Parallel Imports: Challenges from Unauthorized Distribution Channels

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Abstract

We examine the problem of parallel imports: unauthorized flows of products across countries, which compete with authorized distribution channels. The traditional economics model of a discriminating monopolist that has different prices for the same good in different markets requires the markets to be separated in some way, usually geographically. The profits from price discrimination can be threatened by parallel imports that allow consumers in the high-priced region some access to the low-priced marketplace. However, as this article shows, there is a very real possibility that parallel imports may actually increase profits.

The basic intuition is that parallel importation becomes another channel for the authentic goods and creates a new product version that allows the manufacturer to price discriminate. We propose a two-country, three-stage model to quantitatively study the effects and strategies. In the third stage, and in the higher priced country where parallel imports have entered, we characterize the resulting market segmentation. One segment of consumers stays with the authorized version as they place more value on the warranty and services that come with the authorized version. Another segment switches to parallel imports because a lower price is offered due to lack of country-specific features or warranties. Parallel imports also generate a third and new segment that would not have bought this product before. Unlike counterfeits that are fabricated by imitators, all parallel imports are genuine and sourced from the manufacturer in the lower-priced country through authorized dealers. Therefore, the manufacturer's global sales quantity should increase, but profit may rise or fall depending on the relative sizes and profitability of the segments. A profit-maximizing parallel importer should set price and quantity in the second stage after observing the manufacturer's prices in both countries. There will be a threshold of across-country price gap above which parallel imports would occur. In the first stage, the manufacturer can anticipate the possible occurrence of a parallel import, its price and quantity, and its effect on authorized sales in each country to make a coordinated pricing decision to maximize the global supply chain profit. Under some circumstances the manufacturer should allow parallel imports and under others should prevent them. Through a Stackelberg game we solve for the optimal pricing strategy in each scenario. We then find in one extension that when the number of parallel importers increases, the optimal authorized price gap should narrow, but the prices and quantities of parallel imports may rise or fall. In another extension, we find that when the manufacturer has other means—such as monitoring dealers, differentiating designs, and unbundling warranties—to contain parallel imports, the authorized price gap can widen as a function of the effectiveness of nonpricing controls.

In summary, parallel imports may help the manufacturer to extend the global reach of its product and even boost its global profit. If the manufacturer offers a discount version through its authorized dealers, it is running a high risk of confusing customers and tarnishing brand images. Parallel imports may cause similar concerns for the manufacturer, but unauthorized dealers are perceived as further removed from the manufacturer. Therefore, there is less risk of confusing consumers when parallel imports are channeled through unauthorized dealers. Furthermore, they are more nimble in diverting the product whenever their transshipment and marketing costs are small enough not to offset the authorized price gap and the valuation discount. This may explain why some manufacturers fiercely fight parallel imports, while others knowingly use this alternative channel.
(*International Marketing*; *Parallel Imports*; *Pricing*; *Intrabrand Competition*; *Channel Conflict*; *Stackelberg Game*)

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1. Introduction

Each year billions of dollars worth of products in the world market are sold outside authorized distribution channels, as the following story illustrates (*Forbes* 1995):

> A typical "carbitrager" buys a Grand Cherokee Limited V-8 from a Toronto dealer for $28,125 and sells it for $46,342 in Munich, 17% less than the official German price. Setting aside $14,847 to cover all costs he still makes a profit of $3,370 on each car. He made $3 million last year on a sales of $36 million, and the sales have doubled in each of the past four years.

In general, business enterprises can profit from purchasing products in a lower-priced region and shipping them to a higher-priced region for sale. This practice has been known as "arbitrage" (*Forbes* 1995), "product diversion" (*New York Times* 1996), "gray market" (Cespedes et al. 1988, Cavusgil and Sikora 1988, Cross et al. 1988, Gilbert et al. 1986, Weigand 1989), or "parallel imports" (Duhan and Sheffet 1988, Chard and Mellor 1989, Weigand 1991). We choose to use "parallel imports" here because the flows are more likely to occur internationally than domestically, and we focus on the parallel nature of the authorized and unauthorized channels. Kuttner (1998) gave a good explanation for this intriguing global problem:

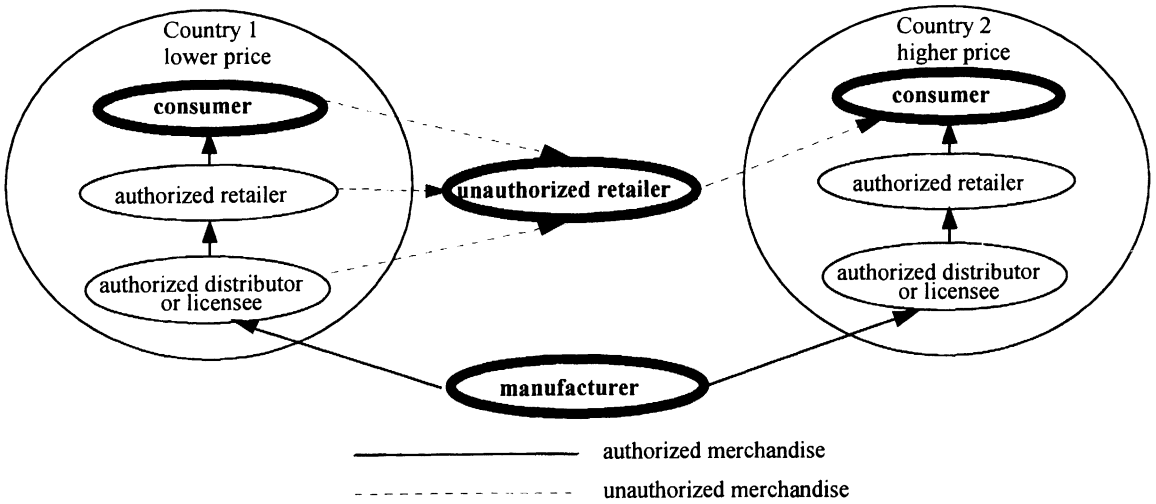
> The globalization of price competition, in short, is lagging far behind the globalization of commerce. Price-rigging remains a form of "non-tariff barrier" that nobody is seriously contesting. Neither the rules of the World Trade Organization, the European Union, nor the domestic antitrust laws of leading nations reach this problem. You might think that in an age of global corporations, mail-order catalogs, and Internet sales, global consumer prices would have long since converged, but no. In some respects, pricing disparities and barriers are becoming more entrenched. While national antitrust laws effectively restrain price maintenance within nations, they hardly touch it globally.

Kogut (1985), Mertens and Ginsburgh (1985), Schut and Van Bergeijk (1986), and Shepard (1991) also observed this unique challenge in diverse international markets. When the U.S. dollar was strong in the early 1980s, there was a total annual inflow of parallel imports reaching a peak of $10 billion (*Business Week* 1988) and growing at 22% (Lowe and McCrohan 1989). More recently, the Asian economic turmoil halted many construction projects there and redirected previously ordered earth-moving equipment into the strong U.S. market, causing the gray market share of hydraulic excavator sales to rise from 4.7% in 1997 to 19.5% in 1998 (*Business Week* 1998). There is also evidence that parallel imports affect U.S. exports in a wide range of industries. A survey (Michael 1998) of consumer nondurable, durable, and industrial goods exporters showed that 67% of firms reported knowing or even skillfully using parallel export channels. In reality, there may exist many possible forms of parallel traders such as catalogue retailers and discount stores. They have various ways to source products from the manufacturer, authorized resellers, and even consumers sometimes. For our analysis, we focus on decision making of the manufacturer, the parallel importer, and the buying consumers in the two markets for this paper. We choose to leave the distributors for future studies. Figure 1 presents all parties and their interactions in a complex and more realistic picture, but highlights those players that we focus on in this study.

Research in the area of parallel imports and gray marketing has been scarce compared with pervasive practices. Assmus and Wiese (1995) carefully characterized various institutional details into categories of reimportation, parallel importation, and lateral gray importation. They emphasized the need to coordinate prices in different countries using one of four strategies: centralization, formalization, economic measures, and informal coordination according to environmental complexity and local resources. The parallel import flows we study here (as in Figure 1) are general enough to embrace their three categories, and our analysis answers their call for centralized and formalized coordination mechanisms.

Bucklin (1993) rightfully pointed out the complexity of interactions among the players (trademark owners, authorized dealers, and gray market operators) and the absence of comprehensive empirical data because of its sensitive nature. He presented an array of modeling approaches and used numerical studies to examine the claims made by each party in the conundrum to draw public policy implications. Our study has a similar focus on the intrabrand competition and the perspective of an international firm's managing its independent channel members in two countries. Through a theoretical game model we further tackle

Figure 1 Players Involved in Parallel Imports



the interactive effects that Bucklin identified to be difficult. It turns out that the manufacturers are not victims in this story, a conclusion supported here and by Bucklin.

Gerstner and Holthausen (1986) studied a model of a monopolist serving two market segments where the high-value consumers also had access to the cheaper market. They also considered two illuminating extensions where the "leakage" of customers from the high to the low-price market could be optimally controlled. Nevertheless, the transaction costs that the consumers of both types had to access the cheaper market were governed by different probability distributions. The stochastic demands of the high-value consumers were hence independent of transaction costs, which were independent across consumers. In the parallel imports situation, because of the existence of a profit-seeking parallel trader, the transaction cost in gaining access to the low-price market depends on the collective consumer demand in the high-price market, as well as the manufacturer's and the parallel importer's profit motives. This interrelationship governs the pricing decisions in the two channels, which are best captured in a game theoretical model in this article.

Several other studies looked at international exclusive territory distribution and manufacturers' attitudes toward its violation in parallel imports. Yang et al. (1998) examined four pricing strategies—"local," "uniform," "friction," and "global"—used by multinational manufacturers, and assessed their effectiveness against parallel imports. Dutta et al. (1994) and Bergen et al. (1998) used the transactional cost approach in enforcing the exclusive contract to explain why optimal enforcement policies would generally tolerate some level of dealer "bootlegging," which was an intermediate solution between the extremes of terminating violators and abandoning exclusivity entirely.

The main contribution of this article is to recast parallel imports as a game of discriminatory pricing in international markets. On one hand, parallel importation undermines the manufacturer's ability to price discriminate in separate markets. On the other hand, it adds a product version to the high-priced market for consumers to choose, so the manufacturer can further price discriminate there. Depending on the trade-off between these two effects, the manufacturer may wish to fight or allow parallel imports in order to maximize global profits. In either case, the manufacturer should actively manage parallel imports, which can be done through proper pricing and other means. To quantitatively analyze the effects and strategies, this article proposes a three-stage model. In the first stage, the manufacturer sets authorized prices in Country 1 (the lower-priced) and Country 2 (the higher-priced). In the second stage, the unauthorized dealer sources from Country 1 and sets prices for unauthorized goods in Country 2. In the third stage, consumers in Country 2

choose between authorized and unauthorized versions. We obtain the condition under which the manufacturer should prevent or allow parallel imports and the optimal pricing strategy in each scenario. The analysis also provides testable hypotheses and managerial implications.

The rest of the paper is organized as follows. Section 2 examines the third-stage problem and presents a market segmentation model. We describe how parallel imports emerge and impact the manufacturer's sales and profits. Section 3 examines the first- and second-stage problems and formulates a Stackelberg leader-follower pricing game. We solve the optimal when-and-how strategies for the manufacturer to prevent and allow parallel imports. In §4, the basic model is extended to two cases: one of multiple competing parallel importers, and the other of supplementing with nonpricing controls. We then derive a set of testable hypotheses and discuss managerial implications. Finally, in §5, we conclude with a summary of findings and suggestions for further research in this area.

2. A Market Segmentation Model

2.1. Emergence of Parallel Imports

Consider a manufacturer that markets a product in two countries through captive distributors. This is a common one-manufacturer, two-distributor; one-product, two-market model in the literature of channel management and international marketing. Factors such as income level, purchasing power, government regulation, competitive environment, and volatile exchange rate often interact, leading to very different prices even in adjacent countries. We now define a set of variables to construct the manufacturer's total profit function in the global supply chain, defined as the sum of sales revenues in all countries less total production, transportation, and distribution costs as follows:

p_i = the product's retail price through the authorized channel in Country i, $i = 1, 2$;
Q_i = the product's retail quantity through the authorized channel in Country i;
N_i = the maximum market size for the product in Country i;
a_i = the demand coefficient of Country i, affected by income level and exchange rate[1];
c = the variable production cost;
s_i = the variable cost of shipping into and selling in Country i (including duties, tariffs, transportation, and distribution costs); and
π = the manufacturer's total profit in the global supply chain.

In our analysis, we assume that the manufacturer is coordinating retail prices in various countries and is incurring distribution costs. In reality, manufacturers often influence retail prices through setting transfer prices for captive dealers or charging wholesale prices to independent distributors. Another way to view the "manufacturer" in this model is as a coordinating representative making centralized decisions for all players in the authorized channels. We now introduce a linear demand function for the authorized product in each country:[2]

$$p_i = a_i (N_i - Q_i), \quad i = 1, 2. \tag{2}$$

[1]The demand coefficient is a proxy of purchasing power and is influenced by income level I_i and exchange rate e_i as follows:

$$a_i = \frac{e_i}{U_i'(I_i)} \quad i = 1, 2 \tag{1}$$

where $U_i(.)$ is a utility function on all consumption other than the product under study. Because $U_i(.)$ is concave and nondecreasing, a_i increases with e_i and I_i, i.e., higher income and higher exchange rate lead to higher purchasing power.

[2]The demand function's linearity is assumed for analytical tractability. It emerges when consumers with different incomes have the same utility function that is separable in income and the product under study. This demand structure was suggested by Tirole (1988, pp. 96–97). The following derivation follows Malueg and Schwartz (1994). Let y denote the consumption of the numeraire good such as money and Q the consumption of this product. Suppose the utility function is

$$V(y, Q) = U(y) + NQ - \frac{1}{2} Q^2,$$

and the budget constraint is $ey + pQ = eI$. The inverse demand function in implicit form is

$$p(Q) = \frac{e(N - Q)}{U'(I - pQ/e)}.$$

For (pQ/e) "small," $U'(I - pQ/e)$ approximately equals $U'(I)$. We then have the inverse demand function of the model. Note index i was omitted.

We make further assumptions that the price in one country does not affect the demand in the other, a consumer will buy one unit at most, and $a_2 > a_1$ and $N_1 = N_2$. This means that Country 2 has lower price elasticity than Country 1 because of income level and/or exchange rate rather than market size. The manufacturer's global profit maximization problem, when no parallel imports are present, is as follows:

$$\max_{p_1, p_2} \pi = \sum_{i=1}^{2} \left(N - \frac{p_i}{a_i}\right)(p_i - c - s_i). \quad (3)$$

As most parallel imports are premium brands, manufacturers usually have the market power to set prices. The solution to "price to market" is therefore the familiar monopolistic pricing, where a price gap increases with the purchasing power difference, the market size, and the difference in shipping and distribution costs.

$$p_1 = \frac{a_1 N + c + s_1}{2}, \; p_2 = \frac{a_2 N + c + s_2}{2}, \quad (4)$$

$$p_2 - p_1 = \frac{(a_2 - a_1)N + s_2 - s_1}{2}. \quad (5)$$

With the price disparity, some form of arbitrage will likely emerge when shipping costs plus duties and tariffs are modest. Unlike counterfeits (studied by Grossman and Shapiro 1988), parallel imports are genuine goods and buyers are not deceived. Sometimes consumers even actively seek out parallel imports from discount outlets in order to buy the "gray" version (Yoshida 1993). Nevertheless, parallel imports are usually assessed with a discount in consumer valuation. This is because of additional costs (converting Mercedes from Germany to meet the U.S. emission standard), inconvenience (reading odometers in kilometers rather than miles), or lack of warranty (many electronics are not covered by the manufacturer if sold outside the intended market areas). With this in mind, we now introduce variables and the demand and profit functions for the unauthorized channel:

p' = the retail price for parallel imports in Country 2;
Q' = the quantity demanded for parallel imports in Country 2;
w = the valuation discount factor for parallel imports, $0 < w < 1$;
s = the variable cost of shipping from Country 1 to Country 2 and selling there, including duties, tariffs, transportation, and distribution costs;
A = the quantity of arbitrage shipped from Country 1 to Country 2; and
π' = the profit of the parallel importer.

$$p' = wa_2(N - Q'), \quad \pi' = A(p' - p_1 - s), \quad 0 < w < 1. \quad (6)$$

2.2. Market Segmentation

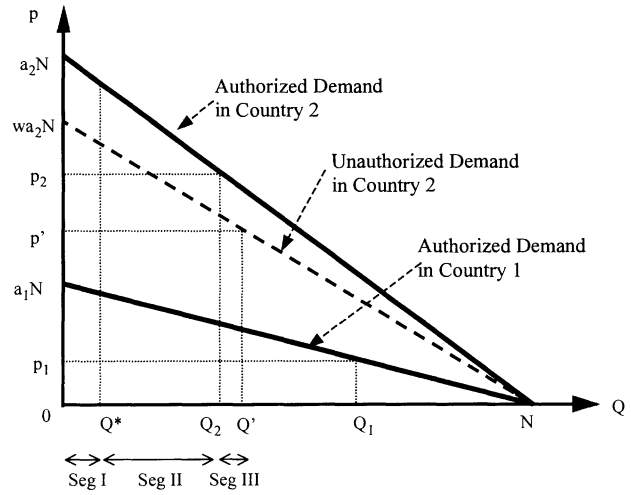
Because prices are set for authorized and unauthorized goods in Country 2, consumers will choose between the two versions. This choice was not examined in previous research (Malueg and Schwartz 1994) because parallel imports were treated as perfect substitutes sold at the same price. However, a similar choice was considered by Conner and Rumelt (1991) when they studied the software piracy problem. If we consider the linear demand curve as a lineup of consumers with different incomes and tastes, those with higher willingness to pay for the product tend to value more of the benefits associated with the authorized product (warranty, after-sales service, and ease of use). Therefore, we have assumed the valuation discount w to be the same proportion of willingness to pay. Consequently, with the two versions present, a segment of consumers will choose to stay with the authorized and another segment will switch to the lower-priced version. Furthermore, a new third segment will emerge, comprised of those who did not consider this product before, but now are willing to purchase the parallel import version. Figure 2 shows the demand curves of authorized and unauthorized sales in the two countries and depicts the three market segments in Country 2 that are caused by the entry of parallel imports.

The boundary between segments I and II is the point Q^* at which a consumer is indifferent between the two versions. It is obtained by equating the consumer surplus, measured by the difference between the willingness to pay and the price charged, between the two versions:

$$a_2(N - Q^*) - p_2 = wa_2(N - Q^*) - p'. \quad (7)$$

The quantity of parallel imports shipped should be the combined size of segments II and III, therefore A

Figure 2 Demand Curves and Three Market Segments in Country 2



$= (Q' - Q^*)$. Thus we have the following two propositions summarizing the emergence of parallel imports and the resulting market segmentation in Country 2.

PROPOSITION 1 (MARKET SEGMENTATION). *When parallel imports and authorized products co-exist in Country 2, each version's sales volume is decided by both versions' prices p' and p_2, the market size N, the purchasing power a_2 and the parallel imports value discount w:*

$$\textit{Authorized products: } Q^* = N - \frac{p_2 - p'}{(1 - w)a_2}, \tag{8}$$

$$\textit{Parallel imports: } A = \frac{wp_2 - p'}{w(1 - w)a_2}. \tag{9}$$

Unlike counterfeits fabricated by substandard imitators, parallel imports are purchased from authorized dealers in Country 1. The "parallel importer" in this model is an independent agent engaged in arbitrage, and should not be confused with the manufacturer's nonexclusive dealers in intensive or selective distributions. We assume it to be a single identity for the modeling purpose. In reality, there may be multiple parties involved in various sourcing, logistics, and marketing activities, but together they constitute a supplemental channel that sources from the manufacturer but competes with the authorized exclusive channel. The parallel importer's problem is to maximize its profit by choosing a selling price p' to offset the purchasing cost p_1 and the transshipment cost s:

$$\max_{p'} \pi' = A(p' - p_1 - s). \tag{10}$$

PROPOSITION 2 (PRICE AND QUANTITY OF PARALLEL IMPORTS). *The parallel importer will choose the price and quantity for parallel imports according to the authorized prices in both countries p_1 and p_2, the transshipment cost s, and the consumers' valuation discount w:*

$$p' = \frac{p_1 + s + wp_2}{2}, \tag{11}$$

$$A = \frac{wp_2 - p_1 - s}{2w(1 - w)a_2}. \tag{12}$$

Proposition 2 can be derived by substituting (9) into (10) and solving the optimization problem. Note parallel imports are economically attractive only if

$$wp_2 - p_1 - s > 0, \text{ or } wp_2 > p' > p_1 + s, \quad \text{which also implies } Q' > Q_2. \tag{13}$$

These two propositions stipulate how large the price gap must be imports start to emerge, and how they increase with the price gap. These relationships can help managers foresee the threat of parallel imports and contain it within a targeted limit. Next, we show the impact of parallel imports on the manufacturer's global sales and profits.

2.3. Impacts of Parallel Imports

PROPOSITION 3 (CHANGE OF SALES VOLUMES). *When parallel imports emerge at quantity A, authorized sales increase by A in Country 1, but decrease by wA in Country 2. Overall, the manufacturer's sales volume increases.*

$$\begin{cases} \Delta Q_1 = A = \dfrac{wp_2 - p_1 - s}{2w(1 - w)a_2} > 0 \\ \Delta Q_2 = \dfrac{p_1 + s - wp_2}{2(1 - w)a_2} = -wA < 0 \\ \Delta Q = \Delta Q_1 + \Delta Q_2 = (1 - w)A > 0. \end{cases} \tag{14}$$

All proofs are provided in the Appendix. From Figure 2 of the market segmentation in Country 2, it is easy to see that the authorized sales there are reduced because of competition from parallel imports, i.e., Segment II switches. Segment III is a new addition to the

total customer base for the product, hence the manufacturer's global sales volume increases. The parallel imports purchased by Segments II and III are sourced from Country 1. Hence, the authorized sales in Country 1 increase by the quantity of parallel imports.

In summary, parallel importation boosts the manufacturer's global sales volume because it provides a lower-priced option. This suggests that the manufacturer could also offer a discount version, but doing so through its authorized dealers has a high risk of confusing customers and tarnishing brand image. Parallel imports may cause similar concerns for the manufacturer, but unauthorized dealers are perceived, and rightly so, as further removed from the manufacturer, hence possessing less risk of confusing consumers.

While increasing the global sales volume, the effect of parallel imports on the manufacturer's global profit is far from clear. The manufacturer loses volume in Country 2, but gains even more volume in Country 1; however, Country 2 has a higher selling price than Country 1. Therefore, there are situations in which the manufacturer's global profit may increase or decrease, which are summarized in the following proposition.

PROPOSITION 4 (CHANGE OF PROFIT). *When parallel imports emerge at quantity A, the change in the manufacturer's global profit is*

$$\Delta\pi = A[(ws_2 - s_1) - c(1 - w) - (wp_2 - p_1)]. \quad (15)$$

The change is negative if there is a large authorized price gap, i.e.,

$$wp_2 - p_1 > (ws_2 - s_1) - (1 - w)c, \quad (16)$$

and is positive when the inequality is reversed.

The result that parallel imports may boost profit is counterintuitive. The traditional economic model of a discriminating monopolist requires the markets to be separated in some way, usually geographically. One would expect the profits from price discrimination to be threatened by parallel imports that undermine the separation. However, parallel imports effectively channel another version of the product into the higher-priced region, creating a vehicle for vertical product differentiation and price discrimination. This benefit may outweigh the loss of the price discrimination ability in otherwise separate national markets.

Examining the overall effect of parallel imports can help managers keep a global rather than local focus. These two propositions give them the means to correctly assess changes brought about by parallel imports and to align the changes with the firm's global sales or profit targets. More interestingly, it pays to proactively anticipate and manage parallel imports. We now turn to the question of how to design a global strategy by taking into account the possible occurrence of parallel imports.

3. A Stackelberg Pricing Game

Because of its flexibility and immediate effectiveness, pricing is usually the first marketing instrument to deploy. It is a particularly viable control variable here, as parallel imports are induced by large price gaps. Departing from (3) and (4) where prices are set in isolation for each market, we show that the manufacturer's pricing decision can be improved if the two markets are considered together and the potential of parallel imports is anticipated. Thus we propose a Stackelberg leader-follower game to capture the interdependence between the manufacturer's and the parallel importer's pricing decisions:

i) Stage 1: The manufacturer sets authorized prices with the possible impact of parallel imports incorporated in the objective function, where p' is a function of p_1 and p_2, and its functional form will be determined in the second stage problem.

$$\max_{p_1, p_2} \pi = (p_1 - s_1)(Q_1 + A) + (p_2 - s_2)(Q_2 - wA) - c[Q_1 + Q_2 + (1 - w)A],$$

$$\text{where } A = \max\left\{\frac{wp_2 - p'}{w(1 - w)a_2}, 0\right\}. \quad (17)$$

ii) Stage 2: The parallel importer chooses a price for parallel imports based on observing the authorized prices p_1 and p_2 as given.

$$\max_{p'} \pi' = \max\left\{(p' - p_1 - s)\left[\frac{wp_2 - p'}{w(1 - w)a_2}\right], 0\right\}. \quad (18)$$

We proceed by first solving the second-stage problem and then substituting the result into the first-stage problem. We derive the equilibria in the following two propositions.

PROPOSITION 5 (OPTIMAL PRICING: ALLOWING). *When there is a parallel importer and the demand and cost parameters satisfy the following condition:*

$$\alpha_1 a_2 N - \alpha_2[(1 - w)c + s_1 - ws_2] - \alpha_3 s > 0, \quad (19)$$

where $\alpha_1 = 2w(1 - w)(wa_2 - a_1)$, $\alpha_2 = a_1 + w(2 - w)a_2$, $\alpha_3 = a_1 + w(4 - 3w)a_2$,

i) *Parallel imports should be allowed to boost the manufacturer's overall profit:*

$$A = \frac{\alpha_1 a_2 N - \alpha_2[(1 - w)c + s_1 - ws_2] - \alpha_3 s}{4w(1 - w)a_2\alpha_2}. \quad (20)$$

ii) *The optimal authorized prices should be set jointly at:*

$$p_1 = \frac{(3w - w^2)a_1 a_2 N - a_1 s}{2\alpha_2} + \frac{c + s_1}{2},$$

$$p_2 = \frac{[(1 + w)a_1 + 2w(1 - w)a_2]a_2 N + wa_2 s}{2\alpha_2} + \frac{c + s_2}{2}. \quad (21)$$

PROPOSITION 6 (OPTIMAL PRICING: PREVENTING). *When there could be parallel imports, but the demand and cost parameters do not satisfy Condition (19), the manufacturer should preemptively prevent parallel imports by setting the authorized prices such that parallel imports are no longer profitable:*

$$p_1 = \frac{w(1 + w)a_1 a_2 N + (wa_1 + w^2 a_2)c + w^2 a_2 s_1 + wa_1 s_2 - 2a_1 s}{2(a_1 + w^2 a_2)},$$

$$p_2 = \frac{(1 + w)a_1 a_2 N + (a_1 + wa_2)c + wa_2 s_1 + a_1 s_2 + 2wa_2 s}{2(a_1 + w^2 a_2)}. \quad (22)$$

These two propositions show that either allowing or preventing parallel imports could result in an equilibrium, depending on demand and cost parameters. They have different implications for the prices, quantities, and profits in the authorized and unauthorized channels. Table 1 compares the equilibria with the benchmark case of monopolistic pricing (when parallel imports are legally prohibited).

The monopolistic pricing equilibrium of Column (1) cannot be sustained when the parallel importer is free to enter the market. Column (2) shows the new equilibrium when the effect of parallel imports is taken into account and, under some market conditions, the optimal strategy for the manufacturer is to allow parallel imports. Column (3) shows that, under other market conditions, the optimal strategy is to prevent parallel imports when the threat is real. The differences between Column (2) and Column (1) and between Column (3) and Column (1) are shown in the two subsequent columns. Because the arbitrage flow could potentially occur in the new equilibria, the price gaps in Column (2) and Column (3) are narrower than in Column (1). We can see this from Table 1 and from the following equations that p_1 moves up while p_2 moves down:

$$\Delta p_1 = a_1 \frac{(wa_2 - a_1)N - s}{2[a_1 + w(2 - w)a_2]} > 0,$$

$$\Delta p_2 = -wa_2 \frac{(wa_2 - a_1)N - s}{2[a_1 + w(2 - w)a_2]} < 0. \quad (23)$$

Nevertheless, the new equilibrium price gap is still wider than the transshipment cost, which is sometimes used as the ad hoc arbitrage preventing price gap:

$$p_2 - p_1 = (wp_2 - p_1) - wp_2 + p_2 \geq s + (1 - w)p_2 > s > 0. \quad (24)$$

Column [(2) − (1)] summarizes the comparison between the equilibrium of allowing parallel imports and the benchmark case: Parallel imports, when permitted, will increase authorized sales quantity in Country 1, decrease that in Country 2, boost overall quantity, and may or may not boost overall profit. Column [(3) − (1)] shows the consequences of preventing parallel imports by pricing. Raising the authorized price in Country 1 will decrease the quantity there, lowering the price in Country 2 will increase the quantity there, and setting a price gap narrower than the monopolistic case in Column (1) will reduce the overall quantity and hurt the overall profit. These quantitative results all reinforce the qualitative observations made by Simon and Kucher (1992): "a uniform price discourages parallel imports but is not optimal. . . . It is better to tolerate a certain amount of parallel imports than to prevent them completely. It is just as foolish to defend the large, traditional price differences. . . ," and by

Table 1 Equilibria of Allowing or Preventing Compared with Benchmark Case

		When parallel imports could occur . . .		Difference from (1)	
	Benchmark: Monopolistic (1)	Allow parallel imports: (2)	Prevent parallel imports: (3)	Allow: (2) − (1)	Prevent: (3) − (1)
Authorized price in Country 1	$\frac{a_1N + c + s_1}{2}$	p_1 in (21)	p_1 in (22)	+	+
Authorized price in Country 2	$\frac{a_2N + c + s_2}{2}$	P_2 in (21)	P_2 in (22)	−	−
Authorized price gap $p_2 - p_1$	$\frac{(a_2 - a_1)N + s_2 - s_1}{2}$	$\frac{s_2 - s_1}{2} + \frac{1 - w}{2\alpha_2}$ $[(1 - w)a_1 + 2wa_2]$	$\frac{a_1 + wa_2}{a_1 + w^2a_2} s + \frac{1 - w}{2(a_1 + w^2a_2)}$ $[(1 + w)a_1a_2N + (a_1 + wa_2)c + wa_2s_1 + a_1s_2]$	−	−
Parallel imports quantity	0	A in (20)	0	+	0
Authorized quantity in Country 1	$q_1^{(1)} = \frac{a_1N - c - s_1}{2a_1}$	$q_1^{(2)} = N - \frac{p_1}{a_1}$	$q_1^{(3)} = N - \frac{p_1}{a_1}$	+	−
Authorized quantity in Country 2	$q_2^{(1)} = \frac{a_2N - c - s_2}{2a_2}$	$q_2^{(2)} = N - \frac{p_2}{a_2}$	$q_2^{(3)} = N - \frac{p_2}{a_2}$	−	+
Manufacturer's global quantity	$q_1^{(1)} + q_2^{(1)}$	$q_1^{(2)} + q_2^{(2)}$	$q_1^{(3)} + q_2^{(3)}$	+	−
Manufacturer's global profit	$a_1(q_1^{(1)})^2 + a_2(q_2^{(1)})^2$	$q_1^{(2)}(p_1^{(2)} - c - s_1) + q_2^{(2)}(p_2^{(2)} - c - s_2)$	$q_1^{(3)}(p_1^{(3)} - c - s_1) + q_2^{(3)}(p_2^{(3)} - c - s_2)$	+/−	−

Gerstner and Holthausen (1986): ". . . price differentiation can be profitable, even in the face of high leakage rates."

Having presented the basic three-stage model (the Stage 3 market segmentation problem in § 2 and the Stages 1 and 2 Stackelberg pricing game in § 3), we now turn to discuss a couple of model extensions, to generate a set of testable hypotheses, and to offer some managerial implications.

4. Extensions, Hypotheses, and Managerial Implications

4.1. Extension 1: Multiple Parallel Importers

Manufacturers in real-world parallel import problems usually have the market power to set prices for their premium brands. The parallel importers, on the other hand, have relatively lower entry costs and often move very fast to enter or exit the market. Therefore, they are usually subject to more market competition. Recent developments in communication, information, and transportation technologies have further lowered search and transshipment costs. For example, Internet "bots" can automatically search for price differences world-wide and in real time. There is better shipping and delivery access, responsiveness, and efficiency in catalogue and on-line sales thanks to a much improved global logistics infrastructure. As a result, we see more incidents of parallel importation and increasing competition. Different degrees of competition can be captured in oligopolistic and perfect competition models. We hence extend the basic Stackelberg model to examine the more realistic case of multiple competing parallel importers.

4.1.1. Oligopolistic Competition among Parallel Importers. We start with the assumption that the au-

thorized and unauthorized goods are differentiated; however, parallel imports are identical regardless of who transships the product (a reasonable assumption given the model setting of only two countries and all parallel importers buy from the authorized dealer in Country 1). Because the activity is competitive, if one importer decides to flood the market with too many parallel imports, it will cause a price fall for all parallel imports. Suppose there are n identical parallel importers, then an individual parallel importer's problem can be modeled as:

$$\max_{Q_i} \pi_i = Q_i(p' - p_1 - s),$$

where

$$Q_i + Q_{-i} = Q' - Q^* = \frac{wp_2 - p'}{w(1 - w)a_2}, \quad (25)$$

where Q_i is the individual parallel importer i's quantity and Q_{-i} is the combined quantity of all other parallel importers. We can first treat Q_{-i} as a constant since it is not the choice of the ith importer, and later replace it with $(n - 1)Q_i$ because all importers are identical. Therefore, we arrive at the Cournot equilibrium of the total quantity and the price for parallel imports. We can re-solve the Stackelberg game now with n parallel importers and obtain the following proposition.

Proposition 7 (Oligopolistic Competing Parallel Importers). *When multiple parallel importers compete with each other,*

i) the authorized price gap narrows with a larger number of parallel importers:

$$p_1 = \frac{[(2n + 1)w - w^2]a_1a_2N - na_1s}{2[na_1 + w(n + 1 - w)a_2]} + \frac{c + s_1}{2},$$

$$p_2 = \frac{[n(1 + w)a_1 + (n + 1)w(1 - w)a_2]a_2N + nwa_2s}{2[na_1 + w(n + 1 - w)a_2]} + \frac{c + s_2}{2}, \quad (25)$$

ii) *but the total quantity of parallel imports may increase or decrease with more parallel importers involved, and the price may rise or fall:*

$$A = nQ_i = \left(\frac{n}{n + 1}\right)\frac{wp_2 - p_1 - s}{w(1 - w)a_2}, \quad (27)$$

$$p' = \frac{wp_2 + np_1 + ns}{n + 1}. \quad (28)$$

The uncertainty about the total quantity and price of parallel imports could be understood from the fact that parallel importers compete with each other while competing together with the manufacturer. The Cournot competition among themselves lowers price and expands quantity when n increases, as expressed with the term $(n/n + 1)$ in (27). On the other hand, their competition against the manufacturer intensifies when n increases, forcing the manufacturer to narrow the authorized price gap, as expressed with the $[wp_2 - p_1 - s/w(1 - w)a_2]$ term in (27). The net effect of the two opposing forces determines whether the total quantity of parallel imports increases or decreases. Note that the case of single parallel importer in §3 is a special case of the model here: When $n = 1$, the results in Proposition 7 reduce to those results in Propositions 2 and 5.

4.1.2. Perfect Competition Among Parallel Importers. If the competition among parallel importers is close to the level of perfect competition, they will price according to their marginal cost, i.e., $p' = p_1 + s$. This is the limiting case of the Cournot competition when the number of parallel importers is very large. It is also the equilibrium price if there is a Bertrand competition among identical parallel importers, i.e., if they compete on price rather than quantity. Taking $n \to \infty$ in (26) ~ (28), we obtain the following proposition.

Proposition 8 (Perfect Competition Among Parallel Importers). *When the competition among parallel importers is perfect, at the equilibrium,*

i) the authorized prices should be set as:

$$p_1 = \frac{2wa_1a_2N - a_1s}{2(a_1 + wa_2)} + \frac{c + s_1}{2},$$

$$p_2 = \frac{[(1 + w)a_1 + w(1 - w)a_2]a_2N + wa_2s}{2(a_1 + wa_2)} + \frac{c + s_2}{2}. \quad (29)$$

ii) *The quantity and price of parallel imports will be:*

$$A = \frac{wp_2 - p_1 - s}{w(1 - w)a_2}, \quad p' = p_1 + s. \tag{30}$$

The following numerical example illustrates the effect of different degrees of competition among parallel importers on the manufacturer's authorized price gap. In Figure 3, the price gap narrows as we move from case A with no parallel importers ($n = 0$), to case B with a single parallel importer ($n = 1$), to case C of oligopolistic competition with three parallel importers ($n = 3$), and to case D with perfect competition among parallel importers ($n = \infty$). The parameters used are $N = 100, a_1 = 1, a_2 = 2, c = 5, s_1 = 1, s_2 = 3, s = 2$, and $w = 0.8$. The shipping costs obey the general triangular inequality that $s_1 + s \geq s_2$.

So far we have only studied pricing strategies for the manufacturer. As parallel imports are induced by price gaps, their emergence naturally forces the manufacturer to reset prices. However, there exist other effective instruments for the manufacturer to proactively manage parallel imports. We now turn to discuss the possibility of combining nonpricing controls over parallel imports with the pricing strategies.

4.2. Extension 2: Nonpricing Controls on Parallel Imports

Manufacturers in the real world often deploy the various nonpricing mechanisms at their disposal to mitigate the parallel import problem. They can be summarized into three main categories:

1. *Monitoring.* In industries like automobiles, electronics, and computers, manufacturers can usually monitor their dealers' sales through product registration. A serial number on each unit is associated with the original destination and dealership. It would be detected if a diverted unit were registered. An authorized distributor who is caught leaking into the parallel import channel could be severely penalized, or even terminated by the manufacturer.

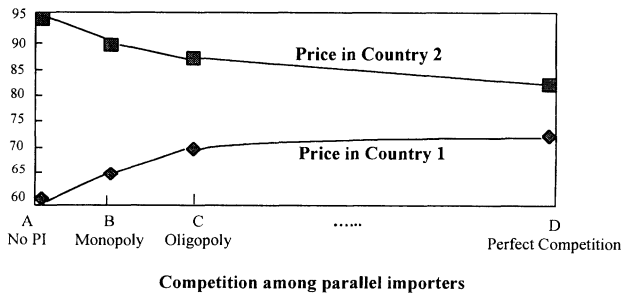
2. *Differentiating products.* Manufacturers can offer distinct product versions to different markets (see an empirical study on "Branded Variants" in Bergen et al. 1996). Some differences like packaging (e.g., size, language of instruction) are minor nuances. Some major differences in product features (e.g., sweetness in drinks) or standards (e.g., power supply) could force buyers of parallel imports to incur high conversion costs and make the substitution of parallel imports less perfect or even impossible. If a version introduced in Country 1 and another version in Country 2 are intentionally designed to be distinct or incompatible, then the Version 1 product diverted to Country 2 is easier to spot and less desirable to consumers in Country 2.

3. *Differentiating services.* Even with identical products, manufacturers can bundle value-added services (e.g., technical support, maintenance, and warranty) only to authorized goods and refuse to service those bought from the unauthorized channel. This built-in service differentiation will also increase the life-cycle cost of parallel imports and make them less desirable.

Each of these mechanisms could be interesting by itself and has the potential to shed light on important issues in manufacturer-dealer relationships, consumer purchases and return decisions, and product design and positioning in the new context of parallel imports. Here, we offer only an initial attempt to extend the basic model to allow the manufacturer to simultaneously use pricing and nonpricing controls. There is a trade-off between them, as each nonpricing control has a cost to implement, but pricing itself has its cost as profits are sacrificed when the price gap narrows.

When the manufacturer simultaneously uses pricing and nonpricing controls to mitigate parallel imports, we use a stylized variable $q \in [0,1]$ to represent the combined effectiveness of nonpricing controls. $q = 1$ represents the highest effectiveness in which parallel imports are completely eliminated by the nonpricing

Figure 3 **Competition Among Parallel Importers Narrows Authorized Price Gap**



controls. $q = 0$ represents no effectiveness at all of nonpricing controls, in which parallel imports are only affected by price differentials. We further specify the cost of implementing the nonpricing controls as a stylized quadratic function $(m/2)q^2$. This means it is increasingly costly to achieve higher control effectiveness. The manufacturer's new profit maximization problem when simultaneously using pricing and nonpricing controls is:

$$\max_{p_1 p_2, q} E\pi = (1 - q)\pi_{\text{with parallel imports}} + q\pi_{\text{without parallel imports}} - \frac{m}{2} q^2, \quad (31)$$

where the profit function with parallel imports completely eliminated comes from (3), and the profit function with unaffected parallel imports comes from (17). We can thus re-solve the Stackelberg game with the new objective function and obtain the following proposition.

PROPOSITION 9 (COMBINING PRICING AND NONPRICING CONTROLS). *When the manufacturer has other means to contain parallel imports at a cost,*

i) *the nonpricing controls should achieve the following optimal effectiveness:*

$$q = \frac{wp_2 - p_1 - s}{2w(1 - w)a_2 m} [(1 - w)c + (wp_2 - p_1) - (ws_2 - s_1)]. \quad (32)$$

ii) *The corresponding authorized prices could be reset with a wider gap:*

$$p_1 = \frac{[(3 - q)w - (1 + q)w^2]a_1 a_2 N - (1 - q)a_1 s}{2\{(1 - q)a_1 + w[2 - (1 + q)w)]a_2\}} + \frac{c + s_1}{2},$$

$$p_2 = \frac{[(1 - q)(1 + w)a_1 + 2w(1 - w)a_2]a_2 N + (1 - q)wa_2 s}{2\{(1 - q)a_1 + w[2 - (1 + q)w)]a_2\}} + \frac{c + s_2}{2}. \quad (33)$$

iii) *The more effective nonpricing controls, the wider the price gap that the manufacturer can sustain:*

$$dp_1/dq < 0, \; dp_2/dq > 0. \quad (34)$$

This proposition shows the substitution effect between pricing and nonpricing controls in mitigating parallel imports. These results should lend themselves to empirical testing and practical applications. We now turn to a discussion of testable hypotheses with managerial implications.

4.3. Hypotheses and Managerial Implications

The nine propositions that have been derived could be subject to empirical tests if we could observe unauthorized sales in the global market. However, the secret nature of channel leakage on the dealer's side and the manufacturer's reluctance to disclose the problem for fear of tarnishing brand image are both understandable. It is therefore difficult to collect data on the actions and counteractions of the parties involved and test the underlying dynamics suggested in this article. Nevertheless, we can reasonably assume that the authorized sales quantities are observable to the manufacturer before and after incurring parallel imports, as well as any pricing and nonpricing decisions. Therefore, we can suggest a set of hypotheses by relying only on the variables that are more readily observable.

HYPOTHESIS 1. *The manufacturer's global sales quantity expands with the emergence of parallel imports (when authorized price differential exceeds transshipment cost s) and* $dQ/dA > 0$.

This is a direct result of the market segmentation model (Proposition 3). If accepted, it demonstrates the strategic value of parallel imports as a means to expand the manufacturer's global reach and increase total sales volume.

HYPOTHESIS 2. *When parallel imports are feasible, the manufacturer readjusts authorized prices to narrow down cross-country gaps and* $d\Delta p/dA < 0$.

This is a result of the Stackelberg game model (Propositions 5 and 6). The event study methodology could be useful here to test this hypothesis when there is a removal of trade barriers such as the formation of EU, the passage of NAFTA, and an entry to WTO, or when there is a technology breakthrough to search and redirect products such as on-line auctions. If accepted, the hypothesis suggests that a manager should refrain from charging a price that is optimal only to the local

market, as if isolated from other markets. The best strategy is to preemptively prevent parallel imports, or purposefully allow them to exist to some extent after carefully evaluating demand and cost parameters.

HYPOTHESIS 3. *As more players enter parallel importation, the authorized price gap further narrows as competition among parallel importers intensifies, i.e.,* $d\Delta p/dn < 0$.

This results from Extension 1 of the model (§ 4.1). If accepted, it warns a manager of the diminishing pricing power in a global market that could be linked by possible parallel import flows. This is more relevant now as fast and efficient communication and transportation methods are bringing down traditional barriers that have protected local markets.

HYPOTHESIS 4. *If other nonpricing controls are effective, the manufacturer can afford to sustain a wider authorized price gap, i.e.,* $d\Delta p/dq > 0$.

These assertions are derived from Extension 2 of the model (Proposition 9). It can apply to such effective measures as lobbying for legal protection, monitoring dealer leakage, designing market-specific products, and restricting manufacturer warranty. If accepted, this provides a manager with a portfolio of product, service, and policy instruments to preserve the pricing power while still mitigating possible parallel imports. Which instrument is more effective and efficient depends on the idiosyncrasy of each situation.

5. Conclusions

In a world with disappearing country barriers, it is of increasing strategic importance for companies to carefully monitor and manage any intermarket flows, even in the elusive unauthorized channels. We have analyzed the effects of parallel imports on a global supply chain with one manufacturer selling in two geographically separated markets (countries). To focus on the manufacturer's perspective, we have assumed that the manufacturer sells through the authorized channel over which it can control prices to maximize global supply chain profits. In the absence of parallel imports, the manufacturer can act like a price-discriminating monopolist because the two markets are separate. However, when the price gap between the two countries is wide enough, parallel importation becomes a profitable activity, and the need arises for the manufacturer to revise its pricing and distribution strategies accordingly.

Parallel imports can be detrimental to the manufacturer as they take away some authorized sales in the higher-priced country, but they also create a new product version that gives consumers more choices and the manufacturer a new way to segment the market and price discriminate. We propose a two-country, three-stage model to quantitatively study the effects and strategies. In the third stage and in the higher priced country where parallel imports have entered, we characterize the resulting market segmentation. One segment of consumers stays with the authorized version because they place more value on the warranty and services the come with the authorized version. Another segment switches to parallel imports because a lower price is offered, due to its lack of country-specific features or warranties. Further generated by parallel imports is the third and new segment that would not buy this product before. Unlike counterfeits that are fabricated by imitators, all parallel imports are genuine and sourced from the manufacturer in the lower-priced country through authorized dealers. Therefore, the manufacturer's global sales quantity should increase, but profit may rise or fall depending on the relative sizes and profitability of the segments. A profit-maximizing parallel importer should set price and quantity in the second stage after observing the manufacturer's prices in both countries. There will be a threshold of across-country price gap above which parallel imports would occur. In the first stage, the manufacturer can anticipate the possible occurrence of parallel imports, its price and quantity, and its effect on authorized sales in each country to make a coordinated pricing decision in order to maximize the global supply chain profit. We find that under some circumstances the manufacturer should allow parallel imports, and under others should prevent them. Through a Stackelberg game we solve for the optimal pricing strategy in each scenario.

We then find in one extension that when the number of parallel importers increases, the optimal authorized price gap should narrow, but the price and quantity of parallel imports may rise or fall. The oligopolistic competition case reduces to perfect competition when the

number of parallel importers goes up to infinity; when the number is one, it reduces to the basic Stackelberg model. In another extension, we find that when the manufacturer has other means—such as monitoring dealers, differentiating designs, and unbundling warranties—to contain parallel imports, the authorized price gap can widen as a function of the effectiveness of nonpricing controls. The hybrid pricing and nonpricing model reduces to the benchmark monopolistic manufacturer case when nonpricing controls effectively prevent parallel imports; when the effectiveness is negligible, it also reduces to the basic model.

The model here did not consider several potentially interesting issues. For instance, the manufacturer could, with careful design, use alternative channel mechanisms to achieve similar price discrimination effects (such as distributing a premium and a generic brand, setting up catalogue or on-line store operations). One effect not included in this model is the parallel imports' erosion on the brand equity. Our results rely on the assumption of unauthorized goods being an inferior product version. There is a potential for the manufacturer to exploit this difference by changing w as a variable (how different the two versions are). Another direction for further research is to examine the authorized dealer's incentive about whether and how much of the product to carry, and its contractual relationship with the manufacturer. The current two-country model can be extended to a multiple-country network design problem. It is also important to collect data and test the impact of parallel imports and gray markets on manufacturers' global strategies in many important areas of global pricing, product design, channel conflict, and partnership management.[3]

Appendix

Proof of Proposition 3. It is straightforward to see that the change in authorized sales in Country 1 is equal to the quantity of parallel imports, because the parallel importer has to purchase from the authorized dealer in Country 1. To get the change in Country 2, substitute (8) and (11) into the following. Add ΔQ_1 and ΔQ_2 to get the total change. □

$$\Delta Q_2 = Q^* - Q_2 = \left[N - \frac{p_2 - p'}{(1 - w)a_2}\right] - \left[N - \frac{p_2}{a_2}\right]$$

$$= \frac{p' - wp_2}{(1 - w)a_2} = \frac{p_1 + s - wp_2}{2(1 - w)a_2} = -wA. \quad \square \qquad \text{(A.1)}$$

Proof of Proposition 4. The change of profit reflects the change of revenues, the change of production cost, and the change of distribution cost:

$$\Delta\pi = p_1\Delta Q_1 + p_2\Delta Q_2 - c\Delta Q - s_1\Delta Q_1 - s_2\Delta Q_2. \qquad \text{(A.2)}$$

Substitute (14) into (A.2) and reorganize the terms into three groups:

$$\Delta\pi = \underbrace{(p_1 - p_2)wA}_{-} + \underbrace{(p_1 - c)(1 - w)A}_{+} + \underbrace{(ws_2 - s_1)A}_{?}, \qquad \text{(A.3)}$$

$$\frac{\partial\Delta\pi}{\partial A} = -(1 - w)c + (p_1 - wp_2) + (ws_2 - s_1). \qquad \text{(A.4)}$$

A closer look shows that the first item in the right-hand side is negative. The second item is also negative because, according to (12), a positive quantity of parallel imports requires $wp_2 > p_1 + s > p_1$, but the third item's sign is unclear. □

Proof of Proposition 5. Solve the first-order condition for the second-stage problem and substitute the result:

$$p' = \frac{p_1 + s + wp_2}{2} \qquad \text{(11)}$$

into the first stage problem. Suppose $wp_2 - p_1 - s > 0$, then

$$A = \frac{wp_2 - p_1 - s}{2w(1 - w)a_2}. \qquad \text{(12)}$$

$$\frac{\partial Q_1}{\partial p_1} = -\frac{1}{a_1}, \frac{\partial Q_2}{\partial p_2} = -\frac{1}{a_2}, \frac{\partial A}{\partial p_1} = -\frac{1}{2w(1 - w)a_2},$$

$$\frac{\partial A}{\partial p_2} = \frac{1}{2(1 - w)a_2}. \qquad \text{(A.5)}$$

Substitute into the first-order conditions:

$$\frac{\partial\pi}{\partial p_1} = Q_1 + A + (p_1 - s_1)\left(\frac{\partial Q_1}{\partial p_1} + \frac{\partial A}{\partial p_1}\right) + (p_2 - s_2)\left(-w\frac{\partial A}{\partial p_1}\right) - c\left[\frac{\partial Q_1}{\partial p_1} + (1 - w)\frac{\partial A}{\partial p_1}\right] = 0, \qquad \text{(A.6)}$$

$$\frac{\partial\pi}{\partial p_2} = Q_2 - wA + (p_2 - s_2)\left(\frac{\partial Q_2}{\partial p_2} - w\frac{\partial A}{\partial p_2}\right) + (p_1 - s_1)\left(\frac{\partial A}{\partial p_2}\right) - c\left[\frac{\partial Q_2}{\partial p_2} + (1 - w)\frac{\partial A}{\partial p_2}\right] = 0. \qquad \text{(A.7)}$$

Multiply (A.7) by $2(1 - w)a_2$ to get:

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$$2p_1 - 2(2 - w)p_2 + 2(1 - w)a_2N + (1 - w)c + s - s_1 + (2 - w)s_2 = 0. \quad \text{(A.8)}$$

Add (A.6) multiplied by wa_1a_2 and (A.7) multiplied by a_1a_2 to get:

$$-2wa_2p_1 - 2a_1p_2 + (1 + w)a_1a_2N + (a_1 + wa_2)c + wa_2s_1 + a_1s_2 = 0. \quad \text{(A.9)}$$

Substitute (A.8) into (A.9) to obtain p_2 in (21), and substitute p_2 into (A.8) to obtain p_1 in (21). Substitute (21) into (12), and Condition (19) follows. Substitute (21) into (12), and Result (20) follows. □

Proof of Proposition 6. Suppose $wp_2 - p_1 - s \leq 0$, then $A = 0$. Because the manufacturer's profit increases monotonically with the price differential, the manufacturer can set $wp_2 - p_1 - s = 0$ to prevent arbitrage and maximize profit at the same time. Now the manufacturer's problem is

$$\max_{p_1, p_2} \pi = (p_1 - s_1)Q_1 + (p_2 - s_2)Q_2 - c(Q_1 + Q_2)$$
$$\text{s.t. } wp_2 - p_1 - s = 0. \quad \text{(A.10)}$$

The solution method of this optimization problem is similar to that in the proof of Proposition 5. □

Proof of Proposition 7. Ignored. Similar to the proof of Proposition 5. □

Proof of Proposition 8. Ignored. Similar to the proof of Proposition 5.

Proof of Proposition 9. The first-order condition of (31) with respect to q is:

$$\frac{\partial E\pi}{\partial q} = -\pi_{\text{with parallel imports}} + \pi_{\text{without parallel imports}} - mq = -\Delta\pi - mq = 0, \quad \text{(A.11)}$$

$$1 - q = 1 - \frac{A}{m}[(1 - w)c + (wp_2 - p_1) - (ws_2 - s_1)]. \quad \text{(A.12)}$$

Substitute (12) into (A.12) to get (32). The steps to obtain (33) are similar to those in the proof of Proposition 5. □

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