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26

Smuggling and welfare in a Ricardo-Viner economy

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Introduction

Since the inauguration of modern, general equilibrium analysis of smuggling by Bhagwati and Hansen (1973), the standard framework for analysis has been some version of the Hecksher-Ohlin-Samuelson (HOS) model. Moreover, with the notable exception of Sheikh (1974), the standard framework depicts smuggling as an activity that uses no domestic resources. In this article we alter the standard framework by treating smuggling as a resource-using activity occurring at legal entry points within a Ricardo-Viner (RV) economy. We pursue this alternative framework for several reasons. First, not only has the RV model become a standard tool of trade policy analysis, but recent research by Grossman and Levinsohn (1989) suggests that markets react to trade-related information releases in a manner consistent with the short-run time horizon. If we follow Mayer (1974), Mussa (1974), and Neary (1978) in treating the RV model as representative of the short run, analysis in the RV context provides a useful depiction of the immediate welfare effects of policy changes in the presence of smuggling[1]. Second, descriptions of smuggling provided in Norton (1988) and in Deardorff and Stolper (1990) suggest that domestic resources are absorbed by smuggling activity and, thus, that smuggling shrinks the productive sectors. Third, the descriptions of smuggling provided by Pitt (1981) for Indonesia and Jenkins (1992) for containerized shipping suggest the importance of camouflaged illegal trade occurring at legal entry points.

We consider the effect on welfare of the existence of a smuggling sector. We find that the presence of smuggling is welfare-improving only if the resulting reduction in the domestic price distortion outweighs the loss caused by the

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devotion of domestic resources to smuggling activity. We also examine the welfare effects, when smuggling exists, of a tariff increase and of strengthened anti-smuggling efforts. We find that a tariff increase does not have an unambiguously negative effect on the welfare of a small country. The tariff increase may improve welfare if it leads to a significant reduction in resources devoted to smuggling. Strengthened enforcement is also found to have an indeterminate effect on welfare – gains from reduced smuggling activity may be outweighed by an increase in the domestic price distortion.

Because smuggling does not produce goods or services that enter the utility function directly, it may be viewed as a directly unproductive, profit-seeking (DUP) activity, which, as is well-known, may produce a paradoxically beneficial outcome in the presence of distortions. Bhagwati (1982) contains a taxonomy of DUP activities, including smuggling, and their welfare consequences. The contribution of this article is its identification of DUP activities as smuggling services that use domestic resources combined with its portrayal of smuggling as camouflaged by legal trade. Besides enhancing the realism of the assumptions, this formulation yields new insights into the normative effects of protection and anti-smuggling efforts as these policies act both on domestic prices and on the share of resources devoted to production.

We begin our analysis with a description of smuggling as an economic activity within an RV economy. Next, we consider the welfare effects of smuggling in a small, tariff-ridden country. An examination of the effects of a tariff increase follows, with attention directed to welfare and distributional implications. We consider finally the welfare and distributional implications of strengthened anti-smuggling activity.

An RV model of smuggling

Before providing a complete depiction of the economy, we characterize smuggling as an economic activity[2]. There are three fundamental aspects of such a characterization: the national identity of smugglers; the technology of smuggling; and the nature of anti-smuggling activity (enforcement) by the government[3].

The first of these is quite straightforward. The Bhagwati and Hansen (1973) analysis assumes that smugglers are foreign residents. Not only does this have implications for welfare analysis, since the income from smuggling is consumed abroad, but it also implies that no domestic resources are used in smuggling[4]. A number of analyses have followed Bhagwati and Hansen in assuming smugglers to be foreign (Bhagwati and Srimvasen, 1973; 1974; Falvey, 1978; Johnson, 1972; Kemp, 1976; Norton, 1988; Ray, 1978). Given our concern with the domestic resource costs of smuggling, we find it convenient to follow Martin and Panagariya (1984), Pitt (1981), Sheikh (1974), and Thursby *et al.* (1991), in assuming that smuggling is undertaken by home nationals.

The second aspect characterizes the technology of smuggling and the literature contains three alternative characterizations. Bhagwati and Hansen

(1973) assume that smugglers acquire the home import in the world market at the world price but, as a result of (unspecified) problems unique to smuggling, they lose some fraction of every shipment. This loss causes the smuggling terms of trade to be inferior to the world price of the import good. While in Bhagwati and Hansen (1973) and the related literature, legal and illegal trade are distinct activities carried on by distinct "firms" ("ships of the night"), Martin and Panagariya (1984), Norton (1988), Pitt (1981) and Thursby *et al.* (1991) present models in which smuggling is accomplished by camouflaging illegal (i.e. untaxed) imports in shipments of legal imports. As with Bhagwati and Hansen (1973), both legal and illegal imports are acquired in the world market, at world prices, and illegal importing involves a loss of some fraction of every shipment[5]. One immediate implication of this model is that equilibrium is characterized by the presence of both legal and illegal imports in the market and, more importantly, by a disparity between the tariff-inclusive price and the actual price in the market[6]. Unlike the approaches of Bhagwati and Hansen (1973) and Pitt-Martin and Panagariya, the third approach, due to Sheikh (1974), assumes that the production of smuggling requires the use of domestic productive resources. For Sheikh, this is the local production of a transportation commodity required for smuggling, but not required for legal trade. Smuggling itself is performed by Bhagwati and Hansen-type "ships of the night". In this article, we combine aspects of the Sheikh and Pitt-Martin and Panagariya characterizations by introducing domestic resource costs into a model of camouflage smuggling[7].

The final element of a model of smuggling behaviour relates to the role of anti-smuggling activity by the government and its integration into the decision calculus of smugglers. Given that smuggling is illegal, the possibility of detection and punishment is clearly an essential aspect of the smuggler's economic environment. Prior to Martin and Panagariya (1984), the existence of enforcement activity was loosely taken to account for the additional cost of smuggled goods relative to legally imported goods. However, as Martin and Panagariya (1984) note, none of this work treated uncertainty as an essential element in the smuggler's calculation[8]. Martin and Panagariya (1984), followed by Thursby *et al.* (1991), model importers as reacting to uncertainty in two ways: they can vary the share of smuggled to legal trade and they can spend some share of each shipment on activities that reduce the probability of detection. We adopt a variant of the Martin and Panagariya approach in our model of smuggling, to which we now turn.

We consider the case of a small, open economy producing two final consumption goods, an importable (good 1) and an exportable (good 2), and smuggling services (good S). These goods are produced from intersectorally mobile labour and sector-specific capital according to production functions that are twice differentiable, linearly homogeneous, and strictly quasi-concave. The government levies an *ad valorem* tariff at rate t. Firms may choose to smuggle some portion of their imports, thus evading the tariff. Denoting legal imports as

M_L and smuggled imports as M_S, we define $\mu = M_S/M_L$ as the ratio of illegal to legal imports.

We assume that the government engages in anti-smuggling activity such that if a smuggler is caught the government confiscates the smuggled merchandise and sells it at the home market price[9]. A firm that smuggles faces a probability of detection (q), which it influences by varying the ratio of illegal to legal imports and through the use of per-unit smuggling services, R. Thus, $q = q(\mu, R)$. We follow Martin and Panagariya in assuming that the probability of detection is increasing in μ, reflecting reduced camouflaging of illegal by legal imports.

R measures the quantity of smuggling services purchased by the importing firm per smuggled unit: $R = S/M_S$. We assume that the probability of detection is reduced by these services, $q_R < 0$. These smuggling services may take the form of special warehousing, special processing at the port, or other activity designed to reduce the probability of detection. We assume that these services are competitively produced from labour and specific capital by a distinct sector in the home economy. The price of smuggling services, p_S, is determined endogenously.

Taking the export good as *numeraire*, and denoting the world and domestic relative prices of the final consumption goods as p^* and p respectively, profits with successful smuggling are:

$$\pi_1 = p(M_L + M_S) - \left[p^*(M_L + M_S) + tp^* M_L\right] - p_S S;$$

and profits with detected smuggling are:

$$\pi_2 = pM_L - \left[p^*(M_L + M_S) + tp^* M_L\right] - p_S S.$$

Considering the probability of detection, q, importing yields the following expected profit function:

$$E(\pi) = (1-q)\pi_1 + q\pi_2 = \left[p - p^*(1+t)\right]M_L + \left[(1-q)p - p^*\right]M_S - p_S S. \qquad (1)$$

Risk-neutral, expected profit-maximizing firms choose optimal levels of legal and illegal imports and the level of smuggling services, given p, p_S, and p^*. The first-order conditions for this problem are[10]:

$$p + q_\mu \mu^2 p = p^*(1+t); \qquad (2)$$

$$(1-q)p - p(q_\mu \mu - q_R R) = p^*; \qquad (3)$$

$$-q_R p = p_S. \qquad (4)$$

The left side of equation (2) gives the marginal revenue from legal import: the revenue from the sale of the unit (p); plus the increase in expected revenue from the reduction in the probability of detection of illegal imports caused by the

increased legal import. The right side is the cost of the additional unit of legal import to the home importer. The left side of equation (3) gives expected marginal revenue from illegal import: the direct expected revenue from the illegal import ($(1-q)p$); less the reduction in expected revenue, via the increased probability of detection ($q_\mu \mu$) and the reduced efficacy of smuggling services ($q_R R$), induced by the marginal illegal import. The right side is the cost of the marginal illegal import (p^*). Finally, equation (4) calls for equality at the margin of the improvement in expected revenue as a result of increasing the use of smuggling services ($-q_R R$) with the cost of those services (p_S).

Smuggling occurs within the context of a general equilibrium. Production conditions are given by the production functions for the three sectors and the full-employment condition:

$$\begin{aligned} Q_1 &= Q_1(L_1), \\ Q_2 &= Q_2(L_2), \\ S &= Q_S(L_S), \\ \bar{L} &= L_1 + L_2 + L_S. \end{aligned} \tag{5}$$

Profit maximization and perfect competition among firms gives

$$\begin{aligned} pQ_1' &= Q_2', \\ Q_2' &= p_S Q_S', \\ p_S Q_S' &= w, \end{aligned} \tag{6}$$

where primes denote first derivatives with respect to labour and w is the nominal wage. Assuming that both community preferences and social welfare can be described by a single homothetic community utility function, $U = U(C_1, C_2)$, where C_j represents consumption of the final consumption good j, we can represent domestic demand as:

$$p = g\left(\frac{C_1}{C_2}\right). \tag{7}$$

Finally, we have balanced trade and material balance conditions:

$$\begin{aligned} p^*(Q_1 - C_1) + (Q_2 - C_2) &= 0, \\ Q_1 + M_S + M_L &= C_1. \end{aligned} \tag{8}$$

Equations (2)-(8), and the definition of μ comprise a system of 14 equations with 14 endogenous variables: p, p_S, M_S, M_L, μ, Q_1, Q_2, S, L_1, L_2, L_S, C_1, C_2, and w. Given the world price (p^*), the tariff (t), and the $q(\bullet)$, $Q_j(\bullet)$, and $g(\bullet)$ functions, the model is determined.

Smuggling and welfare

In general, for a small, tariff-ridden economy, the introduction of smuggling has an indeterminate effect on welfare. Consistent with the theory of the second best, smuggling (a DUP activity) potentially can improve welfare only if it reduces the welfare loss of the tariff. There are two routes by which such a reduction in welfare loss can occur. First, smuggling may reduce the domestic relative price of the importable, thereby reducing the production and consumption distortions associated with the tariff. Second, smuggling may alter the possibilities for production of final goods, which, holding the domestic relative price fixed, may raise the value of domestic output at world prices. We consider these two routes by briefly reviewing the literature on smuggling and welfare. We then assess the effect of smuggling on welfare when the economy takes the RV form described above.

Bhagwati and Hansen (1973) provide the first formal analysis of smuggling and welfare. In their various models, smuggling has costs for the home country because smugglers obtain inferior terms of trade. Smuggling uses no domestic resources and thus can improve welfare only through a reduction in the domestic price from the tariff-inclusive world price. Because legal and illegal trade can coexist in their models only when the domestic price is the tariff-inclusive world price, Bhagwati and Hansen show that, if both forms of trade occur, smuggling cannot improve welfare as it results in tariff revenue loss without altering the domestic price distortion[11]. Kemp's (1976) demonstration that smuggling is irrelevant if the domestic price is unchanged by its introduction and if fines and confiscations replace tariff revenue serves to underscore the conditions necessary for smuggling to improve welfare unambiguously in the Bhagwati and Hansen framework.

Pitt (1981) provides an alternative model of smuggling in which illegal trade depends on the volume of legal trade and in which the domestic price may be less than the tariff-inclusive world price. This "price disparity" provides a channel by which smuggling may reduce the tariff distortion while coexisting with legal trade. Although the price disparity reduces the tariff distortion, Pitt shows that the overall welfare consequences are indeterminant when smuggling requires the use of real resources in the form of a share of imports "melted away" in the process of illegal entry.

Martin and Panagariya (1984) take the Pitt model as a starting point but make the real costs of smuggling a choice variable for the firm. These real costs again take form as a share of imports lost or "melted away" in the smuggling process. Allowing for the endogenous determination of smuggling costs does not resolve the welfare ambiguity. The price disparity reduces the tariff-induced domestic price distortion but the real costs of smuggling imply a worsened rate of transformation of exports into imports.

Sheikh (1974) differs from the previous articles in that it depicts smuggling as an activity using domestic primary factors of production. Legal and illegal trade coexist in this model only when the domestic price is the tariff-inclusive

world price as in the Bhagwati and Hansen model[12]. While both Bhagwati and Hansen and Sheikh assume that smugglers obtain inferior terms of trade, only Sheikh permits smuggling to alter the domestic production possibilities for the two traded goods[13]. Welfare gain from smuggling is thus possible not through a change in the domestic relative price of tradeables but rather through the production changes induced by the movement of factors into smuggling activity[14].

Expansion of smuggling activity may improve welfare, even though the smuggling rate of transformation is inferior to legal trade, because the expansion may reduce the tariff-induced production distortion. Such a distortion reduction requires the expansion of exportables production and the contraction of importables production as a result of smuggling's use of primary factors. The logic here, as Sheikh notes, is identical to that used by Johnson (1967) to demonstrate that growth subject to a tariff may be immiserizing. Without a worsening of the terms of trade, growth may worsen welfare if it exacerbates the domestic distortion.

The present RV model combines Sheikh's emphasis on smuggling's use of domestic resources with the Pitt-Martin and Panagariya mechanism for ensuring a price disparity. Because of this structure, both routes by which smuggling may improve welfare are operative. The conflicting nature of these two routes can be seen by a simple decomposition of the welfare change caused by the introduction of smuggling[15]. Let $\tilde{U}_N$ and $\tilde{U}_S$ be the actual welfare levels with the tariff in place for the no-smuggling and smuggling cases respectively. Note that in the no-smuggling case the domestic price will be $p^*(1 + t)$ but in the smuggling case it may not be. Also let $\bar{U}_S$ be the welfare level achievable when the domestic relative price is $p^*(1 + t)$ and the actual domestic resources devoted to smuggling are thrown away. Then a Hicksian-equivalent measure of the welfare effect of smuggling is

$$\tilde{U}_S - \tilde{U}_N = \{\bar{U}_S - \tilde{U}_N\} + \{\tilde{U}_S - \bar{U}_S\}$$

Net change in welfare = Johnson-Sheikh effect + Price-disparity effect.

The Johnson-Sheikh effect measures the change in welfare from the waste of real resources through smuggling, holding the domestic price fixed. The Pitt-Martin and Panagariya price-disparity effect measures the change in welfare from a reduction in the domestic relative price holding the production possibilities set fixed. In the present RV model, the Johnson-Sheikh effect must be negative while the price-disparity effect must be positive.The net effect of smuggling on welfare, therefore, may be positive or negative[16].

To see why the resource waste of smuggling cannot improve welfare in an RV economy, consider Figures 1 and 2. Figure 1 depicts an inward shift in the production possibilities frontier caused by the use of labour in smuggling services[17]. TT' is the transformation curve and P the production point in the absence of smuggling. DD is the domestic price ratio, which differs from the

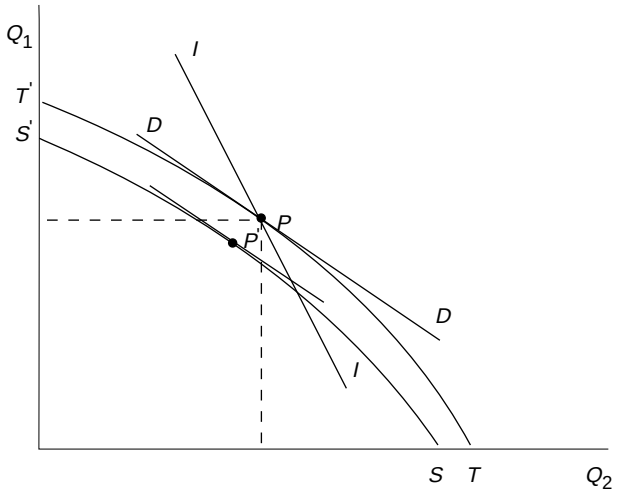

Figure 1.
The use of labour in smuggling services

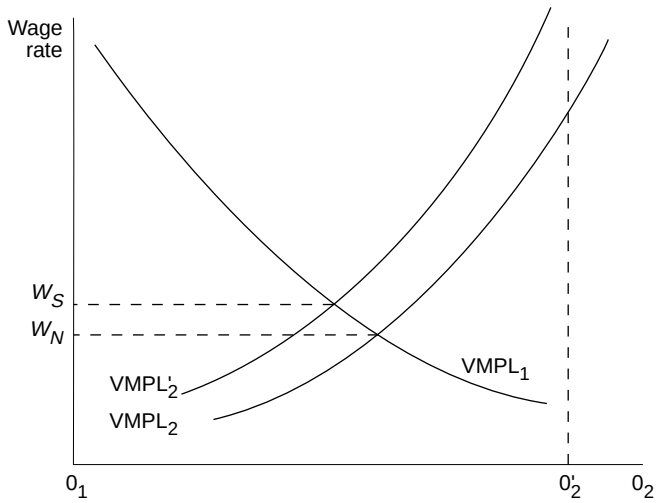

Figure 2.
Value marginal product of labour

international price ratio, II, by the *ad valorem* tariff. The effect of DUP smuggling activity is the withdrawal of labour from final-goods production, shifting the transformation curve inward to *SS′*. At an unchanged domestic price ratio, if the new production point, *P′*, lies to the right of II and neither good is inferior, the resource waste improves welfare. If it lies to the left, the resource waste reduces welfare.

In an RV economy, the new production point must lie to the left of II. This result can be seen by reference to Figure 2, in which the value marginal product of labour in the final-goods sectors are drawn. The width of the box is a measure of the labour endowment devoted to the final-goods sectors. In the absence of smuggling, no labour is devoted to the smuggling sector, the nominal wage is

W_N, and the labour endowment is split between the two final-goods sectors. In the presence of smuggling, however, some labour is devoted to the smuggling services sector. As less labour is devoted to the final-goods sectors, and holding the domestic relative price fixed, the value marginal product of labour must be higher in both sectors, and the nominal wage, W_S, higher. With sector-specific capital, the reduction in labour reduces output in each sector. Referring to Figure 1, the new production point P' must lie within the rectangle formed by the dashed lines. The resource waste of smuggling cannot improve welfare, and the Johnson-Sheikh effect is negative[18].

The second channel by which smuggling may affect welfare in the present model is through its effect on the domestic relative price. Legal and illegal trade coexist but the domestic price is not the tariff-inclusive world price. Instead, a Pitt-Martin and Panagariya price disparity is present. From equation (2),

$$p^*(1+t) - p = q_\mu \mu^2 p.$$

Because $q_\mu > 0$, the tariff-inclusive world price exceeds the domestic price. Thus, the domestic relative price in the presence of smuggling is closer to the world price than it is without smuggling. This price disparity is welfare-improving for the same reason that a tariff reduction is welfare-improving in an otherwise undistorted small economy. Because the price-disparity effect enhances welfare while the Johnson-Sheikh effect reduces it, the net effect of smuggling on welfare in an RV economy is indeterminate.

Effects of a tariff increase

An increase in the tariff, as noted above, reduces welfare in an otherwise undistorted small economy. Martin and Panagariya (1984) were the first to address this question formally in the presence of smuggling. They find that a rise in the *ad valorem* tariff rate raises the domestic price and the portion of imports "melted away" in the act of smuggling – an increase in the real per-unit cost of smuggling. For these reasons, raising the tariff unambiguously reduces welfare. In the present model, as we now show, a rise in the tariff rate likewise induces a rise in domestic price but does not necessarily reduce welfare. Welfare may improve if resources are released by a reduction in smuggling activity and shifted to productive uses.

To assess the effect of an increase in the *ad valorem* tariff rate, we totally differentiate the system describing the home economy. Beginning with the first-order conditions for the importing firm's problem, totally differentiating (2)-(4) yields

$$p^* T\hat{p} - \mu^2\Gamma_1\hat{M}_L + \mu^2\Gamma_1\hat{M}_S = p^* T(\hat{p} + \hat{T}), \tag{9}$$

$$p^*\hat{p} + \mu\Gamma_1\hat{M}_L - (\mu\Gamma_1 + M_S R^2\Gamma_2)\hat{M}_S + M_S R^2\Gamma_2\hat{S} = p^*\hat{p}^*, \tag{10}$$

$$p_S\hat{p} + \Gamma_2 S\hat{M}_S - \Gamma_2 S\hat{S} - p_S\hat{p}_S = 0. \tag{11}$$

where Γ_1 and Γ_2 must be positive if the second-order conditions of the firm's maximization problem are met[19]. Note also that $T = (1 + t)$, and hats denote proportional change in a variable.

Total differentiation of the remaining equations gives:

$$\hat{Q}_1 = \eta_1 \hat{L}_1, \tag{12}$$

$$\hat{Q}_2 = \eta_2 \hat{L}_2, \tag{13}$$

$$\hat{S} = -\eta_S(\Lambda_1 \hat{L}_1 + \Lambda_2 \hat{L}_2), \tag{14}$$

$$\lambda_1 \hat{L}_1 + \lambda_2 \hat{L}_2 + \lambda_S \hat{L}_S = 0, \tag{15}$$

$$\varepsilon_1 \hat{L}_1 + \hat{p} = \varepsilon_2 \hat{L}_2, \tag{16}$$

$$\varepsilon_2 \hat{L}_2 = -\varepsilon_S(\Lambda_1 \hat{L}_1 + \Lambda_2 \hat{L}_2) + \hat{p}_S, \tag{17}$$

$$-\varepsilon_S(\Lambda_1 \hat{L}_1 + \Lambda_2 \hat{L}_2) + \hat{p}_S = \hat{w}, \tag{18}$$

$$\sigma \hat{p} = \hat{C}_2 - \hat{C}_1, \tag{19}$$

$$-p^* M_L \hat{M}_L - p^* M_S \hat{M}_S + Q_2 \hat{Q}_2 - C_2 \hat{C}_2 = p^*(M_L + M_S)\hat{p}^*, \tag{20}$$

$$M_L \hat{M}_L + M_S \hat{M}_S + Q_1 \hat{Q}_1 = C_1 \hat{C}_1, \tag{21}$$

$$\hat{\mu} = \hat{M}_S - \hat{M}_L. \tag{22}$$

In this system, we use the following notation for sectors $j = 1, 2, S$: $\lambda_j = L_j/\bar{L}$, $\Lambda_j = \lambda_j/\lambda_S$; η_j is the elasticity of output with respect to labour in sector j, ε_j is the elasticity of labour's marginal product in sector j, and σ is the elasticity of substitution in demand. As defined $\eta_j > 0$, $\varepsilon_j < 0$, and $\sigma > 0$.

For the case of an increase in the tariff, $\hat{p}^* = 0$ and $\hat{T} > 0$. Among the solutions for the changes in the endogenous variables are the following:

$$\frac{\hat{p}}{\hat{T}} = \frac{1}{D}(\mu \Gamma_1 G_3 - M_L V_1 G_2) > 0 \tag{23}$$

$$\frac{\hat{\mu}}{\hat{T}} = \frac{1}{D}(G_1 G_3 - G_2 G_4) > 0; \tag{24}$$

$$\frac{\hat{M}_S}{\hat{T}} = \frac{1}{D}(M_L V_1 G_1 - \mu \Gamma_1 G_4) \gtrless 0. \tag{25}$$

Parameter definitions and signs are contained in the Appendix.

The tariff increase raises the domestic relative price of the importable. It is interesting to note that in contrast to the case without smuggling, the domestic price rises proportionately by less than the tariff. The policy change also raises the ratio of smuggled to legal imports, a consequence of the increase in the price of legal imports at the initial level of camouflaging. The level of smuggled

imports may rise or fall. It can be shown that the overall level of imports falls, but this decrease may be accomplished by a decline in M_L that outweighs an increase in M_S. Martin and Panagariya (1984) produced similar qualitative results in their "melting-ice" model.

To analyse the welfare effect of the tariff, we use the social welfare function

$$U = U(C_1, C_2).$$

Total differentiation and use of the first-order condition for the consumer's problem yields

$$\frac{dU}{U_2} = pdC_1 + dC_2 \tag{26}$$

where $U_2 = \partial U/\partial C_2$. The material balance constraints imply

$$\begin{aligned} dC_1 &= dQ_1 + dM \\ dC_2 &= dQ_2 - dE \end{aligned} \tag{27}$$

where $M = M_S + M_L$ is home imports of good 1 and E is home exports of good 2. The balanced trade condition implies

$$p^* dM + M dp^* = dE. \tag{28}$$

Substituting (27) and (28) into (26) and expressing changes in percentage form yields

$$\frac{dU}{U_2} \equiv \hat{W} = pQ_1\hat{Q}_1 + Q_2\hat{Q}_2 + (p - p^*)M\hat{M} - p^* M\hat{p}^*. \tag{29}$$

Increases in output quantities and the level of imports raise welfare while an increase in the world price of the importable decreases welfare.

Because the tariff rate increase does not influence the world price, $dp^* = 0$, and the last term of (29) is zero. The first two terms on the right side of (29) involve the production quantities of good 1 and good 2. These quantity changes are affected by the change in the domestic price holding the production possibilities set fixed and by changes in the possibilities set due to increases in smuggling services activity. It is shown in the appendix that

$$pQ_1\hat{Q}_1 + Q_2\hat{Q}_2 = \frac{-p\,Q_1\eta_1}{\Lambda_1\eta_S}\hat{S}, \tag{30}$$

and the coefficient modifying $\hat{S}$ is negative. Small changes in output quantities of goods 1 and 2 have no first-order effect on the value of output if the production possibility set remains fixed. However, the expansion of smuggling services ($\hat{S} > 0$) does reduce the value of output measured at the domestic price.

Combining (30) with (29) and noting $\hat{p}^* = 0$,

$$\hat{W} = (p - p^*)M\hat{M} - pQ_1\eta_1/(\Lambda_1\eta_S)\hat{S}. \quad (31)$$

The change in home welfare depends on the change in import quantity and in the level of smuggling services production.

The change in imports is

$$M\hat{M} = M_S\hat{M}_S + M_L\hat{M}_L = M\hat{M}_S - M_L\hat{\mu}. \quad (32)$$

Using the solutions (24) and (25), and the definitions in the Appendix,

$$M\hat{M} = \frac{1}{D}\{G_4(M_LG_2 - M\mu\Gamma_1) - M_LB_2G_1V_2\} < 0, \quad (33)$$

which indicates that home imports fall. This decline in home imports worsens welfare.

Equation (31) indicates that since $\hat{M}/\hat{T} < 0$, if the tariff increase results in an expansion of the smuggling services activity, home welfare must fall. If, however, smuggling services contract and labour is thereby transferred to the productive sector, the tariff produces an expansion of the final-goods production possibilities set. Home welfare rises if this anti-DUP effect outweighs the loss of welfare from reduced import quantity.

We cannot determine if smuggling services will expand or contract. The change in smuggling services can be expressed as

$$\hat{S} = A_1\hat{P} + A_2\hat{M}_S \quad (34)$$

where A_1 and A_2 are positive coefficients defined in the appendix. Because $P/\hat{T} > 0$, an increase in the level of smuggled imports is sufficient for the smuggling services sector to expand. In this case, the tariff must reduce home welfare. If $\hat{M}_S < 0$, however, smuggling services may decline and welfare may increase. Using the solutions (23) and (25),

$$\frac{\hat{S}}{\hat{T}} = \frac{1}{D}\{M_LV_1(K_1B_2G_1 - K_1B_1G_2 + B_2G_2)$$

$$+\mu\Gamma_1(K_1B_1G_3 - K_1B_2G_4 - B_2G_3)\} \gtrless 0,$$

and we are unable to predict the response of DUP activity to the tariff.

The indeterminate effect of the tariff increase on the demand for smuggling services thus emerges as the source of the indeterminate welfare outcome. Some insight into this result may be gained by a closer view of the smuggler's problem. For a given disparity between the domestic and world price, the smuggler has a given return that he/she will earn from bringing in smuggled goods. The technology of doing this successfully, however, has two inputs: smuggling resources that must be purchased on their own domestic market, and legal imports (which are used to conceal the smuggled ones) that must be

purchased subject to the tariff. What the tariff increase does, then, is to raise the cost of one of these inputs. This will in general cause both substitution away from legal imports as an input and towards smuggling services, and, by raising cost, cause an overall reduction in the quantity of imports supplied to the domestic market. The latter will be offset somewhat by a price increase there, but that does not change the fact that imports, including smuggled ones, are reduced and that the demand for smuggling services may therefore decline. This is easiest to see in terms of substitution of inputs. If the technology of smuggling allowed for no substitution at all – if, that is, legal imports and smuggling services had to be used in fixed proportions – then the demand for the latter would necessarily fall. If demand for smuggling services does fall, the tariff increase produces a positive Johnson-Sheikh effect, raising the value of output.

The RV structure allows us to extend our analysis to the income distributional effects of the tariff. The return to capital specific to smuggling services depends on the response of the price of smuggling services to the tariff increase. This response depends on whether M_S rises or falls. If the amount of smuggled imports rises, p_S rises in response to an increase in the tariff. In this case, the return to specific factors in both the import-competing and in smuggling services rises because it can be shown that

$$\hat{p} > \hat{p}_S > \hat{w} > 0.$$

This result is reminiscent of the Ruffin-Jones neoclassical ambiguity: both specific capital owners in the smuggling services sector and labour generally find their returns bounded by an increase in the relative price of the import-competing good and a decrease in the relative price of the export good. As a result, the effect of the tariff change on the real income of households dependent on those factors is indeterminate.

Effects of strengthened enforcement

In this section we consider the effect of a costless strengthening of the government's ability to detect smuggled imports. Following Martin and Panagariya (1984), we treat changes in the level of anti-smuggling activity (α) as a shift in the $q(\bullet)$ function that leaves the slope unchanged for constant levels of μ and R. This treatment allows us to substitute $q + \alpha$ for q in the equations (2)-(4). The only change this substitution implies for the totally differentiated system (9)-(22) is the replacement of equation (10) with

$$p^* \hat{p} + \mu\Gamma_1 \hat{M}_L - (\mu\Gamma_1 + M_s R^2 \Gamma_2)\hat{M}_s + M_s R^2 \Gamma_2 \hat{S} = p^* \hat{p}^* + p\hat{\alpha}.$$

We note the following solutions in particular:

$$\frac{\hat{p}}{\hat{\alpha}} = \frac{1}{D}(pG_3G_5) > 0 \tag{35}$$

$$\frac{\hat{\mu}}{\hat{\alpha}} = -\frac{1}{D}(pG_3) < 0 \tag{36}$$

$$\frac{\hat{M}_S}{\hat{\alpha}} = -\frac{1}{D}(p^* M_L V_1 + pG_4G_5) < 0. \tag{37}$$

Increased enforcement activity raises the cost of smuggled goods at the initial equilibrium. Importers respond by reducing the share of illegal to legal imports. The domestic relative price of the import good rises as reduced camouflaging reduces the disparity between domestic and the tariff-inclusive world price. The level of smuggled goods also falls.

Although M_S falls, the effect of enforcement on total imports is indeterminate:

$$\frac{\hat{M}}{\hat{\alpha}} = -\frac{1}{D}\{M_L V_1(p^* - p) - (M_S P / M)B_2V_2 + pG_4G_5\} \gtrless 0.$$

The possibility of increased imports arises because the level of legal imports may rise or fall.

The quantity of smuggling services produced depends on the domestic relative price, p, and on the level of smuggled imports, as seen by (34). The net effect on the level of these services is indeterminate:

$$\hat{S} = \frac{p}{D}\{G_5(MB_1V_1 - B_2V_3) - M_L B_2V_1\} \gtrless 0.$$

That increased enforcement has an indeterminate effect on the demand for smuggling services can be usefully viewed through the lens of the smuggler's problem. Increased enforcement reduces the profitability of smuggling, given a fixed disparity between world and domestic prices. The reduced profitability decreases smuggling activity as seen by the fall in M_S, reducing the demand for smuggling services. Increased enforcement, however, raises the domestic price of the importable, widening the price disparity and raising the profitability of successfully smuggled units. Firms can enhance the probability of success in smuggling by raising their purchases of smuggling services. These two effects, reduced smuggling activity and a higher domestic price, have opposing effects on the demand for smuggling services and, thus, we are unable to sign the net effect of increased enforcement on S.

Referring to the expression for the change in home welfare, equation (31), it is clear that the effect of enforcement on welfare is indeterminate[20]. To explain these results intuitively, let us consider how enhanced enforcement affects domestic consumption of the two final goods. The tariff distortion implies that consumption of good 1 is "too low" relative to consumption of good 2. Holding

DUP activities constant, increased enforcement raises the domestic price of the importable exacerbating the production distortion, causing Q_1 to rise. If total imports rise, consumption of good 1 must rise, thereby raising welfare. DUP activities are not unaffected by the enforcement shift, however, and if S rises, labour will be drawn away from final-goods production. Thus, even if total imports rise, Q_1 and C_1 may fall, reducing welfare.

The price of smuggling services responds to increased enforcement, but in an indeterminate way. The increase in the domestic price tends to raise the price of smuggling services while the decrease in smuggling activity tends to decrease the smuggling services price. If p_S rises in response to increased enforcement, we find that

$$\hat{p} > \hat{p}_S > \hat{w} > 0.$$

In this case, the return to specific-factor owners in the import-competing and the smuggling services industries rises. Only those in the import-competing industry unambiguously gain in real terms. If the price of smuggling services falls, we cannot determine its relationship to the percentage change in the wage, although it remains that

$$\hat{p} > \hat{p}_S.$$

Conclusion

We have shown that smuggling need not reduce domestic welfare of a tariff-ridden economy, even when smuggling pulls domestic resources into directly unproductive activity. Welfare will be reduced by the presence of smuggling if the value of productive activity displaced by smuggling exceeds the benefit of the lower domestic price resulting from smuggling. We have also found that a tariff increase need not worsen welfare and that strengthened anti-smuggling activity need not improve welfare. At issue in each case is the extent of the resource cost of smuggling and the gains from relaxing the domestic tariff distortion. Because a tariff increase raises the domestic relative price and lowers home imports, a sufficient condition for welfare to fall is the expansion of resources devoted to smuggling. Enhanced border enforcement also raises the domestic relative price of importables, but may lead to an increase in the quantity of imports. A sufficient condition for enhanced enforcement to worsen welfare is the contraction of home imports and an expansion in the share of labour devoted to smuggling.

Notes

1. The relationship between the short run and long run in an economy with smuggling raises a number of interesting questions in the context of political economies in transition to capitalism. Domestic relative price changes induced by market reform in the context of high trade distortions could lead to increased diversion of productive resources (capital as well as labour) into the DUP sector. As in the long-run models of smuggling, the result

could be performance considerably below that expected for the economy as a result of the reforms. Furthermore, if policy sustainability is determined endogenously via some political-economic process, coalitions of DUP-sector agents with other sectors could undermine the sustainability of the reform. Both of these issues are matters of current research.

2. It might be noted that there is an older, partial equilibrium, analysis of black market activity with an obvious relationship to the current research on smuggling. This line of research goes back to papers by Boulding (1937) and Michaely (1954), who developed a technology that has been used more recently to study black markets in foreign exchange (Sheikh, 1976) and agricultural commodities (Roemer, 1986).
3. Actually, there is a fourth fundamental aspect of the economics of smuggling which we do not explore: market structure. Bhagwati and Hansen (1973) and Johnson (1972) consider monopolistic as well as competitive smuggling; Norton (1988) develops a model in which some smugglers earn rents; and Thursby *et al.* (1991) provide a sophisticated analysis of market structure in smuggling that permits a variety of imperfectly competitive structures including firm heterogeneity.
4. Note that if smugglers are price takers and the act of smuggling requires no productive resources as inputs, as most analyses following Bhagwati and Hansen assume, the national identity of smugglers is irrelevant.
5. Both Pitt (1981) and Martin and Panagariya (1984) explicitly consider the implications of the additional cost of smuggling being paid abroad (e.g. to purchase fraudulent invoices) and in the home country (e.g. bribes to customs officials). Norton (1988), who is primarily concerned with trade in live animals, treats the loss as a constant, but explicitly considers such loss in both legal and illegal trade (with the rate of loss varying between the two).
6. See Bhagwati (1981) for a detailed discussion of price disparities in the different smuggling models.
7. Martin and Panagariya report that they extend their approach to “ships of the night” smuggling in Martin and Panagariya (1983).
8. It is an interesting historical note that consideration of detection returns the analysis of smuggling to the concerns of the eighteenth century scholar and statesman Cesare Bonsana, Marchese di Beccaria (1764).
9. As Thursby *et al.* (1991, pp. 794-5) point out, the results of this type of analysis are sensitive to this assumption. For example, if the government chose to destroy confiscated goods the results would differ quantitatively but, Thursby *et al.* argue, not qualitatively. More seriously, the government could levy a penalty instead of confiscation or in addition to confiscation. We follow the literature in assuming that the government simply resells the confiscated commodity. The appropriateness of this assumption is obviously related to the issue of why the government is taxing the imports in the first place. We return to this question in the conclusion, noting at this point that the model presented here would seem to be most relevant for the case of trade taxes levied for revenue purposes.
10. Our equations (2)-(4) can be seen to be very similar to equations (3)-(5) in Martin and Panagariya. As in Martin and Panagariya (1984), these conditions imply zero expected profits.
11. In the Bhagwati and Hansen model, the revenue loss is a real cost to the economy because it reflects the loss caused by the inferior terms of trade available to smugglers.

12. Legal and illegal trade coexist because Sheikh assumes that the risk of smuggling, which is the expected shrinkage per unit smuggled due to confiscation and fines, increases as the total amount smuggled increases. Kemp (1976) used a similar device to ensure coexistence.
13. These domestic resource costs explain why smuggling is not irrelevant, as it is in the Kemp (1976) model, even though some revenue is raised through fines and confiscation.
14. Bhagwati and Srinivasan (1983) provide a more extensive comparison of the Bhagwati and Hansen, Sheikh, and Pitt models.
15. This decomposition is similar to that used by Bhagwati *et al.* (1969) and Bhagwati and Srinivasan (1983) to decompose the welfare effect of growth in a distorted economy.
16. Deardorff and Stolper (1990) suggest that in the dramatically distorted environments in which smuggling might be expected to be a significant issue, there is some presumption that the resource cost of smuggling would be considerably smaller than the gains from relaxing the distortions.
17. This diagram is virtually identical to that used by Johnson (1967) to illustrate immiserizing growth in the presence of a distortion. Our argument is obviously the same as his.
18. As shown by Sheikh (1974), the Johnson-Sheikh effect has an indeterminate sign in the context of the HOS model, as the use of domestic resources in smuggling may expand exportables and contract importables production. The reasoning underlying this result is the Rybczynski Theorem, which states that in the HOS model a decrease in an input quantity must increase an output.
19. The second order conditions for the importers' problem imply:

$$\Gamma_1 = p(2q_M + q_{\mu\mu}\mu) > 0; \quad \Gamma_2 = q_{RR}\frac{p}{M_S} > 0.$$

20. Our qualitative results are the same as those obtained by Martin and Panagariya (1984), who also find that enforcement has an indeterminate effect on welfare. However, if imports rise in their model, welfare rises. In our model with DUP, an increase in imports is insufficient to guarantee an increase in welfare. This difference in results reflects the different assumptions made about the resource cost of smuggling. Martin and Panagariya use a "melting ice" formulation for the resource costs of smuggling. Thus, when firms respond to enhanced enforcement by raising the intensity of their concealment activities, real resource costs rise but do not take domestic resources away from domestic production. For a given final-goods price, the real resource costs of smuggling do not affect domestic production. In contrast, our formulation treats these resources as domestic productive resources. When firms raise the intensity of their concealment activity, resources are drawn away from domestic final-goods production. Thus, in our model, domestic production is affected by changes in the domestic final-goods price and the real resource costs of smuggling.

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Appendix

Definitions of parameters used in text

$$\delta = C_1 / C_2 > 0$$

$$\lambda_j = L_j / \bar{L} > 0;\ j = 1,2$$

$$\Lambda_j = \lambda_j / \lambda_S > 0;\ j = 1,2$$

$$\Psi = \frac{1}{\varepsilon_2 + \varepsilon_S \Lambda_2} < 0$$

$$\prod = \frac{1}{\varepsilon_1 + \psi\varepsilon_2\varepsilon_S \Lambda_1} < 0$$

$$K_1 = -\Psi\pi\eta_S(\varepsilon_2\Lambda_1 + \varepsilon_1\Lambda_2) > 0$$

$$K_2 = -\Psi\pi\eta_S\varepsilon_2\Lambda_1 > 0$$

$$K_1 - K_2 = -\psi\pi\eta_S\varepsilon_1\Lambda_2 > 0$$

$$\Gamma_1 = p(2q_p + q_{\hat{\mu}\mu}\,\mu) > 0$$

$$\Gamma_2 = q_{RR}\rho / + M_S > 0$$

$$B_1 = \frac{p_S + \Gamma_2 S K_2}{p_S + \Gamma_2 S K_1} > 0$$

$$B_2 = \frac{\Gamma_2 S}{p_S + \Gamma_2 S K_1} > 0$$

$$V_1 = \delta p^* + 1 > 0$$

$$V_2 = \Psi\pi(Q_1\,\eta_1\,\varepsilon_2 - \delta Q_2\,\eta_2\,\varepsilon_1)\ 0 \text{ if } \frac{\eta_1 / \varepsilon_1}{\eta_2 / \varepsilon_2} < 1.$$

$$V_3 = \pi(Q_1\,\eta_1 + \Psi\delta Q_2\,\eta_2\,\varepsilon_S\Lambda_1) - \sigma C_1 < 0$$

$G_1 = p^* - p_S RB_2(K_2 - K_1) > 0$
$G_2 = -p_S RB_2, < 1$
$G_3 = MV_1 + B_2V_2 > 0$
$G_4 = B_1V_2 - V_3 > 0$
$G_5 = (\mu^2 \Gamma_1)/(p^* T) > 0$
$D = G_1 G_3 G_5 - M_L V_1 G_2 - G_2 G_4 G_5 + \mu \Gamma_1 G_3 > 0$
$A_1 = K_1 B_1 - K_2 > 0$
$A_2 = K_1 B_2 - > 0$

Derivation of equation (30)

Using equations (12) and (13)

$$pQ_1 \hat{Q}_1 + Q_2 \hat{Q}_2 = pQ_1 \eta_1 \hat{L}_1 + Q_2 \eta_2 \hat{L}_2). \quad \text{(A1)}$$

Note that in equilibrium, the domestic rate of transformation equals the domestic price ratio, which because of the RV structure implies

$$p = \frac{Q_2 \eta_2 \Lambda_1}{Q_1 \eta_1 \Lambda_2}.$$

Thus, (A1) can be written as

$$pQ_1 \hat{Q}_1 + Q_2 \hat{Q} = \frac{pQ_1 \eta_1}{\Lambda_1}(\Lambda_1 \hat{L}_1 + \Lambda_2 \hat{L}_2). \quad \text{(A2)}$$

Equations (16) and (17) can be used to express $\hat{L}_1$ and $\hat{L}_2$ as functions of $\hat{P}$ and $\hat{P}_S$. Using (14) to solve for $\hat{S}$ as a function of $\hat{P}_S$ and $\hat{P}$, we use the result to eliminate $\hat{P}_S$ from the expressions for $\hat{L}_1$ and $\hat{L}_2$. This procedure yields

$$\hat{L}_1 = F_1 \hat{S} + F_2 \hat{P} \quad \text{(A3)}$$
$$\hat{L}_2 = F_3 \hat{S} + F_4 \hat{P}, \quad \text{(A4)}$$

where

$F_1 = \psi\pi \varepsilon_2 / K_1 < 0$
$F_2 = \psi\pi / K_1 [\varepsilon_2 (K_2 - K_1) - K_1 \varepsilon_S \Lambda_2] > 0$
$F_3 = \psi\pi \varepsilon_1 / K_1 < 1$
$F_4 = \psi\pi / K_1 [K_2 \varepsilon_1 + K_1 \varepsilon_S \Lambda_1] < 0.$

Substituting (A3) and (A4) into (A2) gives

$$pQ_1 \hat{Q}_1 + Q_2 \hat{Q}_2 = \frac{pQ_1 \eta_1}{\Lambda_1}[(\Lambda_1 F_1 + \Lambda_2 F_3)\hat{S} + (\Lambda_1 F_2 + \Lambda_2 F_4)\hat{P}]. \quad \text{(A5)}$$

Note that

$$\Lambda_1 F_2 + \Lambda_2 F_4 = \frac{\psi\pi}{K_1}(\Lambda_1 \varepsilon_2 (K_2 - K_1) + \Lambda_2 K_2 \varepsilon_1) = 0$$

and

$$\Lambda_1 F_1 + \Lambda_2 F_3 = \frac{\psi\pi}{K_1}(\Lambda_1 \varepsilon_2 + \Lambda_2 \varepsilon_1) = -1/\eta_S.$$

Therefore, (A5) reduces to (30).