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Richard Jensen

Jerry Thursby

Marie Thursby

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ABSTRACT

We examine how market structure and enforcement affect smuggling and welfare in a model where smuggling is camouflaged by legal sales. Conditions are given for when some, but not necessarily all, firms smuggle. With camouflaging, the market price is below the price when all sales are legal, so smuggling improves welfare if the price effect outweighs excess smuggling cost. This welfare effect is directly related to the degree of competition. Increased enforcement in this model potentially reduces welfare. The model is shown to be consistent with evidence on cigarette smuggling in the United States for 1975-1982.

Richard Jensen
Department of Economics
College of Business and Economics
University of Kentucky
Lexington, KY 40506-0034

Jerry Thursby
Department of Economics
Krannert Graduate School
of Management
Purdue University
West Lafayette, IN 47907

Marie Thursby
Department of Economics
Krannert Graduate School
of Management
Purdue University
West Lafayette, IN 47907

I. Introduction

In recent years there has been an increasing interest in the analysis of smuggling as an economic phenomenon.¹ The seminal paper in this area is by Bhagwati and Hansen [1973], who examined the welfare effects of smuggling under perfect competition and monopoly in a two good trade model. They found that smuggling would necessarily reduce welfare only when smuggling coexisted with legal trade. This spawned a series of articles which, to a large extent, dealt with when the coexistence of legal trade and smuggling could be welfare increasing. By introducing a third non-traded good, Sheikh [1974] showed that smuggling which coexisted with legal trade could be welfare improving. Pitt [1981] and Martin and Panagariya [1984] obtained the same result by allowing legal trade to coexist with smuggling when firms camouflage their illegal trade by importing some goods legally.

The appeal of these recent papers is that they focus on the microeconomic foundations of the two types of trade coexisting. Pitt's contribution was to show that when competitive firms smuggle by camouflaging, the condition for zero profits in long run equilibrium implies a price disparity² (i.e. a domestic price of imports lower than the tariff inclusive world price). The model of Martin and Panagariya is particularly important because it explicitly introduces the uncertain nature of smuggling into the individual firm's decision problem and shows that the first order conditions for profit maximization require a price disparity when the probability the firm will be detected smuggling is a function of the amount it trades legally. The Bhagwati-Hansen (BH) type of coexistence without price disparity is shown to follow when the probability of detection depends only on the total amount smuggled.

One of the shortcomings of the Pitt and Martin and Panagariya (hereafter P-MP models) is that pure legal traders are driven out of the market when smuggling occurs. At the other extreme, BH type of smuggling allows each firm to either smuggle or trade legally (but not both). This leaves unexplained the intermediate case of camouflaged

smuggling by some, but not all, firms in a market.³ This case is more than a theoretical curiosity. For example, commercial smuggling of cigarettes from low tax to high tax states for sale in legal retail or vending outlets has been a problem in the United States. In 1975 ten states reported this type of smuggling as their most serious cigarette tax evasion problem [ACIR, 1977, p. 10], and the revenue loss to state and local governments in high tax states from cigarette tax evasion was estimated to be \$391 million per year [ACIR, 1977, p. 1]. The Federal Contraband Cigarette Act of 1978 was enacted because the problem with commercial smuggling was considered so widespread. It seems unlikely, however, that all legal outlets were selling contraband cigarettes. Another example of camouflaged smuggling is misweighing or misinvoicing of imports to avoid customs duties. There is no reason, a priori, to expect all importers to do this.

In this paper we model an import sector composed of firms in a Cournot industry in which legal traders can survive along with firms which smuggle through camouflaging as long as firms differ in their excess cost of smuggling and have some market power. The model is quasicompetitive in the sense that increasing the number of firms increases imports and drives the domestic price in equilibrium down to the level that would prevail under pure competition. The model allows the coexistence of camouflagers and legal traders, but in the limiting case of pure competition it can be shown to be equivalent to the P-MP type models. This has the advantage of allowing us to examine how market structure, as well as enforcement, affect smuggling and welfare. The major results are: (1) that the price disparity that occurs in models where smuggled trade is camouflaged is directly related to the degree of competition in the importing industry; (2) since this price disparity is welfare improving, *ceteris paribus*, the welfare effect of smuggling in the model is directly related to the degree of competition as well; and, (3) since the quantity imported by a camouflager exceeds that of a legal trader, *ceteris paribus*, an increase in enforcement may reduce welfare even when enforcement is costless. These results differ markedly from welfare comparisons arising from coexistence with BH-type smuggling.

Sections II - VI are theoretical. Because the literature related to our work focuses on smuggling across national boundaries, the discussion in these sections will do so as well. The model, however, also applies to smuggling across state lines induced by differential tax rates, and our empirical analysis will focus on such a case. In Section VII we show that U.S. cigarette sales for 1975-82 are consistent with our model of camouflaged smuggling.

II. Firm Behavior

Consider an industry with N firms, indexed by i , who behave as Cournot rivals. Each firm imports and sells domestically a good for which it pays a fixed world price, p^* . We assume that the good is homogeneous and domestic production is zero, so that each firm faces the inverse demand function $P(Q)$, where Q denotes the total quantity imported by the N firms. The government levies an ad valorem tariff, t , and provides an enforcement mechanism at level e in order to deter tariff-avoidance. Firm i can, if it chooses, attempt to smuggle a fraction θ_1 of q_1 , the amount it imports. If it does, then the probability of successfully smuggling a unit is $s(\theta_1, e)$, which we assume to be decreasing and concave in both arguments and satisfy $s(\theta_1, e) \in [0, 1]$ for all θ_1 and e and $s(0, e) = 1$ for all e .

However, there is an additional cost to attempting to smuggle which is paid whether the firm is successful or not. This cost could be a real cost (from society's point of view) such as the cost of special packaging or a payment to foreign suppliers to misinvoice, or it could be a transfer such as a bribe to a customs official to misweigh or to "look the other way." In general, we would expect this excess cost to vary across firms.⁴ Those firms whose managers have more experience are more likely to have established ties with suppliers or officials and, hence, lower fees. Similarly, they may have better information regarding the type of enforcement activity so that packaging effort, and therefore cost, may differ. The same arguments would hold for managers with familial ties to suppliers and/or officials. To allow for such differences among firms, we specify a firm specific

parameter, γ_i , which with e determines the excess cost of attempting to smuggle. For simplicity, we assume the total excess cost of smuggling is given by $\gamma_i e \theta_i q_i$. Note that this specific functional form of total excess smuggling cost is not necessary for our results. The analysis carries through for any excess cost function which is linear in $\theta_i q_i$ and for one which is convex in $\theta_i q_i$ as long as the second order conditions are appropriately modified. We chose this form for expositional convenience.

Each firm is assumed to choose q_i and θ_i so as to maximize its expected profit. Expectations are assumed to be rational, so that $1-s(\theta_i, e)$ is the true fraction of $\theta_i q_i$ which is detected and confiscated by the government enforcement mechanism. For simplicity, we assume that all goods confiscated are resold on the market⁵ and there are no fines, so that expected profit to firm i is

$$(1) \quad E\Pi_i(q, \theta) = [s(\theta_i, e)P(Q) - p^* - \gamma_i e] \theta_i q_i + [P(Q) - p^*(1+t)](1 - \theta_i) q_i$$

where $q = [q_1, \dots, q_N]$ and $\theta = [\theta_1, \dots, \theta_N]$. Given standard Cournot-Nash behavior, the first order conditions for an interior solution to this problem are

$$(2) \quad P(Q) \left(\frac{\partial s}{\partial \theta_i} \theta_i + s - 1 \right) + p^* t - \gamma_i e = 0$$

$$(3) \quad [\theta_i s + 1 - \theta_i] [P(Q) + P'(Q) q_i] + \theta_i (p^* t - \gamma_i e) - p^* (1+t) = 0$$

Equation (3) has the usual interpretation that a firm will expand imports up to the point where expected marginal revenue equals marginal cost (assuming the vertical intercept of the demand function exceeds $p^*(1+t)$). Given that importation is optimal, it follows from (2) and the assumptions on s that a firm attempts to camouflage, $\theta_i > 0$, if and only if $p^* t > \gamma_i e$, which says that profit per unit successfully smuggled exceeds the per unit cost of smuggling. Whenever $p^* t > \gamma_i e$, the optimal fraction smuggled is determined uniquely by (2) for any nonnegative vector of imports q and can be written as $f_i(q; p^*, t, \gamma_i, e)$, where $\partial f_i / \partial q_j = \partial f_i / \partial q_j > 0$ for all $i, j = 1, \dots, n$, $\partial f_i / \partial p^* > 0$, $\partial f_i / \partial t > 0$, $\partial f_i / \partial \gamma_i < 0$, and $\partial f_i / \partial e < 0$. Notice firm i 's choice of θ_i depends on the actions of its rivals only through market price, so that a given change in output by any firm (including i) results

in the same change in θ_i because it has the same effect on market price. In particular, an increase in imports by any firm reduces price and induces each firm to increase the fraction it attempts to smuggle. This occurs because the marginal gain of switching a legal unit of imports to an illegal unit, tp , is unaffected by P , but the confiscation loss, $(1 - s)P$, declines with P .

These results imply that when smuggling is optimal for firm i , its problem can be viewed as choosing a level of imports to maximize (1) subject to $\theta_i = f_i(q; p^*, t, \gamma_i, e)$.

Expected profit can be written as

$$(4) \quad \Pi_i(q) = [s(f_i(q), e)P(Q) - p^* - \gamma_i e]f_i(q)q_i + [P(Q) - p^*(1+t)](1-f_i(q))q_i,$$

in which case the necessary condition for an interior solution is

$$(5) \quad [s(f_i(q), e)f_i(q) + 1 - f_i(q)][P(Q) + P'(Q)q_i] = f_i(q)(p^* + \gamma_i e) + (1 - f_i(q))p^*(1+t).$$

Given the definition of $f_i(q)$, (5) is equivalent to (2) and (3). We also assume that (4) is strictly concave in q_i for any $q_{-i} = (q_1, \dots, q_{i-1}, q_{i+1}, \dots, q_n)$ so a unique maximum exists. The second implication of $\partial f_i / \partial q_i > 0$ is that even though the world price and per unit excess smuggling cost are fixed, the average cost of importing is declining in q_i . This result is important in determining several comparative static results in Sections III-VI. Moreover, it prevents us from determining whether marginal cost is increasing in q_i or not, which explains why we explicitly assumed $\Pi_i(q)$ was concave in q_i .

Finally, we must impose some restrictions on the inverse demand function to insure the existence and stability of an industry equilibrium. Assume that there exist real numbers M and K such that $P(0) = M > 0$ and $P(Q) = 0$ for all $Q \geq K > 0$. Also assume $P'(Q) < 0$ and $P'(Q) + P''(Q)q_i < 0$ for all $q_i \in [0, K]$ and all i . The latter condition insures that an increase in imports by any other firm reduces (shifts down) the marginal revenue of firm i and hence the expected marginal revenue of i as well. This is sufficient to insure the stability of an equilibrium and allows us to do comparative statics. It also insures that i 's expected marginal revenue is decreasing in its own imports. Now we can

view the industry problem as a game in which each firm's strategy set is $[0, K]$ and its payoff function is given by (4) if $p^*t > \gamma_1 e$ and by (4) evaluated at $f_1(q) \equiv 0$ if $p^*t \leq \gamma_1 e$. Industry equilibrium is then a Nash equilibrium, which is a vector of imports $(\bar{q}_1, \dots, \bar{q}_N)$ such that $\Pi_i(\bar{q}) \geq \Pi_i(q_i, \bar{q}_{-i})$ for all $q_i \in [0, K]$ and for all $i=1, \dots, N$. Existence of an equilibrium follows immediately (see Theorem 7.1 in Friedman [1977]). The equilibrium vector of imports simultaneously induces equilibrium fractions smuggled by each firm $(\bar{\theta}_1, \dots, \bar{\theta}_N)$ where $\bar{\theta}_i = 0$ if $p^*t \leq \gamma_1 e$ and $\bar{\theta}_i = f_1(\bar{q}) \in (0, 1)$ if $p^*t > \gamma_1 e$.⁶

III. Coexistence of Legal Trade and Smuggling

Now suppose there are two types of firms, differentiated only by the parameter γ_i . Let N_1 firms have γ_1 and N_2 firms have γ_2 where γ_1 and γ_2 satisfy $\gamma_1 e < p^*t < \gamma_2 e$ for given values of e , p^* , and t . Then type 1 firms (with γ_1) will camouflage and type 2 firms (with γ_2) will trade legally whenever it is optimal for both to import. We know that an equilibrium exists in this case. The interesting question is whether or not there exists an equilibrium in which both types import. That is, when (if ever) is the equilibrium characterized by (\bar{q}_1, \bar{q}_2) where $\bar{q}_i = \bar{q}_1 > 0$ for $i=1, \dots, N_1$ and $\bar{q}_j = \bar{q}_2 > 0$ for $j=1, \dots, N_2$?

Proposition 1: There exist locally stable equilibrium outcomes of this smuggling game in which one group of firms uses legal trade to camouflage its smuggling and the remaining firms trade legally.

Proof of Proposition 1: Given $\gamma_1 e < p^*t < \gamma_2 e$, it need only be shown that there exist conditions under which both types of firms import positive quantities. Under the assumptions on expected profit, a necessary and sufficient condition for type 1 firms to import positive q_1 is

$$f_1(\underline{0})[s(f_1(\underline{0}), e)M - p^* - \gamma_1 e] + (1 - f_1(\underline{0}))[M - p^*(1+t)] > 0$$

where $\underline{0}$ is an N -dimensional zero vector. Since $f_1(q)$ is not a function of M , clearly M can be chosen large enough to satisfy this inequality for any feasible and finite values of the

parameters of the model. Given that this holds, there exists a q^0 such that each camouflager's first order condition holds at $q_1 = q^0 \in (0, K)$ in the absence of any legal traders (type 2 firms). A sufficient condition to insure that some type 2 firms also import positive quantities is then $P(N_1 q^0) > p^*(1+t)$. This last condition holds for a large class of demand functions. For example, if demand is linear, then a sufficient condition for $P(N_1 q^0) > p^*(1+t)$ is given by $M > [N_1 p^*(1+t) + p^* t - \gamma_1 e] / (N_1 + 1)$. Hence, the result of this proposition holds for all linear demand functions with vertical intercept M that is "large enough," and therefore also holds for an open, dense set of demand functions around each linear demand function for which the result holds. Given existence, local stability follows from $P'(Q) + P''(Q)q_1 < 0$ (which insures the composition of the best response function of a camouflager with that of a legal trader is less than one in absolute value). Q.E.D.

The result in Proposition 1 is significant because it provides a new and empirically plausible explanation for the coexistence of legal trade and smuggling. One group of firms pays the tariff on all units imported while another distinct group uses its legal trade to camouflage its smuggling. Two features of the model are necessary to obtain this result. One, as noted above, is to differentiate firms in such a way that some may find it profitable to smuggle while others do not. Here we have taken the simple approach of assuming that some firms have a lower excess smuggling cost than others. The other feature is allowing the firms to have enough market power that those which operate legally can survive. As can be seen from the proof, we accomplish this by assuming that the number of camouflagers (N_1) is small enough relative to market demand. Since the equilibrium price if only camouflaging firms imported would be above $p^*(1+t)$, it is possible for legal traders to operate profitably as well.

This model is quasi-competitive in the sense that increasing the number of camouflagers and/or legal traders increases total imports and drives equilibrium price down to the level that would prevail under pure competition.

Proposition 2: An increase in the number of legal traders, or camouflagers, or both, will increase equilibrium output and reduce equilibrium price.

Proof of Proposition 2: Let $\bar{Q}_c = N_1\bar{q}_1 + N_2\bar{q}_2$ be equilibrium industry output and $\bar{\theta}_1 = f_1(\bar{q})$ be the fraction that each camouflager attempts to smuggle in equilibrium. Because camouflagers are identical and $\partial f_i/\partial q_i = \partial f_j/\partial q_j$ for all i and j , it follows from (2) that there is no loss of generality in rewriting this as $\bar{\theta}_1 = f(\bar{Q}_c)$ where f has the same properties as f_i . Then $F_1(\bar{q}_1, \bar{q}_2) = 0$ and $F_2(\bar{q}_1, \bar{q}_2) = 0$ implicitly define \bar{q}_1, \bar{q}_2 , and so $\bar{\theta}_1$ and \bar{Q}_c , where

$$(6) \quad F_1(q_1, q_2) = [s(\theta_1, e)\theta_1 + 1 - \theta_1][P(Q_c) + P'(Q_c)q_1] - \theta_1(p^* + \gamma_1 e) - (1 - \theta_1)p^*(1+t),$$

$$(7) \quad F_2(q_1, q_2) = P(Q_c) + P'(Q_c)q_2 - p^*(1+t).$$

Standard comparative statics and algebraic manipulation reveal that

$$(8) \quad \partial \bar{Q}_c / \partial N_1 = (s\bar{\theta}_1 + 1 - \bar{\theta}_1)\bar{q}_1 P'(\bar{Q}_c)^2 / F$$

$$(9) \quad \partial \bar{Q}_c / \partial N_2 = (s\bar{\theta}_1 + 1 - \bar{\theta}_1)\bar{q}_2 P'(\bar{Q}_c)^2 / F$$

where $F = (\partial F_1/\partial q_1)(\partial F_2/\partial q_2) - (\partial F_1/\partial q_2)(\partial F_2/\partial q_1)$. The firms' second order sufficient conditions and $P'(Q) + P''(Q)q_1 < 0$ imply $F > 0$, so that $\partial \bar{Q}_c / \partial N_1 > 0$ and $\partial \bar{Q}_c / \partial N_2 > 0$. Q.E.D.

Suppose we begin in an equilibrium where all firms earn economic profit, or $P(\bar{Q}_c) > p^*(1+t)$. Then it follows from (7) that free entry of legal traders will drive down equilibrium price until economic profits from legal trade vanish, or $P(\bar{Q}_c) = p^*(1+t)$. However, camouflagers will still earn positive profit. It follows from (2), (6), and (7) that $s(\bar{\theta}_1, e)P(\bar{Q}_c) - p^* - \gamma_1 e = (1 - \frac{\partial s}{\partial \theta_1} \bar{\theta}_1)P(\bar{Q}_c) - p^*(1+t) > 0$, so, in fact, camouflagers break even on each unit traded legally and profit on each unit smuggled. At the other extreme, (6) implies that with free entry of camouflaging firms (i.e. those with lowest excess smuggling cost, γ_1), equilibrium price will fall until

$$(10) \quad \bar{\theta}_1^* [s(\bar{\theta}_1^* e) P(\bar{Q}_c^*) - p^* - \gamma_1 e] + (1 - \bar{\theta}_1^*) [P(\bar{Q}_c^*) - p^*(1+t)] = 0$$

This requires $s(\bar{\theta}_1^* e) P(\bar{Q}_c^*) - p^* - \gamma_1 e > 0 > P(\bar{Q}_c^*) - p^*(1+t)$ so that pure legal traders (γ_2 firms) are driven out of the market. \bar{Q}_c^* is equilibrium output when all firms are type 1 firms earning zero economic profit. This limiting case is the market structure studied by Pitt [1981] and Martin and Panagariya [1984].

IV. Price Disparity

As one might expect, there is a price disparity implied by this model, and it varies both with the composition of the market and the degree of competition. The measure of price disparity we analyze is the equilibrium price when all N firms trade legally, $P(\bar{Q}_\ell)$, minus equilibrium price when N_1 firms camouflage and N_2 trade legally, $P(\bar{Q}_c)$. The equilibrium quantity imported by each firm when all N trade legally is denoted by \bar{q}_ℓ , so that \bar{Q}_ℓ is defined by $P(\bar{Q}_\ell) + P'(\bar{Q}_\ell)\bar{q}_\ell = p^*(1+t)$ where $\bar{Q}_\ell = N\bar{q}_\ell$. Proposition 3 summarizes the major results for this disparity (i.e. $\Delta P = P(\bar{Q}_\ell) - P(\bar{Q}_c)$).

Proposition 3: The price disparity increases with (i) an increase in the fraction of camouflagers in a given industry; (ii) an increase in the number of camouflagers if demand is linear or if $N_1 = N_2$ and demand is concave quadratic; and (iii) an equal increase in the number of camouflagers and legal traders if $N_1 = N_2$ and demand is either linear or concave quadratic.

Proof of Proposition 3: (i) Suppose N_1 is increased and N is held constant, so that $dN_1 + dN_2 = 0$. Then since $P(\bar{Q}_\ell)$ is unaffected,

$$\frac{\partial \Delta P}{\partial N_1} \Big|_{N \text{ constant}} = -P'(\bar{Q}_c) \left[(\partial \bar{Q}_c / \partial N_1) - (\partial \bar{Q}_c / \partial N_2) \right] = -(s\bar{\theta}_1 + 1 - \bar{\theta}_1) P'(\bar{Q}_c)^3 (\bar{q}_1 - \bar{q}_2) / F > 0$$

since $\bar{q}_1 > \bar{q}_2$.

(ii) After some manipulation

$$\frac{\partial \Delta P}{\partial N_1} = \frac{FP'(\bar{Q}_r)^2 \bar{q}_r - [(N+1)P'(\bar{Q}_r) + NP''(\bar{Q}_r)\bar{q}_r](s\bar{\theta}_1 + 1 - \bar{\theta}_1)P'(\bar{Q}_c)^3 \bar{q}_1}{[(N+1)P'(\bar{Q}_r) + NP''(\bar{Q}_r)\bar{q}_r]F}$$

This can be shown to be positive for linear demand with any market composition and for concave, quadratic demand where $N_1 = N_2 = N/2$.

(iii) When $N_1 = N_2 = N/2$ the expression for $\partial \Delta P / \partial N$ simplifies to

$$\frac{\partial \Delta P}{\partial N} = \frac{2FP'(\bar{Q}_r)^2 \bar{q}_r - [(N+1)P'(\bar{Q}_r) + \bar{Q}_r P''(\bar{Q}_r)](s\bar{\theta}_1 + 1 - \bar{\theta}_1)(\bar{q}_1 + \bar{q}_2)P'(\bar{Q}_c)^3}{2F[(N+1)P'(\bar{Q}_r) + \bar{Q}_r P''(\bar{Q}_r)]}$$

which is positive for linear and concave quadratic demand.

Finally, it is worthwhile to note that assuming linear demand is not sufficient to show $\partial \Delta P / \partial N_2 > 0$. Q.E.D.

The first statement in Proposition 3 holds because replacing a legal trader with a camouflager increases \bar{Q}_c , reducing $P(\bar{Q}_c)$, but does not change $P(\bar{Q}_r)$ for given N . On the other hand, suppose the number of camouflagers increases, so that the number of firms in the industry also increases. Then from Proposition 2, both $P(\bar{Q}_c)$ and $P(\bar{Q}_r)$ decline. Proposition 3 shows that $P(\bar{Q}_c)$ declines more rapidly (at least for linear demand or for $N_1 = N_2$ and concave quadratic demand); so the price disparity increases. However, an increase in the number of legal traders has an ambiguous effect on the price disparity. Nevertheless, under the conditions stated, an equal increase in the number of camouflagers and legal traders will cause an increase in the price disparity. Even if an increase in the number of legal traders does reduce the price disparity, *ceteris paribus*, a corresponding increase in the number of camouflagers will more than offset that effect and the price disparity will increase.

The intuition behind results (ii) and (iii) is straightforward. With entry, the marginal revenue of a legal trader and the expected marginal revenue of a camouflager

shift down. Both types of traders reduce imports, but camouflagers are better able to protect themselves from entry because they can drive down average cost by smuggling a higher fraction (i.e. $\partial\theta_1/\partial N > 0$).

Figure 1 shows how the results in Proposition 3 relate to the P-MP measure of price disparity. ΔP is given by the vertical distance between $P(\bar{Q}_\rho)$ and $P(\bar{Q}_c)$. The horizontal axis measures N_1 , so that, depending on what is assumed about N_2 (and therefore N), the graph can represent results (i), (ii), or (iii). Recalling Proposition 2, notice that ΔP converges to the P-MP price disparity for large enough N_1 . That is, $P(\bar{Q}_\rho)$ declines to $p^*(1+t)$, while $P(\bar{Q}_c)$ declines to $P(\bar{Q}_c^*)$; so that $\Delta P = \alpha$ for $N_1 = N_1^*$. Hence the properties of ΔP in Proposition (3) are consistent with our observation that in the limit our market structure is that of P-MP. Notice that when $N_1 \geq C$ in Figure 1 the industry is composed entirely of camouflagers; yet $\Delta P < \alpha$ for $N < N_1^*$. That is, the number of firms is still small enough for each identical firm to make positive economic profit.

Now consider empirical estimates of price disparity. Although ΔP is a natural measure of price disparity, empirically observed prices are $p^*(1+t)$ and the market (domestic) price, P . For $N = N_1^*$, $PD = p^*(1+t) - P$ correctly estimates $P(\bar{Q}_\rho) - P(\bar{Q}_c)$. For $N < N_1^*$, $p^*(1+t)$ does not represent $P(\bar{Q}_\rho)$, so that the measure of price disparity used in previous literature will underestimate ΔP . However, the relation between $P(\bar{Q}_c)$ and $p^*(1+t)$ can be used to assess the extent of smuggling activity. As $N \gtrless C$, $P(\bar{Q}_c) \lessgtr p^*(1+t)$. For $N < C$, only low cost firms smuggle, while for $N > C$ all firms in the industry smuggle. This means that, independent of market structure, a positive value of PD indicates that every firm is camouflaging.

If PD is negative or zero, inferences must be based on a combination of its value and other evidence on smuggling. This is because the observed price may be either $P(\bar{Q}_\rho)$ or $P(\bar{Q}_c)$. A negative value of PD is consistent with either no smuggling (i.e. the market price is $P(\bar{Q}_\rho)$) or $N < C$ and low cost firms conduct a portion of their trade illegally (i.e. the market price is $P(\bar{Q}_c)$). As is clear from the Figure, an estimated zero price disparity

either indicates $N = C$ and firms camouflaging or no camouflaging and $N = N_1^*$. Only for positive estimates will it be clear that smuggling through camouflaging is occurring, and in this case all firms are smuggling.

VI. Competition and Welfare

The existence of a price disparity in the model leads to the possibility that smuggling relative to legal trade can be welfare improving. As in Pitt, when the excess smuggling cost is merely a transfer to the government, then smuggling improves welfare via the price disparity. The results of the last section indicate that this welfare improvement is maximized when there is free entry of camouflagers. If, on the other hand, there is a real excess smuggling cost, the welfare effect of smuggling depends on the relative magnitudes of the excess cost and lower price due to camouflaging. Here again, the welfare effect of smuggling will depend on the degree of competition. While the price disparity is maximized with free entry of camouflagers, free entry will drive up total excess smuggling cost because entry leads to an increase in the equilibrium quantity firms try to smuggle. The following proposition characterizes the impact of a change in the number of firms on welfare.

Proposition 4: An increase in the number of camouflagers will reduce welfare whenever $\gamma_1 e^{\bar{\theta}_1} [1 + (N_1/\bar{\theta}_1)(\partial\bar{\theta}_1/\partial N_1)] \geq P(\bar{Q}_c) - p^*$, but an increase in the number of legal traders will increase welfare if $\gamma_1 e^{\bar{\theta}_1} (N_1/\bar{\theta}_1)(\partial/\partial N_1) \leq P(\bar{Q}_c) - p^*$ where $\partial\bar{\theta}_1/\partial N_1 = (\partial f_1/\partial N_1)(1/\bar{q}_1)(\partial\bar{Q}_c/\partial N_1)$.

Proof of Proposition 4: We assume demand comes from a utility function that can be approximated by $U = U(Q) + m$, where m is consumption of a competitively produced composite commodity, so that welfare is correctly measured by the standard surplus measures. Hence, welfare is consumer surplus plus expected profits plus expected government revenue from tariff collections and confiscations. Expected profits plus

government revenue can be shown to be $[P(\bar{Q}_c) - p^*] \bar{Q}_c - \gamma_1 e \bar{S} - K(e)$ where $\bar{S} = \bar{\theta}_1 N_1 \bar{q}_1$ is total quantity firms attempt to smuggle and $K(e)$ is the cost of enforcement. Therefore

$$(11) \quad W = \int_0^{\bar{Q}_c} P(Q) dQ - p^* \bar{Q}_c - \gamma_1 e \bar{S} - K(e)$$

Standard comparative statics and algebraic manipulation yield

$$\frac{\partial W}{\partial N_1} = [P(\bar{Q}_c) - p^* - \gamma_1 e \theta_1 \{1 + (N_1 / \bar{\theta}_1) (\partial \bar{\theta}_1 / \partial N_1)\}] \bar{q}_1 + [P(\bar{Q}_c) - p^* - \gamma_1 e \bar{\theta}_1] N_1 (\partial \bar{q}_1 / \partial N_1)$$

where $P(\bar{Q}_c) > p^* + \gamma_1 e$ by the first order necessary conditions of camouflagers and $\partial \bar{q}_1 / \partial N_1 < 0$. Hence $\frac{\partial W}{\partial N_1} < 0$ if $P(\bar{Q}_c) - p^* - \gamma_1 e \theta_1 [1 + (N_1 / \bar{\theta}_1) (\partial \bar{\theta}_1 / \partial N_1)] \geq 0$, which proves the stated result for camouflagers.

Similarly, one can show

$$\frac{\partial W}{\partial N_2} = \left[P(\bar{Q}_c) - p^* - \gamma_1 e (N_1 \bar{q}_1 / \bar{q}_2) \frac{\partial f}{\partial N_2} \right] (\partial \bar{Q}_c / \partial N_2) - \gamma_1 e \bar{\theta}_1 N_1 (\partial \bar{q}_1 / \partial N_2)$$

using the fact that $\partial \theta_1 / \partial N_2 = (\partial / \partial N_2) (\partial \bar{Q}_c / \partial N_2) / \bar{q}_2$. Since $(\partial \bar{q}_1 / \partial N_2) < 0 < (\partial \bar{Q}_c / \partial N_2)$, $\partial W / \partial N_2 > 0$ if $(N_1 \bar{q}_1 / \bar{q}_2) (\partial f / \partial N_2) \leq (P(\bar{Q}_c) - p^*) / \gamma_1 e$. Observing that $\bar{q}_1 (\partial f / \partial N_2) = \bar{q}_2 (\partial f / \partial N_1)$, this last inequality can be written as that in the statement of the proposition. Q.E.D.

An increase in the number of camouflagers expands total imports at the margin, where total excess cost increases through two effects. One is the additional excess cost of the import increase, $\gamma_1 e \theta_1$, and the other is the additional cost from smuggling a higher fraction of imports, $(\gamma_1 e \bar{\theta}_1 N_1 / \bar{\theta}_1) (\partial \bar{\theta}_1 / \partial N_1)$. If the sum of these exceeds the increase in consumer surplus at the margin, then the subsequent loss in profits and government revenue is large enough for welfare to decline. Because an increase in the number of legal traders affects $\bar{\theta}_1$ in a fashion symmetric to that of an increase in camouflagers, we can state the condition for this to increase welfare in terms of $\partial f / \partial N_1$. With an increase in legal traders, consumer surplus and government revenue both increase, and the condition states a sufficient condition for their increase to outweigh the reduction in profits.

V. Enforcement

In a similar fashion, the welfare effects of increasing enforcement will depend on whether or not it increases real smuggling costs and on the elasticity of the fraction smuggled by a camouflager. An increase in enforcement will reduce both the fraction smuggled by each camouflager and total imports, increasing price and reducing and consumer surplus in equilibrium. Then if γ_1 represents a transfer to the government, an increase in enforcement reduces welfare. If, however, γ_1 represents real resources devoted to camouflaging, then an increase in enforcement can improve welfare since it reduces the total amount of imports smuggled, and so the total excess smuggling cost. Proposition 6 summarizes the results for this case.

Proposition 5 summarizes the comparative statics results needed to prove Proposition 6. Comparative statics results for changes in t and p^* are also given. The proof is omitted because it is straightforward and not informative.

Proposition 5: An increase in either e or γ_1 reduces \bar{q}_1 , \bar{Q}_1 , \bar{S} , \bar{Q}_c , and ΔP but increases \bar{q}_2 and $P(\bar{Q}_c)$. An increase in t increases \bar{q}_1 and reduces \bar{q}_2 , but the effect on all other equilibrium values is ambiguous. All effects of a change in p^* are ambiguous.

Proposition 6: An increase in the level of enforcement (excess smuggling cost of a camouflager) reduces welfare if the equilibrium fraction smuggled by a camouflager is inelastic with respect to the level of enforcement (excess smuggling cost).

Proof of Proposition 6: It follows from (11) that
$$\frac{\partial W}{\partial e} = [P(\bar{Q}_c) - p^*](\partial \bar{Q}_c / \partial e) - \gamma_1 \left(\bar{S} + e \frac{\partial \bar{S}}{\partial e} \right) - K'(e).$$
 Since $\partial \bar{Q}_c / \partial e < 0$ and the marginal cost of enforcement, $K'(e)$, must be nonnegative, a sufficient condition for $\partial W / \partial e < 0$ is
$$\bar{S} + e \frac{\partial \bar{S}}{\partial e} \geq 0, \text{ or } -(e/\bar{S})(\partial \bar{S} / \partial e) \leq 1.$$
 Similarly,
$$\frac{\partial W}{\partial \gamma_1} = [P(\bar{Q}_c) - p^*](\partial \bar{Q}_c / \partial \gamma_1) -$$

$e \left(\bar{S} - \gamma_1 \frac{\partial \bar{S}}{\partial \gamma_1} \right)$ is negative if $-(\gamma_1 / \bar{S})(\partial \bar{S} / \partial \gamma_1) \leq 1$. Since $\partial \bar{S} / \partial e \leq 0$ and $\partial \bar{S} / \partial \gamma_1 < 0$, the statement of the proposition follows immediately under the convention of writing elasticities as positive numbers. Q.E.D.

An increase in the level of enforcement causes each camouflager to reduce imports since its expected marginal revenue shifts down and its marginal cost shifts up. This raises price, and leads legal traders to expand imports, but the net effect is fewer total imports, less smuggling, and a higher price. Welfare is reduced unless the resulting loss in consumer surplus is offset by a reduction in total excess smuggling cost. If the fraction smuggled is inelastic with respect to enforcement, the welfare increase from lower total excess smuggling cost (due to the lower fraction smuggled) is not large enough to offset the loss in consumer surplus. An increase in γ_1 shifts the camouflagers' marginal costs up, causing them to reduce imports with the same effects on equilibrium values, and therefore welfare, as a change in e .

Finally, it is worth noting why we cannot obtain welfare results for changes in the tariff and world price. Recalling Proposition 5, an increase in the tariff causes camouflagers to increase imports and legal traders to decrease imports. Legal traders reduce imports because their marginal cost shifts up. Camouflagers' marginal cost shifts up also, but to a lesser extent since they also increase the fraction they try to smuggle. Increasing the fraction smuggled increases expected marginal revenue enough to outweigh this effect, so each camouflager expands imports. The net effect on equilibrium total imports, smuggling, and the price are uncertain. Although the effects of an increase in the world price are very similar to those of an increase in the tariff, we cannot determine how any equilibrium values change when p^* changes. The difference is that an increase in p^* increases camouflagers' marginal cost only through their legal imports, while an increase in p^* increases marginal cost through legal and illegal imports.

VII. Empirical Analysis

In this section we consider the empirical relevance of this type of smuggling. Pitt's original model was developed to explain the observed price disparity for Indonesian exports of rubber. Branson and Macedo [1987] examine the black market premium related to Pitt-type smuggling in the Sudan. Norton [1988] developed a model similar to Pitt's to explain pig smuggling between Northern Ireland and the Republic of Ireland. All of these studies assume perfect competition. In this section we consider situations where this assumption may not be warranted.

An obvious example is where governments restrict entry through import licenses. Smuggling is generally regarded as prevalent in Indonesia, and recent data for Indonesia show that of 5229 traded commodity classifications, 1484 were under license and only 296 of these were subject to quotas (Pangestu, [1987]). 1360 of these items were manufactures such as steel, textiles, machinery, pharmaceuticals, and plastics. A natural question to ask is whether licensing is merely a technicality, or whether there are indeed few firms in the market. In the case of polyester and rayon fibers, the government recently liberalized the licensing procedure so that six state trading companies are allowed to import fibers rather than the previous sole importer (Pangestu, p.32). The right to import plastics is restricted to three firms (Pangestu, p. 34).

Interstate cigarette smuggling in the U. S. is another likely candidate for our model. Different cigarette taxes across states provide the incentive for this smuggling, and it has been considered a major problem by state and local governments since the early 1970s. There is also evidence that cigarette industry structure is neither collusive nor perfectly competitive (Manchester [1973], Sumner [1981], Appelbaum [1982], and Sullivan [1985]).⁷ Recalling that our model allows for a variety of market outcomes (both in terms of competition and degree of illegal activity), it is a natural choice for examining domestic trade of cigarettes.

In Sections A and B we focus on the cigarette example. The primary reason is that price data needed to examine the extent of smuggling are readily available for cigarettes. We present evidence that camouflaged smuggling is widespread enough to be statistically significant in a regression framework. Moreover, empirical estimates of price disparity are consistent with the view that some, but not all, firms in the market smuggle.

A. Industry Smuggling Characteristics

Cigarette smuggling practices include consumers crossing state lines for personal consumption purchases, as well as smuggling of cigarettes by wholesalers and retailers for resale in retail or vending outlets. While we account for casual smuggling in our empirical estimates, our interest is primarily in the latter. The exact mechanism for commercial (organized) smuggling varies, but it generally involves distributors or retailers in high tax states purchasing cigarettes from a wholesaler in a low tax state. The state tax in the low tax state is paid, but the wholesaler is paid a premium not to affix any tax indicia to the cigarettes. The distributor or retailer in the high tax state then uses a counterfeit tax stamp to evade the higher tax. Enforcement evidence suggests the bulk of these purchases are made in North Carolina and some in Kentucky [ACIR, 1977 and 1985].

There are a number of empirical studies of cigarette smuggling. The Advisory Committee on Intergovernmental Relations [ACIR 1977, 1985] estimated the revenue loss to high tax states from all forms of cigarette smuggling to be \$390 million in 1975. A demand equation for cigarettes was estimated using data from non-smuggling states and used to predict cigarette consumption in smuggling states. Comparing the estimates with legal sales (that is, tax paid cigarette sales) gave a measure of the extent of smuggling. Since the ACIR's interest was in revenue loss regardless of the form of smuggling, it did not attempt to differentiate between casual and commercial smuggling. Other studies finding significant smuggling effects are Manchester [1973], Baltagi and Levin [1986], and Baltagi and Goel [1987]. These studies, like the ACIR study, do not provide evidence on the extent of casual versus commercial smuggling.

Like the ACIR, we examine how the presence of smuggling affects demand estimation.⁸ But we differ by using data from smuggling as well as non-smuggling states, and we account for smuggling with regressors expected to be sensitive to the different forms of smuggling. To differentiate between the two forms of smuggling, we rely on the fact that casual smuggling is predominantly consumers crossing into adjoining low tax states to purchase cigarettes from retail outlets while commercial smuggling is predominantly trucking of large quantities of cigarettes purchased from wholesalers in North Carolina and, to a lesser extent, Kentucky.

Before turning to our estimation strategy, several additional facts need to be mentioned. First, consumers who purchase commercially smuggled cigarettes are unaware, in general, that they are purchasing contraband goods. Second, the measure of cigarette sales available on a state by state basis is the quantity of cigarettes for which the local state taxes have been paid. That is, actual quantity demanded in the i th state at time t , Q_{it} , is the sum of observable legal or tax-paid cigarette sales, L_{it} , and commercially smuggled cigarettes, I_{it} . Cigarettes smuggled by consumers from adjoining states are substitutes for locally available cigarettes, Q_{it} .

Consider a standard demand equation for cigarettes

$$Q_{it} = \beta_0 + \beta_1 RP_{it} + \beta_2 INC_{it} + \beta_3 t + \beta_4 AVR_{it} + \beta_5 Q_{it-1} + \epsilon_{it}$$

where i refers to the state, t refers to the time period, Q is tax paid cigarette sales, RP is retail price, INC is income, and AVR is the average retail price in neighboring states. We include a time trend to control for declining cigarette sales in response to advertised health hazards of smoking. AVR is the average price of cigarettes in neighboring states and accounts for casual smuggling. In the presence of commercial smuggling, we can substitute $Q_{it} = L_{it} + I_{it}$ into the above and rearrange to form

$$(12) \quad L_{it} = \beta_{it} + \beta_1 RP_{it} + \beta_2 INC_{it} + \beta_3 t + \beta_4 AVR_{it} + \beta_5 L_{it-1} + u_{it}$$

where $u_{it} = \beta_5 I_{it-1} - I_{it} + \epsilon_{it}$. In the absence of commercial smuggling, $u_{it} = \epsilon_{it}$ is a zero mean disturbance uncorrelated with the regressors. But with commercial smuggling, the disturbance u_{it} is no longer a zero mean disturbance and can be expected to be related to smuggling activity. That is, an appropriately specified equation for L_{it} would either include I_{it} and I_{it-1} , or determinants of those variables.

To determine whether commercial smuggling exists we need to determine whether u_{it} is a classical disturbance uncorrelated with determinants of I_{it} or a non-classical disturbance correlated with determinants of I_{it} . We proceed by regressing L_{it} on the demand variables plus the difference in tax rates between state i and North Carolina ($TAXDIF_{it}$). In the absence of smuggling the estimated coefficient of $TAXDIF$ should not be significantly different from zero; in the presence of smuggling the estimated coefficient should be significantly different from zero. It should be noted that the sign of $TAXDIF$ is indeterminate because of other excluded variables when smuggling occurs (enforcement, etc.) and because of interaction of $TAXDIF$, the excluded variables, and the demand variables.

Instrumental variables estimation is used because of possible simultaneity due to the presence of RP as a regressor in (12). As instrument for RP we use the predicted value of RP in a regression of RP on the regressors in (12) as well as $TAXDIF$, a dummy variable to reflect the enactment of the Federal Cigarette Contraband Act of 1978, the state cigarette tax rate, the wholesale price plus the federal excise tax, and an index of the wage rate of grocery store workers. Data are annual for the period 1975-82 for 29 states. We exclude North Carolina and Kentucky because they are a source for commercially smuggled cigarettes, as well as states with local cigarette taxes, states with more than 5 percent of sales on Indian reservations, and states with at least 5 percent military. The latter two sets of states are excluded because cigarette sales on military and Indian reservations are exempt from state taxes, hence a potential for intrastate smuggling exists. Finally, we exclude Utah because of the high proportion of Mormons in that state.

A total of 232 observations are used. Tax paid sales and income are per capita. We use both a linear and a log-log version of the model with the results given in Table 1.

Retail price, lagged (legal) sales, and trend have expected signs and are significant. We find income insignificant, as do Baltagi and Levin. While there is anecdotal evidence that casual smuggling occurs and some authors have found it to be statistically important (though of small effect – see Baltagi and Levin and Manchester), we find it to be statistically unimportant. On the other hand, the statistical significance of TAXDIF indicates that commercial smuggling is pervasive. Only if I_{it} is substantial would TAXDIF be expected to be significant in an equation describing consumer behavior.

B. Empirical Price Disparity

For some of the states in the sample, cigarettes are primarily smuggled in, while for others there is no smuggling or cigarettes are smuggled out. In this section, we focus on price disparity in states where cigarettes are primarily smuggled into the state. Combined with our results on the importance of commercial smuggling, the observed price disparity can be used to indicate whether all firms are smuggling.

In Section IV we discussed the information contained in the sign of observed price disparity, $PD = p^*(1+t) - P$. To give empirical content to the measure in the cigarette case, several adjustments are made in calculating PD. Since the cigarette tax is per unit rather than ad valorem, the first term in PD is replaced by $p^* + t$.⁹ For the cigarette case, p^* is the wholesale price plus distribution costs and federal excise tax.

Our measure of the cigarette price disparity for the i th in-smuggling state at time t is

$$(13) \quad PD_{it} = WP_t + FT + ST_{it} + D_{it} - RP_{it}$$

where

WP is the wholesale price at time t (equal for all states)
 FT is the federal excise tax (equal to \$.08 for all observations)
 ST is the state tax
 D is a measure of distribution cost, and
 RP is retail price.

Because direct data are unavailable, we construct a measure of distribution cost based on observed markup in states with no in-smuggling. Observed markup for the jth non-smuggling state is $(RP_{jt} - WP_t - FT - ST_{jt})$, so that it includes factor costs and profits. As is appropriate for a state with no smuggling, this measure implies a zero observed price disparity in the jth state at time t. Barring differences in factor costs or market structure across states, this markup would proxy distribution costs in the absence of smuggling. However, factor costs do differ across states, and to account for this we weight the markup by an index of relative wage rates. Since the primary factor cost in cigarette retailing is labor,¹⁰ we use wage rates of grocery store workers. In (13), then,

$$D_{it} = (RP_{jt} - WP_t - FT - ST_{jt})/WI_{ijt}$$

where WI_{ijt} is the ratio of wage rates in j to those in i.

Ideally we would calculate markup using states not engaged in any form of smuggling (in or out), but we cannot be certain which (if any) states fall in that category. We initially choose North Carolina and Kentucky as the "base" states since it is known that only out-smuggling occurs there. A second base group is composed of states for which we have strong priors that no commercial smuggling occurs. States in this group have state taxes within 10 cents per pack of the North Carolina tax (taxes are averages over the period and stated in 1982 prices). In all exercises we exclude from consideration states with large American Indian and military populations as well as Utah and states with local taxes.¹¹

In a 1975 survey [ACIR, 1977], six of the states in our sample indicated that smuggling by stamp counterfeiting was a serious problem. We calculated the price disparity in those states for each of the 8 years in our sample. Using the North Carolina and Kentucky markup, the price disparity is positive in only 7 of the 48 cases. Using

average markup in our “perceived no-smuggling” states, the price disparity is positive in only 16 cases.

We also examine price disparity for states whose average tax rates were at least 20 cents per pack above the N.C. tax (seven states). This selection criterion does not discriminate between commercial and casual smuggling, but it does capture states with the greatest incentive to smuggle (either commercially or casually). Using the North Carolina-Kentucky markup base, the price disparity is positive in one-third of the cases. For the second markup base, the price disparity is positive in 48 percent of the cases.

To summarize, we observe a negative price disparity in the majority of cases examined. In the context of previous models of camouflaging, this result would be inconsistent with the presence of smuggling. But we know from enforcement and statistical evidence that commercial smuggling is a prevalent phenomenon. Our model allows the interpretation that some, but not all, firms in the industry smuggle.

VIII. Concluding Remarks

BH is the only study prior to this one to examine the welfare effects of smuggling with varying degrees of competition. This paper provides an analysis of smuggling and market power when smuggling occurs through camouflaging. The advantage of the model is that it includes both the realistic type of smuggling modelled by P-MP and BH’s equally realistic notion of different firms conducting the two types of trade (i.e. smuggling and legal trade). We have shown that the coexistence of two types of firms is precluded if and only if there is free entry of firms capable of camouflaging. In particular, if the smuggling technology and enforcement effort make camouflaging profitable for only a small number of firms, then even in the long run we could observe some firms trading legally and others camouflaging.

Unlike BH, however, coexistence in this model can be welfare improving. Here, as in P-MP, this is due to the price disparity implied by the first order conditions for camouflagers. As one might expect, this disparity and therefore the welfare effects of

smuggling are related to the degree of competition in the market. In BH's case of coexistence (where smugglers do not camouflage), monopoly was preferred to perfect competition (since with no price disparity "the fewer smugglers, the better" p. 184). Here we obtain the more conventional result that welfare is higher the more firms there are whenever there is no real excess smuggling cost. When there is a real excess cost to smuggling, the welfare effects depend on the extent to which increased competition increases excess smuggling costs.

Finally, we show that observed price disparity with camouflaging can be positive or negative. In previous models, camouflaged smuggling produced a positive disparity. This followed because the analysis was restricted to perfect competition. In a more general setting, camouflaging can occur with negative observed disparity when not all firms smuggle. Our empirical evidence on commercial cigarette smuggling in the U.S. is consistent with this being the case.

University of Kentucky
Purdue University
Purdue University and National Bureau of Economic Research

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DATA APPENDIX

Sales per capita, retail price and state taxes are from The Tax Burden on Tobacco, Vol. 20 (The Tobacco Institute, 1985). Wages of grocery store workers are from 1977 Census of Retail Trade, U.S. Department of Commerce. Disposable personal income per capita is from Bureau of Economic Analysis, U.S. Department of Commerce. Wholesale prices are from Tobacco Situation and Outlook Yearbook, Economic Research Service, U.S. Department of Agriculture (March 1975 and December 1986). Data are available from the authors upon request.

Footnotes

¹The text cites work directly related to ours. Studies of somewhat related illegal activities are Ethier's [1986] analysis of illegal immigration and Grossman and Shapiro's [1988] study of counterfeit product trade. The analysis of smuggling has also been related to currency convertibility issues by Macedo [1987]. For an interesting discussion and analysis of smuggling in West Africa, see Stolper and Deardorff [1988]. For a survey of tax evasion issues, see Skinner and Slemrod [1985].

²The price disparity in Pitt's certainty model can be derived from the firm's first order conditions (see his equation (2a)) as well as the zero profit condition.

³Norton [1988] develops a model for smuggling of agricultural goods. Firms in his model decide the allocation of a given quantity between domestic and foreign illegal and legal sales. Their desire to smuggle is based on their distance from the border. In principle, this could lead to a variety of market outcomes, but he does not examine the market equilibrium.

⁴Assuming different excess costs is the easiest way to introduce heterogeneity into this model. The desired result could be obtained as well by assuming different probabilities of success functions for the firms, but the analysis is much more cumbersome in this case.

⁵We abstract from issues related to why the tariff is imposed. If the tariff were imposed to restrict consumption or to encourage production, resale of confiscated goods would not be an ideal assumption. If, however, revenue maximization is the government's goal, the resale assumption is not a problem.

⁶Because we are interested in camouflaging (such as underinvoicing), we do not consider the possibility that $\theta_1 = 1$. Formally this can be ruled out by assuming $s(1,e) = 0$ for $e > 0$.

⁷Available data do not allow tests of market power at separate stages of cigarette marketing. Both the cited studies and ours treat the market as the combined system of manufacturers, wholesalers, and retailers. Nonetheless, the studies of market power

presume that the major scope for exercise of monopoly power is at the manufacturing level. Although their methods differ, these studies tend to reject both the cartel and perfect competition hypotheses. This is the case most appropriate for our model since we specify an arbitrary number of non-colluding firms.

Since data are for all cigarettes, both these studies and ours abstract from product differentiation. Explicitly introducing product differentiation to our theoretical model should produce similar results as long as the firms' choice variables are quantities. Alternatively, one could interpret the model in terms of smuggling a particular brand.

⁸For specific functional forms of demand, one could use (6) and (7) to solve for \bar{q}_1 and \bar{q}_2 . With data on N_1 and N_2 , one could directly estimate the legal sales equation implied by our model.

⁹For fixed p^* , results in Sections II - VI are the same qualitatively with either a per unit or ad valorem tax.

¹⁰Initially we thought transportation cost would be an important cost and thus affect smuggling incentives. Apparently, it is a minor cost. Input-output data for 1977 [Department of Commerce, 1984] show that transportation cost accounted for .5 percent of the value of tobacco products. More recently, an undisclosed cigarette company official told us that in 1984 average transportation cost amounted to .6 cents per pack of cigarettes.

¹¹States with military bases and Indian reservations are subject to another type of smuggling which would bias the legal sales data. Utah is excluded because of the large Mormon population. The state tax rate would not reflect the effective tax for states with local taxes. An effective tax rate could be calculated using data on local sales and local tax rates. Smuggling incentives are affected by these local tax rates, so that the local and rest of state sales reflect the extent of smuggling. Hence the effective tax rate so calculated is endogenous.

Table 1. Cigarette Demand Equation Results

Variable	Linear Model		Log-Log Model	
Constant	22.66	(3.37)**	.24	(3.57)**
Retail Price	-26.76	(-1.90)*	-1.14	(-1.92)*
Income	-1.14	(-.56)	-1.01	(-.72)
Average Price Neighboring States	7.96	(.93)	.03	(.70)
Trend	-.61	(-4.33)**	-.005	(-4.91)**
Lagged Sales	.96	(78.49)**	.97	(75.94)**
Tax Difference with NC	17.94	(1.67)*	.02	(1.97)**
R ²	.98		.98	

t-ratios given in parentheses

* Significant at 10% level

** Significant at 5% level

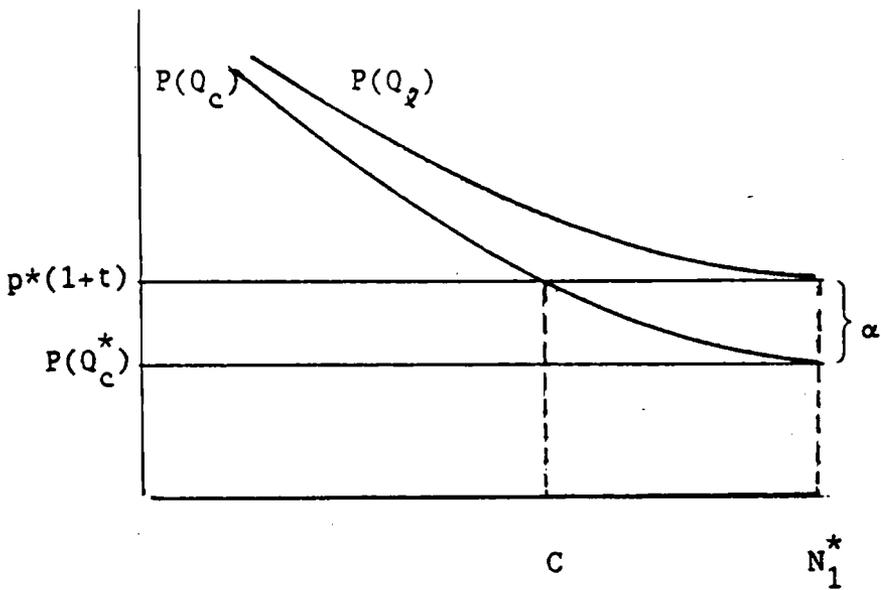


FIGURE 1