Drop-shipping Contract

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Abstract of thesis entitled:

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This paper studies how dropshipping affects a supply chain by using a game-theoretic approach. In a dental x-ray equipment industry antitrust case, the dropshipper that provided a limited amount of services triggered a chain of reactions from the manufacturer and its other dealers. The manufacturer first allowed the dropshipper to operate as its dealer, then unilaterally terminated the dropshipper after receiving complaints from other dealers. This paper aims to give an economic explanation of the manufacturer's actions. A sequential game model is set up to analyze the situation. The model shows that the manufacturer prefers adding the dropshipper even though it will hurt an existing dealer. However, the manufacturer prefers the dealer over the drop-shipper when facing an "either-or" situation.

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摘要

本論文採用博弈論方法研究直運對供應鏈的影響。在牙科射線設備行業的反競爭法案件中，提供有限服務的直運商引發了製造商和其傳統經銷商之間的一連串事件。製造商先是允許直運商作為其經銷商之一，然後在收到其他傳統經銷商的投訴後單方面終止與直運商的合作。本文旨在為製造商的行為提供一個經濟學解釋，並建立了一個序列博弈模型來分析該情況。本文的模型可以證明製造商偏向於加入直運商，即使這會損害現有的經銷商。但是，當面對「二選其一」的情況時，製造商偏向於選用傳統經銷商而非直運商。

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CONTENTS

1 INTRODUCTION

How does adding a dropshipper affect a supply chain? This question is motivated by an antitrust lawsuit concerning a change of sales practice by a dealer.

In the dental x-ray anti-trust case, *"Hayden v Siemens 1987"* [1], a change of ownership of Siemens's authorized dealer, Hayden, led to a change of its sales practice from being a full-service dealer to focusing on mail-order and dropship practices with minimum services. Siemens appeared to approve the change in practice by dropshipping its dental x-ray equipment to some of Hayden's customers (dentists).

The dental x-ray equipment was sold to the dentists through the dealers. It seems to make sense to say that dealers' services were important. According to the case, services included "showrooms to present and demonstrate the equipment, sales personnel trained in its operation, and service personnel capable of assembling, installing, calibrating and servicing the equipment."

In sharp contrast, if mail-order catalogs were used as the sales channel and products were dropshipped directly by Siemens, it required "no sales force, service staff or showroom." Mail-order catalogs had pictures and descriptions of the equipment. Only a toll-free phone number was available for further information and assistance to the catalogs' readers. While dentists required assemble, install, calibrate or service of the X-ray equipment, the mail-order sales practice only provided dentists with the names of those local independent service organizations that offered these services. In other words, full-service dealers would save dentists a lot of hassles, while a dropshipper with its minimum service requires the dentists to obtain services elsewhere.

While the changed sales practice of Hayden remained for a period of time, eventually Siemens unilaterally terminated Hayden. A key allegation was that Siemens terminated Hayden because of complaints by other full-service dealers, an allegation Siemens denied.

This paper offers to explain some facts of the case. I build a model that allows me to examine the decision to add a dropshipper in a supply chain that can be profitable to a manufacturer but hurt the existing full-service dealer. I then use the model to examine the manufacturer's incentives to terminate the dropshipper when it is confronted by an "either-or" situation, i.e., either use the full-service dealer only, or the dropshipper only. The model assumes that it is prohibitively costly for the dropshipper to provide the kinds of services that the full-service dealer can provide. Another important assumption is that

[1] HL Hayden Co. of NY v. Siemens Medical Systems, 672 F. Supp. 724 - Dist. Court, SD New York 1987

the manufacturer can only charge a single per-unit wholesale price to its dealers. Therefore, non-linear pricing and price discrimination are assumed away.

Specifically, the model modifies that of Winter (1993). Consumers are characterized by a Hotelling location and a time cost. They can only buy from a dealer but not directly from the manufacturer. On a Hotelling line, there are only two dealer locations: the west-end (s=0) and the east-end (s=1). A dealer capable of providing services that save consumers' time, referred to as the full-service dealer, is already located on the west-end. While the east-end is initially unoccupied, the manufacturer is given a choice of including a dropshipper there. If added, the dropshipper cannot offer any services to consumers. Adding the dropshipper introduces price competition, potentially affecting the price and service level offered by the full-service dealer. To induce the pair of prices charged by the dropshipper and the full-service dealer as well as the service level of the full-service dealer, the only instrument the manufacturer can rely on is its wholesale price.

I compare the profit levels of both the manufacturer and the full-service dealer of adding and not including a dropshipper.

I then use the model to examine if given a choice of the drop-shipper only or the full-service dealer only, the manufacturer would prefer the full-service dealer.

Next section reviews the past literature and some antitrust cases. Section 3 sets up the model. Section 4 offers some analytical steps to solving the equilibrium of the model by showing some equilibrium properties. Section 5 offers a numerical solution to the model. I offer some concluding remarks in the last section.

2 RELATED LITERATURE AND CASES

2.1 Dropshipping

Dropshipping is a supply chain arrangement and retail fulfillment method. A dropshipping store does not keep the products it sells in stock. Instead, it transfers the customer's order to the manufacturer, who directly ships the goods to the customer (Shi et al. (2020)). There are some unique characteristics to the dropshipping arrangement. Khouja (2001) points out the dropshipping dealers can save the holding costs of the inventories, include storage, insurance, taxes, and obsolescence cost. On the other hand, dropshipping also lengthens the delivery time (Khouja (2001)). The inventory ownership and stocking decision rights are different from the traditional arrangement (See Table 1). There is a risk-pooling effect, where

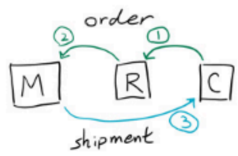
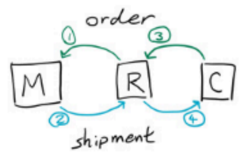
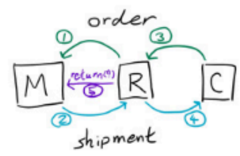
	Drop-shipping	**Traditional**	**Consignment**
Order/ shipment Flow			
Pre-sale Product Ownership	Manufacturer	Retailer	Manufacturer
Payment	After Deal	Before Deal	After Deal

Table 1. Comparison of Supply Chain Arrangement Methods

the dealer's inventory risks are transferred to the manufacturer or wholesaler (Netessine and Rudi (2006)). Dropshippers often spend more time on marketing (Shi et al. (2020)) and customer acquisition (Gan et al. (2010)). Another characteristic, which this paper focuses on, is that the dropshipping dealers usually provide a limited amount of services. Section 2.2 discusses more on this characteristic by discussing the antitrust lawsuit, *"Hayden v Siemens 1987"*. Appendix A briefly discusses three other legal cases concerning dropshipping.

Dropshipping differs from the traditional supply chain arrangement and consignment at least in the shipment flow, the ordering sequence, the inventory ownership, and the payment timing. Table 1 shows the detailed differences. Dropshipping has a unique shipment flow where the manufacturer (M) directly ships the product to the consumer (C) without passing through the retailer or dealer (R). Therefore, it is possible for the dealers not to have touched and seen a product they sell at all.

2.2 *Hayden v Siemens 1987*

While the dropshipping method has been used since the 80s as revealed by the *"Hayden v Siemens 1987"* antitrust lawsuit, a change of the ownership of Siemens's authorized dealer, Hayden, led to a change of its sales practice from being a full-service dealer to focusing on mail-order and drop-ship practices with minimum services. This section summarizes some key facts in this lawsuit, where some other drop-shipping related lawsuits are stated in the Appendix.

Siemens was a manufacturer who produced high-end dental x-ray equipment. Siemens marketed and sold its products through the "authorized full-service dealers" network. Full-service dealers are dealers who offer consumers a full range of services, including "assembling, installing, calibrating and maintaining dental x-ray equipment, maintaining personal contact with dentists, and educating dentists about the equipment and its value".

Hayden was also a full-service dealer for Siemens, providing a full range of services, operating and serving the metropolitan New York area. After Marvin Schein ("Schein") takeover Hayden in 1980, he then started Schein D.E. The new company, Schein D.E., sold the discounted dental equipment by mail order operation nationally, which also operating outside New York. Since then, Hayden and Schein D.E. change its sales practice from being a full-service dealer to focusing on mail-order and drop-ship practices with minimum services.

Although Schein D.E., as a mail-order house, had no "sales force, service staff, or showroom" and did not "assemble, install, calibrate or service the equipment it sells", it offered a toll-free phone number for further information and assistance to the catalogs' readers. While dentists require assemble, install, calibrate or service of the X-ray equipment, the mail-ordering practice was to provide dentists with the names of those local independent service organizations that offered these services. Due to cutting costs by providing fewer services, Schein D.E. was able to provide discounted rates to its customers. The prices of Siemens's products sold by Schein D.E. were 20-25% less than the full-service dealers.

Although Siemens required its dealers to provide a full range of services, Siemens either allowed its products to include in Schein D.E.'s catalog or, cooperated with Schein D.E after noticing its inclusion. Siemens's warehouse would drop-ship its products directly to Schein D.E.'s customers, who were not at the New York area that Hayden covered.

Siemens then received dealers' complaints in 1982 and 1983 as the full-service dealers' sales had lost to the drop-shipper. On August 30, 1983, Siemens sent an "Authorized Dealership Agreement", which specifying what services Siemens considered essential, to every dealer including Hayden. All Siemens dealers signed the agreement except Hayden. By late November, Siemens had terminated Hayden as its dealer.

The following lists some facts from the case:

1) The manufacturer (Siemens) had its full-service dealers in different regions;
2) Hayden (& Schein D.E.) changed from a full-service dealer to a mail-order dropshipper;
3) The dropshipper (Schein D.E.) offered a limited amount of services and provide a 20-25% discount to consumers;

4) The dropshipper (Schein D.E.) operated outside its authorized region (New York) and competed with other full-service dealers in other regions;

5) The manufacturer (Siemens) allowed the dropshipper (Schein D.E.) to operate, by drop-shipping the products directly to dropshipper's consumers;

6) The full-service dealers lost sales to drop-shipper and complained to the manufacturer (Siemens);

7) The manufacturer (Siemens) then terminated the dropshipper (Schein D.E.) as its dealer.

Siemens changed from allowing the existence of the dropshipper to terminating the drop-shipper after Siemens received the complaints. Can economics explain the change? Although causation cannot be drawn from the evidence in the case, I use a model to explain the possible rationale and incentives behind Siemens's actions.

2.3 Literature Review

This section reviews some literature that study and research on dropshipping with economic models. Khouja (2001) studies a model to identify the optimal mix of drop-shipping and in-house inventory. Netessine and Rudi (2006) study the wholesaler's decision between the traditional, drop-shipping, and dual-channel based on the transportation cost difference and the net drop-shipping markup.

Yao et al. (2008) develop a Stackelberg game with drop-shipping e-tailers to study how to improve the delivery quality by information sharing. They show that the e-tailers are able to incentivize suppliers to improve the quality of delivery by a suitable profit-sharing contract. Gan et al. (2010) consider the asymmetric information case in which only the retailer knows the realized demand, and propose a commitment-penalty contract that gives incentive retailer to share the information.

Zhang (1712) analyzes the characteristics and the upside of the dropshipping model with a wholesale price contract and contrasts it with the traditional model based on inventory risk. Ma et al. (2017) formulate a newsvendor model with different return rates and study the optimal expected profits of the mix of drop-shipping and inventory-holding. Peinkofer et al. (2019) investigate the operational challenges that drop-shipping suppliers faced by adopting a qualitative research methodology.

Shi et al. (2020) study vertical and horizontal competition between a manufacturer, an online drop-shipping retailer, and a physical retailer under considering different decision sequences in the supply chain. They consider a demand function with heterogeneous consumers' reservation price and product's matching probability for online purchasing. Their result suggests that the manufacturer would decide the mode by different matching probability and travel cost to the physical store.

The previous studies focus on the inventory and logistic factors with exogenous, random demand functions (Khouja, 2001; Yao et al., 2008; Gan et al., 2010; Lu, 2017; Ma et al., 2017). In this paper, I adopt Winter's (1993) model as the demand functions, which takes into account the different levels of services provided by the retailer and dropshipper.

3 MODEL

Consider a sequential game including the following players:

1) A manufacturer M;

2) Two retailers: a full-service dealer R and a dropshipper D;

3) N consumers (indexed by i).

The manufacturer produces a product with a constant marginal cost $c \geq 0$. The manufacturer has no direct access to the consumers, it needs one or multiple retailers to market and sell the product. The manufacturer first chooses which retailer(s) to use. The manufacturer then sets a wholesale price $w \geq 0$, assuming the manufacturer sets the same wholesale price for different retailers. Denote the manufacturer's profit function by

$$\pi_M = (w-c)(q_R + q_D)$$

where q_R and q_D are the quantities demanded for the full-service dealer and the drop-shipper, respectively.

The two retailers locate and operate in different locations. Assume the full-service dealer and the dropshipper are located at the west and the east regions of a town respectively. Let the full-service dealer's location s_R be 0 and dropshipper's location s_D be 1. Both retailers have the freedom to set a non-negative retail price $P_R, P_D \geq 0$ themselves. The full-service dealer could offer different levels of services to the consumers by putting different service effort $e_R \geq 0$. A higher service effort will lower the consumers' total cost of buying the product by lowering the queuing time $T(e_R)$. The service effort generates a service cost [2] βe_R to the full-service dealer, where β is a service cost parameter. Therefore, the full-service

[2] I assumed the service cost as a fixed cost rather than per-unit cost in my model to be consistent with Winter (1993). In reality, some services have fixed cost, such as showroom set-up cost and salesmen's salaries, some have per unit cost, such as assemble and maintenance cost.

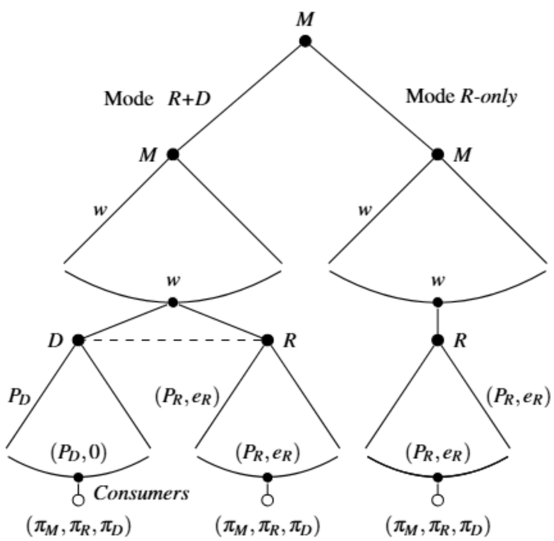


Figure 1. The "Add-on" Situation

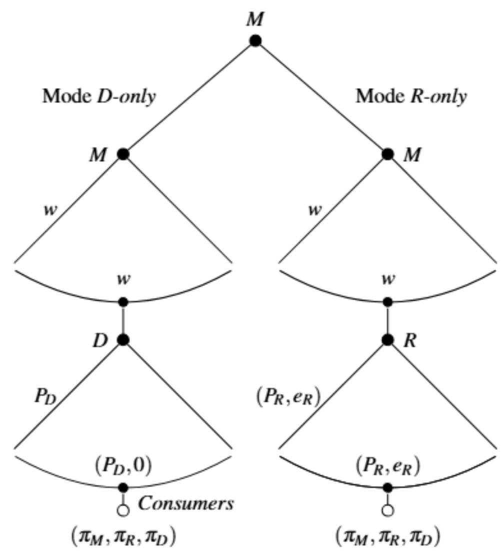


Figure 2. The "Either-or" Situation

dealer's profit function is as follow:

$$\pi_R = (P_R - w)q_R - \beta e_R$$

The dropshipper sets its own retailer price P_D. I assume that its β is prohibitively high. Therefore, it is never optimal for the dropshipper to provide any service, i.e. $e_D = 0$. Therefore, the dropshipper's profit function is as follow:

$$\pi_D = (P_D - w)q_D$$

This game has four stages:

1) The manufacturer chooses a mode to adopt;

2) The manufacturer sets the wholesale price w;

3) The full-service dealer and(or) the dropshipper sets the retail price p_R, p_D, and the full-service dealer also decides the service effort e_R;

4) The consumers decide to buy the product or not and where to buy it.

In stage 1, I study two cases. The first case (Figure 1) represents the situation when Siemens received an order from Schein D.E., the dropshipper and the second case (Figure 2) represents the situation where Siemens faced complaints from other dealers. In the first case, the manufacturer has the opportunity to add the dropshipper as one of its retailers, so the manufacturer has to choose between a full-service dealer-only (mode *R-only*) and a dual-channel (mode *R+D*). In the second case, the manufacturer receives the dealer's complaint and no longer can choose the dual-channel. Therefore the manufacturer has to choose full-service dealer-only (mode *R-only*) or a drop-shipper-only (mode *D-only*) as its retailer. These two cases will help our discussion on Siemens's action in the case.

Each consumer will only buy at most one product. Each Consumer i has its own location s_i, time cost θ_i and reservation price v_i, assuming s_i and θ_i are both independent and uniformly distributed between 0 and 1. For simplicity, their reservation price is assumed to be a constant, $v_i = v \;\; \forall i$. A two-dimensional consumer space with θ and s will be used to analyse the quantity demanded for the product. The total cost for buying the good is the sum of the total time cost and the price, where the total time equals to the travelling time plus the queuing time [3]. i.e.

$$\begin{aligned} Total\,cost &= Price + Travelling\;time * Time\,cost + Queuing\;time * Time\,cost \\ &= p_n + (|s_n - s_i|)\theta_i + T(e_n)\theta_i \qquad\qquad where\; n = R, D \end{aligned}$$

$T(e_n)$, the queuing time, as a function of the retailer's service effort, assume $T(x) = \alpha f(x)$, where $f'(x) < 0$, $f''(x) \geq 0$; and α is the service importance parameter representing the importance level of service.

4 EQUILIBRIUM

I use backward induction to solve the sequential game to obtain the subgame perfect equilibrium. First, get the demand functions for the full-service dealer $q_R(p_R, e_R; p_D)$ and the dropshipper $q_D(p_D; p_R, e_R)$. Then, solve for the optimal price P_R^*, P_D^* and optimal service effort e_R^* by maximizing the profit functions of the retailers. Afterward, solve for the optimal wholesale price w^* by maximizing the manufacturer's profit function. Finally, choose the optimal mode by comparing the manufacturer's optimal profits in the different modes.

4.1 The Consumers' Decision

A consumer will not buy from a retailer if the total cost is larger than the reservation price v. If there are two retailers to choose from, the consumer will buy from the retailer that generates a lower total cost. The following inequalities summarise the consumers' decision:

[3] In Winter's (1993) model, consumers need to queue in the store. The queuing time could be shortened if the store provides better services. In the dental x-ray case, the queuing time can be understood as the time used to gather product information. The time used to gather information would be lower when a better services are provided, such as salesforce and showroom. As the idea is similar, I use the same term to be consistent with Winter's (1993) model.

$$p_R + s_i\theta_i + T(e_R)\theta_i \geq v, \tag{1}$$

$$p_D + (1 - s_i)\theta_i + T(0)\theta_i \geq v, \tag{2}$$

$$p_R + s_i\theta_i + T(e_R)\theta_i \geq p_D + (1 - s_i)\theta_i + T(0)\theta_i, \tag{3}$$

Where (1) represents the consumers who will not buy from the full-service dealer; (2) represent the consumers who will not buy from the drop-shipper; (3) represent the consumers who will buy from the full-service dealer rather than the drop-shipper, vice versa when the sign inverted. For (1) and (2), when the two sides equal, the consumers are indifferent between buying from the retailer or not buying (referred to as the product margin). When the two sides equal in (3), the consumers are indifferent between buying from the full-service dealer or the drop-shipper (referred to as the inter-retailer margin). Figure 3 shows the consumer space with the product margins and inter-retailer margin.

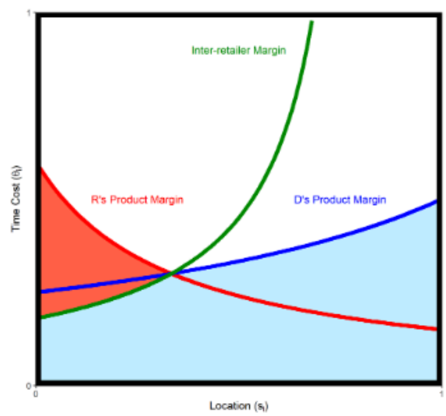


Figure 3. The Consumer Space

When there is only a full-service dealer, the consumers located in the area under the R's product margin will buy from R. Similarly, when there is only dropshipper, the consumers located in the area under the D's product margin will buy from D. When both retailers exist, the consumers located in the red shaped area will buy from R and the consumers located in the blue area will buy from D.

4.2 The Demand Functions

The R's quantity demanded is the number of consumers who will buy from the full-service dealer. As I assumed the time cost θ and location s are both independently and uniformly distributed on [0,1], the number of consumers equals the size of the area. Therefore, I calculate the area using integration. To integrate the curves, I make θ as functions of s for the binding equations of (1), (2) and (3):

$$\theta_1(s; p_R, e_R, v) = \frac{v - p_R}{s + T(e_R)}; \qquad \theta_2(s; p_D, e_D, v) = \frac{v - p_D}{1 - s + T(e_D)};$$

$$\theta_3(s; p_R, e_R, p_D, e_D, v) = \frac{p_R - p_D}{1 - 2s + T(e_D) - T(e_R)}.$$

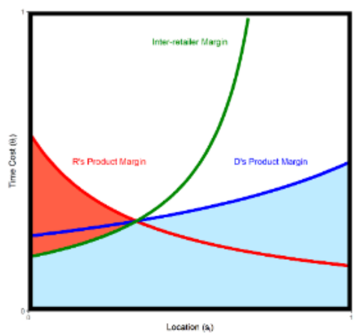


Figure 4. The Consumer Space when $P_R > P_D$.

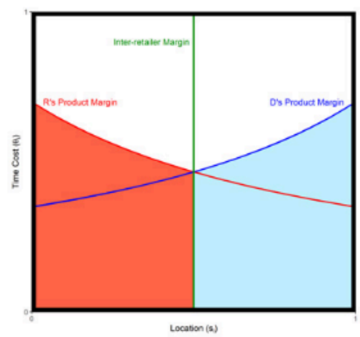


Figure 5. The Consumer Space when $P_R = P_D$.

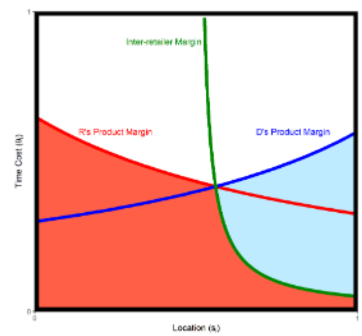


Figure 6. The Consumer Space when $P_R < P_D$.

The consumer space has different divisions when the variables and parameters change, the direction of the inter-retailer margin is determined by the price difference (see Figures 4, 5 and 6); the intersections affect the shape as well, the major intersections are:

$$s_1^{\theta=1} = v - p_R - T(e_R); \qquad s_2^{\theta=1} = 1 - (v - p_D - T(e_D));$$

$$s_3 = \frac{(v - p_R)(1 + T(e_D)) - (v - p_D)T(e_R)}{(v - p_D) + (v - p_R)}.$$

where $s_1^{\theta=1}$ is the intersection where (1) meet $\theta = 1$, similarly for $s_2^{\theta=1}$; s_3 is the location where the three curves intersect. The three curves will not intersect x-axis. Different intersections give different divisions. Some examples are shown in the Figures 7 - 9, the remaining cases are shown in the appendix.

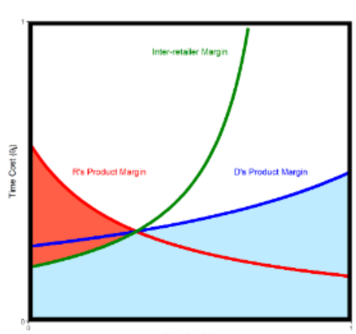


Figure 7. The Consumer Space when $P_R > P_D$, $s_1^{\theta=1} < 0$, $s_2^{\theta=1} \geq 1$ and $0 \leq s_3 \leq 1$.

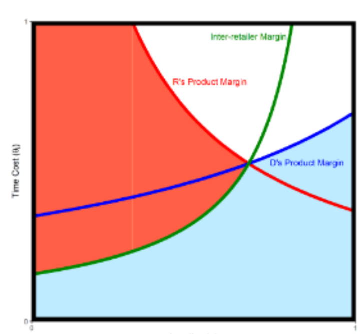


Figure 8. The Consumer Space when $P_R > P_D$, $0 \leq s_1^{\theta=1} \leq 1$, $s_2^{\theta=1} \geq 1$ and $0 \leq s_3 \leq 1$.

Figure 9. The Consumer Space when $P_R > P_D$, $s_1^{\theta=1} \leq 0$, $s_2^{\theta=1} \geq 1$ and $s_3 > 1$.

In one-dealer cases, i.e., mode *R-only* and mode *D-only*, the quantity demanded for the dealer equals the area under its product margin curve. For *R-only*, R's product margin is downward sloping. When $s_1 < 0$, the area equals the integral of (1) from 0 to 1; when $s_1 > 1$, the area equals 1; when $0 < s_1 < 1$, the area equals the integral of horizontal line $\theta = 1$ from 0 to s_1 plus the integral of (1) from s_1 to 1. Similarly for mode *D-only*, the demand function could be summarised by the equation shown below:

The Demand Functions for Full-service Dealer-Only

R's Demand

$$q_R(p_R, e_R; p_D) = \int_{s=max\{min\{s_1^{\theta=1},1\},0\}}^{s=1} \theta_1(s; p_R, e_R, v)ds + max\{min\{s_1^{\theta=1}, 1\}, 0\}.$$

D's Demand

$$q_D(p_D; p_R, e_R) = 0.$$

The Demand Functions for Dropshipper-Only

R's Demand

$$q_R(p_R, e_R; p_D) = 0.$$

D's Demand

$$q_D(p_D; p_R, e_R) = \int_{s=0}^{s=max\{min\{s_2^{\theta=1},1\},0\}} \theta_2(s; p_D, e_D, v)ds + 1 - max\{min\{s_2^{\theta=1}, 1\}, 0\}.$$

For mode *R+D*, the two dealers divide the market. The market is divided by the inter-retailers margin. Let us say the market is segmented at $s = s_3$. The area under the R's product margin equals the integral of (1) from 0 to s_3 (Area A); the area under the D's product margin equals the integral of (2) from s_3 to 1 (Area B); the area under the inter-retailer margin equals he integral of (3) (Area C). The inter-retailer margin is upward sloping when $P_R > P_D$; vertical when $P_R = P_D$; downward sloping when $P_R < P_D$. When $P_R > P_D$, Area C equals the integral of (3) from 0 to s_3, which representing how D's existence causes R's lost sales. When $P_R = P_D$, Area C equals 0; When $P_R > P_D$, Area C equals the integral of (3) from s_3 to 1. In equilibrium, $P_R > P_D$ prevails. When $P_R > P_D$[4], R's and D's quantity demanded equals Area A - Area C and Area B + Area C, respectively, i.e.

[4]The demand functions for $P_R = P_D$ and $P_R < P_D$ are in the Appendix.

The Demand Functions for Dual-Channel

R's Demand

$$q_R(p_R, e_R; p_D) = \int_{s=max\{min\{s_1^{\theta=1},1\},0\}}^{s=max\{min\{s_3,1\},0\}} \theta_1(s; p_R, e_R, v)ds + max\{min\{s_1^{\theta=1}, 1\}, 0\}$$
$$- \int_{s=0}^{s=max\{min\{s_3,1\},0\}} \theta_3(s; p_R, e_R, p_D, e_D, v)ds$$

D's Demand

$$q_D(p_D; p_R, e_R) = \int_{s=max\{min\{s_3,1\},0\}}^{s=max\{min\{s_2^{\theta=1},1\},0\}} \theta_2(s; p_D, e_D, v)ds + 1 - max\{min\{s_2^{\theta=1}, 1\}, 0\}$$
$$+ \int_{s=0}^{s=max\{min\{s_3,1\},0\}} \theta_3(s; p_R, e_R, p_D, e_D, v)ds$$

4.3 A Few Remarks

Remark 1 *The demand functions have the following properties:* $dq_n/dP_n \leq 0$, $dq_n/dP_m \geq 0$, $dq_n/de_n \geq 0$, $dq_n/de_m \leq 0$ *for* $n = R, D; m \neq n$. *The convexity are seen in the service elasticity, but not in the price elasticity.*

The demand functions are downward sloping, it is linear for single retailer cases, the convexity is unclear for the dual-channel case. A higher service effort drives a higher quantity demanded at a decreasing rate. The cross-price elasticity is positive and the cross-service elasticity is negative. The demand curves are shown in Figure 10 to 12.

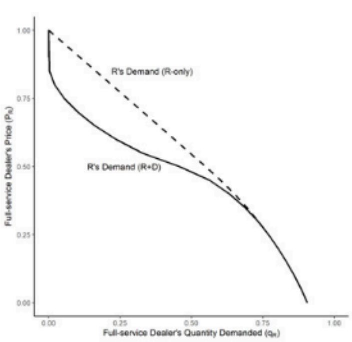


Figure 10. P_R against q_R

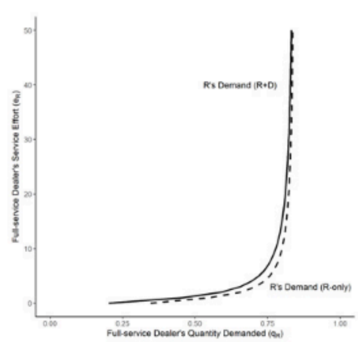


Figure 11. e_R against q_R

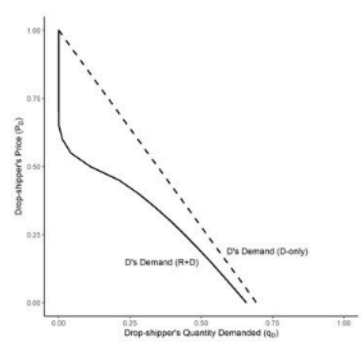


Figure 12. P_D against q_D

Because of the complexity of the demand functions, I am not able to obtain the analytical solution for the equilibrium. However, I can draw some conditions for the equilibrium.

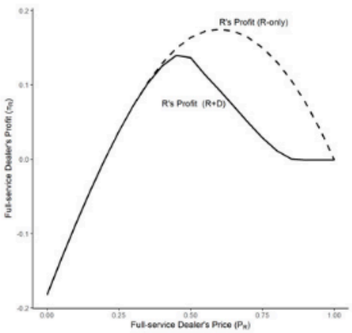


Figure 13. π_R against P_R

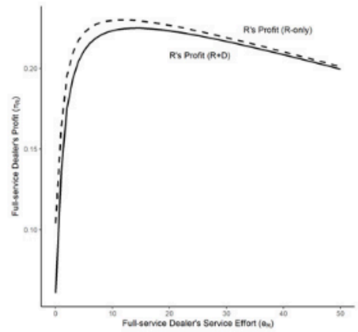


Figure 14. $_R$ against e_R

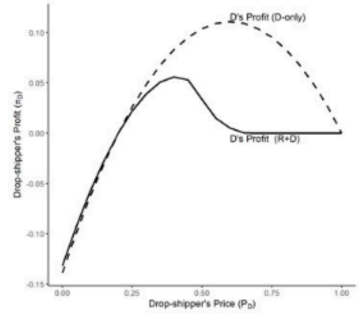


Figure 15. $_D$ against P_D

Remark 2 *D's profit function $\pi_D(p_D; p_R, e_R)$ is concave (see Figure 15). Therefore, the dropshipper has a unique, finite optimal price (P_D^*) by maximizing π_D in the first order condition in stage 3.*

Remark 3 *R's profit function $\pi_R(p_R, e_R; p_D)$ is concave (see Figure 13 & 14) against both p_R, e_R. Therefore, the full service dealer has a unique, finite optimal choice set (p_R^*, e_R^*) by maximizing π_R in the first order condition in stage 3.*

Remark 4 *M's profit function $\pi_M(w)$ is concave (see Figure 16). Therefore, the manufacturer has a unique, finite optimal wholesale price $(w*)$ by maximizing π_M in its first-order condition in stage 2.*

Remark 5 *In the stage 3 Nash Equilibrium, given the wholesale price w, R's optimal choice (P_R^*, e_R^*) is a best response to D's optimal choice $(P_D^*, 0)$, vice versa. By remark 2 and 3, there exists a unique Nash Equilibrium. With remark 4, there exists a unique subgame perfect Nash equilibrium.*

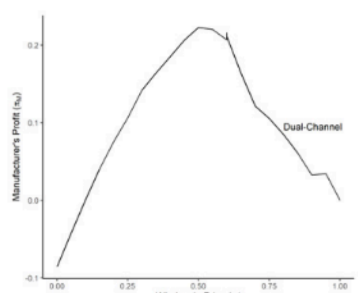


Figure 16. π_M against w

5 NUMERICAL SOLUTIONS

As the model is too complicated to solve analytically, I numerically solve for the equilibrium conditions of the model. I first substitute all variables and parameters with a set of real numbers (see Table 2).

Exogenous Variables	Inputs	Endogenous Vairables	Inputs
v	1	w	[0,1] by 0.05
c	0.1	P_D	[0,1] by 0.05
α	[1,10] by 1	P_R	[0,1] by 0.05
β	[0,0.01] by 0.001	e_R	[0,50] by 1
$T(x)$	$\alpha/(x+1)$		

Table 2. Numerical Inputs

By substituting the real numbers into the variables and parameters, the quantities demanded q_R, q_D and the profit π_M, π_D, π_R under different modes are obtained by the above equations. I solve for the numerical solution by the logic of backward induction and iterations. In stage 3, where the retailers optimize their profit by choosing the price and service effort. For the mode *R-only* and *D-only* , the best actions would be the actions that generate the highest profit. For dual-channel (mode *R+D*), as the two retailers decide their actions simultaneously, to reach the equilibrium, iteration is used, i.e. R chooses its best action (P_{R1}, e_{R1}) given D's action $(P_{D0}, 0)$, then D chooses its best action $(P_{D1}, 0)$ given the R's choices (P_{R1}, e_{R1}), and repeat the process until both actions do not change given the other's actions.

In stage 2, the manufacturer optimizes its profit by setting an optimal wholesale price. Given the equilibrium obtained in stage 3, the manufacturer sees one equilibrium situation case for each wholesale price and chooses the one with the highest manufacturer's profit. In stage 1, the manufacturer sees the maximum profit for each mode, and chooses the one that gives the higher manufacturer's profit. Note that the manufacturer's and retailers' action choices, due to the limitation of computational resources, are discrete. In most cases, the results are reasonable.

The numerical solution gives some results. First, under dual-channel, the equilibrium R's price is always greater than or equal to D's price, i.e. $P_R \geq P_D$. Figure 17 shows the equilibrium prices across different α. It is easy to understand this phenomenon, as the dropshipper cannot provide better service to compete, it has to set a lower price than the full-service dealer to compensate for the lack of services. Similarly, for the full-service dealer, it could charge higher because it provides better services than another retailer.

Comparing the dual-channel with *R-only*, the full-service dealer will choose a lower service effort when the dropshipper exists. Figure 18 shows the R's service effort in dual-channel and *R-only* modes. The full-service dealer is forced to compete in price when the drop-shipper exists, i.e. the competition is more toward price competition in the dual-channel mode, a result consists with Winter (1993). Figure 19

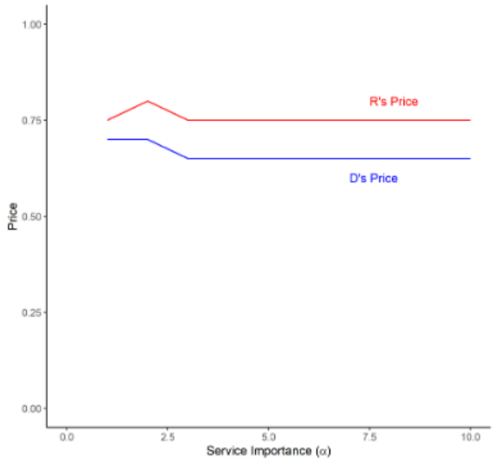


Figure 17. Under mode *R+D*, $p_D < p_R$.

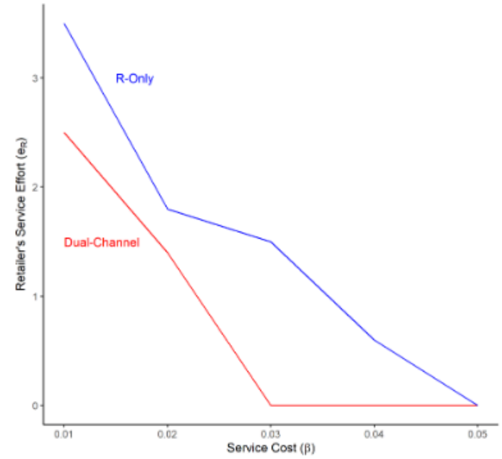


Figure 18. Under mode *R+D*, e_R is lower than that under mode *R-only*.

shows R's profit in equilibrium for the dual-channel is always lower than the R-only situation. Therefore, the full-service dealer always prefers to have no dropshipper.

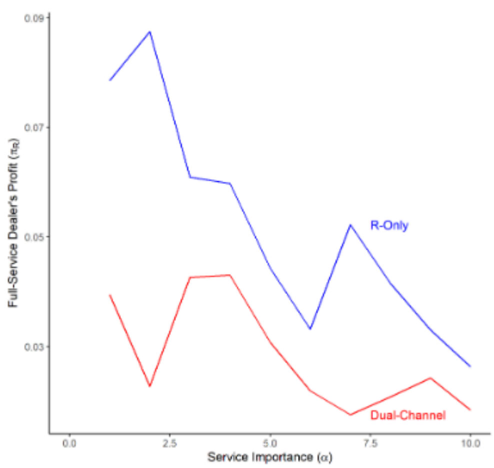


Figure 19. Under mode *R+D*, π_R is lower than that under mode *R-only*.

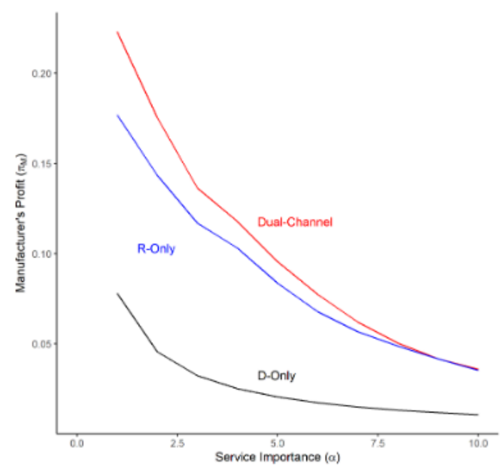


Figure 20. M prefers mode *R+D* to mode *R-only*, and mode *R-only* to mode *D-only*.

In stage 1, the manufacturer chooses through different modes, deciding which retailer(s) to use. Figure 20 shows the optimal manufacturer's profit in different modes. It is clear that the manufacturer always prefers the mode *R+D* to the mode *R-only*, and prefers the mode *R-only* to the mode *D-only*. The differences between the three are smaller when the importance of services α increases.

6 DISCUSSIONS AND CONCLUSIONS

Extending Winter's (1993) model by studying two asymmetric retailers: the traditional retailer and the dropshipper, I offer an explanation of Siemens's actions by showing that:

1) M prefers mode *R+D* to mode *R-only*;

2) Under mode *R+D*, $p_D < p_R$;

3) Under mode *R+D*, π_R is lower than that under mode *R-only*;

4) Under mode *R+D*, e_R is lower than that under mode *R-only*;

5) M prefers mode *R-only* to mode *D-only*.

Siemens, the manufacturer, allowed Schein D.E, the dropshipper, to operate at first. This can be explained by the increase of the manufacturer's profit in the equilibrium, i.e. the manufacturer's profit of dual-channel mode (*R+D*) is higher than the full-service dealer-only mode (*R-only*).

Then Siemens unilaterally terminated the dropshipper, meaning it reverted back to the full-service dealer-only mode (*R-only*) after the full-service dealers complained about Schein's operation process. The full-service dealer might have threatened the manufacturer to end their business with the manufacture if the drop-shipper continued to operate. As under the dual-channel mode (*R+D*), the retailers have to choose a lower price and lower service level in order to compete with dropshipper, the retailer's profit would be lower than the full-service dealer-only model (*R-only*). The lowered profit might have prompted the full-service dealer to threaten the manufacturer.

I have no proof of a threat. There is also no causality I can claim in which a threat caused Siemens to terminate the dropshipper, for which Siemens specifically denied. The manufacturer has an incentive to terminate the dropshipper if the retailer's threat is credible. The manufacturer's profit would drop significantly if the retailer leaves and only the dropshipper stays. If the manufacturer cannot choose its most profitable mode, the dual-channel mode, the manufacturer would choose full-service dealer-only over dropshipper-only mode. This appears a reasonable explanation of Siemens's actions.

Besides, when the service is less important to the consumers, the extra profit generated by adopting the dual-channel instead of retail-only will be higher, which means the manufacturer would have higher incentives to allow the dropshipper to operate.

There are still plenty left for future research. My model is analytically unsolvable. It might be solvable by assuming some simpler functional forms. Also, the benchmark case in which the manufacturer is vertically integrated with the retailers remains unsolved. As this paper focuses on an older antitrust case before the Internet, future research should study other newer legal cases, perhaps including some of those briefly discussed in Appendix A.

A OTHER LEGAL CASES CONCERNING DROPSHIPPING

The Truck Tire Antitrust Case (Bostick v Michelin)[5]

The truck tire case is very similar to the dental x-ray case. Coincidentally, the two cases both occurred in the 80's. The key facts of this lawsuit include:

1) The manufacturer (Michelin) had its dealers to distribute its tires, Michelin required its dealers to service its products in a first class manner;
2) Bostick, which was a dealer in Estill, South Carolina, expanded its business by practicing drop-shipping;
3) The dropshipper (Bostick) offered a limited amount of services [6] and provide a 12% discount to consumers;
4) The dropshipper (Bostick) competed with other dealers in other regions (such as Charleston, South Carolina);
5) The manufacturer (Michelin) allowed the dropshipper (Bostick) to operate by dropshipping the products directly to the dropshipper's consumers;
6) The other dealers lost sales to the dropshipper and complained to the manufacturer (Michelin);
7) The manufacturer (Michelin) then terminated the drop-shipper (Bostick) as its dealer.

The Laminates Antitrust Case (Dart v Plunkett)[7]

In the laminates case, the manufacturer refused to dropship the product in the first place, it differs from the tire and x-ray cases. The key facts of this lawsuit include:

1) The manufacturer (Dart) had its distributors to distribute its laminates and adhesives;
2) Plunkett, which was the Tulsa regional distributor of Dart, wanted to expanded its business by practicing dropshipping;
3) The dropshipper (Plunkett) requested the manufacturer (Dart) to dropship into areas serviced by other distributors;
4) The manufacturer (Dart) refused to dropship on behalf of the dropshipper (Plunkett);
5) The manufacturer (Dart) then terminated the dropshipper (Plunkett) as its distributor.

[5] Bostick Oil Co. v. Michelin Tire Corp., Com. Div., 702 F. 2d 1207 - Court of Appeals, 4th Circuit 1983
[6] "Bostick did not provide any initial mounting or other service"
[7] Dart Industries, Inc. v. Plunkett Co. of Oklahoma, 704 F. 2d 496 - Court of Appeals, 10th Circuit 1983

The FVC Case[8]

The largest dealer of the manufacturer changed from a traditional retailer to dropshipping FVC product, eventually FVC's profit dropped dramatically. This result is consistent to my model, where the manufacturer's profit of the mode *D-only* is significantly lower than mode *R-only*. The key facts of this lawsuit include:

1) The manufacturer (FVC), was the leading provider of broad band network video applications, had its OEM partners;

2) Nortel, which was the major partner of FVC, change it operation method. Nortel no longer stock FVC's products, but instead adopt the dropshipping arrangement;

3) The manufacturer (FVC) then suffered from a signification reduction in revenue and profit [9].

[8] In re FVC. COM Securities Litigation, 136 F. Supp. 2d 1031 - Dist. Court, ND California 2000

[9] The profit reduction caused FVC to publish a fake financial report, which is the major focus of the lawsuit.

B OTHER DEMAND FUNCTION CASES

When $P_R = P_D$, Area C equals 0, R's and D's quantity demanded equals Area A and Area B, respectively, i.e.

R's Demand

$$q_R(p_R, e_R; p_D) = \int_{s=max\{min\{s_1^{\theta=1},1\},0\}}^{s=max\{min\{s_3,1\},0\}} \theta_1(s; p_R, e_R, v)ds + max\{min\{s_1^{\theta=1},1\},0\}$$

D's Demand

$$q_D(p_D; p_R, e_R) = \int_{s=max\{min\{s_3,1\},0\}}^{s=max\{min\{s_2^{\theta=1},1\},0\}} \theta_2(s; p_D, e_D, v)ds + 1 - max\{min\{s_2^{\theta=1},1\},0\}$$

When $P_R > P_D$, Area C equals the integral of (3) from s_3 to 1, R's and D's quantity demanded equals Area A + Area C and Area B - Area C, respectively, i.e.

R's Demand

$$q_R(p_R, e_R; p_D) = \int_{s=max\{min\{s_1^{\theta=1},1\},0\}}^{s=max\{min\{s_3,1\},0\}} \theta_1(s; p_R, e_R, v)ds + max\{min\{s_1^{\theta=1},1\},0\} + \int_{s=max\{min\{s_3,1\},0\}}^{s=1} \theta_3(s; p_R, e_R, p_D, e_D, v)ds$$

D's Demand

$$q_D(p_D; p_R, e_R) = \int_{s=max\{min\{s_3,1\},0\}}^{s=max\{min\{s_2^{\theta=1},1\},0\}} \theta_2(s; p_D, e_D, v)ds + 1 - max\{min\{s_2^{\theta=1},1\},0\} - \int_{s=max\{min\{s_3,1\},0\}}^{s=1} \theta_3(s; p_R, e_R, p_D, e_D, v)ds$$

C OTHER CONSUMER SPACE CASES

The Consumer Space When $P_R > P_D$

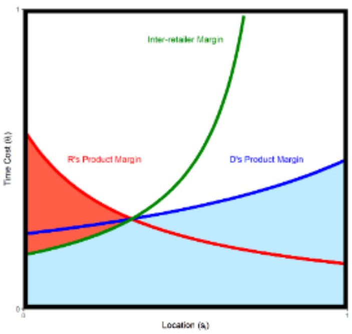


Figure 21. The Consumer Space when $P_R > P_D$, $s_1^{\theta=1} \leq 0$, $s_2^{\theta=1} \geq 1$ and $0 \leq s_3 \leq 1$.

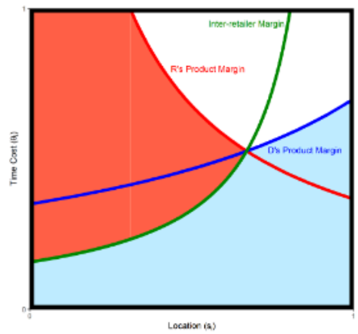


Figure 22. The Consumer Space when $P_R > P_D$, $0 \leq s_1^{\theta=1} \leq 1$, $s_2^{\theta=1} \geq 1$ and $0 \leq s_3 \leq 1$.

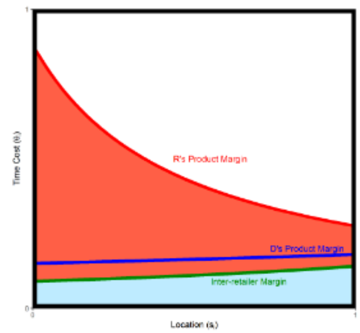


Figure 23. The Consumer Space when $P_R > P_D$, $s_1^{\theta=1} \leq 0$ and $1 \leq s_3$.

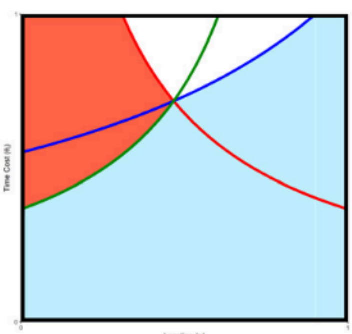


Figure 24. The Consumer Space when $P_R > P_D$, $s_1^{\theta=1} < 0$, $0 \leq s_2^{\theta=1} \leq 1$ and $0 \leq s_3 \leq 1$.

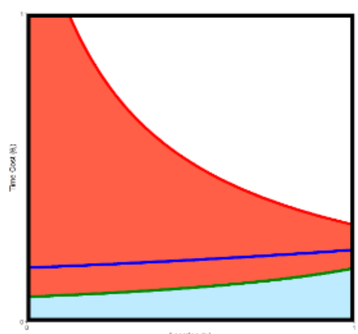


Figure 25. The Consumer Space when $P_R > P_D$, $0 \leq s_1^{\theta=1} \leq 1$ and $1 \leq s_3$.

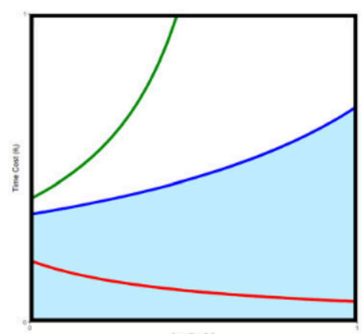


Figure 26. The Consumer Space when $P_R > P_D$, $1 \leq s_1^{\theta=2}$ and $s_3 \leq 0$.

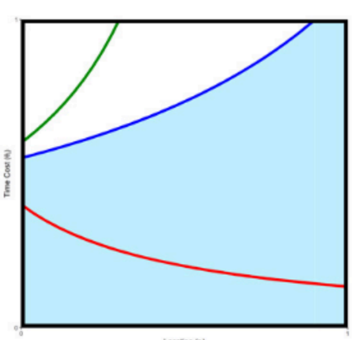


Figure 27. The Consumer Space when $P_R > P_D$, $0 \leq s_1^{\theta=2} \leq 1$ and $s_3 \leq 0$.

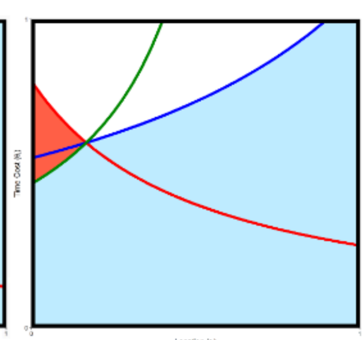


Figure 28. The Consumer Space when $P_R > P_D$, $s_1^{\theta=1} < 0$, $0 \leq s_2^{\theta=1} \leq 1$ and $0 \leq s_3 \leq 1$.

The Consumer Space When $P_R = P_D$

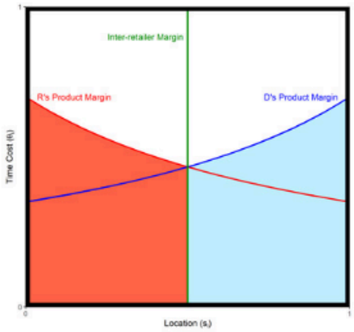


Figure 29. The Consumer Space when $P_R = P_D$, $s_1^{\theta=1} < 0$, $s_2^{\theta=1} \geq 1$ and $0 \leq s_3 \leq 1$.

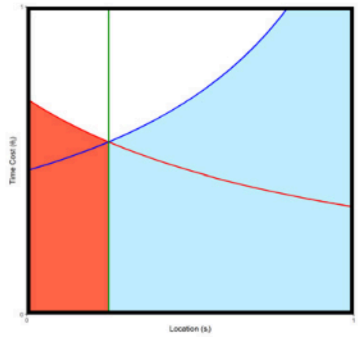


Figure 30. The Consumer Space when $P_R = P_D$, $s_1^{\theta=1} < 0$, $0 \leq s_2^{\theta=1} \leq 1$ and $0 \leq s_3 \leq 1$.

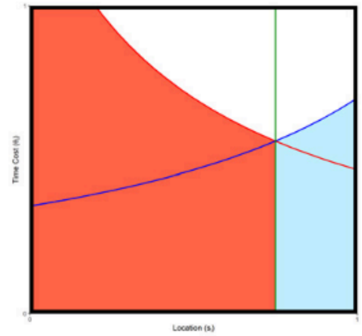


Figure 31. The Consumer Space when $P_R = P_D$, $0 \leq s_1^{\theta=1} \leq 1$, $s_2^{\theta=1} \geq 1$ and $0 \leq s_3 \leq 1$.

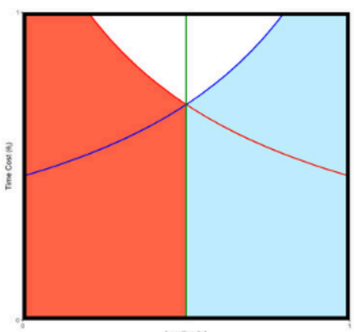


Figure 32. The Consumer Space when $P_R = P_D$, $s_1^{\theta=1} < 0$, $0 \leq s_2^{\theta=1} \leq 1$ and $0 \leq s_3 \leq 1$.

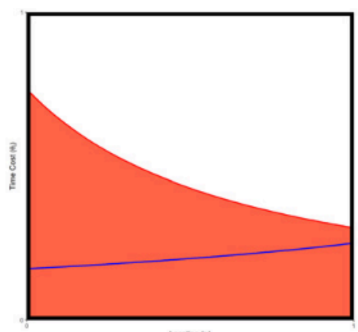


Figure 33. The Consumer Space when $P_R = P_D$, $s_1^{\theta=1} \leq 0$ and $1 \leq s_3$.

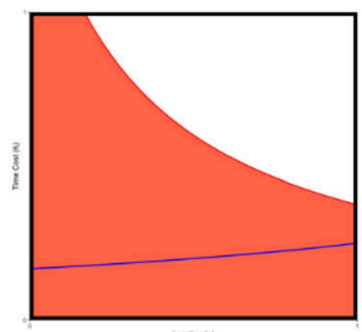


Figure 34. The Consumer Space when $P_R = P_D$, $0 \leq s_1^{\theta=1} \leq 1$ and $1 \leq s_3$.

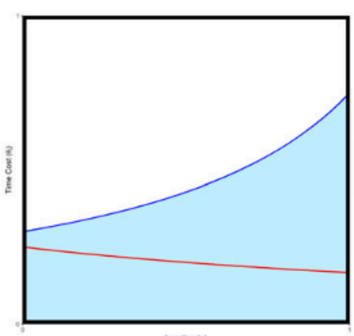


Figure 35. The Consumer Space when $P_R = P_D$, $1 \leq s_1^{\theta=2}$ and $s_3 \leq 0$.

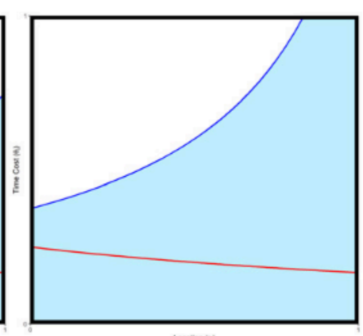


Figure 36. The Consumer Space when $P_R = P_D$, $0 \leq s_1^{\theta=2} \leq 1$ and $s_3 \leq 0$.

The Consumer Space When $P_R < P_D$

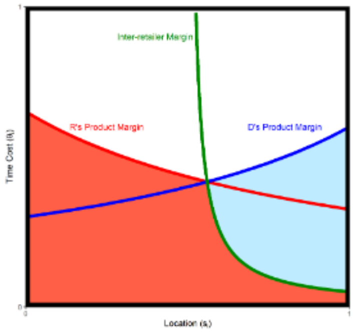


Figure 37. The Consumer Space when $P_R < P_D$, $s_1^{\theta=1} < 0$, $s_2^{\theta=1} \geq 1$ and $0 \leq s_3 \leq 1$.

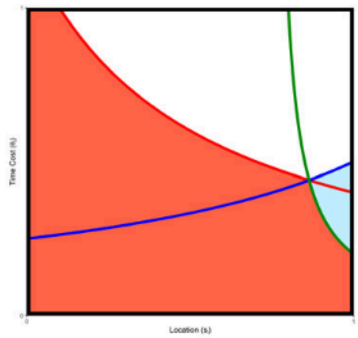


Figure 38. The Consumer Space when $P_R < P_D$, $0 \leq s_1^{\theta=1} \leq 1$, $s_2^{\theta=1} \geq 1$ and $0 \leq s_3 \leq 1$.

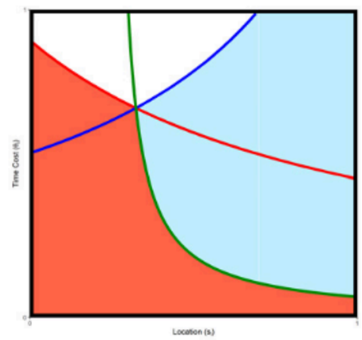


Figure 39. The Consumer Space when $P_R < P_D$, $s_1^{\theta=1} < 0$, $0 \leq s_2^{\theta=1} \leq 1$ and $0 \leq s_3 \leq 1$.

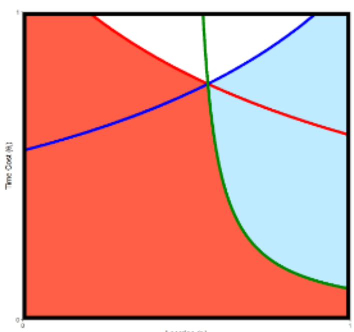


Figure 40. The Consumer Space when $P_R < P_D$, $s_1^{\theta=1} < 0$, $0 \leq s_2^{\theta=1} \leq 1$ and $0 \leq s_3 \leq 1$.

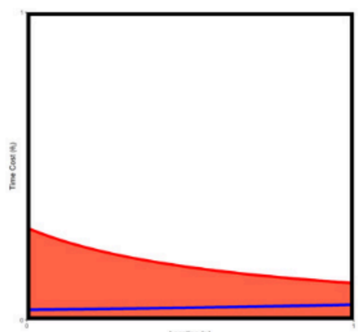


Figure 41. The Consumer Space when $P_R < P_D$, $s_1^{\theta=1} \leq 0$ and $1 \leq s_3$.

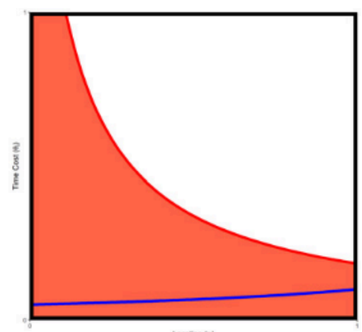


Figure 42. The Consumer Space when $P_R < P_D$, $0 \leq s_1^{\theta=1} \leq 1$ and $1 \leq s_3$.

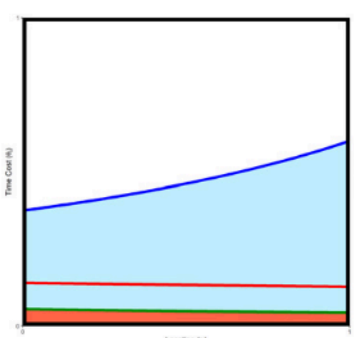


Figure 43. The Consumer Space when $P_R < P_D$, $1 \leq s_1^{\theta=2}$ and $s_3 \leq 0$.

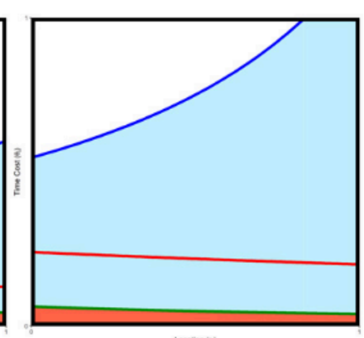


Figure 44. The Consumer Space when $P_R < P_D$, $0 \leq s_1^{\theta=2} \leq 1$ and $s_3 \leq 0$.

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