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Tariffs, Optimal Taxes, and Collection Costs

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Abstract

This paper studies an optimal tax problem for a small open economy where collecting taxes is costly. It is shown that, in the presence of collection costs modeled as an increasing function of the tax rate: (a) the standard rules of optimal commodity taxation (the Ramsey, the inverse elasticity, the Corlett-Hague rules) may no longer be valid; (b) tariffs may replace domestic taxes as a second-best revenue-raising device; and (c) the optimal tariff/tax structure may be uniform rather than differentiated.

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Summary

When discussing the choice among alternative commodity taxes, economists have traditionally been concerned with excess burdens, considered to be the efficiency costs of taxation. Because tariffs distort production as well as consumption, they have been considered inferior to domestic consumption taxes as a revenue-raising device. However, the optimal taxation literature has ignored the administrative costs of taxation--the considerable collection costs, which differ substantially from one commodity to another, and the fact that some taxes are easier to collect than others.

The tax policy literature has noted that although tariffs are less efficient in allocating resources than are domestic consumption taxes, they constitute a major revenue source for countries with poorly developed tax administration because they are relatively easy and inexpensive to collect and, therefore, administratively more efficient than retail sales taxes or value-added taxes. However, the nature of the trade-off between the resource-allocation and budgetary effects of tariffs has never been clarified. Instead, the trade and development literature has emphasized the positive resource-allocation and long-term welfare effects of tariff reductions, neglecting their potentially negative medium-term budgetary effects.

This paper integrates collection costs into the standard open-economy model of optimal commodity taxation and develops an analytical framework that rationalizes the use of tariffs as a second-best revenue-raising device. A simple optimal tax problem is set up for a small open economy where collecting taxes is costly. It is shown that, in the presence of collection costs modeled as an increasing function of the tax rate, the standard rules of optimal commodity taxation (the Ramsey, the inverse elasticity, the Corlett-Hague rules) may no longer be valid: tariffs may replace domestic taxes as a second-best revenue-raising device; and the optimal tariff/tax structure may be uniform rather than differentiated. The empirical relevance of these results is discussed, and it is argued that for plausible values of parameters, there is a nontrivial probability that trade taxes may become part of (or the only element in) an efficient tax-revenue package in a small open economy.

I. Introduction

This paper has two objectives: to stress the need for integrating collection cost considerations into the standard open-economy model of optimal commodity taxation and to develop an analytical framework rationalizing the use of tariffs as a second-best revenue-raising device in countries without well-developed tax administration. To achieve these goals, we set up a simple optimal tax problem for a small open economy in which the government chooses among alternative taxes not just on the basis of their excess burdens (the traditional focus in the optimal tax literature), but also on the basis of resources used in tax collection. We show that, in the presence of collection costs modeled as an increasing function of the tax rate, the standard rules of optimal commodity taxation (the Ramsey, the inverse elasticity, and the Corlett-Hague rules) may no longer be valid; that tariffs may be a more efficient way to raise revenue than domestic consumption taxes; and that the optimal tax rates may be uniform rather than differentiated.

An inquiry into the role of collection costs in models of optimal commodity taxation is motivated by theoretical as well as policy concerns. Most of the theoretical literature implicitly assumes that collecting taxes is costless or that the costs are the same for all taxes, so that, on the margin, collection costs do not make any difference. This is an incorrect assumption. The resources used in tax collection are not negligible; some taxes are easier to collect than others; and, even for the same tax, collection costs differ substantially from one commodity to another. The choice of optimal tax instruments must be based on both administrative and efficiency grounds. We shall corroborate this view by showing that some established theorems on optimal commodity taxation are quite sensitive to the collection-cost assumption. For example, we shall show that higher tax rates should not be applied to commodities with low demand elasticities if the taxes on such commodities also are relatively costly to collect. This may be viewed as yet another complication in an already complex literature, but in our opinion its importance is hard to overemphasize.¹

On the tax policy side, it has been observed that, although tariffs are less efficient than consumption taxes in terms of their allocative effects, they constitute a major revenue source for countries with poorly developed tax administration because, compared with other forms of taxation, they are relatively easy and inexpensive to collect.² The budgetary effect of tariffs, however, has been a neglected issue in the policy literature on open economy taxation. With few exceptions (e.g., Blejer and Cheasty (1990)), the fiscal role of tariffs has gone unmentioned in the literature on stabilization and trade liberalization in developing and socialist countries. The literature has emphasized the positive resource-allocational and long-term welfare effects of tariff reductions, but has ignored their potentially negative budgetary effects. Because these negative effects are likely to appear when the government needs extra revenue to smooth the adjustment process, and because alternative taxes are invariably more difficult and more costly to collect (or cannot be introduced quickly because of the state of tax administration), it is not obvious that tariff reductions represent an optimal policy from the viewpoint of efficiency and welfare. One of the goals of this paper is to clarify the nature of the trade-off between the resource-allocational and budgetary aspects of tariffs.

This paper builds on the standard optimal tax model developed by Frank Ramsey, whose mentor, A.C. Pigou, posed him the problem of raising, without lump-sum taxes, a given amount of revenue "by proportionate taxes on some or all uses of income, the taxes on different uses being possibly at different rates" in order that "the decrement of utility may be a minimum" (Ramsey (1927), p.

¹ For similar opinions see Corden (1974, ch. 4), Sandmo (1976, p. 52), Atkinson and Stiglitz (1980, p. 455), Mirrlees (1986, p. 1199), Stiglitz (1987, p. 1038), Musgrave (1987, p. 259), Diamond (1987, p. 644), and Slemrod (1990, p. 163). One notable exception is Harry Johnson (1965, p. 7), who dismissed administrative costs as "of practical rather than theoretical consequence."

² The share of trade tax revenue in total tax revenue in developing countries in the mid-1980s ranged between 3.6 percent and 79 percent, the average for a group of middle-income countries being 23.2 percent. The corresponding extremes for the former socialist countries of Central and Eastern Europe were 1.6 percent and 16.1 percent, and the average was 6.4 percent. The average for the OECD countries was 1.3 percent (International Monetary Fund (1989)).

47). After Ramsey, the optimal tax problem lay dormant for more than 20 years; further contributions were made by Samuelson in 1951 and Corlett and Hague in 1953. After that, another 20 years passed before the problem was rediscovered by Dixit (1970), Diamond and Mirrlees (1971a, b), Andersen (1972), Atkinson and Stiglitz (1972), and Sandmo (1974).³ The main result of this literature is a (counterintuitive) proposition that optimal tax rates should be differentiated rather than uniform. To this result we shall add a number of caveats related to collection costs, such as the aforementioned qualification of the inverse elasticity rule.

Another branch of the literature on which we shall build is the theory of optimal revenue-raising tariffs. The grandfathers of this literature are Pigou (1947) and Meade (1955a, b). The more recent contributors include Boadway, Maital and Prachowny (1973); Corden (1974); Dasgupta and Stiglitz (1974); Bliss (1980); Smith (1980); and Dixit (1985).⁴ Two main results of this literature are (1) when tariffs are the only instrument to raise revenue, the optimal revenue-raising tariffs are inversely related to the excess demand elasticities, and they are higher than tariffs that optimally exploit the country's monopsony (or monopoly) position in trade,⁵ and (2) when domestic taxes are available, tariffs are an inferior revenue-raising device unless collection costs are taken into account. This qualification is Corden's (1974), and it was first analytically substantiated by Riezman and Slemrod (1985), although their analysis is incomplete. Our contribution to the literature consists of showing that the inverse elasticity rule for tariffs may be reversed when collection costs are taken into account and of proving Corden's conjecture. We also shall show that, unlike consumption taxes, the uniformity of tariffs because of different collection costs is less likely to obtain in an optimum.

To establish the outlined results, we first integrate collection costs into a standard model of optimal commodity taxation.⁶ Given our objectives, we do not strive to develop a model with a fully specified tax collection technology. We concentrate instead on a very simple specification of collection costs, leaving the more elaborate and perhaps more interesting questions for future research. Our approach initially closely follows that of Riezman and Slemrod (1985), who studied the mix of consumption and trade taxes in a standard three-good model of a small open economy and postulated a tax collection technology that is an increasing function of the tax rate.

We describe the optimal tax problem and derive its first-order conditions in Section 2. In Section 3 we characterize the structure of optimal consumption taxes in the presence of collection costs; in Section 4 we perform the same analysis for trade taxes. This dichotomy follows the established approach developed in public finance theory (taxation in closed economies) and the theory of international trade (optimal revenue-raising tariffs). In Section 5 we bring together the two strands of the literature and study the optimal mix of consumption taxes and tariffs in the presence of collection costs. In Section 6 we discuss the uniformity issue in the presence of collection costs. We conclude in Section 7 with some remarks on the empirical relevance of our results.

II. The Model

Goods. Consider a small open economy consisting of two production sectors and a single representative household. There are many competitive firms in each sector; they are owned by the household members and have access to the same technology, with labor as the only input. The household members have an endowment of T hours of time, which they divide between L hours of

³ For surveys, see, among others, Sandmo (1976), Samuelson (1982), Stiglitz (1987), and Stern (1987).

⁴ "Optimality" here refers to the requirement that tariffs raise a given amount of revenue at the smallest possible cost in terms of social welfare.

⁵ On the second point, see the classic paper by Johnson (1950), and extensions by Tower (1976, 1977).

⁶ Aspects of the theory of collection costs in models of optimal commodity taxation have been studied by Corden (1974), Heller and Shell (1974), Yitzhaki (1979), and Wilson (1989).

work and H hours of leisure. Good 1 is an importable; good 2 is an exportable; the amounts consumed are denoted C_i , the amounts produced domestically X_i , and the amounts traded $Z_i \equiv C_i - X_i$.

Prices. Under the small-open-economy assumption, the world prices of goods 1 and 2 are taken as given; they are denoted p_i^* . For simplicity, we assume that the exchange rate is fixed at unity and denote the prices expressed in domestic currency units p_i . From the structure of the model it follows that the balance of trade, $p_1 Z_1 + p_2 Z_2 = 0$, is maintained by adjusting the taxes rather than the exchange rate. No loss of generality is implied by this assumption, because both the exchange rate and the tariffs move the domestic price ratio of tradeables, relative to the world market price ratio, in the same direction. Finally, labor is paid its marginal-product value, denoted v .

Taxes. In keeping with the literature, we assume that commodity taxes can be levied only at the border and the point of purchase -- i.e., only consumption and foreign trade can be taxed.⁷ Producers sell their output in the domestic market at prices $r_1 = p_1 + \tau_1$, and $r_2 = p_2 - \tau_2$, where τ_1 is the import tariff and τ_2 is the export tax. Consumers purchase these goods at prices $q_1 = p_1 + \tau_1 + t_1$ and $q_2 = p_2 - \tau_2 + t_2$, where t_1 and t_2 are the (specific) rates of domestic consumption tax.

In addition to commodity taxes, the model also allows for taxes on wage income, t_{L_i} , and profit income, t_{π_i} , $i = 1, 2$. The tax base for the wage tax is the consumer's wage income in sector i , vL_i . Because labor can be treated as a negative consumption good (i.e., as the obverse of a third good, leisure), the wage tax analytically is equivalent to an ordinary commodity tax. We therefore express the wage tax in a specific form as well; net wage income is then $wL_i = (v - t_{L_i})L_i$, $i = 1, 2$.

The second type of income tax in this model is the profit tax, t_{π_i} . To simplify analysis, we assume that profits are fully taxed away (this is equivalent to assuming government ownership of firms or constant returns to scale), which implies that consumers receive no income in the form of economic profits.⁸ The weight of public-sector production in developing and socialist countries lends some credibility to this assumption, so we believe that it is not too restrictive in the policy context with which we are dealing. Next, we assume that commodity taxes can be set without constraint, which includes the possibility that they can be set optimally. These two assumptions enable us to invoke the well-known theorems on optimal taxation and production efficiency established by Diamond and Mirrlees (1971a, b), Stiglitz and Dasgupta (1971), and Dasgupta and Stiglitz (1972), according to which no differential factor taxes should be imposed.⁹ Thus, we can set $t_{L_i} = t_{L_i}$, $i = 1, 2$.

Collection costs. The tasks set forth in the introduction do not require a detailed specification of the technology of tax administration, so we rely on a simple model of collection costs. The main

⁷ Commodity taxes also could be levied at a third point in this model -- the point of production. From the perspective of collection costs this is an intermediate case between the low-cost trade taxes and the high-cost consumption taxes. By assuming away this case we are forgoing some interesting theoretical questions, but because we are not constructing a theory of collection costs per se, but rather developing a case for such a theory, no loss of generality follows from this assumption.

⁸ Allowing for partial profit taxation requires considerable modification of the standard model; cf. Stiglitz and Dasgupta (1971), Dasgupta and Stiglitz (1972, 1974), and Munk (1978, 1980).

⁹ The theorems in question state that if the government must raise a given amount of revenue without using the lump-sum taxes and wants to minimize the deadweight loss of the tax system, then, under the above assumptions, it should not impose differential factor taxes or other taxes that affect the production efficiency of the economy. The intuition behind this result is that, with no constraints on commodity taxes, any set of after-tax prices, including the optimal one, can be achieved with commodity taxes alone. The assumption of zero-profit income also plays a role in normalization and the choice of untaxed good (see below).

assumption is that collection costs are an increasing function of the tax rate. In what follows, we elaborate briefly on the nature of collection costs and present arguments in support of this assumption.

In general, three types of costs are associated with administration and collection of taxes. First are the costs of administering the tax system in a narrow sense (the costs of assessing tax liability, collecting the various taxes, auditing tax documents, etc.). Labor costs of ensuring compliance probably are the largest component of these costs. Second, taxpayers incur resource costs (mostly their time) as they try to comply with their tax obligations while minimizing the payment or try to evade taxes altogether.¹⁰ Third, society as a whole incurs some opportunity costs by devoting its scarce resources to activities connected with tax avoidance and tax evasion, such as legal counsel on matters of taxation, political activities aimed at forming a social contract with taxpayers, and the bargaining and lobbying activities of special interest groups. To strengthen the case for the empirical relevance of collection costs, we shall include all of the above in our definition of collection costs.

Collection costs depend on a number of factors, such as the measurability of the tax base, the number of taxpayers, the extent to which they are dispersed or concentrated in space and time, the number of different tax rates and their magnitudes, the equipment used by tax administrators, etc. With regard to these factors, trade taxes have some distinct advantages: imports and exports usually flow through a few ports or border crossings, which are easy to police; the definition of the tax base is straightforward; the calculation of tax liability does not require highly skilled labor; and tax compliance is relatively easy to enforce. To simplify analysis, we shall assume that all such factors are correlated with the revenue requirement, which is, in turn, a combination of two vectors of endogenous variables, tax bases and tax rates. Clearly, collection costs are an increasing function of the revenue requirement: the more revenue needs to be raised, the greater the amount of resources that need to be devoted to tax administration. But additional revenue can be raised in a number of ways, so a further distinction must be made regarding the sources of change (tax rate, tax base) and the *ceteris paribus* conditions.¹¹

Consider the tax base. As revenue needs increase over time, more and more commodities and services become subject to consumption taxes, more and more types of income become taxable, and more organizations become liable for the payment of enterprise income taxes. Each time the tax base is widened, tax administration incurs some fixed cost, after which collection costs are likely to remain constant until a further expansion of the tax base takes place. There is, however, a physical as well as an economic limit to the expansion of the tax base, beyond which further attempts to capture the taxes become prohibitively costly. Usually well before this limit is reached, additional revenue is raised by increasing the tax rate rather than widening the tax base. For small changes in the tax rate we should expect the corresponding change in collection costs to be small or even negligible (but nevertheless positive). This method is thus preferred by tax administrators. But it has its limits, too. Because taxes are always assessed on only some fraction of the tax base, as tax rates increase, taxpayers rearrange their activities (e.g., purchases) away from the taxed sectors. Eventually, the tax base begins to shrink and revenues may begin to fall (in the case of tariffs, fewer goods are declared at the border and smuggling increases). To keep net revenue constant, tax collectors must reach into untaxed sectors, which means that tax administration will have to expand.

¹⁰ Opportunity losses suffered by taxpayers who choose to rearrange their activities as part of an avoidance or evasion effort represent distortion costs (excess burdens) in the traditional sense and hence do not constitute a component of collection costs.

¹¹ Ideally, optimal tax rates and tax bases should be determined simultaneously for all taxes, but in our case this would make the government's optimization problem too complicated. Yitzhaki (1979) solves this problem in a two-good (taxed/untaxed) model with the Cobb-Douglas utility and the recycling of tax revenue via lump-sum transfers. He obtains an intuitively plausible result that, in an optimum, the marginal cost (in terms of the utility loss) of raising an additional dollar of revenue via the tax base must equal the cost of raising this amount via the tax rate.

Thus, collection costs seem to be an increasing function of the tax rate as well as the tax base. Because in our model the tax bases -- consumption, trade, and labor -- are fixed (i.e., we do not separate commodities and labor into taxed and untaxed), we shall assume that the collection costs depend on the tax rate only. This collection cost function can be interpreted as a reduced form of a more general function for collection costs, where the factors determining the size of collection costs (such as the labor cost of tax administrators and the time spent by taxpayers filling out tax forms) are all positively correlated with the tax rate.¹² The collection cost functions are thus of the form

$$\begin{array}{llll} a(\tau_1, \tau_2), & a_i > 0, \quad i=1,2 & a(0,0) = 0 \\ b(t_1, t_2), & b_i > 0, \quad i=1,2 & b(0,0) = 0 \\ c(t_L) & c' > 0, & c(0) = 0, \quad 0 \leq t_L < v \\ d(t_\pi) & d' > 0, & d(0) = 0, \quad 0 \leq t_\pi \leq 1 \end{array} \quad (1)$$

where $a(\cdot)$, $b(\cdot)$, $c(\cdot)$, and $d(\cdot)$ denote the collection cost functions for trade, consumption, wage, and profit taxes, respectively. For mathematical convenience we shall assume that these functions are continuously differentiable over their domains. Notice that the tax rates for commodity taxes can be positive as well as negative, but whether taxes are collected or subsidies disbursed, the administrative costs are positive. Although the wage tax analytically is equivalent to a commodity tax, the tax rate for the wage tax is assumed to be non-negative and bounded away from v ; this reflects our assumption of no non wage income. Logically, there can be no collection costs when tax rates are zero.

Consumer optimization. The preferences of a representative household in this economy are described by a strictly concave, monotonic, and continuously differentiable utility function $U(C_1, C_2, L)$, with partial derivatives $U_1, U_2 > 0$, $U_L < 0$. Because the labor supply enters the utility function with a negative sign (as the obverse of a third good, leisure) the household's budget constraint can be written as

$$q_1 C_1 + q_2 C_2 - wL \leq M \quad (= 0) \quad (2)$$

where the outside (non wage or transfer) income M is restricted to zero. Given the price system $(q_1, q_2, w) \in R_+^3 - \{0\}$, the optimization problem for the household is to choose non-negative amounts of C_1, C_2 and L to maximize the utility of consumption subject to budget and time endowment constraints:

$$\begin{array}{ll} \text{Max} & U(C_1, C_2, L) \\ \text{s. t.} & (i) \quad q_1 C_1 + q_2 C_2 - wL \leq M \\ & (ii) \quad L + H \leq T \end{array} \quad (3)$$

The above assumptions ensure that a solution of this problem is unique and that the two constraints are binding at the optimum. First-order necessary conditions for this problem (assuming an interior solution) are given by

¹² A more satisfactory modeling strategy would be to include such considerations as the resource costs of avoidance or evasion explicitly and not through a reduced form function for collection costs. Then one could pose questions such as, Is it better to go to third-best instruments such as tariffs or to step up enforcement activity for commodity taxes? (I am indebted to Professor Dixit for this remark.) However, factors determining collection costs are inherently difficult to model explicitly, and because the focus of this paper is to show that collection cost considerations can radically alter some long-held views on optimal commodity taxation, we opt for a simpler model.

$$\begin{aligned} U_1 - \lambda q_1 &= 0 \\ U_2 - \lambda q_2 &= 0 \\ -U_L + \lambda w &= 0 \end{aligned} \tag{4}$$

where λ is the La Grange multiplier corresponding to the budget constraint. Together with the budget constraint, these first-order conditions can be solved for equilibrium (Marshallian) demand functions $C_1^*(q_1, q_2, w)$ and the equilibrium labor supply function $L^*(q_1, q_2, w)$. When substituted back into the utility function, they define the maximum level of utility obtainable at prices (q_1, q_2, w) and income M , or the indirect utility function $V(q_1, q_2, w, M)$:

$$U(C_1^*, C_2^*, L^*) = V(q_1, q_2, w, M) \tag{5}$$

Like the Marshallian demands, V is homogeneous of degree zero in q_1, q_2, w , and M .

Producer optimization. The production possibilities are described by the transformation function

$$F(X_1, X_2, L) \leq 0 \tag{6}$$

where $F(\cdot)$ is assumed to be a strictly convex, monotonic function defined on R^3 , with partial derivatives $F_1, F_2 > 0$, and $F_L < 0$. Given a production price system $(r_1, r_2, v) \in R_+^3 - \{0\}$, the competitive supply of the production sector is determined by choosing positive amounts of X_1, X_2 , and L that solve

$$\begin{aligned} \text{Max} \quad & r_1 X_1 + r_2 X_2 - vL \\ \text{s. t.} \quad & F(X_1, X_2, L) \leq 0 \end{aligned} \tag{7}$$

From the above assumptions it follows that when this problem has a solution, this solution is unique and, at the optimum, the constraint is binding. First-order conditions for this problem (assuming an interior solution) are given by

$$\begin{aligned} r_1 - \mu F_1 &= 0 \\ r_2 - \mu F_2 &= 0 \\ -v + \mu F_L &= 0 \end{aligned} \tag{8}$$

This system can be solved for equilibrium supply functions $X_1^*(r_1, r_2, v)$ and $X_2^*(r_1, r_2, v)$ and the equilibrium labor demand function $L^*(r_1, r_2, v)$; these functions are homogeneous of degree zero in (r_1, r_2, v) . When substituted back into the objective function these functions define maximum profits available at prices (r_1, r_2, v) or the economy's profit function $\Pi(r_1, r_2, v)$:

$$r_1 X_1^*(r_1, r_2, v) + r_2 X_2^*(r_1, r_2, v) - vL^*(r_1, r_2, v) = \Pi(r_1, r_2, v) \tag{9}$$

Clearly, $\Pi(\cdot)$ is homogeneous of degree 1 in (r_1, r_2, v) .

Normalization and the choice of untaxed good. Because the household receives no exogenous income in the form of either negative or positive lump-sum transfers from the government or in the form of profits (i.e., producer prices do not affect the household's decisions via the profits of firms), the consumer demand functions are homogeneous of degree zero in consumer prices, and they

can be normalized by selecting a *numeraire* good. Similarly, we can normalize the producer prices because the supply functions are homogeneous of degree 0 in (exogenous) producer prices. Thus, we can assume that one good is untaxed and regard this assumption, without any loss of generality, as just a normalization rule (cf. Munk (1978; 1980)). Following the tradition in the optimal taxation literature, we select labor as the untaxed good and set $t_L = 0$ and $v = w = 1$.

Government optimization. The government is assumed to have a fixed revenue requirement \bar{R} , which it uses to purchase predetermined amounts \bar{G}_1 and \bar{G}_2 of goods 1 and 2 from domestic producers. Government consumption does not affect the welfare of households via lump-sum transfers or public goods supplies. To raise \bar{R} , distortionary taxes must be levied, because lump-sum taxes are assumed to be unavailable (for example, they may be prohibitively costly to administer). Profit taxes alone are assumed to be insufficient to finance government spending, so consumption and trade taxes must be deployed as well. Raising the revenue, however, is costly, so the government must take into account not only the yield of various taxes, but their collection costs as well. In addition, the government must set the taxes so as not to disturb the production efficiency of the economy and so as to keep trade in balance.

Taking these constraints into account, the government seeks to maximize social welfare, i.e., the utility of a representative household. This can be thought of as a two-stage optimization problem. In the first stage household members maximize utility and firms maximize profits, taking the prices and taxes as given; this leads to a general equilibrium allocation of resources in the economy. In the second stage the government sets the taxes, knowing how agents will respond and knowing how the general equilibrium system will adjust to these taxes. This optimization problem can be formulated as follows:

$$\begin{aligned} \text{Max} \quad & V(q_1, q_2, w, M) \\ \text{s. t.} \quad & \tau_1, \tau_2, t_1, t_2 \\ & \text{(i)} \quad \bar{R} \leq R = \Pi^* + \tau_1(C_1 - X_1) + \tau_2(X_2 - C_2) + t_1 C_1 + t_2 C_2 - a(\tau_1, \tau_2) - b(t_1, t_2) \\ & \text{(ii)} \quad p_1(C_1 - X_1) + p_2(C_2 - X_2) = 0 \\ & \text{(iii)} \quad F(X_1, X_2, L) = 0 \end{aligned} \tag{10}$$

Here Π^* is the revenue from profit taxation net of collection costs; $\Pi^* = t_\pi \Pi(r_1, r_2, v) - d(t_\pi) = 1 \cdot \Pi(r_1, r_2, v) - d(1)$. (We assume that $\Pi > d(1) > 0$.)

Balance equations for the economy. The basic balance equation for this economy is that the sum of private and government consumption, valued at domestic prices, plus the costs of collecting the taxes be equal to domestic production plus net exports valued at domestic prices:

$$q_1 C_1 + q_2 C_2 + G + a + b + d = r_1 X_1 + r_2 X_2 + [p_2(X_2 - C_2) - p_1(C_1 - X_1)] \tag{11}$$

where $G = p_1 \bar{G}_1 + p_2 \bar{G}_2$, i.e., we assume that -- out of administrative concerns! -- the government purchases are tax free. Next, the labor supply of household members must equal the labor demand by the firms in the two sectors, and it must not exceed the available time endowment:

$$L^*(q_1, q_2, 1) = L^*(r_1, r_2, 1) \leq T \tag{12}$$

Finally, foreign trade must be balanced at world prices ($p_i^* = e \cdot p_i = 1 \cdot p_i$):

$$p_1(C_1 - X_1) + p_2(C_2 - X_2) = 0 \tag{13}$$

Calculation of optimal taxes. The Lagrangean function for the government's optimization problem is

$$\mathcal{L}(\tau_1, \tau_2, t_1, t_2, \eta) = V(q_1, q_2, w, M) + \eta \{ [\tau_1 + (p_1/p_2)\tau_2] (C_1 - X_1) + t_1 C_1 + t_2 C_2 + \Pi^* - a(\tau_1, \tau_2) - b(t_1, t_2) - \bar{R} \} \quad (14)$$

where η is the La Grange multiplier associated with the government's budget constrain and where equation (13) was used to substitute out exports from the expression for tax revenue. First-order conditions for an interior maximum of \mathcal{L} with respect to the choice variables τ_1 , τ_2 , t_1 , and t_2 are¹³

$$\begin{aligned} \tau_1: & -\lambda C_1 + \eta \{ (C_1 - X_1) + [\tau_1 + (p_1/p_2)\tau_2 + t_1] C_{11} - t_2 C_{21} \\ & \quad - [\tau_1 + (p_1/p_2)\tau_2] X_{11} - a_1 \} = 0 \\ \tau_2: & \lambda C_2 + \eta \{ (p_1/p_2)(C_1 - X_1) - [\tau_1 + (p_1/p_2)\tau_2 + t_1] C_{12} - t_2 C_{22} \\ & \quad + [\tau_1 + (p_1/p_2)\tau_2] X_{12} - a_2 \} = 0 \\ t_1: & -\lambda C_1 + \eta \{ C_1 + [\tau_1 + (p_1/p_2)\tau_2 + t_1] C_{11} - t_2 C_{21} - b_1 \} = 0 \\ t_2: & -\lambda C_2 + \eta \{ C_2 + [\tau_1 + (p_1/p_2)\tau_2 + t_1] C_{12} - t_2 C_{22} - b_2 \} = 0 \end{aligned}$$

where $C_{ij} = \partial C_i / \partial q_j$, $X_{ij} = \partial X_i / \partial r_j$, $a_j = \partial a / \partial \tau_j$, and $b_j = \partial b / \partial t_j$, $i, j = 1, 2$. The first term in each of these equations is obtained from Roy's theorem (actually a differential equation discovered by Antonelli in 1886), where $C_i(q_1, q_2, 1) = -(\partial V / \partial q_i) / (\partial V / \partial M)$ and where we use the fact that $\partial V / \partial M = \lambda$. The above first-order conditions can be simplified by rearranging the terms and using the notation

$$t' = [\tau_1 + (p_1/p_2)\tau_2 + t_1], \quad \tau' = [\tau_1 + (p_1/p_2)\tau_2].$$

This gives

$$\begin{aligned} \tau_1: & t' C_{11} + t_2 C_{21} = [(\lambda - \eta) / \eta] C_1 + X_1 + \tau' X_{11} + a_1 \\ \tau_2: & -t' C_{12} - t_2 C_{22} = -[(\lambda - \eta) / \eta] C_2 - X_2 - \tau' X_{12} + a_2 \\ t_1: & t' C_{11} + t_2 C_{21} = [(\lambda - \eta) / \eta] C_1 + b_1 \\ t_2: & t' C_{12} + t_2 C_{22} = [(\lambda - \eta) / \eta] C_2 + b_2 \end{aligned}$$

Finally, we use the Slutsky decomposition of price derivatives of consumer demands, $C_{ij} = s_{ij} - C_j(\partial C_i / \partial M)$, where s_{ij} is the price derivative of compensated (Hicksian) demand functions $C_i(q_1, q_2, 1, \bar{U})$. Collecting the income terms, writing $m = t' [\partial C_1 / \partial M] + t_2 [\partial C_2 / \partial M]$, and using the symmetry of substitution effects, we get

$$\frac{t' s_{11}}{C_1} + \frac{t_2 s_{12}}{C_1} = \frac{\lambda - \eta}{\eta} + m + \frac{a_1}{C_1} + \frac{X_1}{C_1} + \frac{\tau' X_{11}}{C_1} \quad (15)$$

$$-\frac{t' s_{21}}{C_2} - \frac{t_2 s_{22}}{C_2} = -\frac{\lambda - \eta}{\eta} - m + \frac{a_2}{C_2} - \frac{X_2}{C_2} - \frac{\tau' X_{12}}{C_2} \quad (16)$$

¹³ For a discussion of the necessity of these conditions, see Diamond and Mirrlees (1971b), Section X.

$$\frac{t's_{11}}{C_1} + \frac{t_2s_{12}}{C_1} = \frac{\lambda - \eta}{\eta} + m + \frac{b_1}{C_1} \quad (17)$$

$$\frac{t's_{21}}{C_2} + \frac{t_2s_{22}}{C_2} = \frac{\lambda - \eta}{\eta} + m + \frac{b_2}{C_2} \quad (18)$$

These equations implicitly define the optimal structure of trade and consumption taxes used to raise revenue in the presence of collection costs. In the next section we show that some well-established optimal taxation theorems may no longer be valid when collection costs are taken into account.

III. Optimal Consumption Taxes and Collection Costs

1. The Ramsey rule and collection costs

In a closed economy where only consumption taxes are used, equations (17) and (18) read

$$\frac{t_1s_{11}}{C_1} + \frac{t_2s_{12}}{C_1} = \frac{\lambda - \eta}{\eta} + m + \frac{b_1}{C_1} \quad (19)$$

$$\frac{t_1s_{21}}{C_2} + \frac{t_2s_{22}}{C_2} = \frac{\lambda - \eta}{\eta} + m + \frac{b_2}{C_2} \quad (20)$$

If collection costs are zero, these equations are identical to the standard first-order conditions from the theory of optimal commodity taxation (see, e.g., equation (9) in Sandmo (1976)), and they can be used to state the familiar Ramsey rule:

Proposition 1 (The Ramsey rule).

Optimal commodity taxes should be set so that the proportionate reduction in (compensated) demand (the left-hand sides of equations (19) and (20)) is the same for all the commodities (i.e., equal to $m' + (\lambda - \eta)/\eta$).

That $m' + (\lambda - \eta)/\eta$ is indeed negative (m' denotes $t_1(\partial C_1/\partial M) + t_2(\partial C_2/\partial M)$) can be shown in the following way. Multiply equation (19) by t_1C_1 and equation (20) by t_2C_2 , add, and rearrange to get

$$(t_1 \ t_2)' \begin{pmatrix} s_{11} & s_{12} \\ s_{21} & s_{22} \end{pmatrix} \begin{pmatrix} t_1 \\ t_2 \end{pmatrix} = \left(m' + \frac{\lambda - \eta}{\eta} \right) [t_1C_1 + t_2C_2]$$

On the left-hand side we have a quadratic form which is negative (the Slutsky matrix is negative semidefinite), while on the right-hand side the term in brackets is positive (by assumption, the government wants to raise a positive amount of revenue). Hence, $(m' + (\lambda - \eta)/\eta)$ must be negative. The same result holds true if we include collection costs. The parenthesized expression on the right-hand side then reads $(b_1/C_1 + b_2/C_2 + m' + (\lambda - \eta)/\eta)$ and, again, it must be negative.

In the presence of collection costs, the right-hand sides of equations (19) and (20) are no longer equal. Because the term b_i/C_i is positive, the right-hand side will be less negative when marginal collection costs are higher and vice versa. Alternatively, we can move the collection cost terms to the left-hand side and observe that, in an optimum, commodity taxes should be set so that, on the margin,

the reduction in compensated demand, including the resources forgone in tax collection, is the same for all commodities:

$$\frac{t_1 s_{11}}{C_1} + \frac{t_2 s_{12}}{C_1} - \frac{b_1}{C_1} = \frac{\lambda - \eta}{\eta} + m' \quad (19')$$

$$\frac{t_1 s_{21}}{C_2} + \frac{t_2 s_{22}}{C_2} - \frac{b_2}{C_2} = \frac{\lambda - \eta}{\eta} + m' \quad (20')$$

Thus, when collection costs are taken into account, the Ramsey rule of optimal commodity taxation is modified as follows:

Proposition 2: (The Ramsey rule with collection costs).

Optimal commodity taxes should be set so that the reduction in (compensated) demand is greater for the good with lower collection cost; i.e., the higher the marginal collection costs relative to the tax base, the less that good ought to be used to raise the revenue.

The intuition behind this result is straightforward. If, for example, raising an additional dollar of revenue by a slight increase in a tax on gasoline requires a smaller sacrifice in utility than raising this amount by a tax on food products, then the gasoline tax clearly is more efficient.

2. The inverse elasticity rule and collection costs

Next we solve equations (19) and (20) for the optimal tax rates t_1 and t_2 . This will enable us to discuss two more theorems -- the inverse elasticity rule and the Corlett-Hague rule -- and see how they are affected in the presence of collection costs. First we rewrite equations (19) and (20) as follows:

$$\begin{aligned} t_1 s_{11} + t_2 s_{12} &= -kC_1 + b_1 \\ t_1 s_{21} + t_2 s_{22} &= -kC_2 + b_2 \end{aligned}$$

where $-k = (m' + (\lambda - \eta)/\eta) < 0$. Solving these two equations for t_1 and t_2 yields

$$t_1 = -k \frac{s_{22}C_1 - s_{12}C_2}{s_{11}s_{22} - s_{12}^2} + \frac{s_{22}b_1 - s_{12}b_2}{s_{11}s_{22} - s_{12}^2} \quad (21)$$

$$t_2 = -k \frac{s_{11}C_2 - s_{21}C_1}{s_{11}s_{22} - s_{12}^2} + \frac{s_{11}b_2 - s_{21}b_1}{s_{11}s_{22} - s_{12}^2} \quad (22)$$

When the demands are independent, $s_{12} = s_{21} = 0$, so the above expressions simplify to

$$t_1 = -k(C_1 / s_{11}) + b_1 / s_{11}$$

$$t_2 = -k(C_2 / s_{22}) + b_2 / s_{22}$$

So far we have been working with specific tax rates, but they can always be converted into ad valorem rates by dividing the t_i by q_i :

$$\theta_1 = (-k/\sigma_{11}) + (b_1/C_1) / \sigma_{11} \quad (21')$$

$$\theta_2 = (-k/\sigma_{22}) + (b_2/C_2) / \sigma_{22} \quad (22')$$

where $\theta_i = (t_i/q_i)$ are the ad valorem tax rates and $\sigma_{ii} = s_{ii}(q_i/C_i)$ are the compensated own-price elasticities, $i = 1, 2$.¹⁴ The term (b_i/C_i) is the ratio of marginal collection costs relative to the tax base; we shall call it *relative collection costs*. When collection costs are zero, we obtain the familiar inverse elasticity rule:

Proposition 3 (The inverse elasticity rule).

When the demands are independent, the optimal consumption taxes should be set so that the ad valorem tax rates are inversely proportional to the compensated own-price elasticities of demand, i.e., the commodities with low demand elasticities should attract high tax rates and vice versa.

This result also has a clear intuitive interpretation. Minimizing the deviations from a nondistorted pretax allocation requires that the highest taxes be imposed on goods the demand for which shrivels least when their price increases. This is a well-known canon of public finance, understood and applied in fiscal practice for centuries. In a partial-equilibrium framework the inverse elasticity rule was first derived by Ursula Hicks (1947).

Will the introduction of collection costs reverse the inverse elasticity rule? If so, we shall obtain an important qualification to this widely used principle of efficient taxation. For simplicity, assume that $\sigma_{11} > \sigma_{22}$, i.e., that good 2 has a less elastic demand. Therefore, we should expect $\theta_2 > \theta_1$. In order for the inverse elasticity rule to be reversed, it must be the case that

$$\theta_1 - \theta_2 = \frac{1}{\sigma_{11}} \left(-k + \frac{b_1}{C_1} \right) - \frac{1}{\sigma_{22}} \left(-k + \frac{b_2}{C_2} \right) > 0, \quad \text{i.e.,} \quad \frac{\sigma_{22}}{\sigma_{11}} > \frac{-k + \frac{b_2}{C_2}}{-k + \frac{b_1}{C_1}}$$

Because by assumption, $\sigma_{22}/\sigma_{11} < 1$, and $-k + (b_i/C_i) < 0$ (from the first-order conditions), a necessary (but not sufficient) condition for the above inequality to hold is that $(b_2/C_2) > (b_1/C_1)$.¹⁵ Thus, if the relative collection costs for a commodity with a lower price elasticity of demand are sufficiently higher, this commodity need not attract a higher tax rate, as the simple elasticity rule would predict. Quite the contrary, we may want to impose a higher tax rate on the commodity whose compensated elasticity of demand is higher, if it also happens to have lower collection costs. Optimal tax rates are thus inversely related to both the compensated own-price elasticity of demand and the relative collection costs (this, of course, holds true only locally):

$$\frac{\partial \theta_i}{\partial \left(\frac{b_i}{C_i} \right)} = \frac{1}{\sigma_{ii}} < 0 \quad i = 1, 2 \quad \frac{\partial \theta_i}{\partial \sigma_{ii}} = \frac{-(-1)(-k + \frac{b_i}{C_i})}{(\sigma_{ii})^2} < 0 \quad i = 1, 2$$

Thus, we have

¹⁴ These expressions are obtained as follows (for simplicity, we ignore collection costs):
 $\theta_i = t_i/q_i = (-k/q_i) (C_i/s_{ii}) = (-k/q_i) \{ C_1 / [s_{ii} (q_i/C_i) (C_i/q_i)] \} = -k/\sigma_{ii}$.

¹⁵ For example, let $\sigma_{22} = -1$, $\sigma_{11} = -2$, $k = 1$, $(b_1/C_1) = 0.5$, and $(b_2/C_2) = 0.8$. Then $\sigma_{22}/\sigma_{11} = 0.5$, while $(-k + b_2/C_2) / (-k + b_1/C_1) = 0.4$.

Proposition 4 (The collection-cost rule).

When the demand functions are independent, the optimal consumption taxes are inversely proportional to the relative collection costs. The inverse elasticity rule may be reversed provided the relative collection costs on a high-elasticity commodity are sufficiently low compared with the relative collection costs on a low-elasticity commodity.

In setting optimal taxes, the government thus faces a trade-off between the distortionary and administrative aspects of taxes. Finding a balance between these two concerns may involve tax policies that deviate from the simple inverse elasticity rule. The empirical relevance of this proposition depends on the extent to which the sales of low-elasticity goods are difficult to monitor. For example, some low-elasticity goods (wine, spirits) can be home-produced and sold through unofficial outlets, while others, such as gasoline, are technologically complex to produce and sales are easy to monitor.

3. The Corlett-Hague rule and collection costs

The Corlett-Hague rule states that, in a model with a labor/leisure choice and two consumption goods, the tax rate on a commodity that is complementary with leisure should be higher than the tax rate on a commodity that is complementary with labor (i.e., substitutable for leisure). To derive this result, we must convert the Slutsky terms from equations (21) and (22) into the elasticity form using the relation

$$s_{ij} = \sigma_{ij}(C_i / q_j):$$

$$\theta_1 = S^{-1} (C_1 C_2 / q_1 q_2) [-k(\sigma_{22} - \sigma_{12}) + \sigma_{22}(b_1 / C_1) - \sigma_{12}(b_2 / C_2)] \quad (23)$$

$$\theta_2 = S^{-1} (C_1 C_2 / q_1 q_2) [-k(\sigma_{11} - \sigma_{21}) + \sigma_{11}(b_2 / C_2) - \sigma_{21}(b_1 / C_1)] \quad (24)$$

where $S = s_{11}s_{22} - s_{12}^2$. For the case of zero collection costs, similar formulae have been derived by Corlett and Hague (1953), Meade (1955b), Diamond and Mirrlees (1971b), Andersen (1972), Sandmo (1976), and Auerbach (1985). To interpret equations (23) and (24) in terms of complementarity and substitutability with leisure, we use two familiar results from consumer theory: (1) strict concavity of the utility function implies that the Slutsky matrix is negative definite ($s_{11}s_{22} - s_{12}^2 > 0$), and (2) homogeneity of degree zero of compensated demand functions implies that $\sigma_{10} + \sigma_{11} + \sigma_{12} = 0 = \sigma_{20} + \sigma_{21} + \sigma_{22}$ (from $\sum_j s_{ij}q_j = 0$).¹⁶ Using (2) to substitute out σ_{22} and σ_{11} from equations (23) and (24), we obtain

$$\theta_1 = S^{-1} (C_1 C_2 / q_1 q_2) [-k(-\sigma_{20} - \sigma_{21} - \sigma_{12}) - (\sigma_{20} + \sigma_{21})(b_1 / C_1) - \sigma_{12}(b_2 / C_2)] \quad (23')$$

$$\theta_2 = S^{-1} (C_1 C_2 / q_1 q_2) [-k(-\sigma_{10} - \sigma_{12} - \sigma_{21}) - (\sigma_{10} - \sigma_{12})(b_2 / C_2) - \sigma_{21}(b_1 / C_1)] \quad (24')$$

If collection costs are zero, then we have

$$\theta_1 - \theta_2 = S^{-1} (C_1 C_2 / q_1 q_2) [-k(-\sigma_{20} + \sigma_{10})] \quad (25)$$

which will be positive only if $\sigma_{20} > \sigma_{10}$. This means that the government should impose a higher tax rate ($\theta_1 > \theta_2$) on the commodity with a lower compensated cross-elasticity of demand with labor ($\sigma_{20} > \sigma_{10}$). That is, goods that are complementary with leisure (substitutes for labor), such as the skis and sailboats, should be taxed more heavily than goods that are substitutes for leisure (complements with labor), such as telephones, copiers, and commuter services.

¹⁶ σ_{10} and σ_{20} denote the compensated cross-elasticities of goods 1 and 2 with respect to the price of labor (commodity 0), i.e., with respect to the wage rate.

Proposition 5 (The Corlett-Hague rule).

In a three-good model, the ad valorem rates of consumption tax on goods 1 and 2 should be set so that $\theta_1 > \theta_2$ ($\theta_1 < \theta_2$) according as $\sigma_{10} < \sigma_{20}$ ($\sigma_{10} > \sigma_{20}$). In other words, a higher tax rate should be imposed on a good that is more complementary with leisure (less substitutable for labor).

Because cross-elasticities can be positive as well as negative numbers, a remark on the above inequalities is in order. One possibility is to have one good (say, good 2) complementary with labor, so that $\sigma_{20} > 0$, and the other good complementary with leisure, so that $\sigma_{10} < 0$. Then we have $\sigma_{20} > \sigma_{10}$ and equation (25) is positive, i.e., $\theta_1 > \theta_2$. Another possibility is to have σ_{20} and σ_{10} positive, but $\sigma_{20} \neq \sigma_{10}$; i.e., both goods are complements with labor (substitutes for leisure), but one of them is more complementary than the other. Let $\sigma_{10} > \sigma_{20}$. Substituting into equation (25), we get $\theta_2 > \theta_1$, i.e., the government should more heavily tax the second good, which competes less with leisure (is less complementary with work) than does the first good.¹⁷

The basic insight of the Corlett-Hague analysis is that if we cannot tax leisure directly, we can do so indirectly, by taxing the goods that tend to be used during leisure time. If we could tax all goods -- including leisure -- then a *uniform tax* on all commodities would be optimal, as it would be equivalent to a lump-sum tax on the consumer's time endowment. But leisure is an unobservable, and the proxies for individual time endowment -- such as a person's earning ability -- are only imperfectly observable, so the uniform taxation of all goods and the lump-sum faculty tax are both infeasible. The Corlett-Hague result provides a way of "getting at" leisure, which is why it has important policy implications.

Like the Ramsey rule and the inverse elasticity rule, the Corlett-Hague result is derived under the implicit assumption that taxes are costless to collect. Let us, therefore, see how this rule is affected by collection costs and, in particular, whether it can be reversed. Subtracting equation (24) from equation (23), we get

$$\begin{aligned}\theta_1 - \theta_2 &= S^{-1} (C_1 C_2 / q_1 q_2) [\sigma_{10} (-k + b_2/C_2) - \sigma_{20} (-k + b_1/C_1)], \text{ or, for short:} \\ \theta_1 - \theta_2 &= S^{-1} (C_1 C_2 / q_1 q_2) [\sigma_{20} A_1 - \sigma_{10} A_2]\end{aligned}$$

where $-A_1 = (-k + b_1/C_1) < 0$, and $-A_2 = (-k + b_2/C_2) < 0$. Thus, we shall have $\theta_1 > \theta_2$ if $\sigma_{20} A_1 - \sigma_{10} A_2 > 0$, that is, if $\sigma_{20} A_1 > \sigma_{10} A_2$. The Corlett-Hague rule would be reversed if we had, e.g., $\sigma_{10} < \sigma_{20}$, but b_1/C_1 were greater than b_2/C_2 by an amount sufficient to make $\theta_1 > \theta_2$. In other words, we would choose to tax the good with lower collection costs more heavily, even though its cross-elasticity with labor was higher (i.e., even though it was more complementary with labor). As above, we must consider the fact that cross-elasticities can be positive as well as negative numbers. Again three cases present themselves.

(1) Let $\sigma_{20} > \sigma_{10} > 0$, and let $b_1/C_1 > b_2/C_2$, so that $A_2 > A_1$. Then the Corlett-Hague result is reversed, provided that $\sigma_{20}/\sigma_{10} < A_2/A_1$.

(2) If $\sigma_{20} = \sigma_{10} (> 0)$, then clearly $\theta_1 = \theta_2$ only if $A_1 = A_2$ (i.e., $b_1/C_1 = b_2/C_2$); otherwise $\theta_1 > \theta_2$ according as $A_1 > A_2$ (i.e., according as $b_1/C_1 < b_2/C_2$).

¹⁷ Notice that both goods cannot be substitutes for labor. We defined the commodity "labor" so that $s_{i0} = -s_{0i}$, $i = 1, 2$ and because the own-price effects are negative ($-s_{00} < 0$), at least one more element in the first row of the Slutsky matrix, $-s_{01}$ or $-s_{02}$, must be positive.

(3) If $\sigma_{20} > 0 > \sigma_{10}$ then the Corlett-Hague result continues to hold, regardless of collection costs; i.e., we should tax the complements with leisure at a higher rate, even if it costs more to collect the taxes on leisure complements than it does on leisure substitutes. This is a surprising result, because intuitively we would expect collection costs to play a more decisive role in determining the relative size of tax rates. In summary, we have

Proposition 6 (The Corlett-Hague rule with collection costs).

When collection costs are present, $\theta_1 > \theta_2$ according as $\sigma_{10}(-k + b_2/C_2) - \sigma_{20}(-k + b_1/C_1) > < 0$. The Corlett-Hague rule continues to hold unless

(1) $\sigma_{20} > \sigma_{10} > 0$ and $\sigma_{20}/\sigma_{10} < (-k + b_2/C_2) / (-k + b_1/C_1)$; or

(2) $\sigma_{10} > \sigma_{20} > 0$ and $\sigma_{20}/\sigma_{10} > (-k + b_2/C_2) / (-k + b_1/C_1)$;

i.e., unless the collection costs associated with the good more complementary with labor are sufficiently lower than those associated with the good more substitutable for labor. If $\sigma_{10} = \sigma_{20}$, one should impose a higher tax rate on the good with lower collection costs.

Unlike the inverse elasticity rule, the Corlett-Hague rule seems to be more robust in the presence of collection costs. Only if both commodities are complementary with labor could the difference in collection costs account for the reversal of the Corlett-Hague rule. This seems to lend at least some theoretical justification (apart from distributional considerations) to the policy of levying high excises on luxuries such as yachts, jewelry, sports cars, and skis, all of which tend to be associated with leisure.

IV. Optimal Revenue-raising Tariffs and Collection Costs

In this section we assume that there are no domestic consumption taxes and consider import tariffs and export taxes as the only sources of revenue. Consumer prices are then equal to producer prices, and they both differ from world prices for the amount of trade taxes: $q_1 = r_1 = p_1 + \tau_1$; $q_2 = r_2 = p_2 - \tau_2$. The optimization problem for the government now is to choose τ_1 and τ_2 so as to

$$\begin{aligned} \text{Max} \quad & V(q_1, q_2, 1, M) \\ \text{s.t.} \quad & \bar{R} \leq R = \Pi^* + \tau_1(C_1 - X_1) + \tau_2(X_2 - C_2) - a(\tau_1, \tau_2) \end{aligned} \quad (26)$$

and subject to balanced trade and production efficiency conditions. First-order conditions for this problem (assuming an interior optimum) are

$$\tau_1: -\lambda C_1 + \eta \{(C_1 - X_1) + \tau_1(C_{11} - X_{11}) + \tau_2(X_{21} - C_{21}) - a_1\} = 0$$

$$\tau_2: -\lambda C_2(-1) + \eta \{(X_2 - C_2) + \tau_1[C_{12}(-1) - X_{12}(-1)] + \tau_2[X_{22}(-1) - C_{22}(-1)] - a_2\} = 0$$

Substituting the Slutsky equations into these first-order conditions and rearranging, we get

$$(\tau_1/Z_1)(s_{11} - X_{11}) - (\tau_2/Z_1)(s_{21} - X_{21}) = (\lambda/\eta + \tilde{m})(C_1/Z_1) - 1 + a_1/Z_1 \quad (27)$$

$$-(\tau_1/Z_2)(s_{12} - X_{12}) + (\tau_2/Z_2)(s_{22} - X_{22}) = -(\lambda/\eta + \tilde{m})(C_2/Z_2) + 1 + a_2/Z_2 \quad (28)$$

where $\tilde{m} = \tau_1(\partial C_1/\partial M) - \tau_2(\partial C_2/\partial M)$ and where it is assumed that, in equilibrium, imports and exports (Z_1 and Z_2) are not zero. These conditions can be rewritten in terms of excess demand derivatives $z_{ij} = (s_{ij} - X_{ij})$, $i, j = 1, 2$, as follows:

$$\tau_1 z_{11} - \tau_2 z_{21} = -\varphi_1 + a_1 \quad (27')$$

$$-\tau_1 z_{12} + \tau_2 z_{22} = -\varphi_2 + a_2 \quad (28')$$

where $-\varphi_1 = (\lambda/\eta + \tilde{m}) C_1 - Z_1 < 0$, $-\varphi_2 = -(\lambda/\eta + \tilde{m}) C_2 + Z_2 < 0$.

To verify the sign of these inequalities we use the properties of the matrix of excess demand derivatives $Z = [z_{ij}]$, $i, j = 1, 2$. As we know from the stability theory, if the short-run equilibrium that clears the goods markets is to be attained through a stable *tatonnement* process, the determinant of this 2×2 matrix must be positive. From economic theory we know that the diagonal terms are unambiguously negative. However, for equations (27') and (28') to be negative we also want Z to have positive off-diagonal elements. To this end we assume gross substitutability, $z_{12} > 0$ and $z_{21} > 0$, which is a plausible assumption in the 2×2 case.¹⁸ Now it is easy to verify that the terms on the left-hand sides of equations (27') and (28') are indeed negative, so the terms on the right-hand sides must be negative, too.¹⁹

When interpreting optimality conditions (27) and (28) it is useful to draw an analogy to the first-order conditions (19) and (20) from the theory of optimal commodity taxation in closed economies. We saw that in the absence of collection costs the Ramsey rule required that optimal taxes be set so that the proportional reduction in compensated demand is the same for all commodities. In open economies the requirement is that trade taxes be set so that the reduction in *excess demand* (imports and exports) be proportional to the ratio of consumption to *excess demand* (or inversely proportional to the excess demand/domestic consumption ratio), the factor of proportionality being $(\lambda/\eta) + \tilde{m}$.²⁰

Proposition 7 (The Ramsey rule for open economies).

In a two-sector, one-factor model of a small open economy, the optimal revenue-raising tariff and export tax should be set so that imports and exports each fall in the same proportion relative to consumption/imports and consumption/exports ratios.

Notice that this result conforms nicely with intuition. Unlike domestic consumption taxes, trade taxes affect production in addition to consumption, so they must reduce excess demands (imports and exports). Imports fall because, following a tariff-induced increase in domestic price, the consumption of importables decreases while their output increases (because the supply curves slope upward). Exports fall because an increase in the export tax reduces the price of exportables, whereupon the domestic production of exportables falls and their consumption increases. In addition, there are cross-effects of trade-tax changes that operate via substitutability: a higher tariff increases the demand for exportables and reduces their supply, so the excess supply of good 2 is reduced (i.e., excess demand becomes less negative), while a higher export tax reduces the demand for importables (because exportables become cheaper at home) and increases their supply (because the relative price of exportables has fallen), so excess demand again is reduced.

¹⁸ We are assuming only that the supply curves slope upward ($X_{11} > 0$ and $X_{22} > 0$) and that resources are limited, so when output in industry i increases, it must be on account of resources drawn from industry j (i.e., $X_{ij} < 0$, $i \neq j$). In our model, labor supply is ultimately limited by the time endowment T . Before that limit is reached, more labor could be supplied to both sectors by reducing leisure, so we must assume that X_{12} and X_{21} are not positive.

¹⁹ Notice that the two sides of equation (28) are positive -- not negative as in equation (28') -- because there we divide with $Z_2 < 0$.

²⁰ This term is positive, because λ (the marginal utility of income) and η (the marginal social value of a decrease in \bar{R}) are both positive, while the outside income is assumed to be zero, so $\tilde{m} = 0$. In general, income effects are positive, assuming, as we do, that all goods are normal. However, the term $\tilde{m} = \tau_1 (\partial C_1 / \partial M) - \tau_2 (\partial C_2 / \partial M)$ could be negative: because we are dealing with compensated demands, when the price of exportables falls, the purchasing power of the consumer's income increases, so in order to get a change in compensated demand we must take away from the consumer a lump-sum amount of income equivalent to this increase in purchasing power.

To see how collection costs may affect this result, it is useful to solve equation (27') and (28') for an optimal tariff and an optimal export tax.²¹

$$\tau_1 = Z^{-1} [(-\varphi_1 z_{22} - \varphi_2 z_{21}) + (a_1 z_{22} + a_2 z_{21})] \quad (29)$$

$$\tau_2 = Z^{-1} [(-\varphi_1 z_{12} - \varphi_2 z_{11}) + (a_1 z_{12} + a_2 z_{11})] \quad (30)$$

where $Z = z_{11}z_{22} - z_{12}^2$. These formulae are considerably more complicated than the corresponding expressions for optimal commodity taxes because they involve price derivatives of supply functions, for which some of the convenient properties of the Slutsky substitution terms do not hold (e.g., $X_{12} \neq X_{21}$, so that $z_{12} \neq z_{21}$). But we can always restrict ourselves to some special case, such as the independent supply and demand functions. With $s_{12}=s_{21}=0$ and $X_{12}=X_{21}=0$, the optimal trade taxes are given by

$$\tau_1 = \frac{1}{z_{11}} (-\varphi_1 + a_1) \quad \tau_2 = \frac{1}{z_{22}} (-\varphi_2 + a_2)$$

Next, we introduce the excess demand elasticities:

$$z_{11} = \zeta_{11} (Z_1 / q_1) < 0 \quad (\zeta_{11} < 0; Z_1 > 0)$$

$$z_{22} = \zeta_{22} (Z_2 / q_2) < 0 \quad (\zeta_{22} > 0; Z_2 < 0)$$

and consider the ad valorem tariffs $T_1 = \tau_1/q_1$, $T_2 = \tau_2/q_2$.²²

$$T_1 = \frac{1}{\zeta_{11}} \cdot \frac{-\varphi_1 + a_1}{Z_1} > 0 \quad (\zeta_{11} < 0; (-\varphi_1 + a_1) < 0; Z_1 > 0) \quad (31)$$

$$T_2 = \frac{1}{\zeta_{22}} \cdot \frac{-\varphi_2 + a_2}{Z_2} > 0 \quad (\zeta_{22} > 0; (-\varphi_2 + a_2) < 0; Z_2 < 0) \quad (32)$$

It is easy to verify that an optimal revenue-raising tariff (export tax) is a decreasing function of marginal collection costs, and that it is inversely proportional to the elasticity of excess demand for importables (exportables). This conforms with our intuition, but we must interpret the inverse elasticity rule for trade taxes more carefully than for domestic taxes, because ζ_{11} and ζ_{22} are composed of demand and supply elasticities, so the excess demand can be elastic when the demand and/or supply are not and vice versa. These properties of optimal revenue-raising tariffs can be summarized as follows.

Proposition 8 (Optimal tariffs, excess demand elasticities, and collection costs).

With independent demands and supplies, the optimal structure of tariffs, *ceteris paribus*, calls for

- (1) higher tariffs (export taxes) on goods with low elasticities of excess demand and vice versa;
- (2) lower tariffs (export taxes) on goods with high marginal collection costs and vice versa.

²¹ A special case occurs when $|\varphi_1|/Z_1 = \varphi_2/Z_2$; then the reduction in domestic consumption/excess demand ratio should be smaller for the good with higher collection costs: if $a_1/Z > a_2/Z_2$, then $|(-\varphi_1 + a_1)/Z_1| < (-\varphi_2 + a_2)/Z_2$.

²² Although the substitution term z_{22} is negative, the own-price elasticity of excess demand for exportables ζ_{22} is positive, because when the price of exportables increases, the domestic demand (which is lower than the domestic supply to begin with) decreases, while the domestic supply increases, thus increasing the excess supply, i.e., making the (negative) excess demand more negative.

We note two interesting implications of this proposition. The first is that the inverse elasticity rule for trade taxes can be reversed when collection costs are taken into account. Earlier results in the literature on optimal revenue-raising tariffs that correspond to equations (31) and (32) (e.g., Dasgupta and Stiglitz (1974), eqs. 4.7 and 4.9; Bliss (1980), eqs. 15 and 31) thus may no longer be valid if the costs of collecting the customs duties differ by commodity. In particular, if the price elasticity of excess demand is the same for both goods, and the ratios of excess demand to domestic consumption also are the same, then the optimal tariff structure normally should be uniform. But if the collection costs for tariffs and export taxes are different, in an optimum we should always impose different tax rates. Like the corresponding result for optimal commodity taxes (Proposition 4), this result has important implications for the uniformity of optimal taxes, and it will be further discussed in Section 6.

The second implication of Proposition 8 follows from the fact that increasing trade taxes (unlike increasing consumption taxes) moves the relative prices in the same direction, i.e., away from world market prices. If we interpret the Ramsey rule for small open economies as a policy that keeps domestic prices close to world prices (see Riezman and Slemrod, 1985), then in an optimum it may not be desirable to tax both exports and imports. Increasing τ_1 pushes domestic relative prices away from world relative prices, and if this policy is followed by an increase in τ_2 , the domestic relative prices will move still further in the "wrong" direction. On the other hand, if one increases t_1 , increasing t_2 will push the domestic relative prices in the right direction. This implies that the choice between tariffs and export taxes could depend mainly on the relative collection costs of the two taxes.

V. Optimal Mix of Consumption and Trade Taxes

As discussed in the introduction, one of the themes in the literature on optimal revenue-raising tariffs has been the proposition that tariffs, unlike domestic taxes, are a third-best revenue-raising device. Basic intuition behind this result is that, in addition to a distortion in consumption, tariffs also induce a distortion in production, so the excess burden of raising a given amount of revenue through tariffs is likely to be higher than if the same revenue were raised through consumption or production taxes alone. Corden ((1974), ch. 4) indicated that this argument could be reversed in favor of tariffs if one took into account their low collection costs relative to alternative taxes. In this section we prove Corden's conjecture and thus complete the analysis of Riezman and Slemrod (1985), who provided the only earlier analytical treatment of this hypothesis. We first establish the following result.²³

Proposition 9 (Tariffs are a third-best device to raise revenue).

In a model of a small open economy, when both consumption taxes and trade taxes can be used to raise revenue and costs of collecting the taxes are zero, only consumption taxes should be used.

To prove this proposition, it must be shown that the reduction in compensated demand brought about by consumption taxes raising a given amount of revenue (denoted $V(t)$) is smaller than the reduction in compensated excess demand induced by trade taxes raising the same amount of revenue (denoted $V(\tau)$). From the first-order conditions (17) and (18) we have

$$V(t) = C_1^{-1} (t_1 s_{11} + t_2 s_{21}) + C_2^{-1} (t_1 s_{21} + t_2 s_{22}) \quad (33)$$

²³ This proposition is the missing part in the analysis of Riezman and Slemrod (1985). The result is indicated in a footnote as a direct implication of the first-order conditions for optimality, but it is not proved, nor does it follow trivially from these conditions. Interestingly, although many authors have derived the third-best properties of tariffs, none of them have done so directly, by comparing the changes in compensated demand caused by alternative taxes. Instead, most authors impose the requirement that the government expenditure must be financed using trade taxes alone. As a result, domestic producer prices no longer equal world producer prices, and domestic and foreign rates of transformation are no longer equal. (See, e.g., Dixit, 1985, pp. 339-340.)

Assuming that income effects are zero (in our model the government taxes away all profits before they are distributed to the household) and maintaining the assumption of zero collection costs, it also follows from equations (17) and (18) that

$$C_1^{-1} (t_1 s_{11} + t_2 s_{21}) = (\lambda - \eta) / \eta = C_2^{-1} (t_1 s_{21} + t_2 s_{22})$$

This enables us to express $V(t)$ as

$$V(t) = 2 C_1^{-1} (t_1 s_{11} + t_2 s_{21})$$

Next, we find a corresponding expression for $V(\tau)$. From the first-order conditions (15) and (16) it follows that, when collection costs are zero,

$$V(\tau) = 2 C_1^{-1} (\tau' s_{11} - \tau' X_{11} - X_1) \quad (34)$$

where, as before, $\tau' = [\tau_1 + (p_1/p_2)\tau_2]$. To complete the proof, we must show that $V(t)$ is less negative than $V(\tau)$, i.e., that $V(t) - V(\tau) > 0$:

$$V(t) - V(\tau) = 2 C_1^{-1} s_{11} (t_1 - \tau') + 2 C_1^{-1} t_2 s_{12} + 2 C_1^{-1} (\tau' X_{11} + X_1)$$

To show that $V(t) - V(\tau) > 0$, it suffices to show that $\tau' > t_1$. This condition can be obtained from the requirement that both kinds of taxes raise the same amount of revenue:

$$\begin{aligned} \bar{R}(t) &= t_1 C_1 + t_2 C_2 = \tau_1 (C_1 - X_1) + \tau_2 (X_2 - C_2) = \bar{R}(\tau) \\ &= \tau' (C_1 - X_1) \quad \text{(from (13))} \\ C_1 (t_1 - \tau') &= -t_2 C_2 - \tau' X_1 < 0 \Rightarrow \tau' > t_1 \quad \text{Q.E.D.} \end{aligned}$$

Next we show that collection costs may play a pivotal role in determining the choice of tax instruments to raise revenue; i.e., because of lower collection costs, tariffs or export taxes may be preferred to domestic consumption taxes as a revenue-raising device. To this end we compare the first-order conditions for the optimal tariff (15) and the optimal consumption tax on good 1 (equation (17)). If we leave only the common terms $m + (\lambda - \eta)/\eta$ on the right-hand side, and subtract equation (17) from (15), we obtain

$$b_1 = a_1 + X_1 + [\tau_1 + (p_1/p_2)\tau_2] X_{11} \quad (35)$$

Thus, if both consumption tax and tariff are used to raise revenue, the tariff must be less costly to collect: $a_1 < b_1$. Lower collection costs (a_1) may offset higher distortion costs ($X_1 + [\tau_1 + (p_1/p_2)\tau_2] X_{11}$) induced by the tariff, and thus make the tariff as efficient a revenue-raising device as the consumption tax. Moreover, if the collection costs for tariffs are sufficiently low, tariffs become a more efficient way to raise revenue. A necessary and sufficient condition for this to happen is

$$(b_1 - a_1) > X_1 + [\tau_1 + (p_1/p_2)\tau_2] X_{11} \quad (36)$$

The difference between the marginal collection cost (MCC) of the consumption tax and the MCC of the tariff must be greater than the additional production distortion induced by the tariff. Conversely, if the inequality in equation (36) is reversed, then the optimal way to raise revenue would be to use only the domestic tax. The same reasoning applies to the export tax and the consumption tax on good 2, as well as to any mix of trade taxes or consumption taxes. These results can be summarized as follows.²⁴

Proposition 10 (Tariffs as a second-best revenue-raising device).

When collection costs are taken into account, trade taxes, along with domestic consumption taxes, may become part of a second-best revenue-raising tax package in a small open economy. If the difference between the marginal collection costs of the consumption tax and tariff is greater than the production distortion introduced by the tariff, then revenue will be raised more efficiently by tariffs only.

This proposition has important implications for the theory as well as practice of commodity taxation. It shows that collection costs are as important in choosing optimal taxes as the excess burdens the taxes induce. In particular, the loss of social welfare because of resources used in administering a consumption tax system may outweigh the gain in terms of lower distortion costs that such a system provides relative to customs duties. This suggests that, in addition to the narrow focus on the allocative effects of commodity taxes, economists should consider their administrative implications, which are a different but equally important aspect of a tax system's efficiency.

VI. The Uniformity Issue

Few issues in the theory of taxation have attracted as much attention as the uniformity of taxes. This issue has been extensively discussed in at least four different contexts where: (1) the incidence of a corporation income tax (Harberger (1962)); (2) direct versus indirect taxation, i.e., the use of differential commodity taxes for redistributive as well as revenue-raising purposes (Atkinson and Stiglitz (1976)); (3) effective tariff protection (e.g., Grubel and Johnson (1971)); and (4) optimal commodity taxation (Dixit (1970); Sandmo (1974)). The models used and the main issues addressed in these contexts differ in many important details both between and within the four discussions, so the conclusions on the desirability of uniform taxation are highly sensitive to the specification of a particular theoretical model.

On the policy side, advice to countries considering tax reforms invariably includes the recommendation to replace a differentiated structure of taxes with a uniform or proportional tax structure. Conventional arguments for uniformity are based on administrative simplicity grounds, the belief that uniform taxes are more conducive to economic efficiency, and on political economy considerations. The intuition behind the first belief (Due (1988); Bird (1989); Tait (1989)) is that differential taxation is administratively complex and stimulates tax evasion (there are always some commodities that might fall into either the high-tax or low-tax categories, and drawing these distinctions may create administrative problems and inequities). The efficiency argument (Harberger (1988)) is based on the belief that uniform taxes are neutral in providing incentives for resource allocation, i.e., in the absence of other distortions they do not favor any one particular commodity, factor, or sector. Finally, the political economy arguments (e.g., Krueger (1974)) stress the negative effects of artificial rents created by differential taxation, the consequent waste of resources used in rent seeking, and tax inequities resulting from the outcomes of lobbying.

This model could be extended to address some of these issues, but in its present form it is best suited for a discussion of uniformity within the framework of optimal commodity taxation. Uniformity of optimal taxes applies in this framework only in some special, fairly restrictive cases, such as the

²⁴ Unlike Corden (1974, 1984), and Riezman and Slemrod (1985), who use the term "first-best" when describing a revenue-raising tax package in which tariffs figure alongside domestic consumption taxes, we use the more appropriate term "second-best," as the first-best lump-sum taxes have been ruled out by assumption.

separability of utility between consumption and leisure (Auerbach (1979)), and equal income elasticities for all taxed goods (i.e., homothetic consumption indifference maps; Sandmo (1974; 1976)). So far we have used a general utility function, so we are not in a position to discuss how the structure of preferences affects the uniformity of optimal taxes. However, the presence of collection costs enables us to address the issue of uniformity from a different perspective. In particular, we can ask the following questions: Does the case for uniformity that rests on administrative simplicity have any theoretical merit? Does the presence of collection costs in a model of optimal commodity taxation make uniform tax structures more plausible? In keeping with the literature, we consider domestic consumption taxes and tariffs separately.

1. Collection costs and uniformity of consumption taxes

We first consider the case of independent demands and supplies. The optimal structure of consumption taxes is described by equations (21') and (22'), which imply that $\theta_1 = \theta_2$ if

$$\frac{\sigma_{22}}{\sigma_{11}} = \frac{-k + \frac{b_2}{C_2}}{-k + \frac{b_1}{C_1}} \quad (37)$$

Two cases are relevant:

- (1) Even if $\sigma_{11} = \sigma_{22}$, we shall not want to set the tax rates equal to each other unless the marginal collection cost/demand ratios are equal as well.
- (2) If $\sigma_{11} \neq \sigma_{22}$, e.g., $\sigma_{22} > \sigma_{11}$, then the two tax rates should be set equal only if $b_1/C_1 > b_2/C_2$ in an exact proportion. In other words, for uniform taxation to become possible, the commodity with a higher price elasticity of demand also should have lower marginal collection costs relative to the tax base.²⁵

If the demands are not independent, then it follows from equations (23) and (24) that $\theta_1 = \theta_2$ provided that

$$\frac{\sigma_{10}}{\sigma_{20}} = \frac{-k + \frac{b_1}{C_1}}{-k + \frac{b_2}{C_2}} \quad (38)$$

Again two cases are relevant:

- (3) When either σ_{10} or σ_{20} is negative (i.e., complementary with leisure), then the tax rates cannot be uniform, because both the numerator and the denominator on the right-hand side of equation (38) are negative.
- (4) When both σ_{10} and σ_{20} are positive and different (i.e., one good is more complementary with labor than the other), then for equation (38) to hold $\sigma_{10} > \sigma_{20}$ requires that $b_2/C_2 > b_1/C_1$, while

²⁵ We adopt the convention that labels the demand as "inelastic" if the *absolute* value of its price elasticity is less than 1. For example, if $\sigma_{22} = -1.5$ and $\sigma_{11} = -0.9$, i.e., if $\sigma_{22} < \sigma_{11}$, we nevertheless consider the demand for good 1 to be inelastic, because $|\sigma_{22}| > |\sigma_{11}|$.

$\sigma_{20} > \sigma_{10}$ requires that $b_1/C_1 > b_2/C_2$, both times in exact proportions matching the inequality in equation (38).

That is, the commodity that is more complementary with labor (and thus would have to be taxed at a lower rate according to the Corlett-Hague rule) must be associated with lower collection costs for uniform taxation to become possible. In other words, *one reason we may want to deviate from the various elasticity rules of optimal commodity taxation (which imply differentiated tax structures) and opt for uniform taxation instead is that the costs of collecting the taxes differ across goods.* In the above example, if the commodity that should be subject to a higher tax rate because of lower elasticity happens to have higher collection costs, while the commodity that should be subject to a lower tax rate because of higher elasticity happens to have lower collection costs, then we may want to deviate from the simple elasticity rule and tax both goods at the same rate. In a sense, the collection-cost considerations “win” over the elasticity considerations.

2. Uniformity of tariffs and collection costs

Although the argument in favor of uniform tariffs has received a great deal of attention in the commercial policy literature, the case for uniformity of tariffs that relies on differences in collection costs has received virtually no attention. According to Harberger ((1988), p. 91), the two main reasons a country should adopt uniform tariffs are that (1) the effective protection that emerges as a result of a given tariff legislation usually is far from what was intended, mainly because of problems with customs classifications, and (2) as the relative prices change with variations in world prices, rates of protection will also vary. Uniform tariffs minimize these variations, and thus help preserve the neutrality of tax-induced incentives for resource allocation. However, the theoretical arguments in favor of uniform tariffs rely on restrictive assumptions about the shape of output-supply and labor-supply schedules (Corden (1974), p. 71), and it is not obvious how they could be extended to cover the cases considered by Harberger. Therefore, it would be useful to know whether, from a theoretical point of view, the uniformity of tariffs becomes more plausible when collection costs are taken into account.

The optimal structure of trade taxes, as described by equations (31) and (32) calls for uniform tariffs and export taxes whenever:

$$\frac{1}{\zeta_{11}} \left[\left(\frac{\lambda}{\eta} + \tilde{m} \right) \frac{C_1}{Z_1} - 1 + \frac{a_1}{Z_1} \right] = \frac{1}{\zeta_{22}} \left[- \left(\frac{\lambda}{\eta} + \tilde{m} \right) \frac{C_2}{Z_2} + 1 + \frac{a_2}{Z_2} \right] \quad (39)$$

We first consider what this condition implies when collection costs are zero. Then we have

$$\frac{1}{\zeta_{11}} \left[\left(\frac{\lambda}{\eta} + \tilde{m} \right) \frac{C_1}{Z_1} - 1 \right] = \frac{1}{\zeta_{22}} \left[- \left(\frac{\lambda}{\eta} + \tilde{m} \right) \frac{C_2}{Z_2} + 1 \right] \quad (39')$$

Depending on the relative size of excess demand elasticities, we have three cases to consider.

- (1) When excess demand elasticities are equal, $|\zeta_{11}| = \zeta_{22}$, the condition for uniformity reads

$$- \left[\left(\frac{\lambda}{\eta} + \tilde{m} \right) \frac{C_1}{Z_1} - 1 \right] = \left[- \left(\frac{\lambda}{\eta} + \tilde{m} \right) \frac{C_2}{Z_2} + 1 \right] \quad (40)$$

From the optimality conditions (27') and (28') it follows, however, that the left-hand side of equation (40) is positive and less than one, while the right-hand side is positive and greater than one. In

other words, *uniformity of trade taxes is not possible when excess demand elasticities are equal, unless there is a reversal of trade patterns* (i.e., unless Z_1 becomes negative and Z_2 positive). Instead, the export tax rate must be higher when excess demand elasticities are equal. Looking back at equations (27') and (28') we see that if $C_1 = C_2$ and $-Z_1 = Z_2$, then the reduction in excess demands caused by an export tax also would have to be greater than the reduction in excess demands caused by an import tariff. This result probably follows from the asymmetric effects of changes in the tariff and export tax on excess demands, but the intuition behind it remains unclear.

(2) If excess demand for exportables is less elastic, $|\zeta_{11}| > \zeta_{22}$, then a necessary (but not sufficient) condition for uniformity becomes

$$\frac{|\zeta_{11}|}{\zeta_{22}} = \frac{-(\tilde{m} + \frac{\lambda}{\eta}) \frac{C_1}{Z_1}}{-(\tilde{m} + \frac{\lambda}{\eta}) \frac{C_2}{Z_2}} > 1 \quad (41)$$

For the same reason as in case (1), this condition cannot be fulfilled unless the trade pattern is reversed. The numerator on the right-hand side is positive and less than one, while the denominator is positive and greater than one. The rate of tax on exportables (the less elastic good) is higher in this case, but unlike case (1), this result seems intuitively plausible.

(3) When excess demand for importables is less elastic, $|\zeta_{11}| < \zeta_{22}$, then a necessary condition for uniformity of trade taxes becomes

$$\frac{\zeta_{22}}{|\zeta_{11}|} = \frac{-(\tilde{m} + \frac{\lambda}{\eta}) \frac{C_2}{Z_2}}{-(\tilde{m} + \frac{\lambda}{\eta}) \frac{C_1}{Z_1}} > 1 \quad (42)$$

From the previous two cases we know that this (necessary) condition always will be satisfied. A sufficient condition for uniformity of tariffs is that the above ratio equals some fraction $k > 1$ given by ζ_{22}/ζ_{11} . This case is intuitively less obvious, because it implies that the good with a less elastic excess demand does not necessarily have to attract a higher tariff rate.

Next, let us see if the collection costs can make any difference for the above results.

(4) With equal excess demand elasticities, the condition for uniformity of trade taxes reads

$$-(\frac{\lambda}{\eta} + \tilde{m}) (\frac{C_1}{Z_1} - \frac{C_2}{Z_2}) = \frac{a_1}{Z_1} + \frac{a_2}{Z_2} \quad (40')$$

Thus, provided that $a_2/|Z_2| > a_1/Z_1$, we could observe uniform trade taxes where it was not possible without the collection costs. In other words, when excess demand elasticities are equal, uniform trade taxes are desirable to the extent that the costs of collecting the tariffs are sufficiently lower than the costs of collecting export taxes. But given that equation (40') must hold with equality, the probability of uniformity in this case seems to be zero.

- (5) When the excess demand for exportables is less elastic, then the uniformity requires that:

$$-\left(\frac{\lambda}{\eta} + \tilde{m}\right) \left(\frac{C_1}{Z_1} - \frac{C_2}{Z_2}\right) > \frac{a_1}{Z_1} + \frac{a_2}{Z_2} \quad (41')$$

Thus, collection costs may again make the difference. When they were absent from the analysis (case (2) above), export tax rates had to be higher than import tariff rates. Now we see that uniformity may be desired when it is relatively more costly to collect export taxes. Moreover, if tariff collection costs are sufficiently lower, we may choose to set the tariff at a higher rate than the export tax, although exports have a lower elasticity of demand. And unlike case (4), there is a non-negligible probability that the inequality in equation (41') could be satisfied.

- (6) This was the case when we could observe uniformity of trade taxes even in the absence of collection costs. With these costs, a necessary condition for $T_1 = T_2$ would read

$$-\left(\frac{\lambda}{\eta} + \tilde{m}\right) \left(\frac{C_1}{Z_1} - \frac{C_2}{Z_2}\right) < \frac{a_1}{Z_1} + \frac{a_2}{Z_2} \quad (42')$$

This inequality can hold in a number of cases. One sufficient condition would be $a_1/|Z_1| > a_2/Z_2$, i.e., that it costs more to collect tariffs than it does to collect export taxes. This is another situation in which collection-cost considerations might overpower elasticity considerations. However, the inequality could also hold if $a_2/|Z_2| > a_1/Z_1$, in which case the two considerations reinforce each other. Notice, however, that we do not necessarily want to tax the good with the less elastic excess demand and lower collection costs at a *higher* rate; we may want to opt for uniformity instead. In summarizing our discussion of the uniformity issue, two results seem to stand out:

Proposition 11 (Uniformity of commodity taxes and collection costs).

1. Although there is little reason to expect, a priori, that either commodity or trade taxes will be uniform in optimum, it appears that uniformity of trade taxes is less likely to emerge than uniformity of domestic consumption taxes (indeed, uniformity may not obtain even with equal excess demand elasticities).
2. When collection costs are taken into account, uniform tax structures become a more likely outcome of the government optimization problem. Moreover, collection-cost considerations in many cases can reverse elasticity considerations.

These results seem to provide some theoretical justification for the conventional case for uniformity that relies on administrative simplicity, as they demonstrate that the optimal tax/tariff structure may become uniform once collection costs are taken into account. They also are interesting in the wider context of the theory of optimal commodity taxation, because the uniformity of optimal taxes/tariffs has been obtained without restrictive assumptions on the nature of preferences.

VII. Concluding remarks

The empirical relevance of the results established thus far depends ultimately on the relative magnitude of the collection costs of tariffs and consumption taxes on the one hand and the excess burdens that they induce on the other. Estimates of these two sets of data are scant, and one must make do with the few indicators of collection costs and excess burdens that are available for developed market economies, as no comparable research has been conducted for developing countries.

It is hard to say to what extent these results might be relevant for developing countries. The available evidence points to the negative correlation between the level of development and the reliance on trade taxes, but it says nothing about the relative importance of marginal collection costs and the excess burden of tariffs compared with other domestic taxes.²⁶

One should bear in mind that the conventional measure of deadweight loss captures only part of the overall excess burden of taxation. In particular, firms that *do not* enter a given industry because of protection accorded to existing firms (often through political intervention) may suffer significant opportunity losses. These costs may have been especially high in socialist countries, where political criteria have been dominant in determining the level of taxes and subsidies to various firms. On the other hand, the compliance cost measure discussed above includes only the ex post cost of dealing with taxpayers. One could argue that a more representative measure of collection costs is the ex ante cost of forming a social contract with taxpayers, as these costs are implicit in every tax bill passed by legislation. The experience with the poll tax in Great Britain in 1990 vividly illustrates the significance of this aspect of collection costs; another example is the costs associated with budget negotiations in the United States in 1990, where the positive relationship between tax rates and collection costs was clearly implicated.

Finally, consider the long run. Many econometric studies show that long-run elasticities generally are higher than short-run elasticities. On the other hand, as a result of advances in information technology, unit costs of taxation are declining over time. Thus, some commodities that are not taxed in the short run because of high collection costs may be taxed in the long run. But the optimal tax rules of this paper still would apply in the long run: *ceteris paribus*, the commodity with lower collection costs still would have to be taxed more heavily.

²⁶ Riezman and Slemrod (1985, 1987) tested the hypothesis that the use of tariffs as a revenue-raising device depends on the relative collection costs of tariffs versus other taxes and found that all three indices of relative collection costs -- degree of literacy, population density, and labor-force participation rate of women -- had the predicted negative sign and were statistically significant.

The available estimates of the average excess burden of a rather general tax, such as a sales tax or an income tax, are on the order of 8 to 25 percent (Browning (1976; 1987)). Some authors have suggested much higher figures, both for average and marginal rates (Stuart (1984); Ballard, Shoven and Whalley (1985)). Because the higher figures result from assuming higher values of compensated price elasticities and embedding the tax changes in a general equilibrium model, it follows that, for taxes on commodities that have low elasticities of demand, such as tobacco excises, the corresponding deadweight losses would be rather low.

Comparing these figures with the above data on total collection costs, we see that the overall efficiency cost of the tax system could be estimated at about 20 percent (16 percent for the excess burden plus 4 percent for collection costs). It should be emphasized, however, that the figure for collection costs is much firmer than that for the excess burden, which remains sensitive to theoretical assumptions used in calculations.

These comparisons are for average collection costs and average excess burdens. Marginal collection costs vary with the tax base for a given tax rate and are likely to be rather small, because their main components are of an "overhead" nature. However, taking into account the interactions between tax rates and collection costs would make the marginal collection costs nontrivial, as the higher tax rates give rise not only to additional administrative expenditures, but, more important, to additional compliance costs as well. Collard ((1989), pp. 275-276) discusses an example in which this combined marginal excess burden of collection costs is 9 percent, assuming a tax rate of 30 percent, average collection costs of 2 percent, and unit price elasticity.

Another interesting piece of evidence from the study by Sandford, Godwin, and Hardwick (1989) concerns the administrative and compliance costs of the main excises. These costs are estimated at 0.1 and 0.23 percent of total revenue for hydrocarbon oil; 0.08 and 0.06 percent for tobacco products; and 0.72 and 0.31 percent for alcoholic drinks, respectively (p. 168). Thus, there is considerable variation in collection costs for different commodities: within the group of easy-to-collect excises, collection costs vary by a factor of 8, so it is not unreasonable to expect much greater variation in collection costs for other groups of commodities.

These data shed some light on the empirical relevance of results such as expression (36). According to this expression, a necessary and sufficient condition for tariffs to become part of the second-best revenue-raising tax package is that the difference between the marginal collection costs (MCCs) of the consumption tax and the MCCs of the tariff is greater than the production distortion induced by the tariff. If we approximate the cost of production distortion by a Harberger triangle, the marginal excess burden of a tariff is equal to $t_j \varepsilon_{ij}$, where ε_{ij} is the corresponding supply elasticity. For example, if the tariff rate is 30 percent and the supply elasticity is unity, the marginal cost of production distortion induced by the tariff would be 0.3 percent. Next, we can take Collard's example, which puts the MCCs at 9 percent, and assume that, ceteris paribus, for average collection costs of 1 percent (as opposed to 2 percent in his calculation), the MCCs would be half as great. Thus, the difference between the MCCs would be 4.5 percent, which is 15 times greater than the production distortion induced by the tariff. Although this is only an illustration, the magnitudes involved indicate a non trivial probability that expression (36) could be satisfied for many plausible values of parameters.

Sandford, Godwin, and Hardwick also established other results that are relevant for our analysis. The principal excise duties, which carry very high tax rates, have very low compliance costs. Ex post, the choice of the authorities is thus precisely in line with our collection cost rule of Proposition 4. Sandford, Godwin, and Hardwick also show that the compliance costs reinforce the case for simple structures of taxation: the administrative costs of the value-added tax were 2.02 percent of revenue collected in the period 1977-78 and only 1.03 percent after the simplifications in 1986-87 (p. 113).

In a pioneering study of administrative and compliance costs of taxation in Great Britain, Sandford, Godwin, and Hardwick (1989) established the following administrative, compliance, and operating costs, in percent of collected revenue (see Table 1). Unfortunately, customs duties were excluded from this study for a number of technical reasons (customs officials perform many functions unrelated to revenue collection; the revenue accruing from customs duties counts as own resources of the European Economic Community, etc.), but given that the relevant data are available for other taxes and that the tariffs constitute only about 1 percent of total tax revenues, their omission is not critical for this brief analysis.

As can be seen from Table 1, the administrative costs (defined as the public-sector costs incurred in administering an existing tax code) varied between 1.53 percent of total revenue for the personal income, capital gains, and social security taxes and 0.12 percent of tax revenue for the petroleum revenue tax. The compliance costs of taxation (costs incurred by taxpayers or third parties in meeting the requirements laid on them by a given tax structure) ranged from 3.69 percent of total revenue for the VAT to 0.2 percent for excise duties. Total operating costs of the easiest-to-collect petroleum tax thus represent only about 9 percent of the hardest-to-collect income tax.

Table 1. Tax Operating Costs in Percent of Revenue Collected, United Kingdom, 1986-87

	Administrative costs	Compliance costs	Total collection costs
Income tax, capital gains tax, national insurance contributions	1.53	3.40	4.93
Value-added tax	1.03	3.69	4.72
Corporation tax	0.52	2.22	2.74
Petroleum tax	0.12	0.44	0.56
Excise duties ¹	0.25	0.20	0.45
Minor taxes ²	0.85	1.48	2.33
Local rates	1.52	0.37	1.89

1/ Taxes on hydrocarbon oils, tobacco, alcoholic drinks.

2/ Stamp duty; inheritance, car, betting, and gaming taxes.

Source: Adapted from Sandford, Godwin, and Hardwick (1989), p. 192.

Although some of these costs are difficult to define and measure, they are in many ways more tangible and direct than the excess burdens of taxes. Traditionally, however, economists have been concerned with excess burdens, which are considered to be *the* efficiency costs of taxation. Starting with Harberger (1964), the total excess burden of a tax has been approximated by the area of a triangle formed by the compensated demand curve and the relevant price lines, and measured as $\frac{1}{2} t_j^2 \sigma_{ij}$, where t_j is the j -th tax rate and σ_{ij} is the compensated price elasticity of demand for good i . The average tax burden then is given by $\frac{1}{2} t_j \sigma_{ij}$ and the marginal excess burden by $t_j \sigma_{ij}$.

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