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COUNTERFEIT-PRODUCT TRADE

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and

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This paper contains preliminary findings from research work still in progress and should not be quoted without prior approval of the authors.

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Counterfeit-Product Trade*

by

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ABSTRACT

We analyze a two-country model of trade in both legitimate and counterfeit products. Domestic firms own trademarks and establish reputations for delivering high-quality products in a steady-state equilibrium. Foreign suppliers export legitimate low-quality merchandise and counterfeits of domestic brand-name goods. Heterogeneous home consumers either purchase low-quality imports or buy brand-name products, rationally expecting some degree of counterfeiting of the latter.

We characterize a counterfeiting equilibrium and explore its properties. We describe the positive and normative effects of counterfeiting in comparison with a no-counterfeiting benchmark. Finally, we provide a welfare analysis of border inspection policy and of policy regarding the disposition of counterfeit goods that are confiscated at the border.

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I. INTRODUCTION

Trade in counterfeit products is reaching epidemic proportions. Casual observers are becoming increasingly aware of the presence of fakes and trademark-infringing knockoffs in the markets for a wide variety of products, including not only the traditionally forged, luxury consumer goods such as designer clothing, watches, perfumes and leather items, but also higher-technology consumer electronic products such as computers and stereo equipment. There is also mounting evidence of substantial counterfeiting in the markets for records and tapes, foods, pharmaceuticals and an expanding range of industrial goods, including parts for automobiles and airplanes, fertilizers, pesticides, military hardware and medical devices.[1] Business Week, in a recent cover story devoted to counterfeiting (December 16, 1985), called it "perhaps the world's fastest growing and most profitable business."

The growth in counterfeit-product trade has attracted the attention of the international trade community, including corporations, governments, and the international organizations. Firms are hiring specialized private detective services to track down, expose, and prosecute the forgers (Kaikati and Lagarce, 1980), and are devoting more and more resources to making their brand-name products copyproof (Salmans, 1979). A number of companies adversely affected by counterfeiting have bound together to form such organizations as the International Anticounterfeiting Coalition in New York and the Union des Fabricates in Paris. These associations lobby governments for stricter domestic laws, tighter border control, and tougher sanctions against countries

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1. Anecdotal evidence on the extent of counterfeiting and the range of products affected appears regularly in the public and business presses. See the many articles cited in Olenick (1982) and U.S. House of Representatives Committee on Energy and Commerce (1983, 1984). Data from a survey of U.S. businesses is available in U.S.I.T.C. (1984).

that foster illegitimate producers. The governments, for their part, are beginning to heed the call. For example, the U.S. Congress passed the Trademark Counterfeiting Act of 1984 and the Tariff and Trade Act of 1984 after extensive Congressional hearings on the topic, and the U.S. International Trade Commission conducted a comprehensive investigation of counterfeiting in 1983 with a view towards reforming its procedures for handling complaints under the relevant section of the Tariff Act of 1930. Most recently, the United States, Japan, and the European Community have agreed to make the adoption of an anticounterfeiting code one of their primary objectives for the proposed upcoming round of GATT negotiations (New York Times, January 20,1986).

The U.S. International Trade Commission (1984, p.vii) defines counterfeiting as "the unauthorized use of a registered trademark on a product that is identical or similar to the product for which the trademark is registered and used." The anti-counterfeiting code drafted by GATT goes further in ascribing to the forger the intent to "wrongfully benefit through deceit from the efforts of a firm to establish and maintain a product or corporate image with the consumer or the public at large" (emphasis added). Counterfeiting, like patent and copyright infringement, represents a violation of a firm's property rights, in this case the rights to its trademark and associated goodwill. It is distinguished from these related practices, however, in that it alone involves an attempt to defraud consumers via misrepresentation.

Counterfeiting can arise only in markets with imperfectly-informed consumers. If consumers could immediately and costlessly observe all the attributes of goods available for purchase, it would be impossible for an imitator to pass off a product of inferior quality under a false label. The potential counterfeiters would be constrained to offer goods with like characteristics to those of the legitimate brand. Furthermore, the trademark

itself (unlike a patent or a copyright) would have zero value in a world of perfect information. Together, these considerations eliminate any incentive for forgery.

Trademarks take on value in a world of imperfect information. When a firm invests in its reputation by delivering a promised quality, it develops goodwill with its customers. Trademarks allow consumers to identify the products of companies that have satisfied them in the past. Thus, a trademark becomes an asset of the firm, embodying its accumulated goodwill. When governments grant firms exclusive property rights to their marks, they protect firms' investments. Without such protection, firms would find it difficult to appropriate the benefits from maintaining the quality of their products and would have less incentive to do so.

Counterfeiting undermines the functioning of the property rights system. Not only do consumers suffer the direct harm associated with the purchase of low-quality copies purporting to be originals, but the infringement on the legitimate firms' rights alters the incentives to invest in their reputations. It does so in two ways. First, consumers will be willing to pay less for high-quality products in situations where they recognize a risk of obtaining fakes. Second, a consumer who purchases a bogus good may not identify it as such, and may attribute its poor performance to the trademark holder. Then the presence of counterfeits in a market can tarnish the images of honest manufacturers.

In principle, counterfeiting need not be a trade issue. In practice, however, most counterfeits originate in certain countries where laws governing the protection of trademarks are not so strict and enforcement is lax. Indeed, in many less developed countries, the importation of foreign technologies is a conscious development strategy, and the line between imitation and infringement

sometimes becomes blurred. U.S. producers surveyed by the U.S.I.T.C identified Taiwan as the source country in sixty percent of the cases in which they experienced competition from counterfeit products (U.S.I.T.C., 1984). Other countries implicated as havens for firms producing counterfeits include Hong Kong, Indonesia, South Korea, the Philippines and Thailand. Italy supplies many of the counterfeits sold in Europe, while a number of Middle Eastern countries are fast becoming prominent in this market.

In this paper, we develop an equilibrium model of counterfeit-product trade. In doing so, we incorporate into our analysis not only the direct effects of counterfeiting that arise when a consumer purchases a fake instead of a genuine brand-name product, but also the induced effects on the behavior of legitimate producers. We pay special attention to the quality-choice decision of brand-name firms, recognizing that consumers will only purchase from companies that make credible offers and deliver on their promises.

In Section 2, we develop our model, which takes as its starting point the burgeoning literature on equilibrium in markets with imperfectly-informed consumers.[2] To set a benchmark for comparison, we begin Section 3 by establishing the properties of the equilibrium under the assumption that counterfeiting is not feasible. We then introduce the possibility that some imports may be fakes, ask when counterfeiting will occur, and use comparative static techniques to study the determinants of the market share of counterfeits. We conclude this section by comparing home and world welfare levels to those in the benchmark case. In section 4 we study the welfare effects of border inspection policy and of customs policy regarding the disposition of

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2. See, for example, Klein and Leffler (1981), Shapiro (1982, 1983) and Allen (1984). In our model, we follow Shapiro (1983) in assuming that firms can choose from a range of possible qualities, while we borrow from Allen (1984) the assumption that consumers form their expectations rationally.

confiscated products. Finally, a concluding section contains a summary of the results, some of which are quite surprising.

II. A MODEL OF COUNTERFEIT-PRODUCT TRADE

We consider the world market for "blue jeans", a product of heterogeneous quality. The attributes of blue jeans that determine their quality are not immediately observable by consumers. The world comprises two countries: a home country, in which quality-control procedures are well developed; and a foreign country, which lacks the capability to produce high-quality merchandise but has comparative advantage in the production of low-quality jeans. Local enforcement of trademark-protection laws is lax in the foreign country.

The model is cast in discrete time with periods of length T. At the beginning of each period, each of the M identical home firms selects a price, p, and a quality, q, and announces (e.g., advertises) the price and a quality "claim", $\hat{q}$. Later, we will require that the claim be credible. In any event, the true quality must meet or exceed some q_0, which is the minimum-quality item that can "do the job", because we assume that consumers can identify items that will not function as jeans. Each firm has its own distinguishable trademark, but otherwise jeans of like quality produced by different manufacturers are perfect substitutes.

Variable production costs at home are xc(q), where x is output and c(q) is the constant marginal cost of producing jeans of quality q. Implicitly, we are assuming that the jeans industry is small in relation to the home industrial sector, so that the supply of factors used by the industry is perfectly elastic. There is also an "entry cost", F, which must be incurred once and for all at time 0 by any home firm that engages in production and sales. This fee can represent, for example, the cost to the firm of developing its product or

advertising its trademark.

Per-period profits of a representative home firm are $\pi = (p - c(q))x - rF$, where $r \equiv e^{iT}-1$ (i is the instantaneous discount rate) and therefore rF is the interest cost on the entry fee.[3] This expression for profits presumes, as will be the case in equilibrium, that the firm sells all that it produces. We entertain two alternative assumptions about market structure: a fixed number of home firms, and free entry. In the event of the latter, M adjusts at the beginning of time until there are no excess profits. In all cases, we assume that M is large.

The foreign blue-jeans industry produces only "generic goods" of quality q_0. This could be because quality-control methods are undeveloped there, or because firms there lack the ability to establish reputations and thus have no incentive to produce jeans of higher quality. We could allow foreign firms a choice of quality with costs that rise steeply as a function of q, but ignoring this decision altogether simplifies the exposition.

In keeping with the stylized facts, we assume that foreign firms are small, that entry is free, and that the technology there exhibits constant returns to scale.[4] In contrast to the home country, the foreign blue-jeans industry is not negligible in relation to the manufacturing sector there. As foreign production of blue-jeans expands, the prices of at least some factors

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3. These are profits in a symmetric, steady-state equilibrium. Under the assumptions we make about expectation formation and consumer shopping strategies, no asymmetric equilibria exist and adjustment to the steady state is instantaneous.

4. According to an attorney quoted in the Business Week article, in the counterfeiting business "there's no Mr. Big. It's a bunch of little guys." The article later explains that "it is now incredibly cheap to make fakes that once required factories with heavy equipment and hundreds of workers. Today one man in an auto repair shop can copy the contours of a fender on a home computer. He can then make a plastic die and run off hundreds of copies."

of production, e.g., entrepreneurial talent or managerial skills, are driven up. Denoting aggregate foreign output of jeans by X^*, foreign unit production costs are given by $c^*(X^*)$, where $c^{*\prime} > 0$. Each foreign firm, being small, treats c^* as a constant. Total revenue from production in the foreign country, excluding the value of jeans output, is $R^*(X^*)$, with $R^{*\prime} < 0$ and $R^{*\prime\prime} < 0$.

Production takes place each period subsequent to the announcement of price and quality by trademark-owning firms. We assume that foreign and home firms select their output levels simultaneously in a Cournot fashion.

Foreign firms also choose how to label their output at this time. If a pair is labeled honestly, consumers infer that it is of quality q_0 (recall that they can recognize goods of any lower quality). Let p_0 denote the price of such jeans. Alternatively, a foreign firm can mimic the label of a home producer. A pair so labeled is a counterfeit. If the firm exports such a good to the home country, it faces a risk of confiscation by home-country customs agents.[5] This occurs with probability ϕ, where $\phi \equiv bf(\hat{q})$.

ϕ is the product of two components. The first component, b, is the probability that a given package is opened. We consider b to be a policy parameter reflecting the intensity of border inspection. The second component is the probability of detection conditional on a given shipment being inspected. In the United States and elsewhere, trademark owners supply customs

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5. The commercial laws of many countries call for the confiscation of trademark-infringing goods (see U.S.I.T.C., 1984). In the United States, two statutes apply. Under the provisions of the Lanham Act, a trademark owner may record his registered mark with the Customs Service, which then will prohibit entry of goods bearing counterfeit marks. The Tariff Act of 1930 calls for seizure and forfeiture of infringing goods. A firm claiming infringement of its common law trademark by imports may apply to the I.T.C. for relief under Section 337 of the Tariff Act of 1930. If its claim is validated and a determination of injury is made, the Commission will issue an exclusion order to the Customs Service. Customs then has the choice whether or not to permit re-export of goods seized under such an order.

agents with sample products. The agents use these samples in their search for counterfeits. We assume that the greater is the difference between the quality of the sample and that of the counterfeit, the more likely it is that the agents will identify the copies as such. Suppose that the samples are made to match the announced quality, $\hat{q}$, and that customs agents accept the samples as legitimate if the announcement is credible. Then we can write the conditional probability of detection, given q_0, as $f(\hat{q})$, with $f' > 0$.[6]

Turning to the demand side of the model, we assume that all consumers at home and abroad purchase at most one unit of blue jeans. We distinguish two types of consumers in the home economy. Quality-conscious consumers, who number N in total, value a unit of quality at θ in terms of the numeraire. That is, the total utility each enjoys by consuming one unit of jeans of quality q purchased at price p is $U = \theta q - p + y$ for $q \geq q_0$, where y is income and therefore y-p is expenditure on the numeraire good. Note that there is no loss of generality in assuming that utility is linear in q; this merely defines the scale by which quality is measured.

The remaining N_0 home consumers value quality less highly, perhaps because their incomes are smaller. These consumers are happy to purchase a low-quality product, as long as it will do the job. The form of their utility functions is the same as for quality-conscious consumers, but with y and θ replaced by y_0 and θ_0, where $\theta_0 < \theta$. We take parameter values such that, at the prices prevailing in equilibrium, this group of consumers most prefers the generic product among those that are (or could be) offered.

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6. In our formal model, there are no high-quality imports, so it would be optimal for customs agents to confiscate all goods labeled as high-quality. In practice, of course, this policy is infeasible because of the presence of legitimate brand-name imports. Our analysis would be completely unchanged if trademark owners manufactured their products offshore using elastically-supplied foreign labor but home-country managerial resources.

There are N* foreign consumers, all with identical tastes. These consumers value quality at $\theta^* \leq \theta_0$. Hence, they too buy generic jeans, and thus the home country is the only potential market for counterfeits.

Our assumptions concerning the information structure follow Shapiro (1983). Consumers can discern whether a product is at least passable; they can distinguish products of quality q_0 from those that have no value to them. Consumers cannot, however, immediately observe the characteristics of a product that set it above quality q_0. Furthermore, warranties for jeans are not enforceable. Hence, a quality-conscious consumer who chooses other than the generic product buys a good of uncertain worth. If he or she expects that counterfeits account for a fraction s of the goods carrying a particular brand-name label and that the legitimate product is of quality $\hat{q}$, then expected utility from purchasing this brand is $U = s(\theta q_0 - p + y) + (1-s)(\theta\hat{q} - p + y)$ $= \theta[sq_0 + (1-s)\hat{q}] - p + y$.

The consumer does observe the quality of a product upon consuming it, i.e., with a lag of one period. This defines the length of a period in our model. We further assume that consumers share with friends their experiences with the jeans they purchase. Consumers thereby learn the average quality of jeans bearing a given label that were sold during the previous period.

We assume that consumers observe the total quantity of jeans of each label available on the market.[7] Although this assumption is strong, it is needed to enable firms to compete for customers. If consumers could not observe quantity, a legitimate firm that promised a better deal than its rivals could,

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7. In Allen (1984), the equilibrium with observable quantity is also an equilibrium when quantity is not observable. The same is true in our model. However, Allen does not ask whether any new equilibria can arise once quantity becomes unobservable. In fact, there, as here, a continuum of equilibria exists when quantity is unobservable, and for much the same reason.

if believed, flood the market with minimum-quality goods. At high levels of sales, the quick profits associated with being "fly-by-night" exceed the sustainable profits of an honest firm that maintains its reputation. Consumers would be skeptical to an extreme of any "good deals", and would buy only from firms promising the prevailing level of surplus, whatever that level happened to be. If, however, consumers can observe total sales, then a firm can credibly offer a good deal by restricting its output, thereby preserving its incentive to produce the announced quality.

Finally, we specify how expectations are formed. Each quality-conscious consumer accepts at face value the quality claim of any firm, so long as the claim is credible and the consumer does not suspect that firm of having been dishonest in the past. The consumer assesses credibility by determining whether, if believed, the firm has incentive to deliver on its promise. In equilibrium, all firms produce their advertised quality. Thus, consumers' expectations about quality are "rational". Customs agents and potential counterfeiters forecast qualities similarly.

Consumers also must form expectations about the share of counterfeits in each submarket. Each consumer first calculates whether, at the prevailing price and (expected) quality, entry by counterfeiters is deterred, or whether counterfeits should be expected to flood the market. Then, if neither of these extremes is believed to be the case, the consumer assumes that the market share of counterfeits in the relevant submarket will be "normal", i.e., it will be such that the brand in question yields the same expected utility as do others. In a symmetric equilibrium, these expectations, too, are fulfilled.

Firms, consumers, and counterfeiters all must form expectations about future variables. We impose a "perfection" constraint on these expectations: expected actions must be optimal responses for every sub-game. Agents further

believe that any out-of-equilibrium deviation by a single firm will persist, if the deviation is profitable for that firm, and if other firms have no incentive to respond in the sub-game that arises after the deviation.

Consumers calculate the expected surplus associated with each brand, using their subjective probabilities. Each initially chooses the brand offering the highest surplus. If several brands offer the same expected surplus, selection among these is random. After purchasing, the consumer observes whether the quality of the item is equal to that claimed by the trademark owner. If so, and if no other brand offers higher expected surplus in the next period, the consumer buys from the same company again. If, however, the jeans do not perform at quality $\hat{q}$, the consumer next checks whether the fraction of other consumers with similar experiences exceeds the expected market share of counterfeits. From this survey, the consumer infers whether the legitimate firm has "cheated". The customers of a firm that has cheated all believe that this firm will offer minimum quality in the future.[8] Given this belief, these consumers buy elsewhere, and since the offending firm cannot compete with foreign producers in the market for generic jeans, it shuts down. A consumer who has obtained a substandard product, but one who suspects that the fault lies with counterfeiters and not the legitimate firm, nonetheless opts to switch brands if another offers the same level of expected surplus.

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8. We will soon see that, if a firm decides to cheat at all, it is optimal for it to produce minimum quality. Thus, consumers who observe that their firm has not delivered on its promise will also find that the minimum quality has been produced. They then expect the same behavior to persist indefinitely. This approach also is followed by Klein and Leffler (1981) and Allen (1984).

III. PROPERTIES OF EQUILIBRIUM AND REGIME COMPARISONS

A. Equilibrium without Counterfeiting

As a benchmark for comparison, we first establish the properties of the equilibrium when counterfeiting is not feasible. Formally, we assume in this subsection that $\phi \equiv 1$. Consumers infer immediately that $s=0$ for all brands.

A home-country firm advertising price p, claiming quality $\hat{q}$, producing output x, and remaining honest earns a flow profit (gross of fixed costs) of $(p-c(\hat{q}))x$. The present discounted value of a stream of such profits is $(1+r)(p-c(\hat{q}))x/r$. Alternatively, the firm could claim $\hat{q}$, but produce a lower quality. If it did so, it would be discovered after one period, and would then be forced out of business. A firm that elects to cheat maximizes its one-period profit by producing minimum quality, thereby earning $(p-c(q_0))x$. The credibility constraint requires that the firm have an incentive to provide its announced quality. This gives

$$p \geq c(q) + r(c(q) - c(q_0)).$$

As Shapiro (1983) has argued, promises of above-minimum quality can be credible only if firms earn premia over their marginal costs. These premia provide the incentives for firms to maintain their reputations.

Given $p > c(q)$, firms surely will compete for customers. Competition forces the credibility constraint to equality, or

$$p^n = c(q^n) + r(c(q^n) - c(q_0)), \qquad (1)$$

where we use a superscript n to denote equilibrium values in the no-counterfeiting regime. In Figure 1, we depict (1) as the curve CR.

Home producers also can try to expand sales by offering more attractive (but credible) price-quality packages than their rivals. If all firms offer the same expected surplus, then each is rationed and sells to N/M consumers. A firm that offers a slightly better deal can greatly increase its sales and therefore its profits. Since a single firm is small in the overall market, it can expand its sales by a large amount in percentage terms without giving its rivals reason to respond in the ensuing sub-game. Consumers therefore can rationally expect the deviant's better deal to persist. In equilibrium, there cannot exist opportunities for profitable deviations. Thus, competition drives firms to the credible price-quality pair that maximizes quality-conscious consumers' utility.

The price and quality that maximize consumer utility subject to the credibility constraint are found in Figure 1 at the point where the CR curve is tangent to a representative quality-conscious consumer's indifference curve. Algebraically, we have the condition

$$c'(q^n)(1+r) = \theta, \tag{2}$$

which we term the competition equation.

Having determined the equilibrium price and quality of home-country jeans, the rest of the no-counterfeiting equilibrium is readily described. Each home firm is rationed in equilibrium, producing output $x^n = N/M$. Each earns per-period profits of

$$\pi^n = (p^n - c(q^n))N/M - rF. \tag{3}$$

If entry is free, then $\pi^n = 0$, which, together with (3), determines the number

of home firms, M^n.

Foreign firms serve consumers of generic jeans. Market-clearing in this submarket requires

$$X^{*n} = N^* + N_0 \ . \tag{4}$$

Free entry abroad ensures

$$p_0^n = c^*(X^{*n}). \tag{5}$$

Our assumption that foreign producers have comparative advantage in the market for low-quality jeans requires that $c^*(X^{*n}) < c(q_0)$.

In equilibrium, quality-conscious consumers receive lower quality jeans than in the "first best", where no information problems exist.[9] Trade in low-quality jeans benefits the non-quality-conscious, home consumers. With trade, they buy at p_0^n, which is less than $c(q_0)$, the autarky price of these goods. Trade has no effect on the quality-conscious consumers. Finally, under conditions of free entry, the no-counterfeiting equilibrium is a constrained (or second-best) social optimum. If we allow the government to subsidize costs but not to administer entry taxes or provide information, then it must maximize total surplus subject to the zero-profit and credibility constraints. The first-order conditions for this maximization imply $\theta = c'(q)(1+r)$ or $q = q^n$. Given the information structure, changes in quality away from q^n are beneficial only if entry by home firms can be controlled.

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9. The first best occurs where the marginal cost of quality equals the marginal consumer valuation, or $c'(q) = \theta$. Shapiro (1982) proves and discusses a more general version of the result that imperfect consumer information leads to quality deterioration.

B. Equilibrium with Potential Counterfeiting

We seek to characterize equilibrium when counterfeiting is feasible. Let us provisionally assume that copies account for a positive share of the market for each brand. Later, we will check whether this assumption is justified.

Home firms continue to face a credibility constraint in announcing their quality. Starting from a candidate equilibrium with sales rationed, a firm that cheats on quality can sell (1-s)N/M units of the minimum-quality good for one period. Alternatively, it can sell this same quantity indefinitely by fulfilling its promises. We see that the incentive to produce the announced quality is exactly the same as in the no-counterfeiting case. As before, competition will drive the credibility constraint to equality, so we have

$$p = c(q) + r(c(q) - c(q_0)). \qquad (6)$$

Firms again compete for customers, since at the margin it remains profitable to sell more jeans. But now, in their attempts to (credibly) offer surplus in excess of that offered by other brands, the legitimate producers must take into account the response of counterfeiters. A legitimate firm has three choices in this regard. If it chooses a price-quality pair such that counterfeiters can earn positive profits, consumers will expect the market for this brand to be overrun by copies. No sales result under this strategy, so it cannot be optimal. Second, a home firm can announce a price and quality at which counterfeiters of its trademark just break even. Consumers then expect a normal share of fakes, and the legitimate firm enjoys a proportionate share of total jeans sales. Finally, the firm in question can select a price and quality such that foreign producers will not wish to counterfeit its label. By doing so, the firm makes its output especially attractive to consumers, and may

thereby relax its sales constraint. It captures both the share of its own submarket otherwise held by counterfeiters, and some of the market of its legitimate competitors.[10]

In any candidate equilibrium, all foreign firms (counterfeiters or otherwise) earn zero profits. Since any particular home firm is small, it takes the costs of the foreign firms as given. The home firm can drive the counterfeiters out of its submarket by changing its price-quality vector slightly in an appropriate direction. Such a deviation must be profitable, as long as it does not cause the firm to violate the credibility constraint. But profitable deviations cannot exist in equilibrium. It follows that, as a condition of equilibrium with positive counterfeiting, all price and quality changes that cause counterfeiters to earn negative profits must not be credible.

Potential counterfeiters earn zero profits when their unit production costs are equal to the "expected price", i.e., the price of the goods for which the copies are being passed off times the probability that the fakes escape detection at the border. This gives the zero-profit condition,

$$p(1-bf(q)) = c^*(X^*). \qquad (7)$$

depicted as ZP in Figure 2. In an equilibrium with $s > 0$, competition ensures that the zero-profit curve is tangent to the credibility constraint, and that

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10. As before, the deviant firm would not want to expand by "too much", or else consumers would (rightly) expect its rivals to respond in future periods. If they were to respond, the firm could not persist in its high level of sales. But then consumers would suspect quality shading in the current period.

the former curve is more concave than the latter.[11] In Figure 2, we show this tangency; as drawn, their are no points on or above the credibility curve that yield negative profits for counterfeiters. Algebraically, the competition equation requires

$$(1+r)c'(q) = \frac{bf'(q)p}{1-bf(q)}, \tag{8}$$

with $c''/c' > f''/f' + 2f'/(1-bf)$. Equations (6) and (8) jointly determine p and q; then (7) determines X*.

We proceed to describe the remaining equilibrium conditions, still maintaining the assumption that these will be consistent with the existence of a positive amount of counterfeit-product trade. The break-even condition for legitimate, foreign producers of generic jeans is

$$p_0 = c^*(X^*). \tag{9}$$

The supply of foreign jeans must equal demand, where the latter includes both the demand by non-quality-conscious consumers and the unwitting purchases of counterfeits by the quality-conscious consumers. Sales of honestly-labelled generic jeans account for $N^* + N_0$ pairs. Production of counterfeits must be $sN/(1-bf(q))$ if sN pairs are to survive border inspection. We assume at this point that customs agents discard the jeans that they confiscate. Thus, the market share of counterfeits is given implicitly by

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11. If at all quality levels the ZP curve is flatter than the CR curve, no such tangency will exist. In this case, the market for high-quality goods collapses. As an example of this phenomenon, we cite the exit of Louis Vuitton from the Italian handbag market, following a period of intense competition with counterfeiters. See Kaikati and LaGarce (1980, p.58).

$$X^* = N^* + N_0 + \frac{sN}{1-bf(q)} \cdot \qquad (10)$$

Finally, we record home firms' profits. In equilibrium, each trademark owner sells (1-s)N/M pairs of jeans; per-firm profits are

$$\pi = [p-c(q)](1-s)N/M - rF. \qquad (11)$$

When entry is free, $\pi = 0$, which together with (11) determines M.

We now are prepared to investigate whether trade in counterfeit products does in fact occur in equilibrium. Define π^{*n} as the marginal profitability of producing a copy when no counterfeiting actually takes place, i.e., $\pi^{*n} \equiv p(1-bf(q)) - c^*(N^*+N_0)$. Let ZP^n in Figures 2, 3a and 3b represent the points where $\pi^{*n}=0$. In Figure 2, this curve does not intersect CR. In this case, it is profitable for some counterfeiters to enter, if none are present already, at <u>any</u> price-quality pair satisfying the credibility constraint. The equilibrium is at E, where the zero-profit condition associated with the X^* from (10) is tangent to CR. Since $X^* > N^* + N_0$, equilibrium has positive counterfeiting.

If ZP^n intersects CR, as in Figures 3a and 3b, no counterfeiting takes place in equilibrium. These two figures represent qualitatively different situations. In Figure 3a, ZP^n passes above E^n, the equilibrium point for the no-counterfeiting regime. Home firms can select quality, price, and output as if counterfeiting were infeasible, and in the resulting equilibrium counterfeiters have no incentive to enter. The situation is different in Figure 3b. Here, production at (p^n,q^n) would invite entry by counterfeiters. Equilibrium occurs instead at the particular intersection of ZP^n and CR that offers the greatest surplus to quality-conscious consumers. Although

counterfeiters make no sales in such a limit-pricing equilibrium, the threat of their entry affects the market outcome.

When $s > 0$, the output of generic jeans is increased by counterfeiting. Consequently, the foreign wage rises with counterfeiting, and so does the price of low-quality jeans. The foreign country gains from counterfeiting, as its terms of trade improve. Home consumers of low-quality jeans qua consumers (i.e., neglecting their role as owners of firms) must lose.

Home producers may provide either higher or lower quality products in an equilibrium with (actual) counterfeiting than in one where counterfeiting is infeasible. Indeed, from (6) and (8) we see that θ no longer influences the equilibrium quality when $s > 0$. Although the home firms would like to compete for customers by further tailoring their products to consumers' tastes, they are constrained in doing so by the potential response of counterfeiters. Interestingly, the home firms may earn higher profits in an equilibrium with counterfeiting (assuming that M is fixed) than they would if it were infeasible. Price markups rise as we move up the credibility constraint,[12] so if quality increases due to counterfeiting, so too do per-unit profits. Then, if sales do not fall by too much, total profits rise as well. When profits increase, it is because the presence of counterfeiters limits the intensity of mutually-harmful competition among the legitimate firms.

In a limit-pricing equilibrium, foreign output and sales of low-quality jeans are the same as in the no-counterfeiting regime. So too are foreign wages. Thus, the mere threat of counterfeiting has no effect on the foreign country, or on home-country consumers of low-quality jeans. Home producers select (credible) prices and qualities to maximize quality-conscious consumers'

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12. Along CR, $d[p-c(q)]/dq = rc'(q) > 0$.

utilities, subject to the constraint that entry by counterfeiters be effectively deterred. The resulting level of quality can be higher or a lower than in the no-counterfeiting equilibrium. For fixed M, profits per firm are higher in a limit-pricing equilibrium than in the no-counterfeiting equilibrium if and only if quality is higher.

C. Determinants of the Market Share of Counterfeits

In this subsection, we explore some of the determinants of the market share of counterfeits. As one would expect, increases in home relative production costs raise the share of counterfeits. We study here the influences on s of: the lag in information transmission, T; the discount factor, i; the shape of the home cost function, c(q); and the (absolute and relative) sizes of the various market segments, N, N_0 and N*. As a byproduct of the analysis, we also learn what factors affect market prices and quality levels.

Our approach is to calculate comparative-static derivatives of the system of equations (6) through (10). By doing so, we restrict attention to parameter values that imply an equilibrium with a positive amount of counterfeit-product trade. Note, however, that the factors that cause s to decline are also the ones that make it more likely that no counterfeiting will take place in equilibrium. To conserve space, we simply report our results.

The speed of information transmission, T, and the discount factor, i, both enter our model through the composite parameter r. A change in either of these primitive parameters has a similar effect on the incentive firms have to run down their reputations. For example, if T increases, consumers observe quality with a longer lag, and thus quality-shading becomes more attractive. Similarly, an increase in i means that the future profits from maintaining a reputation are discounted more heavily, and again it is more tempting to cut

quality for immediate gain.

When r increases, home firms find it more difficult to convince consumers that their goods are of high quality. The credibility constraint shifts up and becomes steeper. The quality of brand-name jeans falls, thereby reducing the risk to counterfeiters of confiscation. This decline in ϕ directly increases s, and also induces more illegitimate producers to enter. In terms of Figure 2, the ZP curve must shift up to re-establish tangency with the more stringent CR constraint. The increase in the production of forgeries further augments the share of counterfeits in the market. With more foreign production, the foreign wage is higher. Thus, the price of low-quality jeans rises with r.

The shape of the c(q) schedule determines the cost to home firms of increasing quality on the margin. We write the cost function as $c(q,\alpha)$ and assume that $\partial c/\partial\alpha = 0$ at the equilibrium q, and $\partial^2 c/\partial q\partial\alpha > 0$ everywhere. A higher value of α corresponds to a steeper c(q) schedule. Our exercise, then, involves involves pivoting c(q) about the initial equilibrium point.

An increase in α unambiguously raises s. When the marginal cost pivots about q, $c(q_0)$ falls. This means that home firms have a greater temptation to cheat. Like an increase in r, an increase in α causes the credibility constraint to shift up (at least, near the initial equilibrium point). The restoration of equilibrium requires additional output by counterfeiters.

Finally, we consider the effects of shifts in demand. A change in N or in $N^* + N_0$ has no effect on the p and q determined by equations (6) and (8). Thus, by (7), X^* does not change. If N increases with $N^* + N_0$ constant, the total number of forgeries produced remains the same, as does the probability of confiscation. So the market share of counterfeits falls. If $N^* + N_0$ rises, given N, more of the (given) foreign output is sold honestly, and again s falls. An increase in the fraction of quality-conscious consumers, holding

constant the total population, causes the market share of counterfeits to rise if and only if $1-\phi > s$. This condition is satisfied in all plausible cases.

D. Welfare Effects of Potential Counterfeiting

We compare levels of social welfare in the no-counterfeiting and cum-counterfeiting equilibria. Our main result, proven in the Appendix, is

Proposition 1: With free entry by home firms, actual or potential counterfeit-product trade entails a loss in home and world welfare.

Under conditions of free entry, the effect of potential or actual counterfeit-product trade on home-country welfare can be expressed as the sum of three terms. The first effect is the terms-of-trade loss suffered by non-quality-conscious home consumers. This term is non-zero whenever $s > 0$. The second term is the direct loss to quality-conscious consumers that results from their being deceived. They buy counterfeit goods that have a market value of p_0 but pay p instead. This term also is strictly negative when $s > 0$. The final term represents a "quality-adjustment effect". Because the quality level in the no-counterfeiting equilibrium with free entry is a constrained optimum, any change in that level induced by actual or potential counterfeiting entails a loss of welfare.

The first two of these effects represent transfers between home-country consumers and foreign producers. From the point of view of world welfare, these transfers cancel. However, the quality-adjustment effect reflects a loss of efficiency in the world jeans market. Furthermore, when home customs agents discard the goods that they confiscate, trade in counterfeit products entails a second world-welfare loss, namely the opportunity cost of the counterfeits that

are destroyed. This loss would not arise if a policy were followed whereby home customs agents relabel and sell the goods that they seize. We consider the implications of such a policy for home-country welfare in Section 4B.

Surprisingly, counterfeit-product trade need not bring about a loss in domestic or world welfare when the number of home, jeans-producing firms is fixed. For given M and absent counterfeiting, the nationally-optimal quality is the first-best, where $\theta = c'(q)$. As we have noted, quality in the no-counterfeiting equilibrium falls short of this first-best level. For standard, second-best reasons, actual or potential counterfeiting can raise home welfare, if it causes a higher level of quality to obtain, i.e., if $q > q^n$. The threat of entry by counterfeiters may remove the temptation firms otherwise have to compete via (credible) reductions in price and quality. Such competition, while beneficial to consumers, reduces home welfare.

Counterfeit-product trade is most likely to raise home welfare when the actual share of counterfeits is small, since the occurrence of $s > 0$ continues to imply a terms-of-trade loss for non-quality-conscious consumers and a direct surplus loss for quality-conscious consumers when the number of home firms is fixed. A gain in welfare also requires that $bf'(q)$ be relatively large (i.e., that home producers find that quality upgrading is an effective means of raising counterfeiters' costs of doing business).

Finally, we note that when M is fixed, increases in quality up to the first-best level reflect gains in worldwide efficiency. Thus, counterfeit-product trade can also raise global welfare in this case (and must do so whenever it raises domestic welfare). Indeed, if home-country customs agents do not discard the goods that they confiscate, world-welfare improvement can be consistent with quite high volumes of trade in counterfeit goods. In summary:

Proposition 2: With a fixed number of home firms, actual or potential counterfeit-product trade may raise or lower home or world welfare. Counterfeiting is more likely to raise welfare if quality upgrading deters counterfeiters effectively (i.e., f' is large).

IV. POLICY ANALYSIS

Only recently have governments in the more developed countries begun to formulate policy responses to foreign counterfeiting. In the United States, for example, the trademark-protection and trade laws were amended in 1984 to allow for more severe punishment of offenders, and to stipulate that tariff preferences be denied to countries that harbor counterfeiters. Even now, a number of the key policy questions concerning counterfeiting remain unresolved.

Our model allows us to address two of the issues that have featured prominently in the public debate. The first is whether the government ought to devote more resources to searching for counterfeits at the border, as argued by many trademark owners who are the targets of forgeries. Despite these arguments, we have witnessed recently in the United States a trend reduction in U.S. customs enforcement. The second issue concerns the disposition of counterfeit goods seized at the border. Current U.S. law gives the Customs Service several options in this regard, and Congress has not as yet stipulated a procedure choosing among these.

A. Border Inspection Policy

We study in this section the efficacy of tighter border policy. In our model, we capture such a policy change by increases in the parameter b. Recall that b is the probability that a given shipment is examined by customs officials. Here we evaluate the benefits of stricter enforcement. Of course,

a complete analysis would require that these benefits be weighed against the associated real resource costs.

We seek to determine dW/db, where $W \equiv N_0U_0 + NU$ is aggregate home-country welfare. We begin with the case of free entry. Then profits from local jean production are zero, and the income terms that enter U_0 and U can be taken as fixed. Differentiation of W with respect to b gives

$$\frac{dW}{db} = -N_0 \frac{dp_0}{db} - N\theta(q-q_0) \frac{ds}{db} - sN \frac{dp}{db} + N(1-s)[\theta \frac{dq}{db} - \frac{dp}{db}]. \qquad (12)$$

The four terms on the right hand side of (12) are readily understood. The first is a terms-of-trade effect, reflecting any change in the price of imported low-quality jeans. The second term represents the direct effect on consumers' utilities of there being a different likelihood that a particular purchase will turn out to be fake. The third term reflects changes in the terms of trade on counterfeits. Finally, there is a quality-adjustment effect.

To sign these various effects, we need to know how a change in b alters the equilibrium. Throughout this section (and the next) we focus on equilibria that have $s > 0$. The border-policy parameter appears in equations (7) and (8). An increase in b raises the cost of delivering counterfeit products. At the same time, stricter enforcement implies a greater effectiveness of quality upgrading as a means of deterring counterfeiters. As shown in Figure 4, the ZP curve shifts up to ZP' and becomes steeper. Equilibrium is restored by a decline in foreign costs (effected by a reduction in X*), which shifts the ZP curve down to ZP". The new equilibrium, E', has a smaller s and a higher q, the latter reflecting the optimal response of home producers to the policy change.

Two benefits of an increase in b are fairly obvious. First, quality-conscious consumers buy fewer fakes. Second, the shift of foreign resources out of counterfeit production causes p_0 to fall, thereby improving the home

country's terms of trade. However, reflection on the last two terms in (12) reveals that the analysis is more subtle than one might initially suppose. The third term is unambiguously negative. An expansion of enforcement efforts causes the price of legitimate high-quality jeans to rise (along with q). But this implies that when quality-conscious consumers now are deceived by counterfeiters, they pay more for their mistakes. The last, quality-adjustment term can have either sign. Substituting for $dp/db = (1+r)c'(q)dq/db$, we see that this term is positive exactly when the equilibrium quality of home jeans is below that of the no-counterfeiting equilibrium.

Combining these four effects, we find that an increase in b need not be welfare improving, even if we neglect the resource expenditure needed for this policy measure.[13] The explanation lies in the "general theory of the second-best": policies with direct effects that are beneficial can nonetheless have deleterious consequences if their indirect effect is to exacerbate a pre-existing market distortion. An increase in b, which causes q to rise when $s > 0$, can move the equilibrium level of quality away from the (constrained) optimum, if this level initially is too high. We summarize in

Proposition 3: With free entry by home firms and $s > 0$, tighter enforcement of border policy can raise or lower home welfare. A sufficient condition for $dW/db > 0$ is $c'(q) < \theta(1-s)/(1+r)$.[14]

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13. In a limit-pricing equilibrium (with free entry), an increase in b always raises welfare. The first three terms of (13) all vanish in this case, while relaxation of the threat of entry by counterfeiters allows the legitimate firms to offer greater surplus to consumers. This reconciles our result here that dW/db might be negative with our earlier finding that welfare is always higher when $\phi \equiv 1$; the increase in W need not be monotonic.

14. When the government sells confiscated goods rather than destroying them, a sufficient condition for $dW/db>0$ is $c'(q) < \theta/(1+r)$, i.e., $q < q^n$.

We turn briefly to the case of fixed M. Then the home industry earns positive profits, which enter into consumers' utilities through the income variables, y and y_0. The new expression for dW/db contains one new term and a somewhat different quality-adjustment effect. The other (three) terms are exactly as before.

The new term reflects the increase in the profits of home firms that results from their capturing sales otherwise made by counterfeiters. It is given by $-N(p-c(q))(ds/db)$. The quality-adjustment effect that applies when M is fixed is $N(1-s)[\theta-c'(q)](dq/db)$. This term is positive exactly when the equilibrium quality of legitimate jeans falls short of the first-best level.

Once again, the total effect on home welfare of an increase in b is ambiguous. Combining the quality-adjustment term and the terms-of-trade effect on imported counterfeits, we find that a sufficient condition for $dW/db > 0$ when M is fixed is $c'(q) < \theta(1-s)/(1+rs)$. This condition is less stringent than in the free-entry case, because tighter border policy in the present circumstances does not cause socially-wasteful entry.

B. Government Disposition of Confiscated Merchandise

We consider now the issue of the disposition of goods seized by customs officials. To this point, we have assumed that all confiscated counterfeits are destroyed. But in fact, U.S. law gives the Customs Service four options in this regard. They may allow re-exportation of the goods, donate them to charity, destroy them, or turn them over to the General Services Administration for relabeling and sale. In practice, most confiscated merchandise is turned over to the G.S.A., which relinquishes it to a charity if a request is received within a year. After that period, the goods are sold at auction. Of course,

counterfeits deemed to be dangerous are destroyed.[15]

To study what policy of disposition is optimal, we introduce into our model a parameter σ which represents the fraction of confiscated jeans that are resold. We assume that the government removes the bogus trademark from these goods and offers them at the competitive price p_0.

How does this policy variable affect the equilibrium? When $\sigma > 0$, the home government becomes an additional supplier in the market for low-quality jeans. The condition for equilibrium in this submarket changes to

$$X^* + \sigma bf(q)\frac{sN}{1-bf(q)} = N^* + N_0 + \frac{sN}{1-bf(q)}, \qquad (10')$$

where $sN/(1-bf(q))$ is the number of counterfeits produced and $\sigma bf(q)$ is the fraction of these that are seized and auctioned by the home government. The remaining conditions of equilibrium are unchanged. Importantly, this means that σ does not affect the equilibrium values of p, q, or X^*, which continue to be determined by (6), (7) and (8).

Now consider the welfare implications of variations in σ. Such changes have only two effects in the model. First, as σ is increased, the government collects additional revenue of $[p_0 bf(q)sN/(1-bf(q))]d\sigma$. This revenue represents the direct benefit from reducing waste. But, the increase in σ also causes the market share of counterfeits to increase. Since X^* is constant, each pair of low-quality jeans sold by the home government causes one more pair to be falsely labeled. In effect, by entering the market as a supplier of low-quality jeans, the home government forces foreign producers out

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15. Testimony of Richard H. Abbey, Chief Counsel for the U.S. Customs Service, before the House Subcommittee on Crime. See U.S. House of Representatives Committee on the Judiciary (1985, p.138).

of legitimate activities and into counterfeiting. The welfare cost associated with this increase in s under conditions of free entry by home firms is

$$\{\theta(q-q_0) - \frac{\sigma p_0}{1-\sigma bf(q)}\} \frac{sNbf(q)}{1-bf(q)} d\sigma.$$

The first term here captures the loss to quality-conscious consumers, while the second reflects the gain in government revenue. Each term is multiplied by $sNbf(q)/(1-bf(q))$, the total number of units confiscated.

Adding the two effects together, and rearranging terms, we find

$$\frac{dW}{d\sigma} = \frac{sNbf(q)}{1-\sigma bf(q)} [p - \theta(q-q_0)]. \qquad (13)$$

Expression (13) can be positive or negative. But notice that its sign is independent of σ. This proves

Proposition 4: With free entry by home firms, the optimal policy is to sell (discard) all confiscated counterfeits when $p > (<) \theta(q-q_0)$.

Selling the confiscated items is most likely to be socially beneficial when the difference in quality between domestic and foreign jeans is small.[16]

V. CONCLUSIONS

When foreign firms forge the trademarks of home manufacturers, they infringe on the property rights of the legitimate producers. Counterfeiting

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16. Qualitatively, the same conclusion holds when the number of home firms is fixed. Then resale rather than destruction is indicated if and only if $c(q) > \theta(q-q_0)$.

can only be profitable when brand-identifying trademarks, and the reputations that they embody, have significant value to their owners. For reputations to be of value, consumers must be imperfectly informed about product attributes. So, counterfeiting must be studied in the context of imperfect consumer information.

We conduct our analysis of counterfeit-product trade in a dynamic, two-country model with imperfect quality information and brand-name reputations. We solve the model for a steady-state, rational expectations equilibrium, and use it to study the causes and consequences of counterfeits. The confluence of imperfect information and imperfect property rights gives a second-best flavor to our welfare analysis.

The presence of foreign counterfeits harms the home economy in a number of intuitive ways. Some home consumers suffer when they unwittingly purchase copies. And the home country realizes a deterioration of its terms-of-trade, as foreign counterfeit production drives up factor prices in the export sector of the foreign country.

The feasibility of counterfeiting also alters the rivalry between domestic manufacturers. Absent counterfeiting, brand-name producers compete to offer consumers the best deal, subject to a credibility constraint that each firm find it optimal to provide its reputed quality. Potential counterfeiting forces firms to adjust their price and quality so as to protect themselves from imitators, while still competing for consumers. Depending upon the border inspection technology, the possibility of counterfeiting may raise or lower equilibrium quality and price. With free entry by home firms, the quality adjustment in response to counterfeiting necessarily lowers home and global welfare. With a fixed number of home firms, however, brand-name producers may raise their quality in an effort to battle counterfeiters, and this quality

enhancement may cause both home and global welfare to rise (since quality initially was undersupplied due to imperfect information).

Policy responses to counterfeiting may have unintended consequences due to the changes they induce in the quality of brand-name products. Tighter border inspections policy, for example, benefits the home country in that it reduces the price of legitimate imports and lowers the market share of counterfeits. It may nonetheless lower domestic welfare as it causes the quality of brand-name products to increase (perhaps excessively) and worsens the terms of trade on the remaining counterfeits.

Another policy question concerns the disposition of counterfeit products that are confiscated at the border. We consider a policy whereby the customs authority sells a fraction σ of these items and destroys the rest. We find that increasing the fraction that are sold actually raises the market share of counterfeits. The home government's supply of low-quality goods competes with that of legitimate foreign producers, and thereby shifts resources abroad into the illegal subsector. We show that the optimal policy is either to destroy all confiscated products or to auction them all, and we provide a simple sufficient condition that determines which of these is the case.

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Appendix: Proof of Proposition 1

Home welfare is given by $W \equiv N_0U_0 + NU$. When entry is free, profits are zero, so $y^n = y$ and $y_0^n = y_0$. Therefore,

$$W - W^n = -N_0(p_0-p_0^n) + N[(1-s)\theta(q-q^n) + \theta s(q_0-q^n) - (p-p^n)].$$

Using the credibility constraint to substitute for p^n and p, we find

$$W - W^n = N_0(p_0-p_0^n) + Ns\theta(q_0-q) + N\{\theta(q-q^n) - (1+r)[c(q)-c(q^n)]\}. \quad (A1)$$

The first term in (A1) is non-positive. Since, $X^{*n} \leq X^*$, home consumers of low-quality goods pay no more for their jeans in the no-counterfeiting regime, and pay strictly less if $s > 0$ with counterfeiting. The second term is the direct loss to quality-conscious consumers from the presence of counterfeits in the market. The final term is the indirect effect on the surplus enjoyed by quality-conscious consumers caused by the induced change in quality. This too is non-positive, because $c''>0$ implies that $[c(q)-c(q^n)] > c'(q^n)(q-q^n)$, so

$$N\{\theta(q-q^n)-(1+r)[c(q)-c(q^n)]\} < N(q-q^n)\{\theta-(1+r)c'(q^n)\} = 0. \quad (A2)$$

The change in global welfare is $\Delta G \equiv (W - W^n) + (W^*- W^{*n})$. Substituting for $W^*- W^{*n} = R^*(X^*) - R^*(X^{*n}) + (X^*-N^*)p_0 - (X^{*n}-N^*)p_0^n$, and noting (12), we have

$$\Delta G = R^*(X^*)-R^*(X^{*n}) + Ns\theta(q_0-q) + N[\theta(q-q_0) -(p-p^n)] + sp_0/(1-bf(q)).$$

But $R^{*\prime\prime} < 0$ implies $R^*(X^*) - R^*(X^{*n}) < R^{*\prime}(X^{*n})(X^*-X^{*n})$. Using $R^{*\prime}(X^{*n}) = -p_0^n$, we have $R^*(X^*) - R^*(X^{*n}) < -sNp_0^n/(1-bf(q))$. Therefore,

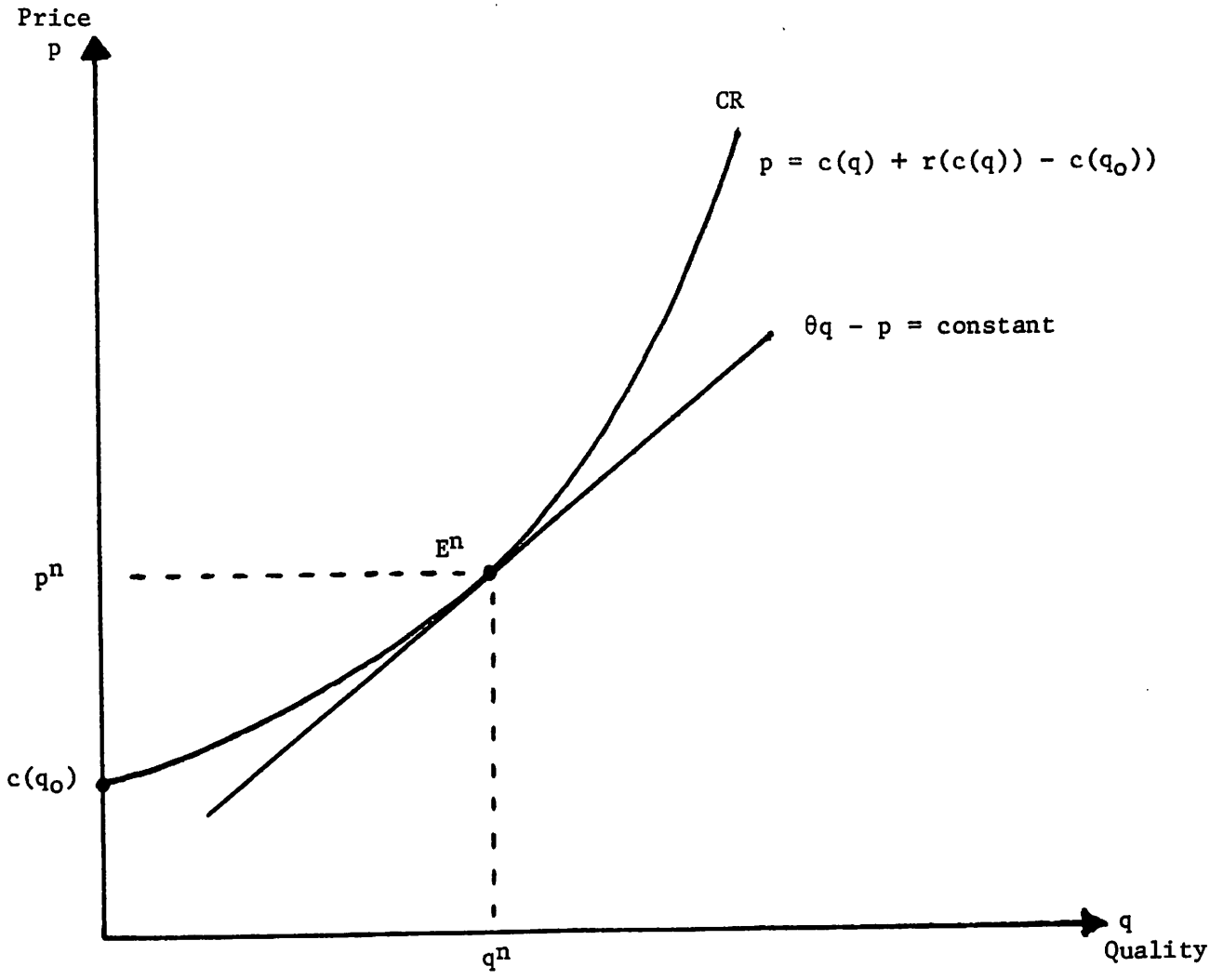
$$\Delta G/N < \theta(q-q^n) - (p-p^n) + s\theta(q_0-q) + s(p_0- p_0^n)/(1-bf(q).$$

The fact that quality-conscious consumers choose to consume the high-quality jeans in the no-counterfeiting equilibrium implies $p_0^n > \theta(q_0- q^n) + p^n$. This, together with $p = p_0/(1-bf(q))$, implies

$$\Delta G/N < (1-s)[\theta(q-q^n)-(p-p^n)] - sbf(q)p_0^n/(1-bf(q))$$

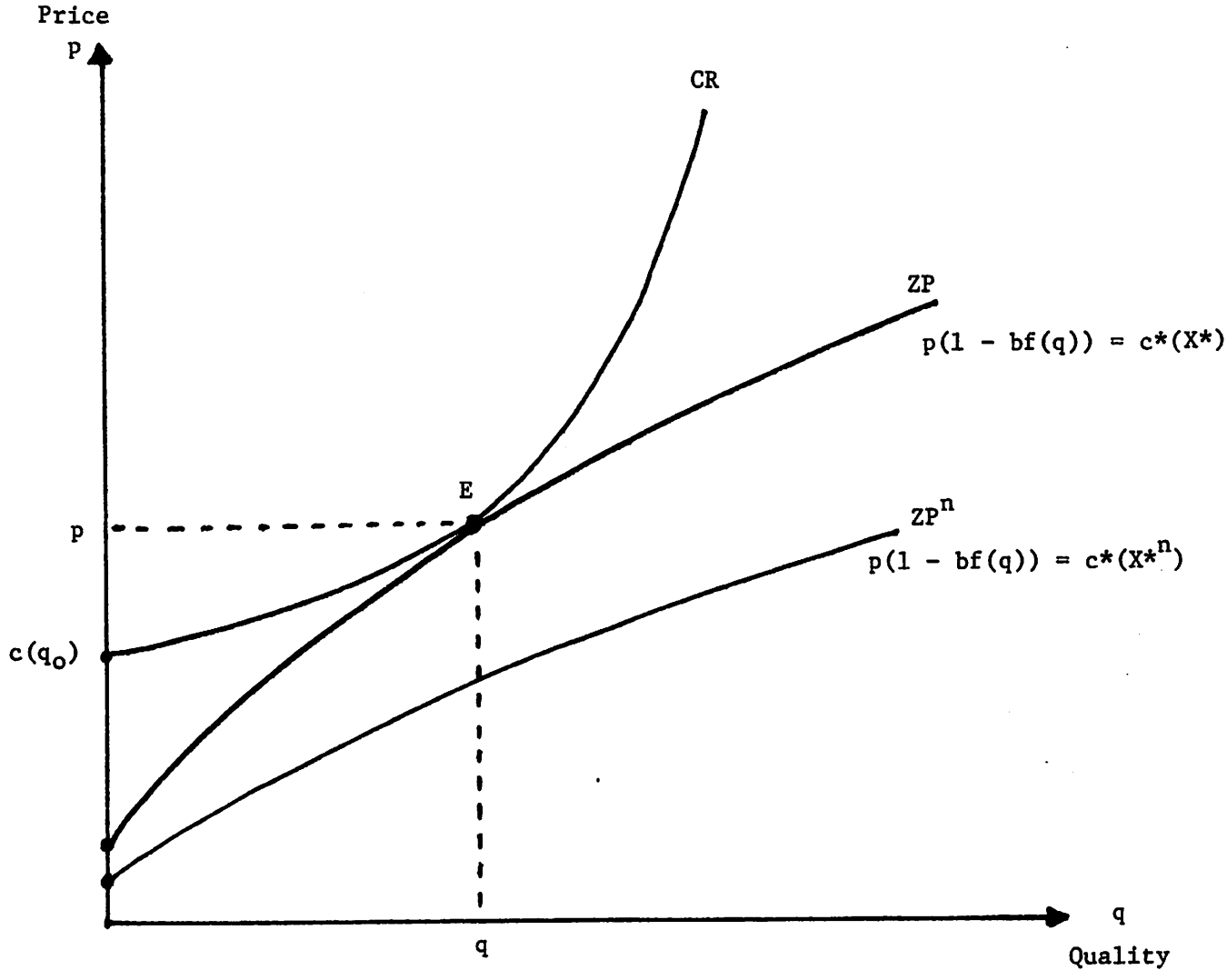
$$= (1-s)[\theta(q-q^n)-(1+r)(c(q)-c(q^n))] - sbf(q)p_0^n/(1-bf(q)). \quad (A3)$$

The first term on the right hand side of (A3) is a "quality-adjustment effect". We have already shown this to be non-positive in (A2). The second term is the value (at no-counterfeiting prices) of the output discarded by home customs agents. This term would vanish if customs agents were to relabel and sell at auction the jeans they confiscate. In any event, $\Delta G < 0$. Q.E.D.



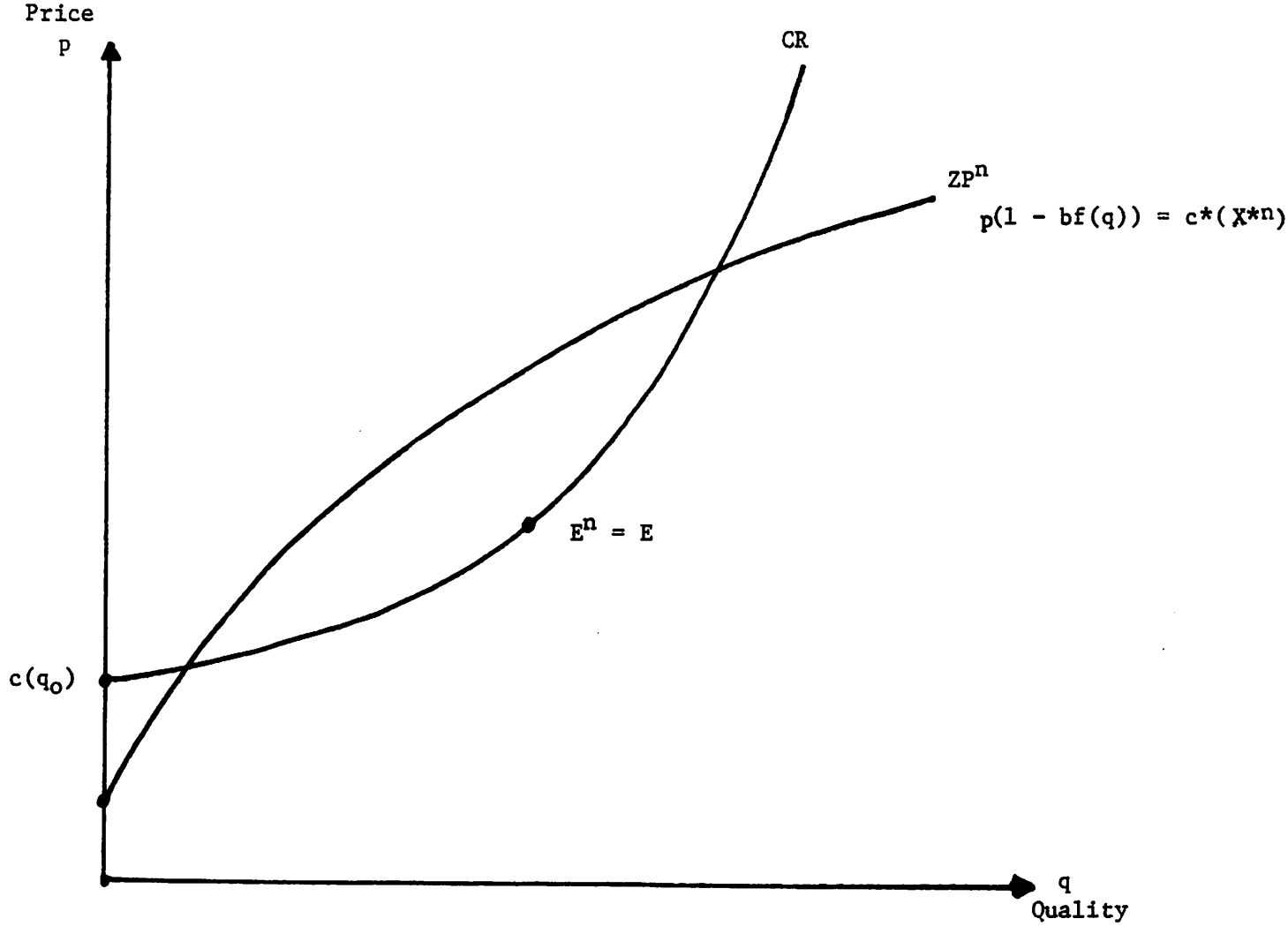
No - Counterfeiting Equilibrium

Figure 1



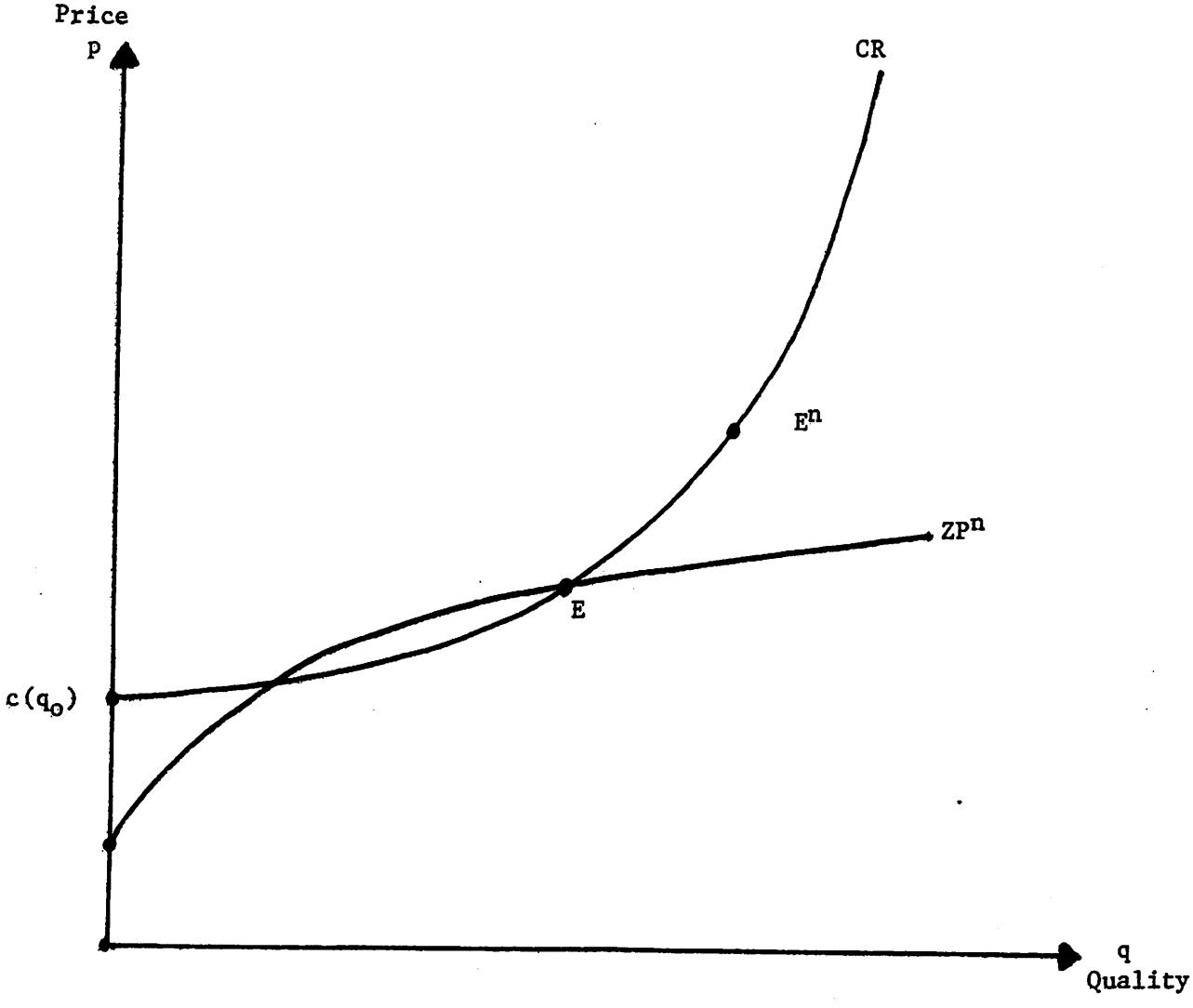
Counterfeiting Equilibrium

Figure 2



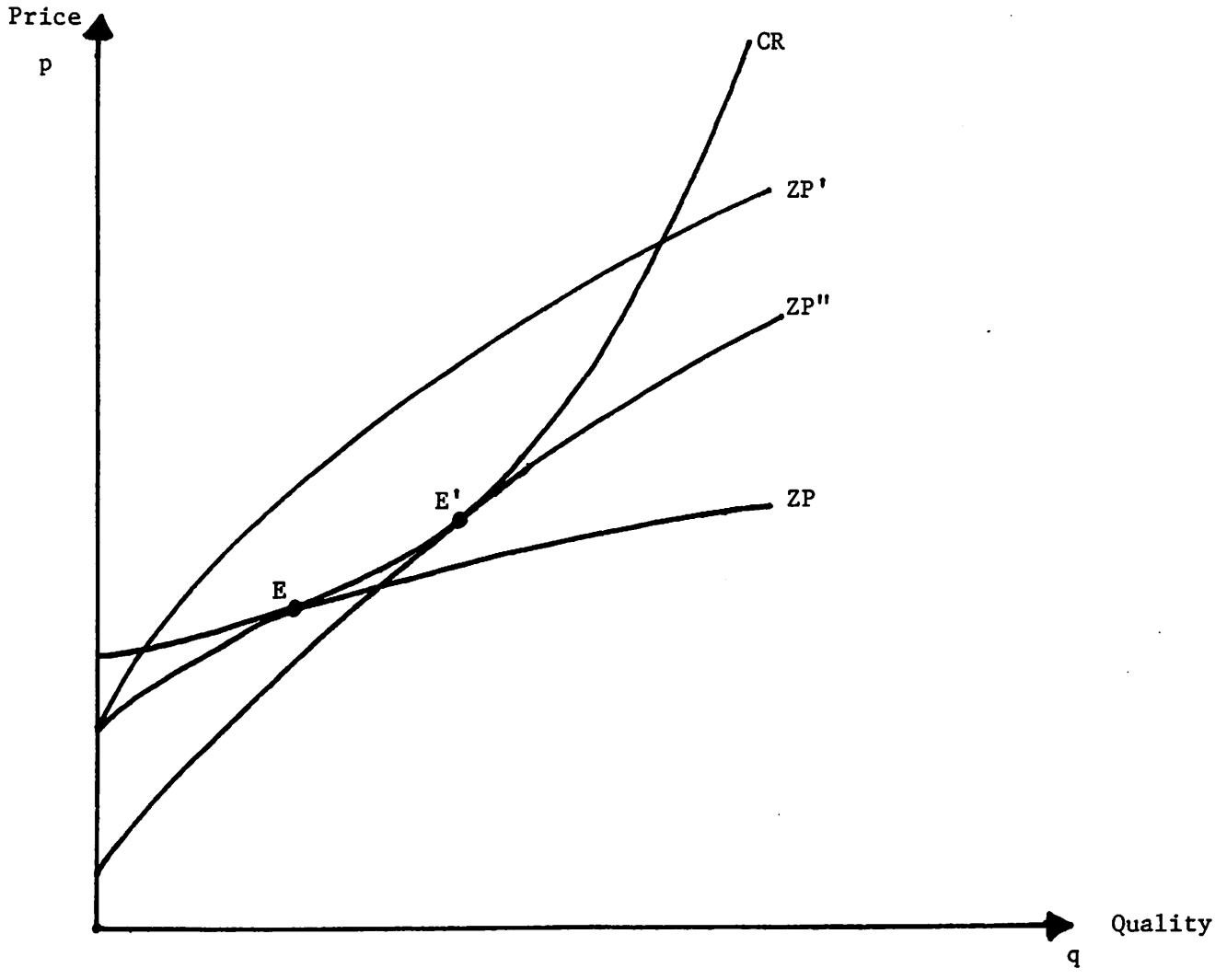
Costly Counterfeiting (s = 0)

Figure 3A



Limit Pricing Equilibrium (s = 0)

Figure 3B



Tighter Border Inspection Policy

Figure 4

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