A THEORY OF SMUGGLING WITH APPLICATION TO INDONESIA

by

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I. Introduction

Illegal transactions have been known to account for large portions of the foreign trade of many developing countries. But only recently has there been an attempt to study smuggling using the tools of economic analysis. The seminal work applying standard two-good trade-theoretic analysis in formulating models of smuggling in an open economy is that of Bhagwati and Hansen (1973). Their primary concern was the welfare implications of smuggling under assumptions of perfect competition or monopoly on one hand and constant or increasing costs in smuggling on the other. They tested the widely held view that in the small country case, smuggling implies an increase in economic welfare since smuggling by definition is the evasion of taxes on trade (or quantitative restrictions) which are always sub-optimal. They found this view to be false except under restrictive conditions. Their work has stimulated a number of extensions which basically rely on the same theoretic structure.[1]

Little effort has so far been made to check whether the conclusions of the Bhagwati-Hansen models correspond with the

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[1]For example Bhagwati and Srinivasan (1974), Johnson (1974), Falvey (1978) and Ray (1978). Sheikh (1974) postulates that the activity of smuggling requires a non-traded third good. While his welfare results differ from those of Bhagwati and Hansen, the nature of smuggling costs and the resulting price equilibrium is essentially the same.

phenomena actually observed in economies characterized by widespread smuggling. In section II of this paper, the nature of smuggling in Indonesia during the 1950's and 1960's is discussed and found not to conform to the Bhagwati-Hansen models. In section III, an alternative model of smuggling is proposed which more adequately explains the phenomena observed. In section IV, the welfare implications of the smuggling model are analyzed. In section V, the results are extended to the case of quantitative restrictions. The question of trade tax revenue maximization is examined in section VI. Finally, in section VII, the importance of smuggling in altering domestic relative prices and the pattern of trade and production for some important Indonesian exports during the 1950's and 1960's is analyzed with reference to the proposed theory of smuggling.

II. Smuggling Phenomena and the Bhagwati-Hansen Models

In terms of the sheer dollar value of smuggling, the Indonesian experience of the 1950's and early 1960's is probably unmatched. The smuggling of exports such as rubber, copra and coffee was most pervasive. A model of smuggling which is relevant for the Indonesian experience must be able to explain the coexistence of three phenomena: smuggling, legal trade and price disparity in a commodity. Price disparity is defined as the positive difference between the domestic market price and the tax-inclusive world price of an exported commodity. Price disparity means that the domestic price of an exportable is

greater than its return from legal export, i.e. any legal export seemingly occurs at a loss.

In the models described by Bhagwati and Hansen, there are no commodities for which legal trade, smuggling and price disparity coexist. In their analysis, smuggling is treated as trade at world prices (i.e. trade taxes are avoided) but involving a less favorable transformation curve than under free trade (i.e. in the absence of trade taxes) because smuggling involves a real cost, for example, additional transport costs.

The basic assumptions used throughout are that primary factors produce two traded goods in a small country, i.e. one for which the terms of trade are fixed. The traded goods X and M, an exportable and importable respectively, are produced by primary factors in perfect competition.

Figure 1 illustrates the Bhagwati-Hansen model of perfect competition in smuggling at constant costs. The production possibility curve is given by AA' and the slope P_fC_f is the fixed international terms of trade. With a tax on exports (tariff on imports), the tax-inclusive terms of trade (which are domestic prices in the absence of smuggling) are represented by the slope of the line tangent to AA' at P_t. With smuggling at constant costs, the smuggling transformation curve is P_sC_s.[2] Since P_sC_s

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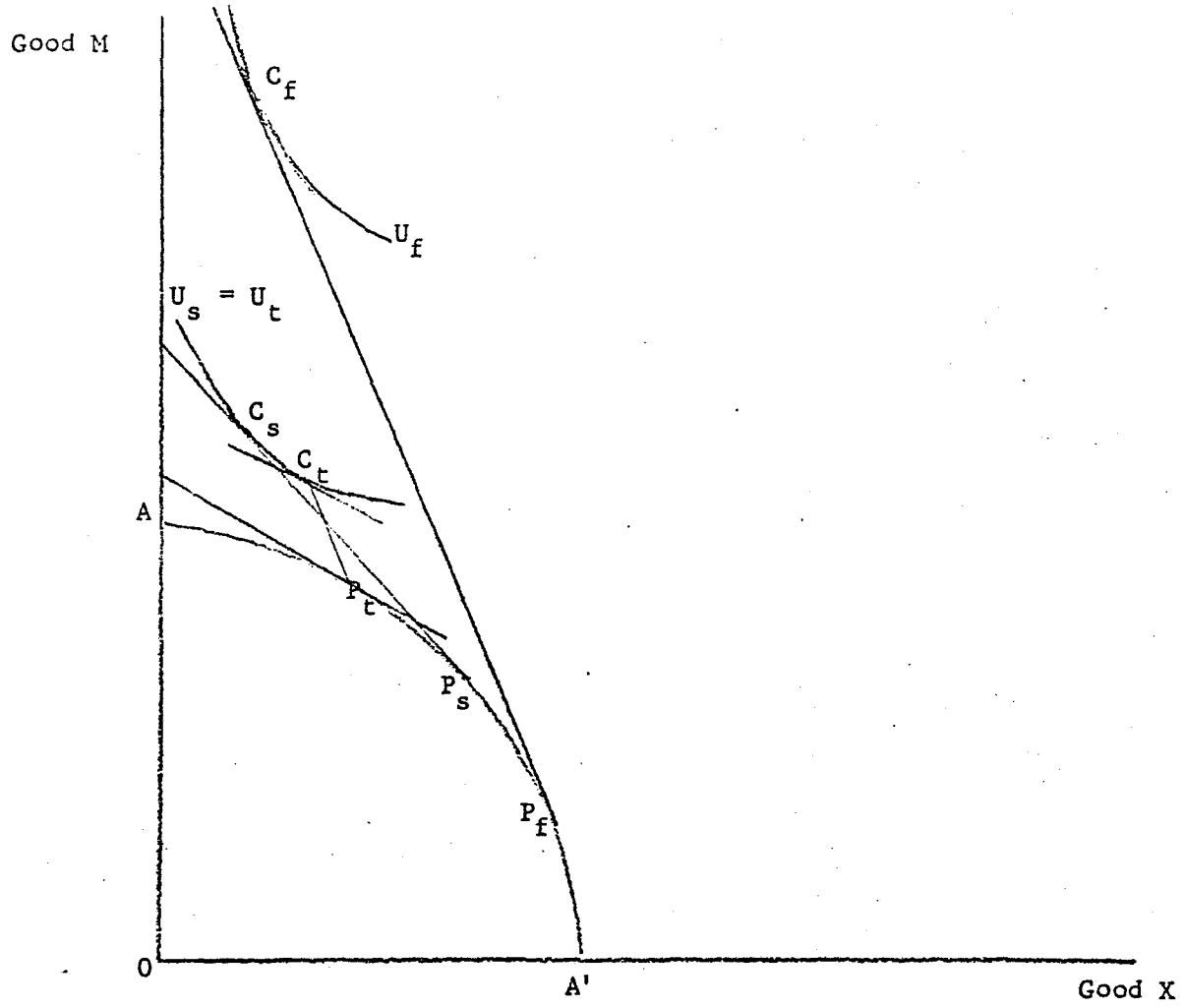
[2] Figure 1 illustrates the special case where welfare is the same in both the legal trade and smuggling cases. Smuggling would be welfare increasing if the smuggling transformation curve were steeper than P_sC_s and welfare decreasing if it were less steep than P_sC_s.

Figure 1



is steeper than the legal transformation curve, price disparity exists, but legal trade is always eliminated.[3]

Figure 2 illustrates the case of perfect competition in smuggling at increasing costs in the Bhagwati-Hansen sense. That is, the individual smuggler has a constant marginal rate of transformation and the decreasing rate of transformation for smuggling as a whole is due only to intra-industrial, interfirm diseconomies of scale. In this case the smuggling transformation curve is P_sC_sB while domestic relative prices are the slope of the straight line P_sC_s. Here again price disparity exists but legal trade does not.[4]

Figure 3 represents perfect competition in smuggling at increasing costs but with legal trade and smuggling coexisting. Smuggling takes place along the transformation curve P_sQB until point Q, then legal trade at international prices takes import availability to C_s. At this point, legal trade and smuggling coexist and there is no price disparity.[5]

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[3] Legal trade may exist in the borderline case where the constant cost of smuggling is such that P_sC_s and P_tC_t coincide. In this case the division of trade between smuggling and legal trade is indeterminate and price disparity does not exist. In addition, smuggling necessarily reduces welfare vis-à-vis the nonsmuggling situation.

[4] Figure 2 again illustrates the special case of identical welfare in both the smuggling and legal trade cases and the conditions for a relative increase in welfare stated in footnote 2 apply.

[5] In this case, smuggling necessarily reduces welfare vis-à-vis the nonsmuggling situation.

Figure 2

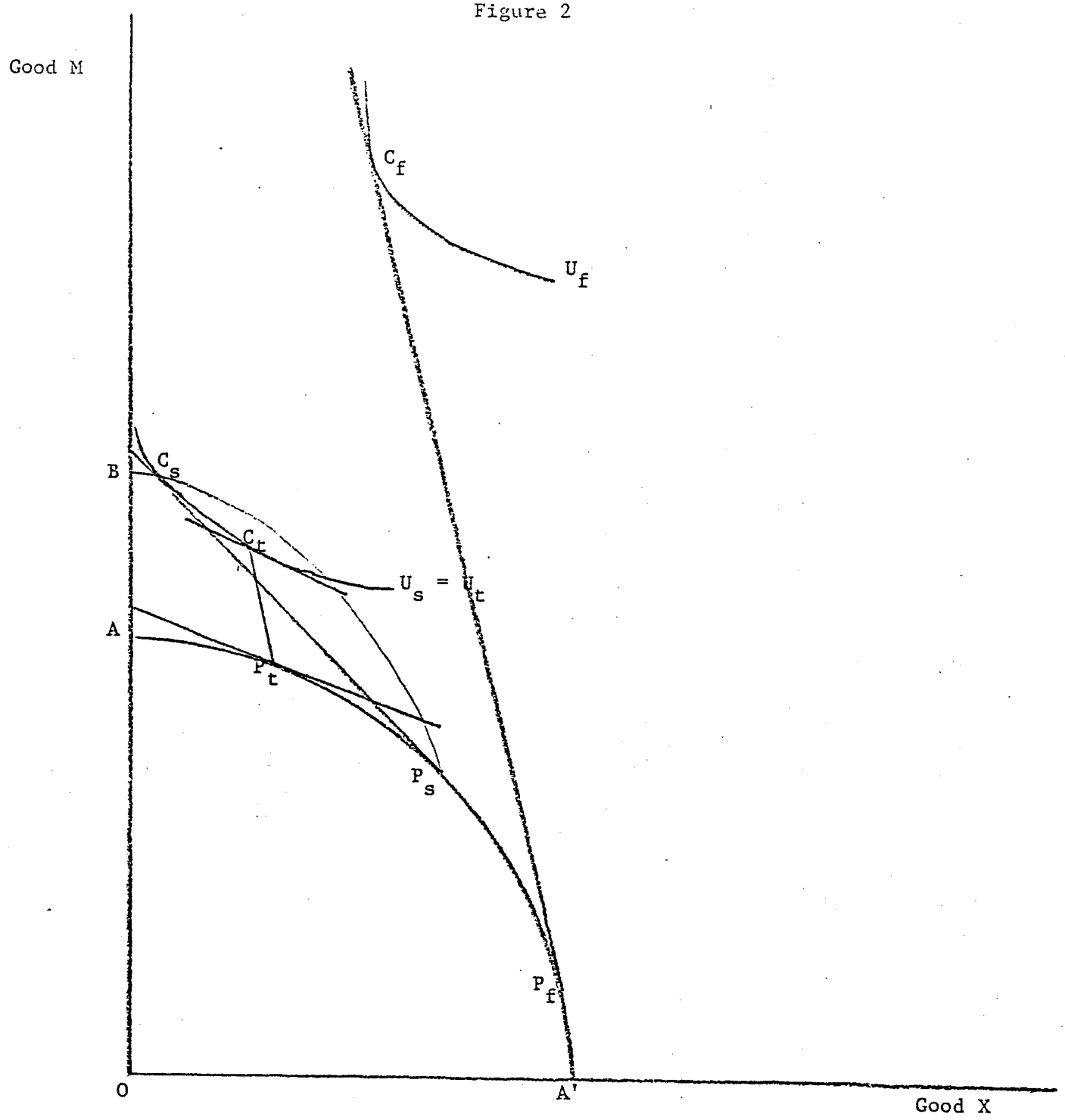
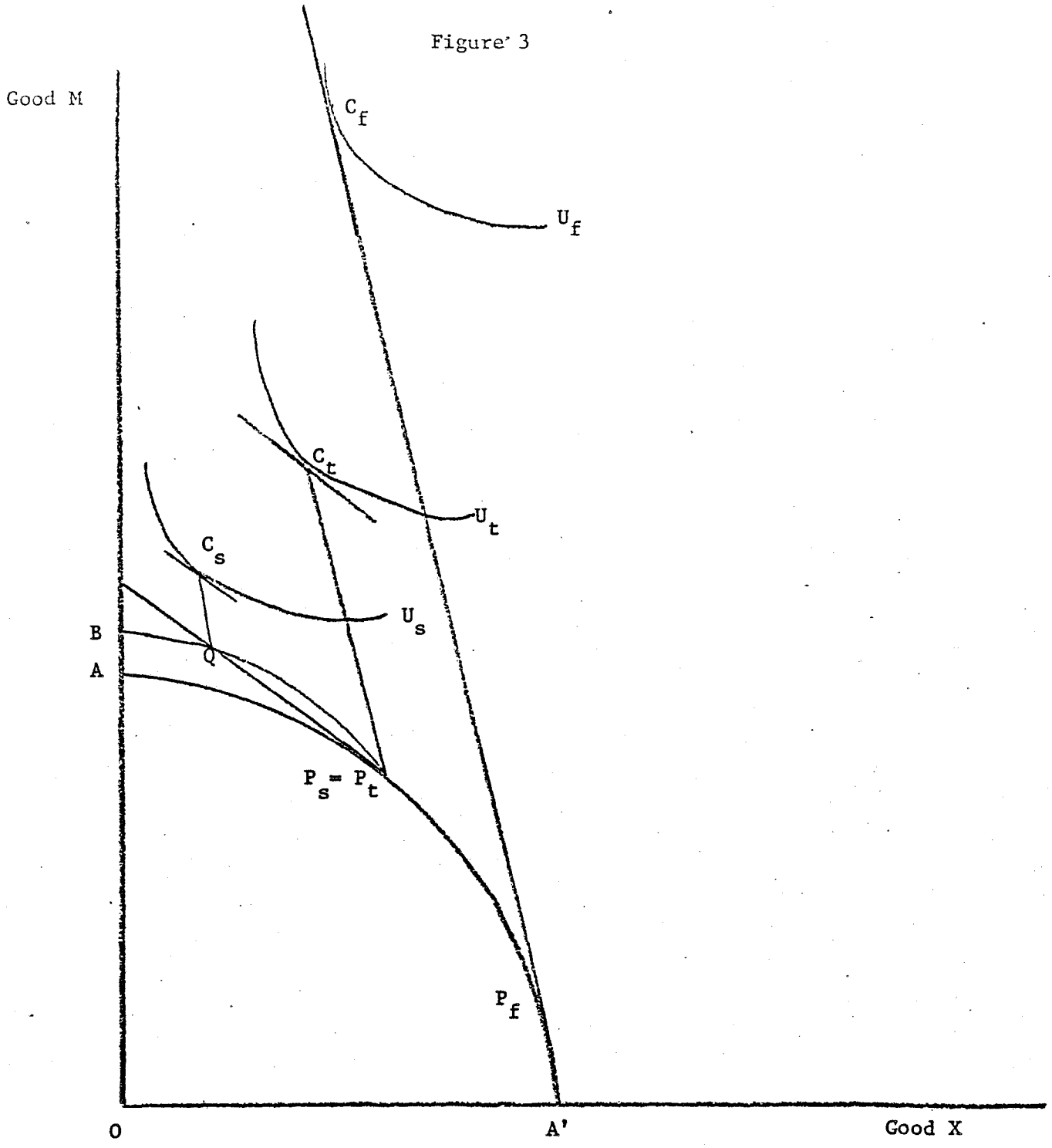


Figure 3



In none of the cases studied above have legal trade, smuggling and price disparity been found to coexist.[6] This is because the Bhagwati-Hansen theory of smuggling assumes the cost of smuggling to be independent of the quantity of legal trade. Under this assumption, there is no reason for legal export to occur at a loss, which is the implication of the coexistence of legal trade and price disparity.

III. An Alternative Theory of Smuggling

A natural justification for legal export at a loss is its ability to reduce the costs of smuggling. To hide their smuggling, it is necessary for trading firms to export legally. Domestic firms which make large purchases of an exportable (such as rubber in Indonesia) will find that unreasonably small levels of registered legal export will invite scrutiny by the authorities. A large share of smuggling occurs not via "ships in the night" but rather in broad daylight off the wharves of customs administered ports. Goods bound for export are misweighed, misgraded, misinvoiced or not invoiced at all with or without the cooperation of customs authorities. Some legal trade is necessary for this type of activity. The greater the legal export, the easier it is to hide smuggle activity from enforcement agencies and therefore the less costly will be

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[6] This statement is also true for monopoly in smuggling. In any case, monopoly in smuggling is not relevant in most real world smuggling situations.

smuggling. Thus, legal export can be viewed as an input into the smuggling activity. In what follows, a formalization of this conception of smuggling is undertaken.

Consider the small economy described earlier. Production and trade is carried out by identical firms. Each firm can trade illegally according to the "smuggling function"

(1) $\bar{s} = g(\ell, s)$

where $\bar{s}$ is the quantity of good X smuggled

ℓ is the quantity of good X legally traded

s is the quantity of good X input into the smuggling activity

$g(\cdot)$ is a strictly concave and twice continuously differentiable linear homogeneous function.

It is further assumed that it has the properties:

(A1) $g_\ell \geq 0$

(A2) $1 \geq g_s \geq 0$

(A3) $s \geq \bar{s}$

Assumption (A1) states that the marginal product of legal trade in the smuggling activity is non-negative. Assumption (A2) states that a unit increase in the smuggling input results in a positive but less than unit increase in actual (ex post) smuggling. The difference between ex ante smuggling, s, and ex post smuggling, $\bar{s}$, is the cost of smuggling. Assumption (A3) prohibits this cost from being negative.

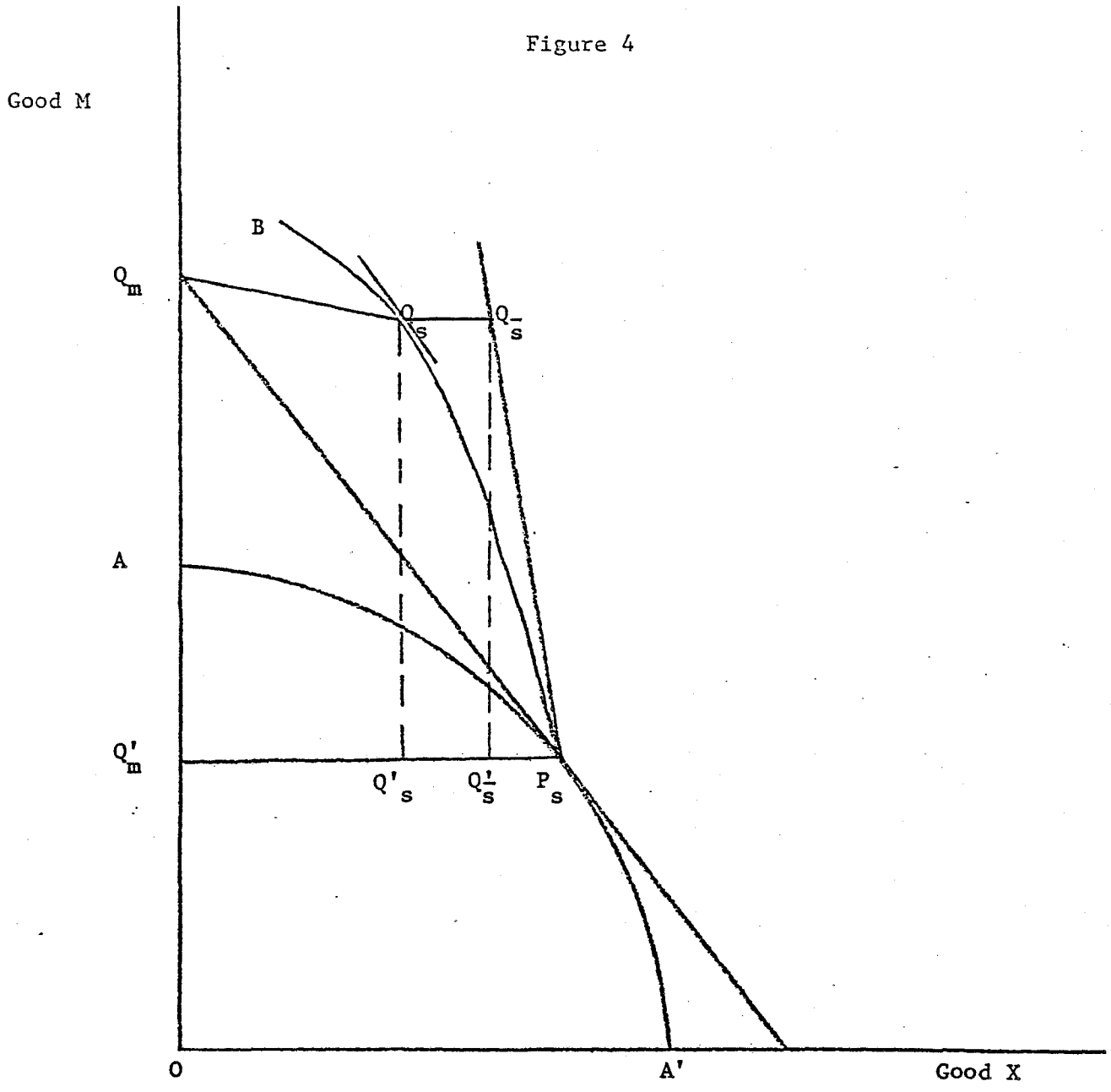
The objective of the firm in trade is to obtain the greatest quantity of good M per unit of good X traded both legally and illegally. The total quantity of good M obtained through legal

and illegal trade is given by $q^s = q^f g(\ell,s) + q^t \ell$, where q^f and q^t are free trade and tax-inclusive free trade prices respectively. The linear homogeneity of this relationship implies that the maximum quantity of good M that can be obtained per unit of good X traded is independent of levels of trade and production. Thus, firms face a linear rate of transformation in total trade (q^s) which is a function of only q^f, q^t and the smuggling technology g.

Firms choose production (and absolute levels of legal and illegal trade) so as to maximize profits (measurable in terms of good M) given q^s. In Figure 4, AA' is the production possibility curve for goods X and M. Every point on AA' is uniquely determined by the value of a parameter Θ. Assume that production occurs at P_s and that legal trade is fixed at $Q_m'Q_s' = \ell_o$. Given ℓ_o and free trade prices of q^f, the curve P_sQ_sB is the smuggling transformation curve $q^f g(\ell_o,s)$. This smuggling transformation curve represents the quantities of imported M that can be obtained for various quantities of s, given ℓ_o and q^f. In particular, for smuggling input $s = Q_s'P_s$ (resulting in $\bar{s} = Q_s'P_s$), the quantity Q_sQ_s' of M can be obtained through smuggling. Starting at Q_s, the legal export $Q_m'Q_s'$ can be exchanged for M until Q_m at the tax-inclusive price given by the slope of Q_sQ_m.

In maximizing profits (at q^s) in terms of good M, a firm maximizes the quantity of M obtainable from both production and trade. Good M is obtainable from three sources. First, a quantity of

Figure 4



M equal to M(Θ) is produced. Second, M is obtainable from smuggling, the quantity thus obtained equal to $q^f g(\ell,s)$. Third, M is legally obtainable at the tax-inclusive terms of trade $q^t = q^f (1 - t)$ in the amount $q^t \ell$.

In order to show that a point such as Q_m achieves the maximum possible after trade quantity of the importable and is consistent with profit maximization, the coordinates of all the relevant points in Figure 4 are identified and used to solve the constrained extremum problem. Note that:

P_s has coordinates $X(\Theta)$, $M(\Theta)$

Q_s has coordinates $X(\Theta) - s$, $M(\Theta) + q^f g(\ell,s)$

Q_m has coordinates 0, $M(\Theta) + q^f g(\ell,s) + q^f(1 - t)\ell$

Firms must choose Θ,ℓ and s so as to maximize the quantity of M obtainable from production and trade subject to the constraint that the quantity of X traded (equal to $\ell + s$) does not exceed the quantity produced.

The Lagrangean of the constrained extremum problem is:

$$(2) \quad \underset{\Theta,\ell,s,\lambda}{\text{Max}}\ \pi = M(\Theta) + q^f g(\ell,s) + q^f(1-t)\ell + \lambda(\ell+s - X(\Theta))$$

The first-order conditions are:

$$(3a) \quad \pi_\Theta = M_\Theta - \lambda X_\Theta = 0$$

$$(3b) \quad \pi_\ell = q^f g_\ell + q^f(1-t) + \lambda = 0$$

$$(3c) \quad \pi_s = q^f g_s + \lambda = 0$$

$$(3d) \quad \pi_\lambda = \ell + s - X(\Theta) = 0$$

Condition (3a) states that the marginal rate of transformation in production is equal to $-\lambda$, the Lagrange multiplier. Condition (3c) states that the smuggling transformation curve has a

slope λ at the optimal point. Thus in Figure 4, $Q'P_s$ is the profit maximizing quantity of s only if the smuggling transformation curve P_sQ_sB has slope λ at Q_s. Condition (3b) states that at the optimum, an additional $-\lambda$ units of M could be obtained from an incremental unit of ℓ. Note that an incremental unit of ℓ results in an additional $q^f(1-t)$ units of M obtained legally and an additional $q^f g_\ell$ units obtained from the smuggling activity.

Taken together, conditions (3a), (3b) and (3c) establish that when profit is maximized, the marginal rates of transformation of X into M in production, legal trade and smuggling are equal.

Although P_s is the profit maximizing production point, it remains to be established that at P_s the rate of transformation in all trade (domestic relative prices) equals the marginal rate of transformation in production $-\lambda$. In Figure 4, the straight line Q_mP_s represents the domestic average rate of transformation in all trade. The slope of Q_mP_s can be written in terms of the differences between the coordinates of Q_m and P_s. The condition that domestic relative prices q^s equal the marginal rate of transformation in production then can be written:

$$(4) \quad q^s = -\frac{M(\Theta) + q^f g(\ell,s) + q^f(1-t)\ell - M(\Theta)}{-X(\Theta)} = -\lambda$$

By Eulers Theorem:

$$(5) \quad g(\ell,s) = \ell g_\ell + s g_s$$

Substituting (5) into (4) yields:

$$(6) \quad q^s = \frac{q^f \ell g_\ell + q^f s g_s + q^f (1-t)\ell}{X(\Theta)}$$

and substituting from (3b) and (3c) yields:

$$(7) \quad q^s = \frac{\ell(-q^f(1-t)-\lambda) + s(-\lambda) + q^f(1-t)\ell}{X(\Theta)}$$

which reduces to

$$(8) \quad q^s = \frac{-\lambda(\ell+s)}{X} = -\lambda$$

Therefore, perfectly competitive firms with constant returns to scale in the smuggling activity will lead the economy to produce at P_s where the marginal rate of transformation $-\lambda$ equals domestic relative prices q^s. Furthermore, these firms will earn zero economic profits because the revenue from foreign trade is just equal to the domestic cost of the tradables. Thus domestic prices can be expressed as the average price of all trade:

$$(9) \quad q^s = q^f \frac{\bar{s}}{s+\ell} + q^t \frac{\ell}{s+\ell}$$

It is also important to note that production and prices are determined independently of preferences, depending only on q^f, the tax rate t and the function g.

IV. Smuggling and Welfare

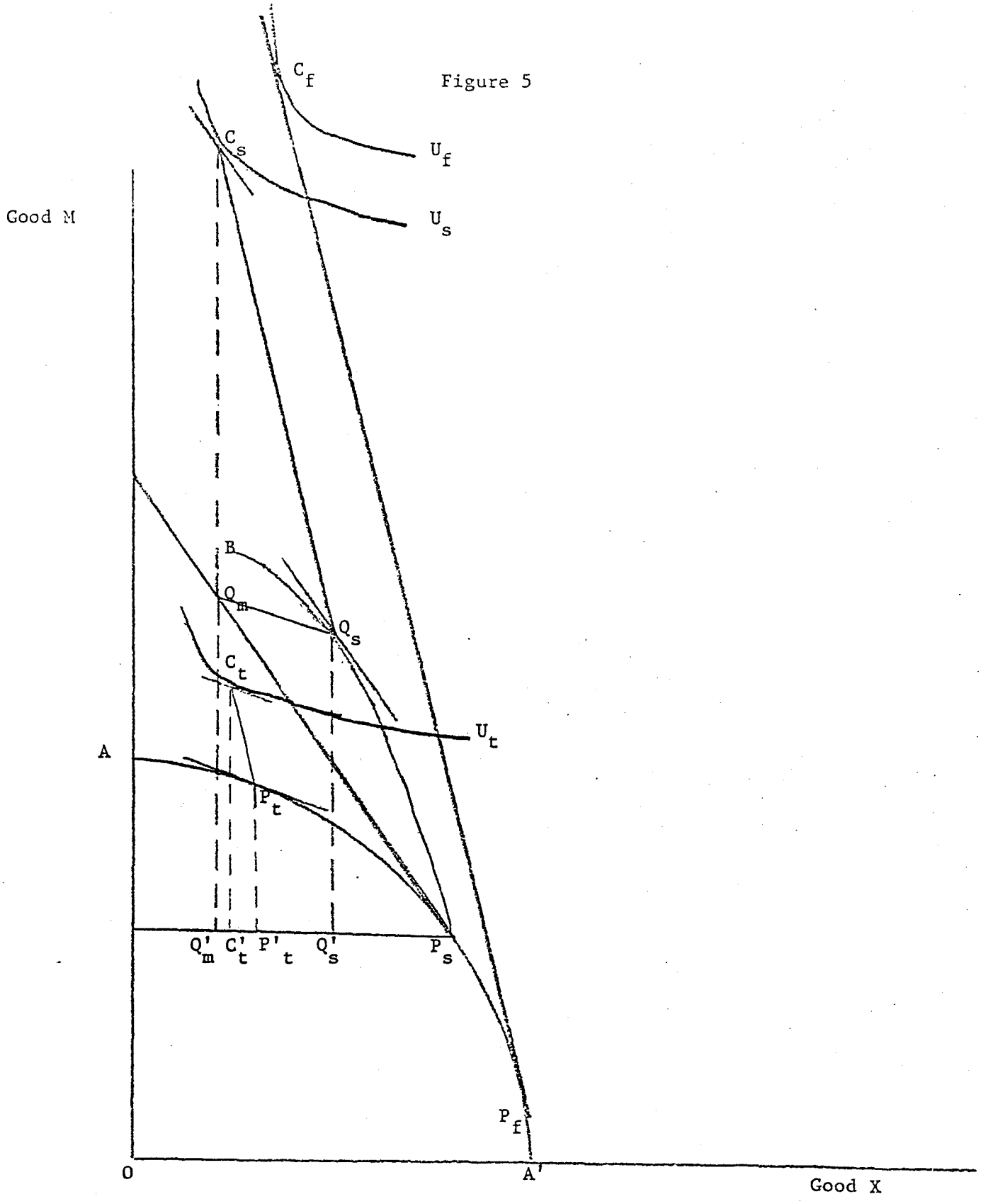
Bhagwati and Hansen in their welfare analysis of smuggling find that smuggling necessarily reduces welfare vis-à-vis the non-smuggling situation whenever legal trade and smuggling coexist. This is true irrespective of whether smuggling is characterized by constant or increasing costs. Since the coexistence of

smuggling and legal trade characterizes real world smuggling situations, their conclusion is an important one for policy. It suggests that governments could improve economic welfare by strictly enforcing suboptimal taxes on trade as opposed to allowing some evasion. However, below it is shown that these conclusions do not hold in our model of smuggling.

Figure 5 illustrates the case of greater welfare in the smuggling situation as compared with the nonsmuggling situation. In the absence of smuggling, production occurs at P_t where the tax-inclusive price is tangent to AA'. Trade occurs at international prices P_tC_t and welfare is at U_t. In the presence of smuggling, production occurs at P_s where the endogenously determined domestic relative price equals the marginal rate of transformation in production. Smuggling proceeds from P_s until Q_s on the smuggling transformation curve P_sQ_sB and legal trade permits exchange at the international terms of trade Q_sC_s with welfare at U_s.

In lieu of illustrating the case of smuggling decreasing welfare vis-à-vis the nonsmuggling situation, note that the Bhagwati-Hansen models of smuggling can be special cases of our model. Their "increasing costs" in smuggling can be merely diminishing returns to a factor in a two-factor production function. Their "constant costs" in smuggling is the limiting case of $g_\ell = 0$ for all values of ℓ and s.

Figure 5



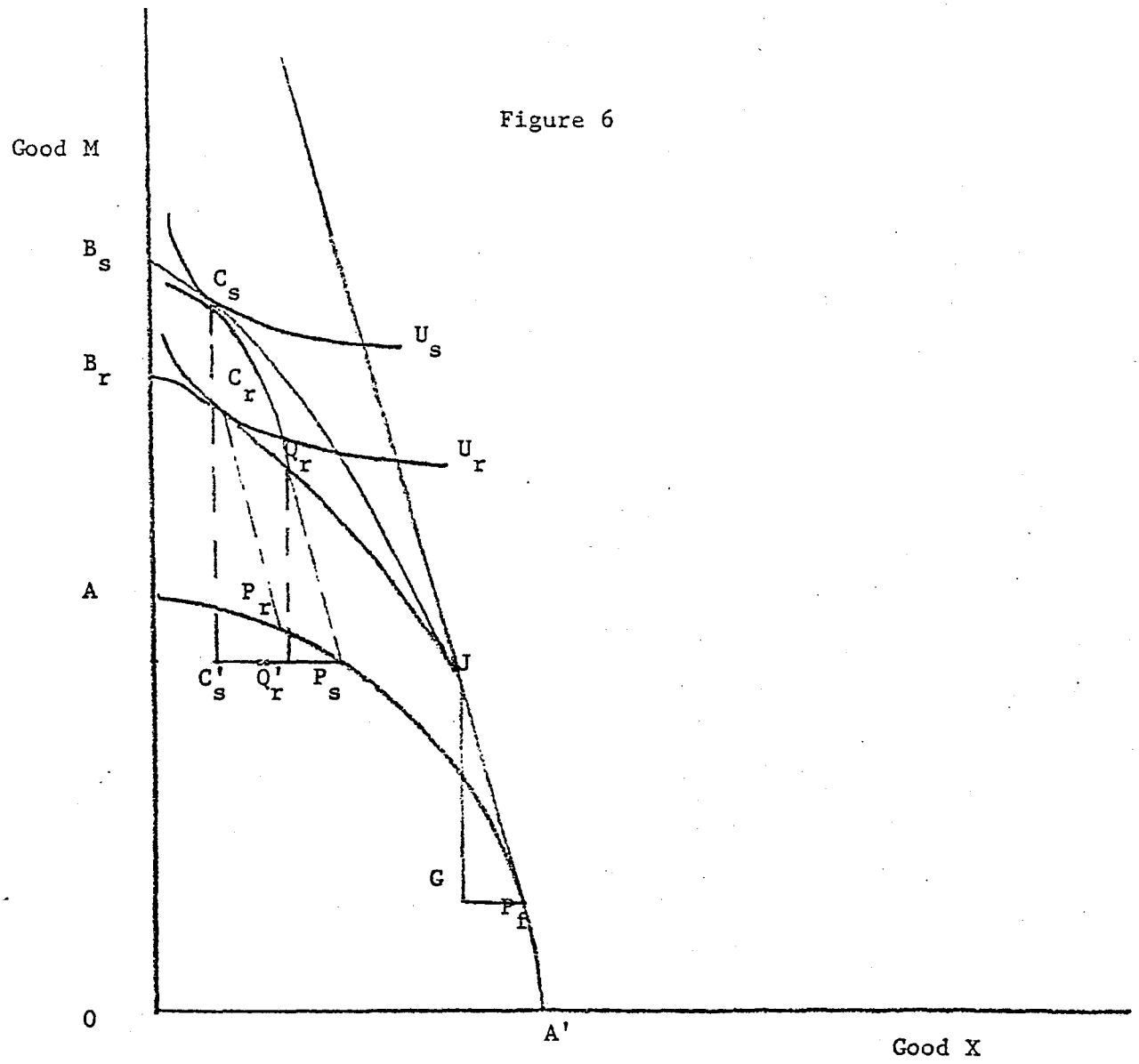
V. Smuggling and Welfare under Quantitative Restrictions

The theory of smuggling presented is easily extended to the case of a quota. In Figure 6, the (nonredundant) quota r on the export of good X (or import of good M) is represented by the segment JG. Since legal trade in the absence of other trade interventions is always the least cost source of imports, the entire quota will be traded at the international terms of trade represented by the slope of P_fJ. In the absence of smuggling, the consumption possibility curve is given by P_fJB_r. Each point on P_fJB_r represents a feasible consumption bundle corresponding to a unique point on the production possibility curve above P_f. Consumption would be at C_r where the community indifference map U_r is tangent to this curve. Production would be at P_r.

In the presence of smuggling, trade can be carried out beyond the quota on the transformation curve $q^fg(r,s)$. The translation of this transformation curve along P_fJB_r traces the envelope curve P_fJB_s, which is the locus of feasible consumption bundles in the presence of smuggling that correspond to points on the production possibility frontier. Consumption will occur at C_s with welfare U_s. Corresponding production is at P_s. Legal trade is given by $Q_r'P_s$ and input into the smuggling activity (s) by $C_s'Q_r'$.

In the example pictured, smuggling is welfare increasing vis-à-vis nonsmuggling for any preference map because the consumption possibility curve in the presence of smuggling P_fJB_s

Figure 6



dominates its nonsmuggling counterpart $P_f JB_r$. However, this need not be the case. If the marginal rate of transformation in smuggling at J is less than the marginal rate of transformation in production at J, then at least part of the smuggling transformation curve will lie below its nonsmuggling counterpart. In this circumstance, smuggling may not be welfare increasing.[7]

VI. Tax Revenue Maximization and Smuggling

Assume that the customs authority is given an export tax rate t by the central government and given the objective of maximizing trade tax revenues. The only instrument the customs authority has at its disposal is the level of its enforcement. Assume enforcement to be costless and that the customs authority is able to completely eliminate smuggling so as to obtain $g(\ell,s) = 0$. Will tax revenue maximization be achieved by the costless suppression of smuggling or by purposefully allowing smuggling to occur? In other words, is it possible that given a tax rate, the situation where some export completely avoids payment of tax yields greater tax revenue than the case where all export pays the full tax? Perhaps surprisingly, the answer to this question is yes.

In Figure 5, with a trade tax and in the absence of smuggling, production is at P_t and legal trade is $C'_tP'_t$. In the presence of

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[7] Falvey (1978) examined the welfare effects of smuggling under quantitative restrictions for the Bhagwati-Hansen models. He found that for constant and increasing costs in smuggling under a quota, smuggling resulted in an unambiguous welfare gain.

smuggling, production is at P_s with legal trade $Q'_mQ'_s$. The quantity of legal trade (and hence tax revenue) in the smuggling situation exceeds that of the nonsmuggling situation. Therefore, the policy of complete and effective enforcement against smuggling may not maximize the level of legal trade.[8] As the enforcement activities of the customs authorities are determinants of the function g, they can choose a g which maximizes tax revenue given the fixed tax rate. Intuitively, the explanation of this phenomenon is that smuggling may have an effect on domestic relative prices (through price disparity) great enough to call forth an increase in the exportables production net of any change in domestic consumption in excess of that lost to legal channels by smuggling. That is, the increase in total trade due to higher prices is greater than the quantity which is smuggled.

VII. Smuggling in Indonesia: Empirical Regularities

In a many commodity model of smuggling similar to the one described, the domestic relative price of the exportable in terms of any importable will be bounded by the tax-inclusive free trade relative price and the free trade relative price. However, in a model where prices are measured in monetary units, the domestic price of an exportable subject to an export tax may be more than its free trade price. This is because smuggled exportable can earn foreign exchange (or be exchanged for commodities) which may be highly valued in illegal (black) markets. Even if there are no trade interventions directed at a particular exportable,

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[8] This finding is contrary to the result of Bhagwati and Srinivasan (1974) for the Bhagwati-Hansen model. They established that, for a given tariff, the revenue that can be collected in the presence of smuggling is less than the revenue in the absence of smuggling.

its domestic price may exceed its legal trade price if there are interventions in the markets for other commodities or capital flows which result in black markets.

Price disparity for any commodity whose prices are measured in terms of money can be calculated by comparing the domestic price of the commodity (q^d, in domestic currency units) to the quantity of domestic exchange that can be earned through legal trade. The latter is just the world price (q^f), quoted in dollars for example, times the effective exchange rate for the exportable (EER). Price disparity as a percentage of the legal trade price may be written as $((q^d/q^f \times EER) - 1) \times 100$.

Table 1 presents data on the price disparity for natural rubber in Indonesia calculated in the above manner on a quarterly basis from 1952 through 1964. There the impact of smuggling on the domestic price of rubber is clearly demonstrated. Over the period 1955-64, price disparity increased the domestic price of rubber by almost 37 percent over the legal trade price. During the period 1961 IV through 1962 I, price disparity resulted in a domestic market price almost double the legal trade price.[9] It is not surprising that the price effects of smuggling seem to have completely counter-balanced the price distorting effects of Indonesian trade policy during the 1960's. The realized domestic currency return to a dollars worth of export (both

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[9]Kenneth Thomas (1966) claims that price disparity for rubber reached 160 percent in September 1965. Estimates of price disparity for a number of agricultural commodities in Indonesia in 1961 are found in Sadli (1961). The greatest price disparity found in the commodities he examined was 162 percent in the case of vetiver oil.

Price Disparity for Rubber in Jakarta 1952-1964

(in percent)

Year \ Quarter	I	II	III	IV
1952	16.69	19.45	9.09	14.50
1953	- 0.35	0.83	4.26	5.37
1954	8.86	19.07	8.64	15.15
1955	41.33	55.74	46.41	30.15
1956	23.62	17.82	21.08	21.47
1957	24.67	31.23	6.59	18.70
1958	8.71	20.41	29.43	46.27
1959	20.98	40.86	38.70	72.50
1960	77.62	67.15	42.62	28.95
1961	40.48	47.77	55.06	94.79
1962	91.45	46.08	1.86	32.96
1963	28.78	38.89	35.92	34.03
1964	53.63	10.63	13.30	8.76

Source: Price disparity is obtained as $((q^d / q^f \times EER) - 1) \times 100$. The domestic price q^d is the wholesale price of rubber (RSS I) in Jakarta obtained from the Biro Pusat Statistik. The world price q^f is the Singapore fob price of rubber (RSS I) in bales (adjusted for transport costs) obtained from the Rubber Statistical Bulletin, various issues. The effective legal exchange rate EER is the authors computation.

legal and illegal) during the period 1958-64, generally regarded as the period of greatest government intervention in trade, was on the average slightly greater, in real terms, than it was in 1971 at the end of Indonesia's dramatic trade liberalization.[10]

An interesting application of the concept of price disparity in establishing the presence of smuggling is the case of Indonesian coffee in the early 1960's. In the years 1960-61 the price disparity of Indonesian coffee averaged about 40-45 percent. Yet during 1962, price disparity apparently leaped to over 200 percent and remained at a similar level for a number of years. This magnitude of price disparity implies that coffee prices were <u>triple</u> what they would have been in the absence of smuggling and quantitative restrictions. These levels of price disparity also indicate that either the level of smuggling in coffee leaped from 1961 to 1962 or that the smuggling function changed abruptly or both. There is a good explanation why this would be so. In 1962, Indonesia became a member of the International Coffee Organization (ICO) and was required to adopt a coffee export quota.[11] This quota was allocated more than proportionately to the government-owned estate coffee sector which produced the higher quality arabica coffee's. Smallholders', predominately in Sumatra and producers of lower priced robusta coffees, were left with a relatively

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[10]See Pitt (1979) for the details of this calculation.

[11]This price disparity calculation relates actual domestic prices to unit legal trade receipts rather than relating them to legal trade receipts less the quota's tax equivalent. Thus, the 200 percent figure understates the actual level of price disparity.

small legal export allotment. As legal trade was legally prohibited on coffee in excess of the quota, the only outlet was the domestic market. The quota should therefore be expected (in the absence of smuggling) to cause a large fall in domestic coffee prices. It might also be expected that the smuggling function would be altered substantially. That is because it might not be in the governments interest to enforce legal trade provisions since the enforcement cannot divert illegal trade into legal (and taxed) channels once the quota is filled. Thus a legal trade quota and probable slackness in enforcement (i.e. a shift in the smuggling function) led to a smuggling boom.[12] Paradoxically, being left out of the ICO quota was a boon for smallholders. They benefited from any higher level of world prices that resulted from the ICO cartel plus they received a greatly increased rupiah return per dollar of total (legal and illegal) export.

An interesting question is whether our theory of smuggling permits quantitative estimates of the level of smuggling. From the theory it follows that if price disparity does not exist then there is no smuggling and if it does exist then there is smuggling. Although data on domestic and foreign prices as well as the effective exchange rate are usually obtainable, estimates of smuggling magnitudes are impossible because the smuggling function $g(\ell,s)$ is unknown and does not lend itself to statistical

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[12] The ICO was not completely unaware of these activities and penalized Indonesia for illegal trade in coffee by reducing their quota.

estimation. However, quantitative conclusions can be obtained if the smuggling function is assumed constant over time. It then follows that smuggling would be a monotonically increasing function of the incentive to smuggle, defined as the terms of trade in smuggling relative to the terms of legal trade. This latter approach has been used to explain the pattern of Indonesian smallholder rubber trade.[13]

The simple model assumes that rubber output in any year (for which there is no reliable data) is a linear function of the contemporaneous domestic price of rubber relative to rice (R), its competing activity in Indonesia, rainfall (W) and a time trend (T). Smuggling is assumed linearly related to the incentive to smuggle (S) defined as the rupiah return to a dollars worth of smuggling relative to the rupiah return to a dollars worth of legal trade. This is just the ratio of the black market rate of exchange to the legal effective exchange rate for rubber export. Domestic rubber consumption is small and is assumed to be constant or linearly related to time. Legal trade is the residual of (unobserved) output less smuggling less domestic consumption. The estimated equation is:

$$\text{Legal export}^{14} = 38217 + \underset{(.251)}{.753W} - \underset{(.037)}{.130T} - \underset{(2882)}{13894D} - \underset{(461.)}{3969S} + \underset{(22.97)}{66.84R}$$

(Standard errors in parenthesis) $R^2 = .84$ DW = 2.03

The variable D is a dummy variable taking the value 1 for the years 1957-58 to account for disruptions in trade due to the

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[13] All references to rubber are to smallholder rubber.

[14] Legal export in tens of thousands of kilograms of smallholder rubber. Rice prices are average retail prices in Sumatra. Rubber prices are wholesale in Jakarta. All the above data obtained from Biro Pusat Statistik. Rainfall data are millimeters at Sungei Gerong, South Sumutra obtained from Direktorat Meterologi dan Geofisika. Blackmarket exchange rates from Picks Currency Yearbook, various issues. Legal effective exchange rates are authors computations.

rebellion which occurred in rubber growing areas in those years. The equation was estimated with annual data of 1949-1972. The elasticities evaluated at means for S and R are -.276 and .146 respectively. The estimated equation indicates that the incentive to smuggle (as defined here) was a significant factor in explaining the variance of legal trade in rubber. A prediction of the level of smuggling in any year is the product of the coefficient of S, 3969, and the value of S in that year. For example, the model estimates that rubber smuggling out of Indonesia in 1960 amounted to 262,000 metric tons. Smuggling in that year is estimated to have been 69 percent of legal trade and 41 percent of total trade in rubber. For the period 1959-65, smuggling is estimated to account for an average of 25-30 percent of all trade in rubber.

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