \phi_j(\partial F^j/\partial x^j_k) = 0, \tag{3.6}$$

$$\pi_k - \gamma(\partial G/\partial m_k) = 0, \tag{3.7}$$

for all consumers i, all firms j, and all commodities k [only tradeables in (3.7)]. In vector notation, these become (with the numbers preserved)

$$W_i U^i_c - \pi = 0, \tag{3.5}$$

$$\pi - \phi_j F^j_x = 0, \tag{3.6}$$

$$\pi^{\mathrm{t}} - \gamma G_m = 0, \tag{3.7}$$

where $W_i \equiv \partial W/\partial u_i$, U^i_c is the vector with components $\partial U^i/\partial c^i_k$ corresponding to all commodities k, etc.

The interpretation is familiar and straightforward. The proportions in U^i_c give the marginal rates of substitution in consumption for consumer i. Similarly, F^j_x yields the marginal rates of transformation in the jth production activity, and G_m

those achieved through trade. The Lagrange multipliers π yield the increments in social welfare that could be achieved if the material balance constraints could be relaxed, i.e., the shadow prices of commodities. If the government acquired a new production technology (project) that had a small net output vector $\mathrm{d}x^0$, this should be implemented if and only if $\pi \cdot \mathrm{d}x^0 > 0$.[1] Now (3.5)–(3.7) say that, within scalar multiples, U_c^i, F_x^j and G_m should all equal π.

The equalities of various marginal rates of substitution are the usual Pareto efficiency conditions. Bhagwati (1971) expresses these as $DRS = DRT = FRT$, where DRS is the marginal rate of substitution in consumption in the home (domestic) economy, DRT is the domestic marginal rate of transformation in production, and FRT is the marginal rate of transformation achievable through foreign trade. This full Pareto efficiency subsumes production efficiency, i.e., the equality of marginal rates of transformation in all production activities and trade.

Further, (3.5) embodies the considerations of interpersonal distribution. For each commodity k, the marginal welfare effect $(\partial W/\partial u_i)\cdot(\partial U^i/\partial c_k^i)$ is equalized across all consumers i.

Decentralized implementation of such an optimum is equally familiar. We set $p = q = \pi$. Consumer i, maximizing $U^i(c^i)$ subject to $p \cdot c^i \leq b_i$ sets $U_c^i = \lambda_i p$, and then b_i is adjusted to make the marginal utility of money $\lambda_i = 1/W_i$. Firm j operating activity j maximizes $q \cdot x^j$ subject to $F^j(x^j) \leq 0$, for which $q = \phi_j F_x^j$. The only new feature concerns trade. In fact, implicit in (3.7) is just the optimal tariff to exploit monopoly in trade. We can convert it to a familiar form when there are just two tradeables. The foreign offer curve $m_2 = m_2(m_1)$ is defined as the solution of $G(m_1, m_2) = 0$, so along it,

$$\frac{\mathrm{d}m_2}{\mathrm{d}m_1} = -\frac{\partial G/\partial m_1}{\partial G/\partial m_2}.$$

Using (3.7), therefore

$$\frac{\pi_1}{\pi_2} = \frac{\partial G/\partial m_1}{\partial G/\partial m_2} = -\frac{\mathrm{d}m_2}{\mathrm{d}m_1},$$

and

$$\frac{\pi_1/r_1}{\pi_2/r_2} = -\frac{r_2}{r_1}\frac{\mathrm{d}m_2}{\mathrm{d}m_1} = \frac{m_1}{m_2}\frac{\mathrm{d}m_2}{\mathrm{d}m_1},$$

where the trade balance condition $r_1 m_1 + r_2 m_2 = 0$ has been used. Choosing good

[1]See Dreze (1982) for a discussion of project evaluation.

2 to have zero tariff ($\pi_2 = r_2$), we have the ad valorem tariff on good 1 as

$$\pi_1/r_1 - 1 = \frac{m_1}{m_2}\frac{\mathrm{d}m_2}{\mathrm{d}m_1} - 1.$$

This is the well-known formula involving the elasticity of the foreign offer curve.

An expression with foreign supply derivatives is available for the general case. As in Section 1.3, write $r^{\mathrm{t}} = R(m^{\mathrm{t}})$ and $G(m^{\mathrm{t}}) = R(m^{\mathrm{t}}) \cdot m^{\mathrm{t}}$. Then $G_m = R + R'_m m^{\mathrm{t}}$, where R_m is the matrix of derivatives $\partial r_k/\partial m_l$ for k, l tradeables, and R'_m is its transpose. Choose the scale of prices to make $\gamma = 1$ for algebraic simplicity. Then (3.7) becomes the formula for optimum tariffs,

$$\tau^{\mathrm{t}} \equiv \pi^{\mathrm{t}} - r^{\mathrm{t}} = R'_m(m^{\mathrm{t}})m^{\mathrm{t}}. \tag{3.8}$$

We can also relate this discussion to that in Section 2.2. For any movement $\mathrm{d}m$ from the optimum along the foreign offer surface $G(m) = 0$, we have $\pi \cdot \mathrm{d}m = G_m \cdot \mathrm{d}m = 0$ by (3.7). This is just the first-order condition for the maximization of (2.4), but now carried out at shadow prices.

As usual, commodities have a wide interpretation, and the formula applies to the case of jointly optimum tariffs on goods and factors when there is international capital mobility, e.g., Jones (1967).

For a small country, with constant r^{t}, the optimum tariffs are zero, i.e., free trade is optimal. Redistribution is better carried out using first-best lump sum transfers.

Next consider externalities, to see how they interact with trade. The principle can be explained with a minimum of algebra by considering a special case. Suppose the total output of commodity 1, written X_1, affects the production possibilities of each firm. Thus (3.2) is replaced by

$$F^j(x^j, X_1) \leq 0.$$

If $\partial F^j/\partial X_1 > 0$, we have an external diseconomy. Now the first-order condition (3.6) remains unchanged for $k \neq 1$, but that for $k = 1$ is replaced by

$$\pi_1 - \phi_j(\partial F/\partial x_1^j) - \sum_J \phi_J(\partial F^J/\partial X_1) = 0.$$

This can be implemented in a market economy by altering the price of good 1 as seen by firms. We make the usual assumption that each firm is too small to recognize the effect of its contribution x_1^j on X_1. Then, facing prices q, it will set $q = \phi_j F_x^j$ as before. To make this consistent with the first-order conditions, we need

$$q_1 = \pi_1 - \sum_J \phi_J(\partial F^J/\partial X_1).$$

The second term on the right-hand side is the Pigovian correction, consisting of the external effect on all firms' technological feasibility constraints valued at the respective shadow prices. For the case of a diseconomy, we have $q_1 < \pi_1$, i.e., a tax to discourage production of this commodity.

The same tax rate applies to all firms because they have identical symmetric roles in generating externalities. If there are firm-specific external effects, the corrective policies will have to be firm-specific, too.

No other first-order conditions are affected. In particular, there is no call for interference in trade on account of the production externality. Similar conclusions follow from a general model allowing all kinds of externalities in production and consumption. This is the Bhagwati–Johnson principle of targeting, which was stated in the Introduction, and discussed by revealed preference methods in Section 2.3. A corresponding result for a closed economy is proved by Sandmo (1975, sec. 2).

The earlier statement had a mirror-image counterpart, namely the deliberate introduction of a distortion for non-economic reasons. Just as an undesired distortion is best eliminated by a tax or subsidy policy that acts directly on the relevant margin, a required distortion is best introduced (i.e., attained at least welfare cost) by a similar most direct policy. Again an example suffices to explain the point. Suppose it is desired, for reasons of national security or otherwise, that the production of commodity 1 should not fall below a stipulated level, say $x_1 \geq \bar{x}_1$. Letting ξ be the Lagrange multiplier for this constraint, the corresponding component of the first-order condition (3.6) becomes

$$\pi_1 + \xi - \phi_j\left(\partial F^j/\partial x_1^j\right) = 0 \quad \text{for all } j.$$

This can be decentralized by means of a production subsidy ξ for commodity 1. No other first-order conditions are affected.

It is customary in this branch of theory to accept unspecified non-economic reasons for such constraints. However, they are often merely convenient short-cuts for the introduction of considerations that have an underlying economic rationale, when a full-fledged treatment would be too cumbersome. For example, the floor on production levels may be motivated by problems of disequilibrium dynamics (adjustment) or uncertainty (trade disruption). This is not to deny that there are genuinely non-economic principles that constrain economic policy.

The question of achievement of a certain proportion of self-sufficiency often arises in public policy discussions. We can use the above method to find the optimum way of doing so. Suppose that for commodity 1 it is desired that domestic production should cover at least 75% of consumption, i.e., $x_1 \geq 0.75c_1$. If ξ is the multiplier, the optimum policy is a production subsidy at rate ξ and a consumption tax at rate 0.75ξ. A tariff alone, in the normal case at some rate between these two values, could achieve the same objective, but it would discourage consumption too much and encourage production too little, relative to the optimum.

We saw in Section 1.3 that there is a degree of arbitrariness in the designation of tax and tariff instruments to implement a given policy. In this case there is one particularly simple method, namely a proportionally distributed quota, as discussed by McCulloch and Johnson (1973). The right to import is awarded to domestic producers, in proportion of one unit of imports for every three units produced domestically. Each unit sold to home consumers can be thought of as 25% imported and 75% home-produced. Free entry eliminates pure profit, so the consumer price p_1, the domestic marginal cost (producer price) q_1, and the world price r_1 must stand in the relation $p_1 = 0.25 r_1 + 0.75 q_1$ in equilibrium. Writing this as $p_1 - r_1 = 0.75(q_1 - r_1)$, we see that the policy implicitly enforces just the right combination of a consumption tax and a production subsidy.

3.2. Optimum without lump sum transfers

Now suppose lump sum transfers across consumers are not possible. In fact, rule out even uniform poll taxes and subsidies. Then we have the standard Ramsey–Diamond–Mirrlees problem of finding the second-best optimal commodity taxation. This is a short-cut just like the use of non-economic constraints; it would be too difficult to carry along the full model that endogenizes the informational costs of lump sum transfers.

The consumers' transfer incomes b_i are zero for all i, and consumer prices p are the only instrument for controlling consumption quantities. Let the demand functions be $c^i(p,b)$, and the indirect utilities $V^i(p,b) = U^i(c^i(p,b))$. Roy's Identity gives

$$V_p^i(p,b) = -\lambda_i\left[c^i(p,b) - e^i\right], \qquad \lambda_i = V_b^i(p,b), \tag{3.9}$$

where V_p^i is the vector with components $\partial V^i/\partial p_k$.

This is the only change from the optimization problem of the previous subsection. The maximand is

$$W(V^1(p,0), V^2(p,0), \dots).$$

The material balance constraint becomes

$$\sum_i c^i(p,0) \leq \sum_i e^i + \sum_j x^j + m - g, \tag{3.10}$$

replacing (3.1). The corresponding first-order conditions replacing (3.5) are

$$-\sum_i W_i\lambda_i\left[c^i_k(p,0)-e^i_k\right]-\sum_i\sum_l \pi_l\left(\partial c^i_l/\partial p_k\right)=0. \tag{3.11}$$

In vector and matrix form, letting primes denote the transposes of (column) vectors, this becomes

$$-\sum_i W_i\lambda_i\left[c^i(p,0)-e^i\right]'-\pi'\sum_i c^i_p(p,0)=0.$$

The other constraints (3.2) and (3.3), and the corresponding conditions (3.6) and (3.7) remain unchanged.

This, too, is mostly familiar. The new condition (3.11) is just the Diamond–Mirrlees optimum tax formula, in the form (66) of Diamond and Mirrlees (1971), or a minor variation of equation (6.18) in the chapter in this volume by Auerbach. Production efficiency is still required, although the second-best nature of commodity taxation precludes full Pareto efficiency. The shadow prices π still equal producer prices q, as in Mirrlees (1969), but differ from consumer prices p, i.e., $DRT \neq DRS$.

The optimal trade policy entails efficiency, i.e., $DRT = FRT$. The monopoly argument is still the only one justifying tariffs; consumption taxes are superior for the redistribution role. A corollary is that the shadow prices of tradeables equal the marginal rates of transformation through trade, or marginal border prices. Note that since factors are included in the list of commodities, we are speaking of taxes or subsidies as required on all goods and factors, and on any ownership rents.

To relate this to results in the previous subsection, let us for a moment re-introduce lump sum transfers b_i. The first-order conditions for them are

$$W_i\lambda_i-\sum_l \pi_l\left(\partial c^i_l/\partial b_i\right)=0.$$

Rewriting (3.11) with b_i as appropriate, and combining with the above, we have

$$\sum_i\sum_l \pi_l\left\{\partial c^i_l/\partial p_k+\left(c^i_k-e^i_k\right)\left(\partial c^i_l/\partial b_i\right)\right\}=0,$$

or

$$\pi'\sum_i\left\{c^i_p+c^i_b\left(c^i-e^i\right)'\right\}=0.$$

The bracketed terms are Slutsky–Hicks substitution matrices. By their singularity property, $\pi = p$ gives a solution. (If the sum of the matrices has the maximal permissible rank, i.e., one less than the number of commodities, it is the only solution to within scale.) Thus the model is reconciled with the earlier one. We can also consider an "intermediate" model of poll taxes or subsidies, where $b_i = b$ for all i but the common value can be optimally chosen. This gives formulae like Diamond (1975); the implications for trade policy are unaffected.

Next consider distortions and constraints when lump sum taxation is impossible. So long as the externalities or non-economic objectives pertain to domestic production or consumption, the condition (3.7) for optimum tariffs is unaffected, and the marginal "border prices" reflect the shadow prices of tradeable commodities. The distortions and constraints are best tackled by the appropriately targeted Pigovian policies even when lump sum transfers are not available. More precisely, what we have is the *additivity property* obtained by Sandmo (1975, sec. 3, 4); "the marginal social damage of commodity m enters the tax formula for that commodity additively, and does not enter the tax formulas for other commodities."

A different problem might arise. These corrective taxes must in general be different for different consumers or firms. This may face the same computational or incentive-compatibility problems as led us to doubt the practicality of lump sum transfers. For externalities or constraints that involve only aggregates over consumers or firms, as in Sandmo's model, the Pigovian policies are uniform across agents and there is no problem. Otherwise we may have to use a restricted optimum as in Diamond (1973). But this still leaves trade policy unaffected, at least in the analytical sense that (3.7) is valid, although the actual values of the various entities may change. For a small country, free trade remains optimum.

This discussion confirms, and extends to the case of commodity taxation, the principle of targeting. One particular facet is worth emphasis. When it is desirable to encourage domestic production, policy calls for subsidies to these producers, instead of tariff protection from imports. This is criticised by laymen on the grounds that import tariffs raise revenue, while production subsidies cost money and put additional strain on other uses of the government's budget. We see this argument to be fallacious. The size of the government's budget has no *direct* welfare relevance. The optimality conditions show that, on considering the overall effects, it is desirable to provide those production subsidies and adjust other taxes appropriately. This is so even when the latter are not of the first-best non-distorting lump sum variety, but commodity taxes involving some distortion between consumer and producer prices, i.e., making $DRS \neq DRT$. One way to explain the point is by observing that a tariff acts like a combination of a production subsidy and a consumption tax at equal rates. So it is just one particular way of financing (in fact overfinancing) the subsidy. The optimum way can do no worse; in fact we expect to have a smaller deadweight loss by levying taxes at lower rates on a broader base of all commodities.

It is worth re-iteration that, although the formulae for optimum tariffs and correction of domestic distortions remain the same whether lump sum transfers or commodity taxation are used in the background, the actual quantities and prices that emerge in the general equilibrium solution will differ. The presumption would be that a subsidy or tax will be set at a lower level if the raising or disbursal of the revenues has to be done through other distortionary taxes or subsidies than it would if lump sum transfers were available. However, general equilibrium interactions can produce counterintuitive outcomes; Atkinson and Stern (1974) provide a case in point for the provision of public goods.

3.3. *Optimum tariffs for revenue*

We have seen that the revenue argument for tariffs is invalid if domestic commodity taxation can be used. But the administrative apparatus of some less developed countries may be too limited, leaving the taxation of transactions that cross international borders as their only effective source of revenue. Many countries faced this situation in the past. Here I consider a third-best policy problem of this kind. As usual, I do not endogenize the reasons for ruling out lump sum transfers and commodity taxes. Previous literature on the question includes Dasgupta and Stiglitz (1974, sec. 4) in the small-country case, and Boadway, Maital and Prachowny (1973) for a country with monopoly power in trade. My treatment is a continuation of the approach of the previous subsection.

For algebraic simplicity, I shall suppose the domestic economy has an aggregate consumer and an aggregate price-taking firm. The more general case can easily be reconstructed by interested readers. Lump sum transfers are also ruled out, so the consumer's demands are given by $c(p,0)$ and his indirect utility by $V(p,0)$. The latter is also the measure of social welfare. Producer prices must equal p, but under constant returns to scale we cannot use a supply function. Instead we introduce the output vector x separately, then require it to be compatible with producer behavior by imposing a constraint $p = F_x(x)$. Setting the factor of proportionality equal to one is a permissable normalization of prices. Now the policy problem is to choose p, x and m to maximize $V(p,0)$ subject to

$$c(p,0) \leq e + x + m - g, \tag{3.12}$$

$$F(x) \leq 0, \tag{3.13}$$

$$G(m') \leq 0, \tag{3.14}$$

$$p = F_x(x). \tag{3.15}$$

Using $p \cdot (c-e)=0$, the material balance constraint (3.12) becomes $p \cdot g \leq p \cdot m$. If we also use $r \cdot m = 0$, this is $p \cdot g \leq (p-r) \cdot m$, which captures the requirement that the government's expenditure must be financed using trade taxes alone.

Let θ be the vector of Lagrange multipliers for (3.15), and the other multipliers as before. Then the first-order conditions are

$$-\lambda[c(p,0)-e]' - \pi' c_p(p,0) + \theta' = 0, \tag{3.16}$$

$$\pi - \phi F_x - F_{xx}\theta = 0, \tag{3.17}$$

$$\pi^{\mathrm{t}} - \gamma G_m = 0. \tag{3.18}$$

The first thing to notice is that the structure of the relationship between the shadow prices and border prices of tradeables is unchanged: (3.18) and (3.7) are identical. Thus we can interpret the "optimal tariff" formula as before, and marginal border prices serve as shadow prices of tradeables.

But the shadow prices π no longer equal domestic producer prices p. It is no longer desirable to keep $DRT = FRT$. This is a "third-best" response to the constraints on other tax instruments. The first-best would use lump sum transfers and keep $DRS = DRT = FRT$; the second-best would use consumption taxes and have $DRS \neq DRT = FRT$.

The differences between p and π can be thought of as the domestic tax component of the policy. It takes the form of a consumption tax and a production subsidy at equal rates. Operationally, the outcome is equivalent to a tariff. The difference between π and r is the foreign component of the policy, and is itself a tariff. Then the shadow prices can be forgotten, and the policy implemented in one piece as a trade tax vector $(p-r)$. This is how the result is usually derived, and it then appears significantly different from earlier tax formulae. But the introduction of the economically meaningful shadow price vector allows us to display the policy package in constituent parts each of which has a clear economic rationale.

Readers might wonder what happens if the optimum tariff that exploits monopoly power in trade raises more than enough revenue. The answer is that we do not achieve the first-best in this way. Government expenditure is fixed, and it becomes necessary to give away some of the revenue by the distortionary means available, namely by reducing tariffs to suboptimal levels.

Finally, we should note a property of the solution. Since F is homogeneous of degree 1, the optimum has $F_x x = F = 0$ and $F_{xx}x = 0$. Then (3.17) gives $\pi \cdot x = 0$, i.e., private production breaks even at shadow prices. This implication of constant returns to scale was discussed in a general model by Diamond and Mirrlees (1976).

4. Gradual reform of policies

The welfare effects of small changes in tax and expenditure policies starting from an arbitrary distorted initial equilibrium have received much attention in public economics. This work is surveyed in Section 8 of Auerbach's chapter in this volume. Similar issues have also been a long-standing concern in trade theory. Haberler (1950) showed how some interference with trade could be beneficial in the presence of domestic distortions. The subject was further developed by Meade (1955), and led to the theory of optimal second-best policies discussed earlier. The design of welfare-improving tariff reforms was studied by Betrand and Vanek (1971), Bruno (1972), Lloyd (1974) and others. Smith (1980) provides a synthesis of much of this literature. The implications for shadow prices in distorted economies have also been extensively studied, and are discussed by Corden (1982).

4.1. Equilibrium and comparative statics

In this section I shall briefly review the basic principles and issues in the framework of a simple comparative-static model. For ease of exposition I shall begin by assuming the country to be small, i.e., take parametric world prices. The case of a large country will be examined in Section 4.4. For the same reason I shall begin with the case where all commodities are tradeable, and extend the analysis to include non-tradeables in Section 4.5. Finally, and in conformity with most of the literature on this subject, I shall ignore distributional issues and assume a one-consumer economy.

Since the allocative effects depend on the *relative* price changes caused by policy reforms or changes in distortions, it helps to specify a numeraire explicitly. I shall modify the notation of Section 1.3 slightly by letting this be commodity 0. Its quantities will be indicated by the subscript 0, and vectors c, x, etc. will comprise all other commodities. Thus the full consumption vector will be (c_0, c), and that of consumer prices $(1, p)$. The consumer's expenditure function will be $E(1, p, u)$, and the compensated demands $E_0(1, p, u)$ and $E_p(1, p, u)$. Subscripts denote partial derivatives; in particular, $E_0(1, p, u)$ is $\partial E(p_0, p, u)/\partial p_0$ evaluated at $p_0 = 1$.

A more important change will be made in the model of production. The assumption of constant returns to scale is useful when studying optimum taxation, but not for comparative statics. Supplies are correspondences, and a small open economy is likely to specialize its production pattern greatly. The literature on gradual reform has avoided these difficulties by assuming a strictly convex technology and single-valued supply functions; I shall follow this practice. The basic construct will be a profit function $\Pi(1, q)$, yielding supply functions

$x_0 = \Pi_0(1, q)$ and $x = \Pi_q(1, q)$. To preserve the independence of consumer and producer price normalizations, this profit will be assumed to be taxed at 100%.

Equilibrium is now easy to describe. The various commodity markets clear, so

$$E_0(1, p, u) = \Pi_0(1, q) + m_0 + e_0 - g_0, \tag{4.1}$$

$$E_p(1, p, u) = \Pi_q(1, q) + m + e - g. \tag{4.2}$$

Trade is balanced, i.e.,

$$m_0 + r \cdot m = 0. \tag{4.3}$$

Finally, the various relative prices differ from one another on account of market failures and taxes. In the notation established in Section 1.3, $p = r + \tau + \alpha$ and $q = r + \tau + \beta$. Recall that there is one degree of freedom in writing this. For algebraic simplicity, I shall utilize it by absorbing τ into each of α and β, or in effect relabelling $(\tau + \alpha)$ as α and $(\tau + \beta)$ as β. Economically, a trade tax or distortion is being separated into the equivalent form of a consumption tax *cum* production subsidy. Thus

$$p = r + \alpha, \qquad q = r + \beta. \tag{4.4}$$

It is readily verified that, in equilibrium, the consumer's net expenditure must equal the net revenues associated with the distortions and taxes, i.e.,

$$E - (e_0 + p \cdot e) = \Pi + (p - q) \cdot c + (q - r) \cdot m - (g_0 + q \cdot g), \tag{4.5}$$

where the arguments of E and Π have been omitted for brevity. But different mechanisms can bring about this balance. Market failures give rise to rents which accrue as lump sums to consumers or profits to producers. The government's budget from commodity and profit taxes and expenditures may be balanced by lump sum transfers to or from consumers. In such cases there is no separate constraint arising from budget balance. Any given set of r, α, β, e_0, e, g_0 and g is compatible with general equilibrium, when lump sum transfers take an appropriate value in the background. Of course, public consumption must not be so high that the private consumers are driven outside the consumption sets that represent their biological survival requirements, but this is not commonly thought to be an issue requiring serious qualification of the theory.

However, if lump sum transfers are not available, the consumer's net expenditure must be zero and the government's budget must balance without transfers, i.e., the two sides of (4.5) must separately equal zero. Then

$$E - (e_0 + p \cdot e) = 0, \tag{4.6}$$

or equivalently,

$$\Pi + (p-q)\cdot c + (q-r)\cdot m - (g_0 + q\cdot g) = 0. \tag{4.7}$$

Such constraints on permissable tax and expenditure policies have corresponding implications for comparative statics. Any change in these policies must preserve general equilibrium. Thus a proposed change in just one component of α or β, or in g_0 or g by itself, will not be feasible. There will have to be an accompanying change, either in the lump sum transfers to preserve (4.5), or in another tax rate to keep each side of (4.5) separately equal to zero. Different offsetting changes of this kind will have different comparative static effects. It is common to assume all such adjustments to be made by means of lump sum transfers, but that is somewhat odd in an area of research founded on the premise of limited possibilities for tax reform.

The comparative static formulae can also differ according to the nature of the distortion or the policy. For example, a consumption tax on commodity k in specific form gives a constant wedge $(p_k - q_k)$, while one in ad valorem form makes the wedge proportional to q_k. Changes in the tax rates will affect the economy differently, especially when the commodity is non-tradeable. If the wedges are due to externalities, the components of α and β will usually depend on various consumption and production quantities, and cannot be treated as exogenous parameters. I shall use wedges in specific form for illustrative purposes because the resulting formulae look simpler, but other applications of the methods may require a different treatment.

The equilibrium conditions can now be simplified. Substituting from (4.1) and (4.2) into (4.3), we have

$$(E_0 - \Pi_0 - e_0 + g_0) + r\cdot(E_p - \Pi_q - e + g) = 0. \tag{4.8}$$

Given the world prices r and the distortions α and β, the consumer prices p and producer prices q are fixed by (4.4). Then, knowing e_0, e, g_0 and g, we can solve (4.8) for u. By totally differentiating this, we can find the welfare effects of changes in any of the exogenous magnitudes. For market failures, or when lump sum transfers are the sole accommodating adjustment, this is all. Otherwise, the changes must preserve the budget balances, i.e., satisfy one of (4.6) and (4.7) as well.

To carry out this program, begin with the total differential of (4.8),[2]

$$\begin{aligned}&\left(E'_{0p}\mathrm{d}p + E_{0u}\mathrm{d}u - \Pi'_{0p}\mathrm{d}q - \mathrm{d}e_0 + \mathrm{d}g_0\right) + m\cdot\mathrm{d}r\\ &+ r'\left(E_{pp}\mathrm{d}p + E_{pu}\mathrm{d}u - \Pi_{qq}\mathrm{d}q - \mathrm{d}e + \mathrm{d}g\right) = 0.\end{aligned}$$

[2] Observe that for two vectors a, b of the same dimension, the inner product $a\cdot b$ equals the matrix product $a'b$.

by homogeneity of E_p and Π_q, we have $E'_{0p} + p'E_{pp} = 0 = \Pi'_{0q} + q'\pi_{qq}$. Therefore the equation simplifies to

$$(E_{0u} + r \cdot E_{pu})\,\mathrm{d}u = (\mathrm{d}e_0 + r \cdot \mathrm{d}e) - (\mathrm{d}g_0 + r \cdot \mathrm{d}g) + (p - r)'E_{pp}\mathrm{d}p - (q - r')\Pi_{qq}\mathrm{d}q - m \cdot \mathrm{d}r. \tag{4.9}$$

The coefficient on the left-hand side is the sum of the income effects on all commodities weighted by world prices. Dixit (1975) and Hatta (1977) examined this in detail, and argued from considerations of uniqueness and stability that it should be positive; see also Section 8.1 of Auerbach's chapter in this volume. Then the sign of $\mathrm{d}u$ is the same as that of the right-hand side. There, the terms of trade effect and the values of physical changes in endowments and government expenditures are readily interpreted. Noting that $E_{pp}\mathrm{d}p$ and $\Pi_{qq}\mathrm{d}q$ are the substitution effects in consumption and production respectively, the remaining terms reflect the social worth of changing the consumption and production levels when they are non-optimal due to the distortions or taxes. Thus (4.9) is a close analogue of (2.5). The only differences are that the changes are small, and substitution effects in consumption are separated from income effects. In the present context of a small economy, the change $\mathrm{d}r$ in world prices r must be an exogenous shift. In the large-country case of Section 4.4 it will be endogenized. Now we proceed to apply (4.9) to specific contexts.

4.2. *Directions of desirable reforms*

Here we consider the effects on u of changes in α and β. With r, e_0, e, g_0 and g held constant, (4.9) becomes

$$(E_{0u} + r \cdot E_{pu})\,\mathrm{d}u = \alpha'E_{pp}\mathrm{d}\alpha - \beta'\Pi_{qq}\mathrm{d}\beta. \tag{4.10}$$

The most immediate result is that an equiproportionate reduction in all distortions, with a balancing lump sum transfer, increases welfare. If $\mathrm{d}\alpha = -\alpha\,\mathrm{d}z$ and $\mathrm{d}\beta = -\beta\,\mathrm{d}z$ for a small positive scalar $\mathrm{d}z$, then the right-hand side of (4.10) is $\{-\alpha'E_{pp}\alpha + \beta'\Pi_{qq}\beta\}\,\mathrm{d}z$. Since E_{pp} is negative semi-definite and Π_{qq} is positive semi-definite, this is non-negative. In fact the matrices omit the numeraire commodity, and are therefore definite so long as there is *some* substitution between that commodity and others. Therefore in practice we can rely on the welfare effect of such a "radial" reform being positive.

A special case is where there is only one distortion, i.e., all others are zero. Then any reduction in this distortion will be an improvement. (This is not self-evident, since the relevant indirect utility function need not be concave in distortion levels.) These results are due to Bruno (1972) and Hatta (1977).

Next consider a reform that changes only one distortion, say by changing the consumer price of the kth commodity. A lump sum transfer again balances the budget. Then $(E_{0u} + r \cdot E_{pu})\mathrm{d}u = \sum_l (p_l - r_l)E_{lk}\mathrm{d}p_k$, where the sum extends over all commodities l, and the numeraire can be included since $p_0 = r_0 = 1$. Now $\sum_l p_l E_{lk} = 0$, i.e., $E_{kk} = -\sum_{l \neq k} p_l E_{lk}/p_k$. Therefore the right-hand side becomes

$$\sum_{l \neq k} p_l E_{lk}\left\{\frac{p_l - r_l}{p_l} - \frac{p_k - r_k}{p_k}\right\}\mathrm{d}p_k.$$

Suppose k is the commodity with the largest proportional distortion, and we lower its consumer price slightly. Then all the terms in brackets above are negative, as is $\mathrm{d}p_k$. Therefore a welfare improvement will result if all the E_{lk} are positive, i.e., this commodity is a substitute to all others. This result was proved by Bertrand and Vanek (1971).

Finally, consider second-best reforms involving the introduction of a new distortion in response to an existing and irreversible one. As an example, consider a consumption subsidy on commodity k, i.e., $\alpha_k < 0$. Consider the introduction of a small trade tax $\mathrm{d}\tau_l$ on commodity l, which increases each of α_l and β_l by this amount. Then

$$\left(E_{0u} + r \cdot E_{pu}\right)\mathrm{d}u = \alpha_k E_{kl}\mathrm{d}\tau_l,$$

i.e., a welfare improvement emerges from a tariff ($\mathrm{d}\tau_l > 0$) if commodities k and l are complements ($E_{kl} < 0$), and from an import subsidy if they are substitutes. Of course balancing lump sum transfers are assumed to occur in the background. As we move to finite values of τ_l, a by-product distortion in the trade of commodity l is introduced, and

$$\left(E_{0u} + r \cdot E_{pu}\right)\mathrm{d}u = \left\{\alpha_k E_{kl} + \tau_l\left(E_{ll} - \Pi_{ll}\right)\right\}\mathrm{d}\tau_l.$$

The second-best optimum response τ_l is where the bracketed expression on the right-hand side becomes zero, i.e.,

$$\tau_l = -\alpha_k E_{kl}/\left(E_{ll} - \Pi_{ll}\right).$$

In particular, if $l = k$, the trade tax offsets the initial distortion, but only partially. Many second-best exercises of this kind can be found in Corden (1974).

In our example, observe that the tariff partly "defeats" the consumption subsidy and raises the consumer price. If the subsidy is a historical accident, or merely implicit in an external diseconomy that leaves consumers facing a price below the social opportunity costs, there may be no problem. But if the subsidy has been achieved by an organized consumer group who can see through the effect of the tariff, they can use their political power to prevent its implementation. Thus second-best remedies may not always be available.

A second critical assumption in all the above results was the presence of balancing lump sum transfers. If we do without them, the proposed reforms must preserve (4.6), i.e.,

$$E_p \cdot \mathrm{d}p + E_u \mathrm{d}u - e \cdot \mathrm{d}p = 0.$$

Combining this with (4.10), we have the constraint on the reform:

$$\{(E_{0u} + r \cdot E_{pu})/E_u\}(e - E_p)'\mathrm{d}\alpha = \alpha' E_{pp} \mathrm{d}\alpha - \beta' \Pi_{qq} \mathrm{d}\beta. \tag{4.11}$$

The welfare effect of any primary reform, e.g., the introduction or reduction of a tariff, will depend crucially on the other elements of the whole reform package. A general theoretical treatment would soon degenerate into a catalogue and a collection of apparent paradoxes. Some special cases such as the Corlett–Hague model are well known (see Section 8.2 of Auerbach's chapter in the volume), but in practice each application must be examined on its own.

We can also use (4.10) and (4.11), with an added Lagrange multiplier, to obtain first-order conditions for optimality of certain packages of policy instruments. In particular, for revenue-raising tariffs to be optimal, we need

$$\mu(e - E_p) = (E_{pp} - \Pi_{qq})\tau,$$

where μ is a scalar multiplier. The same formula can be derived from (3.16) and (3.17).

4.3. Shadow prices of commodities and projects

Welfare effects of changes in the consumer's endowments or the government's expenditure on commodities can also be studied using the above methods. In fact we can interpret a change $(\mathrm{d}g_0, \mathrm{d}g)$, not as a change in public consumption, but as the result of the government implementing a small project with net outputs $(-\mathrm{d}g_0, -\mathrm{d}g)$. This allows us to use the analysis for derivation of shadow prices appropriate to project selection.

When lump sum transfers are the balancing policy to preserve equilibrium, (4.9) gives

$$\left(E_{0u}+r\cdot E_{pu}\right)\mathrm{d}u=\left(\mathrm{d}e_0+r\cdot \mathrm{d}e\right)-\left(\mathrm{d}g_0+r\cdot \mathrm{d}g\right). \tag{4.12}$$

In particular, the project $(-\mathrm{d}g_0, -\mathrm{d}g)$ is desirable if and only if its value at the prices $(1, r)$ is positive. In the sense used in Section 3, these prices are the shadow prices that should be used in the cost–benefit tests of small public projects. Dreze (1982) calls them "welfare prices", since they are proportional to the marginal welfare effects of amounts of the commodities.

This is the basic case for the use of world prices as shadow prices even when domestic market prices differ on account of distortions or taxes. The argument goes back to Little and Mirrlees (1969), and the debate that ensued is surveyed by Corden (1982). I shall therefore confine my discussion to some brief remarks.

Several assumptions were made in establishing the result. That of constant world prices will be removed in the next subsection; marginal border prices become the appropriate shadow prices, provided the actual tariff levels are optimum. All commodities were assumed tradeable. This will be generalized in Section 4.5, and we will see that the presence of non-tradeables does not affect the rules for shadow prices of tradeables. However, there is the question of the appropriate definition of a tradeable. The distortions in trade that were allowed took the form of price wedges. If there are quantitative restrictions such as import quotas that are binding, then at the relevant margin those commodities are not tradeable, and their shadow prices must be determined by the methods similar to those used for non-tradeables.

Perhaps the most important assumption is that the marginal adjustment in budgetary balances is carried out using lump sum transfers. If some distortionary taxes must be changed instead, the new equilibrium is described by

$$\left(E_{0u}+r\cdot E_{pu}\right)\mathrm{d}u=\left(\mathrm{d}e_0+r\cdot \mathrm{d}e\right)-\left(\mathrm{d}g_0+r\cdot \mathrm{d}g\right)+\alpha' E_{pp}\mathrm{d}\alpha-\beta'\Pi_{qq}\mathrm{d}\beta,$$

and

$$E_u\mathrm{d}u=\left(e-E_p\right)\cdot \mathrm{d}\alpha.$$

Eliminating $\mathrm{d}u$, we have the constraint linking the joint changes in endowments or project outputs, and taxes. Again, it is clear that by restricting the permissible changes suitably, we can create all sorts of paradoxical results. However, we know from the work of Section 3 that if commodity taxes can be chosen optimally, then we will set $\beta=0$, and $q=r$ will serve as the shadow price vector.

4.4. Endogenous world prices

When the home country is sufficiently large in international trade to affect the equilibrium world prices, we have to use (4.9) remembering that r depends on m through the relation $r = R(m)$, or substituting for m,

$$r = R\left(E_p - \Pi_q - e + g\right). \tag{4.13}$$

Differentiating this,

$$\mathrm{d}r = R_m\left(E_{pp}\mathrm{d}p + E_{pu}\mathrm{d}u - \Pi_{qq}\mathrm{d}q - \mathrm{d}e + \mathrm{d}g\right).$$

Using $\mathrm{d}p = \mathrm{d}r + \mathrm{d}\alpha$ and $\mathrm{d}q = \mathrm{d}r + \mathrm{d}\beta$, we have

$$\left[I - R_m\left(E_{pp} - \Pi_{qq}\right)\right]\mathrm{d}r = R_m\left[E_{pu}\mathrm{d}u - \mathrm{d}e + \mathrm{d}g + E_{pp}\mathrm{d}\alpha - \Pi_{qq}\mathrm{d}\beta\right],$$

where I is the identity matrix. Assuming the matrix on the left-hand side is non-singular,

$$\mathrm{d}r = \left[I - R_m\left(E_{pp} - \Pi_{qq}\right)\right]^{-1}R_m\left[E_{pu}\mathrm{d}u - \mathrm{d}e + \mathrm{d}g + E_{pp}\mathrm{d}\alpha - \Pi_{qq}\mathrm{d}\beta\right].$$

Define the vector ρ by

$$\rho' = \left[m' - \alpha' E_{pp} + \beta'\Pi_{qq}\right]\left[I - R_m\left(E_{pp} - \Pi_{qq}\right)\right]^{-1}R_m. \tag{4.14}$$

Now collect terms in (4.9), and use the definition (4.14) to write

$$\begin{aligned}\left(E_{0u} + r\cdot E_{pu}\right)\mathrm{d}u = {} & (\mathrm{d}e_0 + r\cdot\mathrm{d}e) - (\mathrm{d}g_o + r\cdot\mathrm{d}g)\\ & + \left(\alpha' E_{pp} - \beta'\Pi_{qq} - m'\right)\mathrm{d}r\\ & + \alpha' E_{pp}\mathrm{d}\alpha - \beta'\Pi_{qq}\mathrm{d}\beta,\end{aligned}$$

or

$$\begin{aligned}\left[E_{0u} + (r+\rho)\cdot E_{pu}\right]\mathrm{d}u = {} & \left[\mathrm{d}e_0 + (r+\rho)\cdot\mathrm{d}e\right] - \left[\mathrm{d}g_0 + (r+\rho)\cdot\mathrm{d}g\right]\\ & + (\alpha-\rho)' E_{pp}\mathrm{d}\alpha - (\beta-\rho)\Pi_{qq}\mathrm{d}\beta.\end{aligned} \tag{4.15}$$

This is the large-country equivalent of (4.9), since it expresses the welfare effects of exogenous changes in distortions, endowments and projects, with the necessary adjustments in lump sum taxation in each case.

Corresponding results follow. First observe that the first-order conditions for the optimum choice of α and β are $\alpha - \rho = 0 = \beta - \rho$. Substituting in (4.14),

$$\rho' = \left[m' - \rho'\left(E_{pp} - \Pi_{qq}\right)\right]\left[I - R_m\left(E_{pp} - \Pi_{qq}\right)\right]^{-1} R_m.$$

This is satisfied by $\rho' = m'R_m$ or $\rho = R_m' m$, which is just the optimum tariff formula (3.8). If R_m is non-singular, we have

$$\rho' R_m^{-1} - \rho'\left(E_{pp} - \Pi_{qq}\right) = m' - \rho'\left(E_{pp} - \Pi_{qq}\right),$$

and the solution is unique.

In view of the optimum, an equiproportionate reduction in all distortions should be defined as a move $\mathrm{d}\alpha = -(\alpha - \rho)\mathrm{d}z$ and $\mathrm{d}\beta = -(\beta - \rho)\mathrm{d}z$, where $\mathrm{d}z$ is a small positive scalar. Using this in (4.15), we see at once that such a move will increase welfare. The asymptotic outcome of successive reforms of this kind will be the optimum.

Now consider the effects of endowments or projects at given distortions. We have

$$\begin{aligned}\left[E_{0u} + (r+\rho)\cdot E_{pu}\right]\mathrm{d}u = {} & \left[\mathrm{d}e_0 + (r+\rho)\cdot \mathrm{d}e\right] \\ & - \left[\mathrm{d}g_0 + (r+\rho)\cdot \mathrm{d}g\right].\end{aligned} \tag{4.16}$$

This looks a lot like (4.12), and using the same arguments as there, we have the shadow prices $(1, r+\rho)$. However, this is an important difference. By analogy with the small-country case, one would have thought that the shadow prices would be the world marginal rates of transformation $G_m = r + R_m' m$, whether or not actual tariffs were optimum. This is not so; the correction term ρ is more complicated. Social cost–benefit analysis in a large economy with suboptimal tax policies is therefore considerably more difficult. For further discussion of this issue, see Smith (1980).

It should be noted again that the above calculation assumes constant tax rates or distortions in specific form (α and β). Under other assumptions, e.g., constant ad valorem tax rates, the principles governing the calculation would be the same but the actual formula for ρ would be different.

Lump sum finance of the project, assumed here, is not the crucial feature; the optimality of indirect taxation is. We saw in Section 3 that the marginal border prices are the appropriate shadow prices for tradeables under optimum commodity taxation (3.7), or when optimum tariffs for revenue are used, (3.18). For a more detailed discussion of the role of optimum taxation for the characterization of shadow prices, see Roberts (1978).

4.5. Non-tradeable commodities

Prices of non-tradeables must be determined endogenously, and change in response to any changes in distortions, taxes or projects. This makes the analysis more complicated, even for a small country. Many of the results on gradual reform, e.g., the benefit from a radial reduction in all distortions, remain valid. Therefore I shall consider only the essentially new aspect of shadow prices, generalizing the model of Warr (1982). The small-country assumption is re-introduced.

Since there must be at least two tradeable commodities, take one of them as the numeraire and write the price vector for consumers as $(1, p^{\mathrm{t}}, p^{\mathrm{n}})$. Then the expenditure function will be $E(1, p^{\mathrm{t}}, p^{\mathrm{n}}, u)$ and E_{t} will denote the vector of compensated demands for tradeables, i.e., the vector of partial derivaitives of E with respect to the components of p^{t}. Similar notation will apply to production and trade. Then the equilibrium conditions are

$$E_0(1, p^{\mathrm{t}}, p^{\mathrm{n}}, u) = \Pi_0(1, q^{\mathrm{t}}, q^{\mathrm{n}}) + m_0 + e_0 - g_0, \tag{4.17}$$

$$E_{\mathrm{t}}(1, p^{\mathrm{t}}, p^{\mathrm{n}}, u) = \Pi_{\mathrm{t}}(1, q^{\mathrm{t}}, q^{\mathrm{n}}) + m^{\mathrm{t}} + e^{\mathrm{t}} - g^{\mathrm{t}}, \tag{4.18}$$

$$E_{\mathrm{n}}(1, p^{\mathrm{t}}, p^{\mathrm{n}}, u) = \Pi_{\mathrm{n}}(1, q^{\mathrm{t}}, q^{\mathrm{n}}) + e^{\mathrm{n}} - g^{\mathrm{n}}. \tag{4.19}$$

Trade balance requires

$$m_0 + r^{\mathrm{t}} \cdot m^{\mathrm{t}} = 0. \tag{4.20}$$

We are assuming constant world prices of tradeables, r^{t}, and constant price wedges $p^{\mathrm{t}} - r^{\mathrm{t}} = \alpha^{\mathrm{t}}$, $q^{\mathrm{t}} - r^{\mathrm{t}} = \beta^{\mathrm{t}}$ (thus fixing $p^{\mathrm{t}}, q^{\mathrm{t}}$), and $p^{\mathrm{n}} - q^{\mathrm{n}} = \alpha^{\mathrm{n}} - \beta^{\mathrm{n}}$. Balancing lump sum transfers are also assumed.

As before, we can combine (4.17), (4.18) and (4.20) into one equation,

$$(E_0 - \Pi_0 - e_0 + g_0) + r^{\mathrm{t}} \cdot (E_{\mathrm{t}} - \Pi_{\mathrm{t}} - e^{\mathrm{t}} + g^{\mathrm{t}}) = 0. \tag{4.21}$$

This, together with (4.19), determines u and q^{n}. If the government undertakes a small public project $(\mathrm{d}g_0, \mathrm{d}g)$, we have

$$\begin{aligned}&(E_{0\mathrm{n}}\mathrm{d}p^{\mathrm{n}} + E_{0u}\mathrm{d}u - \Pi_{0\mathrm{n}}\mathrm{d}q^{\mathrm{n}} + \mathrm{d}g_0)\\&+ r^{\mathrm{t}} \cdot (E_{\mathrm{tn}}\mathrm{d}p^{\mathrm{n}} + E_{\mathrm{t}u}\mathrm{d}u - \Pi_{\mathrm{tn}}\mathrm{d}q^{\mathrm{n}} + \mathrm{d}g^{\mathrm{t}}) = 0,\end{aligned}$$

and

$$E_{\mathrm{nn}}\,\mathrm{d}p^{\mathrm{n}} + E_{\mathrm{n}u}\,\mathrm{d}u = \Pi_{\mathrm{nn}}\,\mathrm{d}q^{\mathrm{n}} - \mathrm{d}g^{\mathrm{n}}.$$

Since $\mathrm{d}p^{\mathrm{n}} = \mathrm{d}q^{\mathrm{n}}$, these become

$$(E_{0u} + r^{\mathrm{t}} \cdot E_{\mathrm{t}u})\,\mathrm{d}u + \left[E_{0\mathrm{n}} - \Pi_{0\mathrm{n}} + r^{\mathrm{t}\prime}(E_{\mathrm{tn}} - \Pi_{\mathrm{tn}})\right]\mathrm{d}q^{\mathrm{n}} = -(\mathrm{d}g_0 + r^{\mathrm{t}} \cdot \mathrm{d}g^{\mathrm{t}}),$$

and

$$E_{\mathrm{n}u}\,\mathrm{d}u + (E_{\mathrm{nn}} - \Pi_{\mathrm{nn}})\,\mathrm{d}q^{\mathrm{n}} = -\mathrm{d}g^{\mathrm{n}}.$$

So long as there is some substitution between tradeables and non-tradeables, the substitution matrix corresponding to the latter alone will be negative definite. Then we can solve the second equation for $\mathrm{d}q^{\mathrm{n}}$, substitute in the first, and obtain $\mathrm{d}u$. To write the result more simply, define π^{n} by

$$\pi^{\mathrm{n}\prime} = -\left[E_{0\mathrm{n}}' - \Pi_{0\mathrm{n}}' + r^{\mathrm{t}\prime}(E_{\mathrm{tn}} - \Pi_{\mathrm{tn}})\right](E_{\mathrm{nn}} - \Pi_{\mathrm{nn}})^{-1}. \tag{4.22}$$

Thus we have

$$(E_{0u} + r^{\mathrm{t}} \cdot E_{\mathrm{t}u} + \pi^{\mathrm{n}} \cdot E_{\mathrm{n}u})\,\mathrm{d}u = -(\mathrm{d}g_0 + r^{\mathrm{t}} \cdot \mathrm{d}t^{\mathrm{t}} + \pi^{\mathrm{n}} \cdot \mathrm{d}g^{\mathrm{n}}). \tag{4.23}$$

Comparison with (4.12) enables us to interpret this at once. The shadow prices of the tradeables are still the world prices r^{t}, while π^{n} gives the shadow prices of the non-tradeables. The coefficient of $\mathrm{d}u$ on the left-hand side is the Hatta term, which should be positive for stability.

In a distortion-free economy, we have $p^{\mathrm{t}} = q^{\mathrm{t}} = r^{\mathrm{t}}$, $p^{\mathrm{n}} = q^{\mathrm{n}}$, and by homogeneity

$$E_{0\mathrm{n}} + p^{\mathrm{t}\prime}E_{\mathrm{tn}} + p^{\mathrm{n}\prime}E_{\mathrm{nn}} = 0 = \Pi_{0\mathrm{n}} + q^{\mathrm{t}\prime}\Pi_{\mathrm{tn}} + q^{\mathrm{n}\prime}\Pi_{\mathrm{nn}}.$$

Then (4.22) becomes $\pi^{\mathrm{n}} = p^{\mathrm{n}} = q^{\mathrm{n}}$, i.e., the shadow prices of non-tradeables equal their domestic market prices. With distortions, the two can diverge. In fact there is no general guarantee that shadow prices will remain non-negative; this is pointed out by Bhagwati, Srinivasan and Wan (1978). The issue is discussed further by Smith (1980), to pinpoint the source of the difficulties. When the non-tradeable in question is a factor that is inelastically supplied by consumers and does not affect their utilities, any consumption distortions do not matter. Production distortions ($p^{\mathrm{t}} \neq r^{\mathrm{t}}$) are what gives rise to gaps between the shadow prices of factors and the values of their marginal products at market prices. In fact (4.22) becomes

$$\pi^{\mathrm{n}} = -\left(\Pi_{0\mathrm{n}} + r^{\mathrm{t}\prime}\Pi_{\mathrm{tn}}\right)\Pi_{\mathrm{nn}}^{-1},$$

which in Smith's context can be seen as the value of the marginal product at world prices.

Further complications arise from monopoly power in trade, and absence of lump sum transfers; the issues should now be familiar and need not be discussed again.

5. Multi-country trade policy problems

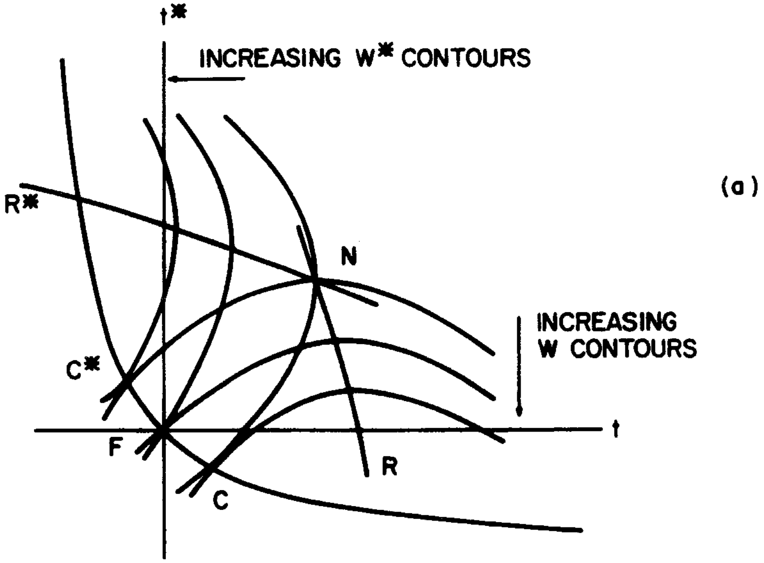
The last three sections dealt with various aspects of trade and tax policies in one country, under the assumption that the rest of the world followed passive policies. The foreign net supply functions were fixed. They could embody any fixed policies in other countries, but did not shift in response to active changes in those policies.

In fact, several countries make policy decisions simultaneously. Each country's welfare can be affected by the policies of all, and each country is aware of this interdependence and of similar awareness or part of others. In this section I shall consider three issues that arise in this context. The first is a game-theoretical analysis of conflict and cooperation in tariff setting, the second is the possibility of a group of countries coordinating their policies for mutual benefit by forming a customs union, and the third concerns harmonization of different countries' tax systems.

5.1. Tariff setting with retaliation

We saw in Sections 2 and 3 how a country could gain by exploiting its monopoly power in trade against a passive world, and derived a formula for first-best optimum tariffs. The question of whether such gains over free trade for one country could exist even when others retaliate with their own tariffs was studied by Johnson (1953–54). His analysis has been extended by Mayer (1981), and that is the approach I adopt.

For expository simplicity, consider a model with two countries and two tradeable goods. The countries are called home and foreign, with all variables pertaining to the latter distinguished by an asterisk superscript. Let t, t^* be the two countries' *ad valorem* tariff rates on their respective import goods. Determine the equilibrium, and write $W(t, t^*)$ and $W^*(t, t^*)$ for the resulting welfare levels.


t*
INCREASING W* CONTOURS
R*
(a)
N
INCREASING
W CONTOURS
C*
t
F
R
C

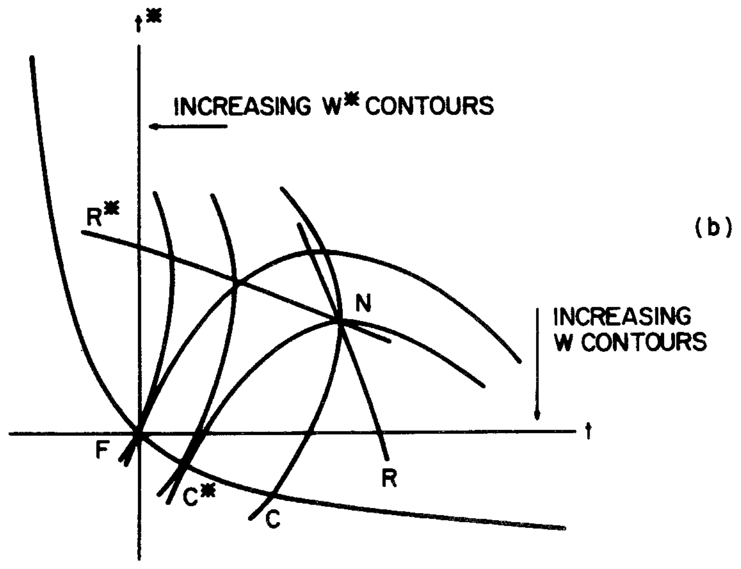

t*
INCREASING W* CONTOURS
R*
(b)
N
INCREASING
W CONTOURS
t
F
R
C*
C

Figure 5.1

In the "normal" case to which I shall confine attention here, the contours of W and W^* are as shown in Figure 5.1. The countries' reaction functions R and R^*, i.e., the loci giving the home and foreign optimum choices of t and t^* corresponding to various given levels of the other country's tariff, are also shown. Detailed discussions of the slopes of these curves can be found in the references given above.

If the tariff game is played non-cooperatively, the usual notion for the outcome is the Nash equilibrium, i.e., the point N where R and R^* meet. Of course this can never be Pareto-superior to the free-trade point F; the latter is Pareto-efficient for the world. But it is possible that one of the countries prefers N to F. Such a case is in Figure (5.1b). In the case of Figure 5.1a, both countries lose from the non-cooperative tariff war relative to free trade. The problem is a standard Prisoner's Dilemma.

Now let the countries cooperate and attain an efficient outcome. Suppose the home country imports good 1, i.e., $p_1 = p_1^*(1+t)$. Similarly $p_2^* = p_2(1+t^*)$. The condition for efficiency is that the relative prices should be equal across countries, so $p_1/p_2 = p_1^*/p_2^*$, or

$$(1+t)(1+t^*) = 1.$$

This locus of Pareto-efficient outcomes is a hyperbola, and is shown in Figure 5.1. The home country prefers points to the south-east along it; the foreign country, to the north-west.

The limits of attainable points along this locus are defined by the outcome that would result if coordination broke down. Suppose this is the Nash equilibrium. Then a negotiated outcome must give each country at least as much welfare as it has at N. This defines the bargaining frontier CC^* of the negotiation game. It is interesting to observe that an outcome on this locus can never involve positive tariffs in both countries. Except at the free-trade point, which lies on the bargaining frontier in the case of Figure 5.1, at least one country must be subsidizing trade.

Economic theory has its usual difficulties in singling out a point on the frontier, or even ruling out a breakdown. Relative bargaining strengths of the countries can vary, depending on their abilities to make credible threats or promises, and their patience and incentives to maintain a reputation if the game is repeated over time. These issues are discussed at length in Schelling (1960, chs. 2, 3, 5), and have implications for tariff negotiations, but not in the form of clear predictions of the outcome.

We can also pose questions similar to those of Section 4 in a many-country world, and look for beneficial gradual reform of all trade policies on a cooperative basis. An example of this is in Hatta and Fukushima (1979). They show that similar rules, e.g., a proportional reduction in all tariffs or a reduction in the largest tariff alone, yield potential benefit to the world. To be precise, the utility possibility frontier for the world shifts outward. International transfers of purchasing power may be necessary if these benefits are to be distributed into a Pareto improvement for the countries.

A case where one country uses trade policy as a second-best response to international externalities is examined by Markusen (1975). The first-best would require coordinated Pigovian taxation, and questions of distribution of gains among countries would arise.

5.2. *Customs unions*

Here we consider a group of countries, with disparate initial trade and tax regimes, getting together to coordinate policies to their mutual benefit. The cooperation may occur in different dimensions. A free-trade area abolishes tariffs among member countries, but allows each to set its own trade policy with non-members. A customs union has free trade among members and common external tariffs against non-members. A common market or economic union will involve further coordination, e.g., in fiscal and monetary policies, migration, etc.

The case of a customs union has been the one most extensively studied. As neither the pre-union nor the post-union outcome is one of complete free trade, the change is subject to the general problem of the second-best. This is the form in which it was first studied. The comparative statics of the move from an arbitrary initial regime to a set of common tariffs at arbitrary rates was examined, and yielded categories of trade-creation which was beneficial, and trade-diversion which could be harmful. The net effect was ambiguous. This literature is surveyed by Lipsey (1970) and Corden (1982).

However, from a normative or policy standpoint, we want to know whether it is possible to *choose* a common tariff to ensure benefit, even though some other level of it may be harmful. This should in principle present no difficulty. It is always possible to arrange the common external tariffs so that non-member countries face the same trading prices as they did before the union. The internal free trade leads to equalization of producer prices in member countries, which is a clear gain in efficiency. The only question is whether the gain can be distributed to consumers. Ohyama (1972) showed how this could be done using lump sum transfers. Dixit and Norman (1980a) extended the proposition to the case where there are no lump sum transfers across or within countries, but commodity taxation can be suitably arranged. These tax or subsidy rates can differ across member countries, but a configuration can be cooperatively implemented to the benefit of all members. An added advantage is that the composition of trade with non-members is exactly the same as before the union, so they are not hurt by the change either. Thus a customs union, with some coordination of the member countries' tax policies, can be arranged to ensure a Pareto improvement over the status quo. The proofs, and the conditions, are the same as those for similar exercises in Section 2, and there are therefore left to the readers.

5.3. Tax harmonization

International conflicts of interest are not confined to trade policies. In general equilibrium, any domestic policy measure by any country can affect all of them. In particular, consider a country's domestic production and consumption taxes or subsidies. We know that a combination of a production subsidy and a consumption tax at equal rates is tantamount to a tariff if the commodity is being imported, and an export subsidy if it is being exported. Thus one might regard a consumption tax on its own, or a production subsidy on its own, as partial substitutes for import restrictions, or export promotion, as the case may be. Import restrictions can harm other countries; export subsidies are regarded as "unfair" trade practices; GATT codes attempt to limit both. Consumption and production taxation has a legitimate domestic policy role for correcting externalities, raising revenues, etc. Ambiguities and conflicts arise when the legitimate policies are used in pursuit of the "harmful" or "unfair" trade aims. The issues involve political and strategic aspects that cannot be resolved here. But simple economic analysis helps correct some misconceptions and establish the economic facts concerning the damage that is alleged.

A case in point arises as follows. The theory speaks of taxing production and consumption *activities*; in practice taxes are collected at points of *transactions*, primarily sales. In any open economy, a production tax can be implemented by taxing sales of commodities which originate in the home country; this is the "origin principle". A consumption tax should similarly be implemented using the "destination principle", i.e., sales would be subject to tax when the buyer was home-based. An alternative is to use the origin method and then apply a "border tax adjustment", i.e., refund the tax for exports, and levy it on imports as if they were produced when brought into the country. This is the method commonly used for the E.E.C.'s Value Added Tax. The import-restricting or export-promoting aspect of a consumption tax is most visible in this border tax adjustment. The United States which rely mostly on direct taxes for which there is no border tax adjustment, have at times regarded such adjustments applied by other countries as unfair trade practices. This has led to calls for international tax harmonization using the origin principle.

Theoretical analyses of the problem generally consider uniform ad valorem taxes on all goods. Since only relative prices matter, such systems are neutral in their effects on trade. The clearest recent statement of this for our purpose is in Grossman (1980). First consider the case where there are no intermediate goods. Let r_k be the prices in the rest of the world, t_0 the origin-based tax rate in ad valorem form, and t_D the similar destination-based rate. Under origin-basing, home producers will receive $r_k/(1+t_0)$, so the relative prices they face will be, for goods 1 and 2, $[r_1/(1+t_0)]/[r_2/(1+t_0)] = r_1/r_2$. Consumers face prices r_k directly. Thus there is no distortion; the tax is effectively a pure rent tax on the incomes of the (inelastically supplied) primary factors. Under destination-basing, home producers face prices r_k and consumers, $r_k(1+t_D)$. Again there is no distortion, and the tax acts like a lump sum tax on the consumers' incomes (rents to the primary factors they supply).

If there are intermediate goods, the neutrality result persists so long as the tax applies to the value added at the processing stage just prior to the taxed transaction. Grossman demonstrates this, and shows how distortions can arise under other systems. In particular, he argues that a change to origin-basing, given the way the value added tax in the E.E.C. is administered, can work against U.S. interests.

Non-uniform tax systems will not be neutral with regard to trade. Theory alone can say little about the likely effects. Hamilton and Whalley (1983) have solved a numerical model of world trade to study the border tax adjustment issue mentioned above. They find that the welfare effects are small in comparison with wider issues of trade liberalization. But the U.S. gets some aggregate net benefit from the existing systems in Europe and Japan. This is because the U.S. is a net importer of manufactured goods from these regions, and such goods have higher rates of taxation there. A border tax adjustment would act like an export tax and worsen the U.S. terms of trade. Of course import-competing producers in the U.S. may gain at the expense of the rest of the economy.

6. Some further topics

The subject of the normative theory of international trade is too large to permit an exhaustive treatment here. In Section 1, I explained the limitations, some imposed by the state of the subject, others self-imposed. In the same way, I have selected three topics for brief treatment in this section. The first is that of quotas, whose practical relevance is running ahead of their theoretical analysis. The second is effective protection, which has been thoroughly analyzed, but is not so centrally placed in the public economics aspects which are my focus here. Finally, there is political economy, or the "positive" study of the effects of conflicting interest groups on the conduct of trade policy.

6.1. Quotas and non-tariff barriers

The traditional instruments of trade policy are tariffs, and the bulk of the theory of the subject is concerned with their effects. However, in recent years, various multilateral agreements have greatly reduced tariff levels, while quotas and other non-tariff barriers to trade have become much more prominent. Theory is beginning to catch up with these developments. Here I shall briefly review some work on quotas.

At the level of Walrasian general equilibrium, no new theory is needed. Each quota or other quantitative restriction has its rent or shadow price. The restriction could be replaced by a tariff at this rate, and the same equilibrium allocation would result, expect perhaps for differential income effects if the tariff revenues and the quota rents are differently distributed. A particularly important practical difference is that significant portions of quota rents go to foreign suppliers, especially if they own distribution channels for imports in the home country. The transfer of rents may be total if the quotas are implemented as "voluntary" export restrictions by other countries. In practice, if the policy bureaucracy allocates the quotas inefficiently, and re-sales cannot occur to restore efficiency, there will be further dead-weight losses which the "equivalent" tariff would have avoided.

Tariffs and quotas can differ in their allocative effects once we step outside the Walrasian model. The case of monoply is discussed, among others, by Bhagwati (1965) and McCulloch (1973), and I shall not repeat those issues here. Even within the Walrasian context, differences arise when the alternative policies are used in a "second-best" context. The equivalence noted above arises when it is possible to choose the rates of tariffs or quotas independently on all economically distinguishable commodities. When it is necessary to choose a common tariff rate for a group of commodities, or a quota applicable to the total of quantities of imports over such a group, we have in each case a second-best policy, and it is not possible to say in general how they will compare with each other.

A case in point is where trade takes place at several dates, with different technologies and preferences at each. The fully optimal policy will select appropriately time-varying tariffs or their equivalent time-varying quotas. Now suppose policy must be fixed in advance, in common for all periods. A uniform quota of this kind will have a shadow price that changes over time, while a uniform tariff will give rise to a changing trade pattern. Which second-best policy will come closer to the full optimum in the sense of producing a smaller welfare loss? The answer depends on the exact nature of the time dependence of the underlying conditions. A similar problem arises when some parameters of the model change. Comparative statics of a tariff regime will differ from those of a quota regime.

Another setting that has been studied a great deal is that of uncertainty. If the policy instruments must be set in advance, i.e., apply at a common rate across all states of the world, similar problems arise. Following the technique developed by Weitzman (1974), such comparisons have been made by Fishelson and Flatters (1975), Pelcovitz (1976) and others. The answers depend on the nature of the uncertainty, and on the slopes of demand and supply curves, as well as on other constraints or targets in the optimization problem. A special case of some interest is where a policy constrained in this way happens to yield the full optimum. This occurs in Young and Anderson (1980). Consider a partial equilibrium setting in which imports m of the good in question yield benefit $B(m)$, so the domestic price is $B'(m)=p$. The foreign price in state s of the world is $p^*(s)$, and the probability of this state occurring is $\theta(s)$. It is desired to maximize expected net benefit

$$\sum_s \theta(s)\{B(m(s))-p^*(s)m(s)\},$$

subject to a constraint on expected import cost

$$\sum_s \theta(s)p^*(s)m(s)\leq \overline{M}.$$

Introducing a multiplier μ for the constraint, the first-order conditions when imports can be varied across states of the world are

$$\theta(s)\{B'(m(s))-p^*(s)\}-\mu\theta(s)p^*(s)=0,$$

i.e.,

$$p(s)=(1+\mu)p^*(s).$$

This policy can be implemented by an ad valorem tariff at rate μ common to all states. If the constraint were on the expected quantity of imports, a uniform specific tariff would be best. More generally, trade restrictions under uncertainty create potential arbitrage gains in shifting contingent quotas across states of nature, and can serve as second-best replacements for missing contingent markets.

A case of particular interest arises when financial markets exist as a partial substitute for complete contingent markets. Helpman and Razin (1980) consider tax and tariff policy in such an economy, and extend several of the targeting results.

Finally, consider a situation of even greater practical relevance. In practice, it is never possible to distinguish commodities as finely as the theoretical ideal, and tariffs or quotas must be levied on relatively broad commodity groups. Thus a country may have a choice between a tariff and a quota on the commodity group "automobiles". In fact there are different kinds of automobiles, less than perfectly substitutable for each other in production as well as consumption. A higher level optimum policy would choose a separate quota, or its equivalent tariff, for each kind. Which of the two coarser policies, a common tariff or a group quota, would come closer to the optimum?

In practice, such groups usually involve commodities that are quite good substitutes for one another. The presumption from optimum taxation theory would be that such commodities should be taxed at nearly equal ad valorem rates. Any departure from this would alter relative prices and cause large substitutions (quantity changes) with their associated dead-weight losses. In our context, this can be seen most easily from the optimum tariff formula (3.8). For simplicity of exposition, suppose the matrix R_m is symmetric, as is the case if preferences in the rest of the world are homothetic (a common assumption in trade theory) or income effects on the group of commodities in question are negligible. Then

$$\tau_k = \sum_l m_l(\partial r_k/\partial m_l),$$

and for $k = 1,2$,

$$\tau_1/r_1 - \tau_2/r_2 = \sum_l \partial \log(r_1/r_2)/\partial \log m_l.$$

When these commodities are very good substitutes in the rest of the world's excess supply, (r_1/r_2) is nearly constant and (τ_1/r_1) should be close to (τ_2/r_2).

In such a case, a uniform ad valorem tariff for the group will closely approximate the full optimum policy. We can also see how a quota for the group will depart from optimality. The shadow price of the quota will provide the wedge between the domestic price and the world price for each commodity in the group, i.e., it will act like a uniform specific tariff. This will imply too low ad valorem tariffs on the commodities with higher world prices, and too high tariffs on ones with low world prices. The rest of the world's supply will accordingly substitute away from the latter and towards the former. Such "quality upgrading" of imports in response to quotas is often observed in practice. It can greatly reduce the effect on domestic employment or output that the trade restriction was designed to achieve. Baldwin (1982) discusses in greater detail this and related undesirable consequences of quantitative restrictions on trade.

6.2. *Effective protection*

Most of the above analysis is based on a very general model of production, which permits all kinds of final goods, intermediate goods and primary factors, tradeable or non-tradeable. All the results concerning welfare effects of policy changes, characterization of optimum policies, etc. are valid in correspondingly general circumstances. All that is needed is convexity of the set of feasible net outputs of each sector, and therefore of the economy as a whole.

It only remains to interpret the results in specific contexts. For pure intermediate goods, for example, consumption optimality conditions are irrelevant, and only the production and trade conditions like (3.6) and (3.7) matter. These imply equalization of marginal rates of transformation through domestic production and trade, which includes preservation of production efficiency.

The traditional theory of trade involving intermediate goods introduces the new concepts of effective tariffs and effective protection. The starting point is that the extent to which a productive activity is encouraged or discouraged depends on the protection available not only to its output but also to its inputs. Tariffs raise the home price of a commodity above the world price. Thus output tariffs should make an activity more profitable and encourage it, while input tariffs should make it more costly and discourage it. Intuition suggests that the net effect should depend on whether the value added per unit scale of this activity at domestic prices exceeds that at world prices. Measuring the scale by the gross output, and letting a_{kl} be the input of the kth good per unit gross output of the lth, the excess of value added at domestic prices above that at world prices is

$$\left\{(r_l+\tau_l)-\sum_k(r_k+\tau_k)a_{kl}\right\}-\left\{r_l-\sum_k r_k a_{kl}\right\}=\tau_l-\sum_k\tau_k a_{kl}. \tag{6.1}$$

This is called the *effective tariff* rate (in specific rather than ad valorem form) for the activity of producing good l. It is supposed to be a determinant of the gross output of this good in the same way that the *nominal tariff* rate τ_l relates to the net output. We now examine whether this works, and whether it can help us in our normative analysis.

In conventional welfare economics, gross outputs or sectoral activity levels are of no concern. What matters is the net production that is available to consumers. And, as Ethier (1977) puts the matter succinctly: "...regardless of the structure of intermediate goods, nominal rates measure the distortions in the terms at which the domestic economy can transform available quantities of goods into each other." This is the implicit content of the general results of Sections 2–4 when applied to models with intermediate goods; explicit derivations of these propositions can be found in Ray (1980).

Gross outputs may enter the analysis via non-economic constraints. As usual, dynamic considerations from a more complex model lie behind these. A typical case is where changes in the terms of trade dictate contraction of some industries, and adversely affect the employment or real incomes of primary factors specific to these. Then there is pressure to maintain the levels of such activities above some floor, and tariff protection is proposed. When such industries use intermediate inputs, is the relevant concept that of effective protection?

At one level, protection of any kind is irrelevant. The theory of Sections 3.1–3.2 continues to apply, and in particular the principle of targeting remains valid. The best way to compensate the losers is not tariff protection at all, whether nominal or effective. It is a subsidy which raises the incomes of the owners of the factors in question, and encourages their employment by firms, without creating any by-product distortions elsewhere. This is discussed in Dixit and Norman (1980a, pp. 184–185).

Now suppose these superior policies are not available, and tariff protection must be used. We can always express each gross output in terms of all nominal tariff rates, and proceed. What is gained by using certain combinations of nominal tariff rates in the manner of (6.1)? If gross outputs can be expressed as functions of just these combinations, there will be some economy of notation and information.

Matters are relatively simple if the input coefficients (a_{kl}) are constant, but otherwise, serious problems arise. It is not clear whether formula (6.1) should be used with the coefficients appropriate to world prices, domestic prices, or some "average". The coefficients are functions of the relative prices of all inputs, intermediate and primary. The domestic prices of the former involve the nominal tariff rates. If these re-enter the analysis in this way, the economy of information is lost. Suitable separability in production may help, but its exact nature and role are unclear. These matters are discussed by Ethier (1977) and Jones and Neary (1982, sec. 3.1).

In some cases the magnitude of interest is not the gross output but something else, e.g., the real return to a primary factor specific to this sector. In each such case, a different combination of nominal rates can be relevant.

Finally, implementation of the policy must be in the form of taxes on international movements of commodities, i.e., the setting of *nominal* tariffs. Therefore it might be better to conduct the analysis in these terms throughout.

To sum up, Samuelson's dictum about consumer surplus seems to apply equally well to effective protection: the concept can safely be used only by those who understand it sufficiently well to do without it.

6.3. *Political economy*

The mainstream theory of public finance has been normative. It postulates a social welfare function, embodying alternative desiderata of efficiency, equity, etc., and the trade-offs among them. It then assumes that the available policy instruments are chosen to maximize this function, subject to constraints of technology, resource availability, compatibility with individual behavior, etc. The results consist of characterizations of optimum policies. The analysis of trade policy that was reviewed above belongs squarely in this tradition.

In recent years, an alternative "positive" view of the process of economic policy making has emerged. Here the policy choices are assumed to result from political action by interested individuals or groups. This literature has been surveyed by Mueller (1979). The branch that is most pertinent to the concerns of this chapter comes from Tullock (1967), Posner (1975) and, most importantly, Krueger (1974). This article led to a large volume of research on the political economy of trade policy; a recent extension and synthesis can be found in Bhagwati (1982).

The underlying idea is as follows. Most of the government's economic policy measures involve the creation or destruction of revenues, profits or rents. Tariffs and taxes produce revenues, subsidies disburse them; quotas create rents; regulation and deregulation can increase or decrease profits depending on the circumstances. Individuals and groups have incentives to obtain these benefits for themselves, and therefore to expend some resources on activities that promote the appropriate policies. These activities can range from lobbying for a tariff to bribing an official to secure the allocation of a quota. Consumers might wish to lobby for less protection, in the interests of lower prices. The success of such activities, singly or in competition with each other, will depend on circumstances. Groups will have to solve an internal free-rider problem to mount such efforts; thus diffuse consumer groups may be at a disadvantage relative to concentrated producers' lobbies.

These profit-seeking activities (the term being understood to include all the kinds mentioned above) do not produce any commodities for consumption. Rather, they produce income transfers, and may also in the process affect some distortions in the economic equilibrium. To the extent that the activities require economic resources (factor inputs), less is available for production of consumable commodities. Even when the primary activity is a pure transfer, such as a bribe, incentives will arise to spend resources in an activity that will help some individual to attain the position where he can receive such bribes. So long as there is some stage at which the relevant profit-seeking activity requires factor inputs and "produces" the profits or rents at constant returns to scale, the entire profit will in equilibrium accure as payments to those factors. In general, there will be at least a partial transformation of the rent or profit into such real resource cost.

Now let us return to our normative viewpoint and assess the economic cost of the policy in question. When there is profit seeking, this comprises not merely the conventional dead-weight burden of the distortion caused by the policy, but also that part (or whole) of the profit that is transformed into factor payments in the seeking activity. The presumption is that the efficiency costs of distortionary policies can be much higher when they are instituted by the process of profit seeking. This is the conclusion of Posner (1975) with regard to monopoly profits, and Krueger (1974) for tariffs and quotas.

Needless to say, further analysis produces several arguments qualifying this presumption. First, not all such activities work toward increasing distortions. A consumer lobby, if it overcame the free-rider problem, might achieve removal of an existing tariff. The efficiency gain from this policy must then be set against the resource cost of the lobbying. Or there may be a pre-existing tariff, and the lobbying may be intended solely to obtain its revenue. Now the price wedge is unchanged, but the move of some resources from the production sectors to the lobbying sector alters the output and trade levels. Since this is a change that takes place in an already distorted economy, it may prove to be beneficial as an instance of the paradox of the second-best. More specifically, we may have a case where the withdrawal of some inputs from productive activities raises the value of the national product at the appropriate shadow prices, which is immiserizing growth run backwards. Bhagwati (1982) discusses and catalogues the various possibilities.

In an economy with rent seeking, the shadow prices appropriate for project evaluation are also affected. Foster (1981) examines this issue, and shows that in some circumstances market prices should be used despite the presence of distortions. The best-known example is the Harris–Todaro model of a developing economy, where migrants from the rural sector spend resources (their own labor time while unemployed in the urban-sector) seeking the institutionally fixed high urban wage. Let w_r, w_u be the wages and marginal products in the two sectors, L the urban labor force, and E the urban employment. Assuming equal probability of employment for all in the urban labor force, and risk neutrality, the expected-wage equalization condition for equilibrium is $w_r = w_u(E/L)$. Now an urban-sector project that employs one person induces additional migration to increase the urban labor force by L/E, and causes the loss of $w_r(L/E) = w_u$ in the form of rural output. This is the opportunity cost of hiring the person, and therefore the shadow wage.

7. Empirical work

Kenen (1975, preface) expressed concern that international trade had become "the last refuge of the speculative theorist". That could never be quite true so long as debates on capital flourished; rapid growth of applied work on trade issues has made it even less valid. Such research on welfare and policy issues was surveyed in the Kenen volume by Corden (1975) and Magee (1975, sec. 4). More recent work is discussed by Greenway (1983, chs. 6, 9, 11). Here I shall give a very selective review of the problems and the literature; a fuller treatment would require at least a chapter by itself.

7.1. General issues and problems

It must be recognized at the outset that empirical work in this area faces formidable problems. Data are at least as scarce and error-prone as in work involving one country, and in addition are often incompatible across countries in coverage and classification. Trade data may also be incompatible with the industrial statistics for each country. There have been some improvements; note for example the sources used by Baldwin (1979, p. 12). But empirical implementation of the theory in an ideal way is still not possible.

Consider the information requirements of the theory developed in Sections 2–4. We need functions representing preferences and technologies, whether in primal form or dual. We need the first-order derivatives of these functions (the demands and supplies), and in places the second-order derivatives (the income and price elasticities of demand and supplies). In principle, we might attempt to estimate flexible functional forms, e.g., trans-log, but reality is some way off. Demand estimates are usually for imports or exports as a whole, or at most a few major commodity categories. In each case, the right-hand side variables are usually confined to income, own price, and sometimes the price of one close substitute. On the production side, detailed input–output tables are available, but information on elasticities of substitution among inputs is very poor.

Even if better data were available, serious econometric problems would remain. In the absence of a carefully specified model of the whole world, estimation of any one demand or supply equation suffers from the usual simultaneity bias. Secondly, since we hope to use the estimation as the basis for calculating the effects of policy changes, the the whole exercise is subject to the Lucas critique: the estimated parameters need not be stable in face of the policy shift.

There are faults on the side of the theory, too. It is the traditional metastatic model of general equilibrium. Therefore it leaves out several important aspects of the real world: increasing returns and imperfect competition, disequilibrium dynamics including adjustment lags and unemployment, money, exchange rates, trade imbalance and a whole lot more. Applied work, both in estimation and in prediction, has to make ad hoc modifications to the model to handle these features where they are deemed important.

One other item that figured prominently in our normative theory was the social welfare function. Applied work has usually stayed well clear of this. Welfare effects are often measured in terms of real income, i.e., concentrating on efficiency and ignoring distribution. Sometimes the effects of a policy on common ad hoc criteria such as employment or the trade balance are computed, with no attempt to fit them into a welfare framework.

When measuring the effects of trade policies, it is important but difficult to pay attention to quantitative restrictions. As measured by their tariff equivalents, they are usually several times more important than explicit tariffs, and dead-weight losses increase faster than linearly with the distortion. However, calculation of the tariff equivalent is no easy matter.

7.2. Marshallian surplus calculations

The first group of actual empirical studies I shall outline is based on the Marshallian methodology, i.e., welfare effects are calculated from the areas of dead-weight loss triangles. Consumer demand functions for individual commodities or groups are either taken from other prior work, or estimated for the purpose. Supply curves are similarly estimated; sometimes they are assumed to be infinitely elastic. Demands for intermediate inputs are handled in some studies by using an input–output table, and neglected in others.

The article by Magee (1972) is clearly worthy of leadership in this list. He computes the welfare effects for the U.S. of various hypothetical policy changes assumed to be implemented in 1971. Some distinguishing features of the work are as follows: (1) It is recognized that changes in dead-weight losses are annual flows, and that the costs of a distortion (or benefits of removing one) will increase over time, because of economic growth, and also because demands and supplies become more elastic in the long run. Adjustment costs (primarily unemployment) of policy changes are also taken into account; these diminish over time. The net effect is calculated using discounted present values. (2) Imports are classified into those which compete directly with U.S. production and those which do not; the price and production effects of tariff changes are calculated separately for the two using different elasticities. (3) Quantitative restrictions are handled by estimating their equivalent tariffs. (4) Macroeconomic effects on the government's budget and monetary policy, exchange rates, etc. are ignored.

Some of the central results are summarized in Table 7.1, adapted from Magee's table 13. They show that the U.S. stands to gain significantly from free-trade policies of its own or its trading partners, and that most of the gains come from elimination of quantitative restrictions. One suspects that these figures are underestimates since they neglect economies of scale, reduction of domestic monopoly power due to increased competition from imports, etc. One also suspects that the conclusions hold even more strongly in 1982 than they did in 1972, given the increased importance of quantitative restrictions in the intervening period.

Several studies were motivated by the multilateral trade negotiations under the auspices of GATT. Those attempting to compute potential benefits from the

Table 7.1
Gains to the U.S. economy from relaxation of trade restrictions ($ billions in discounted present values at 8%, 1971 prices).

Removal of U.S. import restrictions	
Tariffs: Directly competitive imports	19.55
Other imports	13.57
Quantitative restrictions	88.25
Removal of other countries' restrictions on U.S. exports	
Manufactures	11.40
Agriculture (mostly QRs)	125.16

Tokyo Round were carried out while the negotiations were in progress. Thus they missed the actual outcome in all its glory: most tariffs were to be cut from their existing levels t to new levels t' according to the formula $t' = 16t/(16 + t)$. I shall use assumptions about cuts that are roughly comparable across studies.

Cline et al. (1978) examine several tariff cut formulae, and calculate the effects on trade patterns, employment, and overall welfare for several countries. These are short-run or impact effects, expressed in annual terms. Equilibrating changes in exchange rates and terms of trade are allowed, but found to be small in practice for the uniform multilateral tariff cuts considered. The economies are assumed to operate with enough slack to ignore full-employment constraints, and macroeconomic policies are assumed to be passive. Cross-effects both in demand and of the input–output kind in production are ignored.

For a 60% cut in all tariffs in all countries, it is estimated that the U.S. static welfare gains would be $490 million/year. (The total for U.S., Canada, E.E.C. and Japan is $1.4 billion/year.) This would be doubled if quantitative restrictions on textiles were also reduced pro rata. Import-competing industries would lose 90,000 jobs, but export industries would gain 120,000, representing a small net effect (gain of 30,000). Similar results are found for other industrial countries. LDCs are seen to score impressive increases in exports, but overall welfare effects are not given. The effects of removal of quantitative restrictions on textiles are particularly impressive.

Baldwin et al. (1980) conduct a similar analysis. The added features are : (1) Domestic and imported goods are imperfect substitutes. (2) Detailed input–output tables are used for the calculation of indirect effects in production. (3) One-year impact effects are found and capitalized at 10%. The policy change is a uniform 50% tariff cut in all countries. Quantitative restrictions are not removed. The welfare and employment effects for the U.S. are calculated. The benefits at 1967 prices come to $1056 million, swamping the one-off costs of adjustments of

$37 million for labor and $5 million for capital. The employment effect is small (a net loss of 15,400 jobs) as is the terms of trade effect (a 0.003% improvement).

The welfare gains are smaller than those found by Cline et al., and much smaller than Magee's figures. Recall that his figures for the complete removal of tariffs on U.S. imports and exports amount to $40 billion. If demand curves are linear, a 50% cut will achieve 75% of this gain. Magee allows the gains to increase over time at 4% due to growth, and further due to increases in elasticities through time. He also discounts them at a smaller rate. However, it seems that a sizeable discrepancy would remain even if the calculations of Baldwin et al. were modified to do the same.

Baldwin and Murray (1977) examine the effect of the same 50% multilateral tariff reduction on the LDCs. They find substantial benefits (over $2 billion discounted present value) in trade creation, swamping by a factor of 10 the losses that arise as generally lower tariffs erode the special advantage the LDCs have under GSP (Generalized System of Preferences). But they do not compute terms of trade shifts and the consequent welfare changes.

7.3. Computable general equilibrium models

The next group of studies has a closely related methodology, but a tighter general equilibrium framework. Specific functional forms are assumed for preferences and production functions; these are usually CES or some variant. The model is not subjected to any systematic econometric estimation. Some parameters are given values estimated in other contexts; others are educated guesses. Sensitivity studies are often carried out to check how critical the choices are. Finally, some parameters, typically scaling factors, are selected so as to replicate the initial situation as an equilibrium; this is called calibration.

The new equilibrium following the policy change is then solved numerically, using Scarf's algorithm or some other method. The price and quantity changes are thus found; the welfare change is implicit in the preferences and is usually converted to monetary measures for ease of interpretation. Thus the method is purely comparative-static, and ignores any disequilibrium or dynamic adjustment following the policy change.

The methodology is explained in detail for the case of international trade by Shoven and Whalley (1974), and a survey of several applications is in Shoven and Whalley (1983).

To illustrate the approach and compare the results with the Marshallian one, let us consider two studies of the Tokyo Round, Deardorff and Stern (1981) and Whalley (1982). These were carried out after the negotiations were complete, and use the actual cuts agreed, unlike the Baldwin and Cline studies outlined before. The two also differ from each other. Deardorff and Stern (i) treat individual countries, (ii) have no production substitution in their main calculation, and (iii) neglect most proposed changes in quantitative restrictions on the grounds that they were only advisory, and not quantifiable. Whalley (i) considers four country blocks, (ii) allows production substitution, and (iii) deals separately with the effects of the tariff cuts, and of best guesses about how the changes in quantitative restrictions would operate.

The results are qualitatively similar. Tariff cuts give most industrial countries welfare gains. Depending on the method used, Deardorff and Stern obtain totals ranging from \$1.1 billion/year to \$4.3 billion/year. Whalley's U.S., E.E.C. and Japan blocks total gains of \$3.84 billion/year. These figures are in the same range as those of the other studies discussed above. The present authors describe gains as small, being under 0.1% of GNP, but it is not clear why that is a relevant comparison. Employment and exchange rate figures are again small.

The striking new feature is that LDCs can lose as a result of tariff cuts. Deardorff and Stern find welfare losses for most LDCs, with their total ranging from \$112 million/year to \$63 million/year. Whalley's block labelled "Rest of the World", which includes LDCs, loses a more substantial \$1.96 billion/year. Whalley attributes this to terms of trade shifts. The reason in Deardorff and Stern's case is less clear, but there are some countries that suffer substantial losses of trade volume and employment. This is in contrast to the gains found by Cline et al. and Baldwin and Murray.

The effect of quantitative restrictions (non-tariff barriers) is evident from Whalley's results. Table 7.2, adapted from Whalley's table 4, highlights the differences. The reversal of fortunes between the E.E.C. and the "Rest of the World" is remarkable.

I shall mention two more studies to illustrate different applications of the method. Goulder, Shoven and Whalley (1983) examine the issue of international capital mobility. For a small country in a perfect international capital market, the

Table 7.2
Welfare effects measured by Hicksian compensating variations, in \$ billions/year.

Policy change	E.E.C.	U.S.	Japan	Rest of the World	Total
Tariffs cut	2.47	0.43	0.97	−1.93	1.94
Non-tariff barriers lowered	−4.04	1.48	0.38	3.64	1.46
The two together	−2.26	2.26	0.97	2.26	3.23

domestic tax treatment of saving does not affect investment at home; only the net lending abroad is changed. Similarly, a tax distorting the return to investment does not affect saving. In a world without capital mobility, both policies affect the common equilibrium level of domestic saving and investment. Thus the considerations of relative merits of personal income and consumption taxes, and alternative methods of corporate profit taxation, hinge upon the degree of capital mobility. The results show that the empirical importance of this is substantial. Consider a shift from income to consumption basing in personal taxation. Without capital flows, the U.S. economy stands to gain more than $500 billion in discounted present value terms in the central case. With high capital mobility, there can be a welfare loss of almost the same magnitude, because there are large capital outflows which earn only the net-of-foreign-tax return.

Heady and Mitra (1982) introduce an optimization approach, in contrast to the comparisons of two particular policies that characterized the above studies. They use an explicit social welfare function incorporating interpersonal distribution judgments. They also consider cases where the tax instruments are so limited that production efficiency may not be desirable; a systematic theoretical treatment would be quite difficult. Examples based on data on Brazil and India are studied. In particular, they examine the third-best role of tariffs for redistribution when commodity taxation is limited. The answers depend very sensitively on the redistribution parameter and the elasticity of substitution in production.

8. Concluding comment

There is a story of an eminent economist who, when he was a mere lecturer and department chairmen were in a position to give him orders, was asked to teach a course in international trade, a subject in which he was not then an expert. After spending three weeks studying the literature, he announced his finding to his colleagues: "I have been reading all about international trade, and it is just like any other economics." I hope this brief survey will suffice to convince readers that trade policy is just like any other public economics. More importantly, I hope it will contribute to the acceleration of the recent and welcome trend towards the routine incorporation of international trade in public finance models.

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