TIMING AND ORDERING DECISIONS UNDER SINGLE AND DUAL PRODUCT ROLLOVER STRATEGIES

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By

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I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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ABSTRACT

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September, 2011

In many industries, firms replace products that have been introduced to the market and that are in advanced stages of their life cycles. The process of introducing a new product and eventually displacing an old one is referred to as *product rollover*. In planning for new product introduction, it is very important that careful business decisions are made for phasing out the old product, as the related costs may be significant. In this thesis, we study the ordering and timing decisions of a supplier for successive generations of a product under two different strategies: single product rollover and dual product rollover. In both cases, we present models explicitly accounting for inventory holding costs, salvage value, lost sale cost, demand uncertainty of both the products and product cannibalization. We report the results of an extensive numerical study to investigate the structural properties of the expected profit function, and how the optimal timing and ordering decisions change under different settings.

Keywords: product rollover, timing, cannibalization.

ÖZET

TEKLİ VE ÇOKLU ÜRÜN ÇEVİRİMİ STRATEJİLERİ ALTINDA ZAMANLAMA VE SİPARİŞ VERME KARARLARI

Ahmet Korhan ARAS
Endüstri Mühendisliği, Yüksek Lisans
Tez Yöneticisi: Yrd. Doç. Dr. Ayşegül Toptal
Eylül, 2011

Sanayinin birçok alanında şirketler halihazırda pazarda bulunan ürünlerini, o ürünlerin yeni versiyonlarıyla değiştirirler. Yeni ürünün pazara sokulup eski ürünün pazardan kaldırılması sürecine *ürün çevirimi* adı verilir. Yeni ürünün pazara girişinin planlaması evresinde, eski ürünün pazardan çekilmesi ile ilgili verilecek kararlar oldukça önemlidir çünkü yanlış zamanlamanın maliyeti oldukça büyük olabilir. Bu tezin konusu, bir tedarikçinin, tekli ürün çevirimi ve çoklu ürün çevirimi stratejileri altında, sipariş verme ve zamanlama kararlarının incelenmesidir. Her iki strateji için de envanter, yok satma maliyetlerinin ve ürünün tasfiyesinden elde edilen kazancın detaylıca ele alındığı, her iki ürünün de talebinin rassal olduğu modeller geliştirilmiştir. Ayrıca yamyamlaşma olgusu da modellenmiştir. Bunlara ek olarak, beklenen kar fonksiyonunun yapısal özelliklerini ve eniyi zamanlama ve sipariş verme kararlarının farklı durumlarda nasıl değiştiğini araştırmak amacıyla kapsamlı bir sayısal analiz yapılmıştır.

Anahtar sözcükler: ürün çevirimi, zamanlama, yamyamlaşma.

To my mother and grandparents...

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Chapter 1

Introduction

In many industries, firms replace products that have been introduced to the market and that are in the advanced stages of their life cycles. The process of introducing the new product and eventually phasing out the old product is referred to as *product rollover*. The questions they face at the product rollover stage are when to introduce the new (upgraded) product to the market and when to phase out the old product. The answers to these questions are getting more attention due to the increasing emphasis on the market leadership [15]. To be the first on the market helps firms to acquire the additional share and to be more powerful than their rivals. In other words, shortening a product's life cycle can be a competitive weapon in terms of being first in the market [4]. Consequently, the product life cycles in many industries, especially technology-driven industries, are shorter [15]. This, in turn, leads to more frequent product rollovers. Therefore, the topic of product rollovers is becoming a more important problem.

There are strategic issues that a firm should deal with at the product rollover stage. Three of them are listed in Lim and Tang [15] and are related to *timing issues*, *pricing issues* and *contingencies*. We focus on the timing issues in this thesis. The tradeoff related to the timing issues in product rollovers can be explained as follows: If the firm introduces the new product too early then it may *cannibalize* the demand of the old product which leads to less of revenue from the old product. Conversely, if the firm introduces the new product too late, then it sells the new product, which most probably has higher marginal revenue, in relatively short time. If the firm phases out the old product too early, then the firm may lose the potential customers who would want to buy the old product and ends up with more remaining inventory of the old product. Conversely, if the old product is phased out too late then it may reduce the sales of the new product.

Basically, there are two strategies related to the withdrawal of the old product and the introduction of the new product. The first one is *single product rollover* and the second one is *dual product rollover*. In single product rollover, withdrawal of the old product and the introduction of the new product are done simultaneously. That is, in this strategy, there is only one product at any point in time. In the dual product rollover strategy, however, the new product is introduced before the withdrawal of the old product. In other words, there is a time window in which both products are being sold at the market. We focus on both product rollover strategies and develop two different models.

Many papers related to the product-rollover area address the tradeoff between the product performance and introduction timing [2, 3, 6] whereas few studies emphasize the inventory aspect. As we mentioned earlier, as the product life cycles are getting shorter, and thereby, the frequency of rollovers increases, managing the end-of-cycle inventory becomes more crucial [5]. In this thesis, we assumed that the new product is satisfactory and ready in terms of performance (or quality) at the beginning and address a different type of tradeoff. The basic tradeoff in our problem is the liquidation of inventory of the old product and the introduction/withdrawal times of the new/old product, respectively.

Our objective in this study is to incorporate inventory related issues of a firm into decisions related to timing of product rollover. It is of our interest to gain insights into how the level of inventory on hand and associated holding cost affect the optimal timing of both the introduction of the new product and the withdrawal of the old product. To do so, we develop detailed models for both the single and dual product rollover cases.

In our problem, we consider a firm which currently has a product in the market and is planning to introduce the new product while eventually phasing out the old product. We assume a finite selling period in which the demand for the old and the new product, if ever introduced to the market, is stochastic. Specifically, we model the demand arrivals of each product as a Poisson process. For simplicity, the selling price and the unit procurement cost of both products are assumed to be fixed during the selling period. Each unsold unit of both products types has a salvage value. Furthermore, we assume that there is a lost sale cost associated with each demand that cannot be satisfied. We also assume that a (holding) cost is charged for each unit of both products kept in the inventory. By defining the inventory related costs (procurement, lost sale and holding) this way, we manage to incorporate inventory concept into our model in a detailed manner. We develop expected profit functions for both the single and the dual product rollover cases.

We conduct an experimental analysis for both product rollover models in order to gain insights into the behavior of optimal introduction and withdrawal timings as well as optimal order quantity. We examine the impact of problem parameters on the optimal introduction and withdrawal timings. Moreover, we investigate some special cases such as the ones in which the profit margins of the products are the same or the ones in which new product is more profitable than the old product to gain insights into the behavior of optimal timings and order quantity.

The rest of this thesis is organized as follows. In Chapter 2, related literature is summarized. In Chapter 3, problem is defined explicitly and the models related to both product rollover strategies are formulated. In Chapter 4, experimental results are discussed. Finally, in Chapter 5, we conclude the thesis and present present possible future extensions.

Chapter 2

Literature Review

In this section, we present some characteristics of the previous work done related to the introduction timing issue. We compare the papers according to the following characteristics: (1) the demand structure, (2) the way how cannibalization is considered, (3) length of the selling period, (4) product rollover strategies and (5) problem parameters. Let us start with a classification of papers according to the first attribute.

Introduction timing of a new product has been researched to a considerable degree in the marketing literature. In many of the papers related to introduction timing in the marketing literature, demand (sales) is modeled using a diffusion process–generally the Bass model–or as the extensions of the Bass model. The Bass model, which is more well-known and has been widely used, is one of the earliest diffusion models [1]. It is a model regarding the timing of adoption of a new product (technology, innovation, etc.) and assumes an exponential growth of initial purchases (of the new product) to a peak and then an exponential decay in the purchases. As one of the earliest papers analyzing introduction timing, Kalish and Lilien [10] develop a market diffusion model that incorporates negative word-of-mouth associated with new product failure, resulting from premature introduction. Wilson and Norton [22], Mahajan and Muller [17] and Krankel et al. [11] use the extensions of the Bass model in their papers. Wilson and Norton [22] propose a multiple-generation demand diffusion model based on information flow. As an extension, Mahajan and Muller [17] use a similar diffusion model to solve a more general (relaxed) problem defined in Wilson and Norton [22]. Krankel et al. [11] focus on demand diffusion and technology improvement simultaneously.

In more recent papers, demand (sales) process is modeled differently to incorporate other issues into product rollover concept. Moorthy and Png [18] assume stationary and known demand while incorporating market segmentation, cannibalization. Liu and Ozer [16] combine the concepts of stochastic technological changes and product rollover, and assume deterministic demand. Lim and Tang [15] assume deterministic demand which is also a function of time. Cohen et al. [6] emphasize the new product development process and develop a detailed model which includes a sales (demand) rate function. Li and Gao [14] combine supply chain management and product rollover by examining the effects of information sharing between a manufacturer and retailer. They model the demand as random and age dependent.

One of the most important issues related to product introduction timing is cannibalization. Cannibalization happens when both the old and the new product are in the market, and simply, refers to the fact that one of the product causes a drop in the demand (sales) of the other product. One of the earliest papers that considered the cannibalization issue is Wilson and Norton [22]. They develop a model in which the new product contributes a lower unit margin and partially cannibalizes sales of the original product, but also broadens the market, causing sales to develop more rapidly. Levinthal and Purohit [12] explicitly quantify the cannibalization effects of both products on each other and the associated cost of cannibalization. Moorthy and Png [18] argue that it is inappropriate to introduce old products before new products. Padmanabhan et al. [19] suggest that it may be appropriate in some circumstances to introduce old products before new products (such as in the presence of network externalities or exogenous technological improvements). Lim and Tang [15] consider the cannibalization effect of both the old and the new products on each other. They explicitly model the effect of cannibalization by defining customer loyalty factors for both products and by defining two types of effects due to the the prices of the products, which are (1) own price effect and (2) effect between the prices of the old and the new product.

A common characteristic of introduction-timing studies is that they consider finite selling period (Cohen et al.[6], Lim and Tang [15], Wilson and Norton [22]). Other studies which generally deal with multiple generations of products and their introduction timing, consider infinite selling period. In Krankel et al. [11], a model which determines the optimal introduction timing for successive product generations is developed under a dynamic programming framework over an infinite horizon. Li and Gao [14] consider a periodic review inventory system over an infinite horizon.

One of the issues related to introduction of a new product is the rollover strategy. A considerable number of studies assume single product rollover (i.e., the old product is withdrawn from the market as soon as the new product is launched). Wilson and Norton [22] consider the one-time introduction (single product rollover) decision for a new product generation under the assumption that the new product has a lower profit margin than the old product. They conclude that the optimal policy for the firm is to introduce the new product immediately or not to introduce it at all (now or never rule). Mahajan and Muller [17] extended the work of Wilson and Norton [22] by considering the discount of profits and by dropping the assumption that the new product has a lower profit margin. As a result, they proposed a "now" or "at-maturity" policy which suggests that a firm should introduce the new product as soon as it is available or else delay its introduction to a much later date at the maturity stage of the old product.

More recent papers incorporate new product development and/or technology development process into product rollover concept. One such study which involves single product rollover, is Cohen et al. [6]. They show that single product rollover (product replacement) always increases the introduction timing. They also argue that faster is not necessarily better if the new product market potential is large and if the existing product has a high margin. In addition, they also argue that an improvement in the new product development capability does not necessarily lead to an earlier introduction of the product. Krankel et al.[11] prove the optimality of a state-dependent threshold policy under single product rollover strategy. That is, the firm must compare the technology level of the old product with a certain threshold value and introduce the new product whenever the technology level of the old product is below that value. Liu and Ozer [16] consider stochastically evolving technology under single product rollover. The arrival time and the performance advancement of each new technology is assumed to be uncertain and is modeled as Markov process. They develop a dynamic programming formulation to determine the single product rollover (replacement) strategy. They show that a firm needs to replace its products more frequently as technology evolution accelerates, but having more product replacements is not equivalent to having lower product replacement thresholds.

Another rollover strategy during the launch of a product is the dual rollover strategy. In this strategy, the old product is not withdrawn from the market when the new product is launched. One of the earliest studies that compare single and dual product rollover is Levinthal and Purohit [12]. They develop a two-period model of a firm that sells the old product in the first-period and is able to introduce a new product in the second-period. They find that as the magnitude of product improvement of the new product increases, sales of the old product should be decreased. In other words, for a sufficiently large improvement, the firm chooses to stop selling the old product. Moorthy and Png [18] analyze a different product introduction timing issue, however, their work is closely related to dual product rollover. They compare the simultaneous and sequential introductions under two different scenarios and show that sequential introduction is better than simultaneous introduction when cannibalization is a problem. Additionally, when the seller cannot pre-commit, sequential selling is much less attractive.

Lim and Tang [15] develop a model that compares single and dual product rollover strategies and obtain analytical results. They also incorporate pricing decisions into their model. They firstly present the optimal pricing scheme and then discuss the optimal introduction timing for both rollover strategies. They find that it is optimal for the firm to choose a dual product rollover strategy when the marginal costs of the old and the new products are similar. Moreover, if the firm chooses a dual product rollover strategy, the optimal market share of each product depends on the marginal cost difference between the two products. They also find that when the dual product rollover strategy is optimal, the optimal duration for the firm to sell both products depends on the loyalty factors associated with both products. Li and Gao [14] extend the existing literature by considering coordination issues in supply chain context. They examine the value of information shared by the manufacturer with the retailer in a two-echelon setting. Their model simultaneously deals with product rollovers and upstream information about new-product introductions. They show that if the supply chain is coordinated, information sharing improves the performance of both supply chain entities. Additionally, under the optimal supply chain contract, the manufacturer would have no incentive to mislead the retailer about new-product introduction and when demand variability increases, information sharing becomes more crucial in terms of cost savings.

The problem parameters play an important role in the rollover strategy and introduction timing. In the marketing literature, considerable number of studies include only profit margins or profit per unit item, marginal costs. Kalish and Lilien [10], Wilson and Norton [22] and Lim and Tang [15] consider price and marginal cost of the product. The model developed in Mahajan and Muller [17] includes gross profit margins and discount factor. More recent papers, however, incorporate more parameters. Cohen et al. [6] consider marginal revenue and marginal cost and they explicitly model the product development process and its related parameters (e.g., speed of product improvement). They also include market parameters such as the size of the potential market and competitor product performance. They indicate how optimal introduction timing and its implied product performance targets vary with those factors. Liu and Ozer [16] define a profit rate with respect to performance gap and consider product replacement cost. Krankel et al.[11] make more detailed analysis by further taking into account the fixed cost of introduction, discount rate and certain market parameters in addition to the unit profit margin. In Li and Gao [14], retail, wholesale, buy-back prices as well as manufacturers salvage value, holding cost, profit sharing ratio, price protection rate are taken into consideration.

Most of the studies discussed above give no or less emphasis on the relationship between the liquidation of the on hand inventory of the old product and the optimal introduction timing of the new product. Main focus of our study is to examine this relationship under both product rollover strategies and to compare them. To do that, we model inventory related costs in detail. We consider holding cost and salvage value for each item that is kept in the inventory. Our study shows some similarities to Lim and Tang [15]. We also assume a finite selling period which we break into time zones and develop profit functions for each of them. The major difference with our study is that we assume stochastic demand, in particular Poisson distributed demand, whereas the demand is assumed to be deterministic in Lim and Tang [15]. Therefore, the maximization of expected profits is the objective function in our study. Also, our study incorporates the cannibalization issue in a detailed manner.

Chapter 3

Problem Definition and Model Formulation

Consider a firm which currently has a product in the market and is planning to introduce the upgraded version of the existing product. The optimal values of the introduction timing of the new product (T_n) and the withdrawal timing of the old (existing) product (T_o) over a finite time interval $[0, t]$ is of interest for the firm (T_n, $T_o \in [0, t]$). We assume that $T_n \leq T_o$ to make sure that there will be at least one product in the market during the entire time interval $[0, t]$. In other words, the firm sells either one or both of the products as long as it stays in the market.

We will consider two strategies related to the new product introduction. The first strategy is called "single product rollover" and the second one is called "dual product rollover". In "single product rollover", the introduction of the new product and the withdrawal of the old product are done simultaneously (i.e., $T_n = T_o = T$). In this strategy, the old product exists in the market during $[0, T]$ and the new product exists during $[T, t]$. In "dual product rollover", however, the new product is introduced prior to the old product is withdrawn from the market (i.e., $T_n < T_o$). This strategy deals with the case where both products coexist in the market during $[T_n, T_o]$, only the old product exists during $[0, T_n]$ and only the new product exists during $[T_o, t]$ (see Figure 3.1 and Figure 3.2). The different time zones will be referred to using index k. In the case of single product rollover, this index may attain values 1 and 2, corresponding to time intervals $[0, T]$ and $[T, t]$, respectively. Similarly, it may attain values 1, 2, and 3 corresponding to time intervals $[0, T_n]$, $[T_n, T_o]$ and $[T_o, t]$ in the case of dual product rollover.

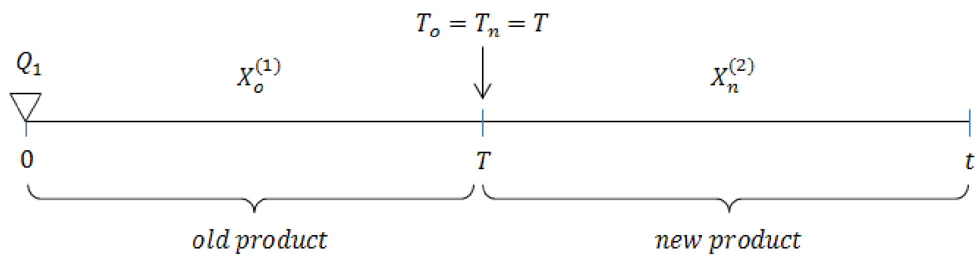

Figure 3.1: Time line of single product rollover

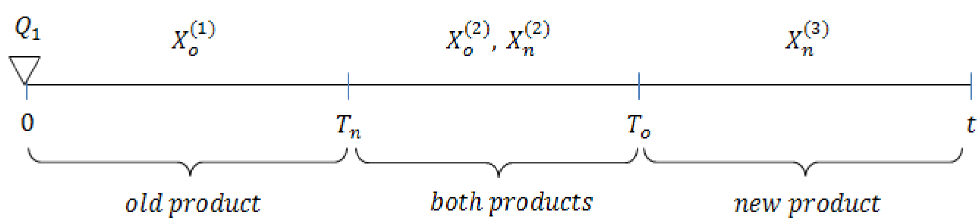

Figure 3.2: Time line of dual product rollover

The firm has a starting inventory (Q_1) of the old product and faces a random demand during the time that it is in the market (i.e., $[0, T_o]$). Since no replenishment opportunity is available, once the demand for the old product exceeds the starting inventory, the firm incurs a lost sale cost of $\$b_o$/unit. Conversely, if the demand for the old product is below the starting inventory, the firm salvages the remaining products with a salvage value of $\$v_o$/unit. For each product purchased (produced), the firm pays a procurement cost per unit and pays a fixed replenishment cost which is independent of the purchased (manufactured) quantity. However, we do not include those cost components for the old product in our expected profit function. The reason is that the time horizon of interest does not have to contain the time epoch when the fixed cost and the procurement cost are charged. The time horizon of interest may be "any time" after those costs are charged. Therefore, we assume that they are sunk costs. The procurement cost and the fixed ordering cost for the new product, however, are explicitly included in the expected profit function, because, (1) the order (production) quantity Q_2 of the new product is a decision variable, (2) the associated costs are incurred in the time horizon of interest. Each unit of product held in the inventory, costs \$$h_o$/unit/unit time. Same parameters are also defined for the new product. Table 3.1 summarizes the notation used in this thesis.

p_j :	Selling price of product j, $j = o, n$.
b_j :	Lost sale cost of product j, $j = o, n$.
h_j :	Inventory holding cost for product j, $j = o, n$.
c_j :	Procurement cost of product j, $j = o, n$.
v_j :	Salvage value of product j, $j = o, n$.
K_n :	Fixed cost of replenishment for the new product.
Q_1 :	On-hand inventory for the old product.
Q_2 :	On-hand inventory for the new product.
λ_o^k :	Demand rate of the old product in time zone k, $k = 1, 2$.
λ_n^k :	Demand rate of the new product in time zone k, $k = 2, 3$.
γ_o :	Portion of demand of the old product that is cannibalized by the new product.
γ_n :	Portion of demand of the new product that is cannibalized by the old product.
T_n :	Introduction time of the new product.
T_o :	Withdrawal time of the old product.
t :	Length of the selling period.
$X_o^{(1)}$:	Demand in the 1^{st} time zone, $[0, T_n]$ for the old product.
$X_o^{(2)}$:	Demand in the 2^{nd} time zone, $[T_n, T_o]$ for the old product.
$X_n^{(2)}$:	Demand in the 2^{nd} time zone, $[T_n, T_o]$ for the new product.
$X_n^{(3)}$:	Demand in the 3^{rd} time zone, $[T_o, t]$ for the new product.
$\Pi(Q_1, Q_2, T)$:	Total profit function of the firm (Single product rollover).
$\Pi_o(Q_1, T_o, T_n)$:	Profit function of the old product (Dual product rollover).
$\Pi_n(Q_2, T_o, T_n)$:	Profit function of the new product (Dual product rollover).
$\Pi(Q_1, Q_2, T_o, T_n)$:	Total profit function of the firm (Dual product rollover).

Table 3.1: Notation

Having defined the parameters of the problem, let us explain what the sequence of events are in both single and dual product rollover. In single product rollover, the firm carries an initial inventory (Q_1) of the old product at the begining of the selling period. Then, the firm decides on the timing of the introduction (withdrawal) of new (old) product. Once the timing decision is made, (the optimal) Q_2 is ordered. We assume that Q_2 is always available when the new product is introduced. The firm sells only the old product until the that time. It makes a revenue of $\$(p_o - c_o)$ for each product sold and incurs a cost at a rate of $\$h_o$ for each product that is hold in the inventory by the time they are sold. Depending on the demand, which is random, the firm either run out of stock or meets the demand exactly or end up with an excess inventory. If it runs out of stock, then for each excess demand it incurs a cost of b_o. If it ends up with excess inventory, it salvages it at $\$v_o$ immediately after the product is withdrawn from the market. The firm has a initial inventory (Q_2) of the new product just as the new product is introduced. Sequence of events are very similar for the new product.

In dual product rollover, the sequence of events described in the above paragraph are very similar. The major difference in this strategy is that the firm decides on both the introduction timing of the new product and the withdrawal timing of the old product besides the order quantity Q_2. In between the introduction of the new product and the withdrawal of the old product, both products are present in the market. When both products are in the market at the same time, they may cannibalize the sales (demand) of each other.

Regarding problem parameters, it is worth stating some conditions that make our models valid and make the problem reasonable. A very natural one is that the selling price of a product is greater than any kind of unit cost. Otherwise, it would not be even profitable for the firm to stay in the business. Moreover, in order for our model to be reasonable and realistic we assume that the salvage value is less than the procurement cost. This condition is quite reasonable and necessary because if the salvage value were greater than the procurement cost, then the firm would gain profit out of each lost sale which is not realistic. In this case, the optimal order quantity Q_2 would be infinity. Other than these, we do not have any other condition that need to be stated regarding our problem setting.

Our objective is to maximize the sum of the expected profits of both products over the interval $[0, t]$. The decision variables for the single product rollover case are T and Q_2 and the decision variables for the dual product rollover case are T_n, T_o and Q_2. T, T_n and T_o are defined as continuous variables over $[0, t]$, whereas Q_2 is defined over nonnegative integers.

Before we derive the expected profit function of the firm for both product rollover strategies, let us visit some earlier results that we will frequently utilize in our derivations. In developing the model for the single product rollover, we use a slightly different version of the expected profit function derived in Toptal and Çetinkaya [21]. We later present the function derived in Toptal and Çetinkaya [21] and the modifications we make in the following subsection. Now we present other useful results that we will utilize throughout this chapter. These results are related to the concept of *order statistics*.

(R1) (Ross [20], p.318) Given that $N(t) = n$, the n arrival times S_1,..., S_n have the same distribution as the order statistics corresponding to n independent random variables uniformly distributed on the interval $(0,\ t)$. Here, S_1, ..., S_n are the random variables showing the event (arrival) times of a Poisson process.

(R2) (Toptal and Çetinkaya [21]) Let $\overline{U}_1$, $\overline{U}_2$, ..., $\overline{U}_n$ be the order statistics of n i.i.d. random variables U_1, U_2, ..., U_n distributed uniformly over $(0,\ t)$. Then we have

$$E\left[\overline{U}_k\right] = \frac{kt}{n+1}\ , \quad 1 \leq k \leq n.$$

3.1 Single Product Rollover

The expected profit function under this scenario can be developed by deriving the expected profit functions associated with the first time zone $[0, T]$ and the second time zone $[T, t]$ and summing them up. The expected profit function for the first time zone is a special case of the expected profit function derived under Poisson demand in Toptal and Çetinkaya [21]. In this paper, the authors analyze the supply and exit decisions under a price skimming strategy for a new product. As opposed to ours, the existence of a single product over a single period is modeled. The product's selling price is initially set to p, and it is gradually decreased at a rate of β over time in accordance with a price skimming strategy. The procurement cost per unit is c, and a fixed cost of K is incurred as development costs for the new product. Similar to ours, unsold items are salvaged at $v per unit. There is a stockout cost of $b for each unit of unsatisfied demand and an inventory holding cost of $h for each item that stays in inventory for a unit time. Using our notation, the expected profits as a function of order quantity Q and length of selling period T in Toptal and Çetinkaya [21] are given by:

$$\begin{aligned}
&\Pi(Q,\ T) = -cQ - K.\kappa(Q) \\
&+ \sum_{i=0}^{Q} \left(pi - \frac{\beta iT}{2} + \frac{hiT}{2} - QhT + (Q-i)v \right) P\{X_o^{(1)} = i\} \\
&+ \sum_{i=Q+1}^{\infty} \left(pQ - \frac{\beta Q(Q+1)T}{2(i+1)} - \frac{hQ(Q+1)T}{2(i+1)} - (i-Q)b \right) P\{X_o^{(1)} = i\}.
\end{aligned}$$

where $\kappa(Q)$ is equal to 1 if $Q > 0$ and is equal to 0 if $Q = 0$.

In our model, we do not consider any reduction in the price of either product. Therefore, for the expected profit funtion of the old product, we use this expression where $\beta = 0$. Additionally, we do not subtract procurement cost and fixed cost because as, we stated earlier, we assume them to be sunk costs.

For the expected profit function associated with the second interval, a very similar expression to that of the first interval can be used with a slight modification. For a given introduction time T, two intervals are independent of each other and almost identical in terms of the structure of expected profit functions. The only structural difference between the two arises from the fact that they are defined over different time intervals. This affects only the terms which are functions of T. The expected profit function for the second interval is actually the same as the one derived in Toptal and Çetinkaya [21] except that T is replaced by $(t-T)$ and, of course, appropriate parameters are used. Therefore, the expected profit function over $[0, t]$ is

$$\Pi(Q_1, Q_2, T) = \sum_{k=0}^{Q_1} \left(p_o k + \frac{h_o k T}{2} - Q_1 h_o T + (Q_1 - k) v_o \right) P\{X_o^{(1)} = k\}$$
$$+ \sum_{k=Q_1+1}^{\infty} \left(p_o Q_1 - \frac{h_o Q_1 (Q_1 + 1) T}{2(k+1)} - (k - Q_1) b_o \right) P\{X_o^{(1)} = k\}$$
$$+ \sum_{m=0}^{Q_2} \left(p_n m + \frac{h_n m (t - T)}{2} - Q_2 h_n (t - T) + (Q_2 - m) v_n \right) P\{X_n^{(2)} = m\}$$
$$+ \sum_{m=Q_2+1}^{\infty} \left(p_n Q_2 - \frac{h_n Q_2 (Q_2 + 1)(t - T)}{2(m+1)} - (m - Q_2) b_n \right) P\{X_n^{(2)} = m\}$$
$$- c_n Q_2 - K_n . \kappa(Q_2). \tag{3.1}$$

where $\kappa(Q_2)$ is equal to 1 if $Q_2 > 0$ and is equal to 0 if $Q_2 = 0$. Thus, the fixed cost is included in the expected profit only if the firm orders a positive amount of Q_2.

As noted earlier, we assume the demand arrival process to be a Poisson process. Therefore, in the above expression, $P\{X_o^{(1)} = k\} = \frac{(\lambda_o^{(1)} T)^k}{k!} \cdot e^{-\lambda_o^{(1)} T}$ and $P\{X_n^{(2)} = m\} = \frac{(\lambda_n^{(2)} (t-T))^m}{m!} \cdot e^{-\lambda_n^{(2)} (t-T)}$.

3.2 Dual Product Rollover

Our strategy for developing the expected profit function for this scenario is as follows. First of all, we derive the expected profit function for the old product, which stays in the market during periods $[0, T_n]$ and $[T_n, T_o]$, by decomposing it into smaller components, namely expected salvage value, expected lost sale cost, expected revenue and expected holding cost. We derive expressions for these components individually and then sum them up to obtain the expected profit function for the old product. Having derived the expected profit function for the old product, we utilize a similar expression, after some modifications for the new product. That is, the steps that are followed to derive the expected profit function are the same. Only major difference between the expected profit functions of the old and the new product stems from the fact that they stay in the market in different periods of time, $[T_n, T_o]$ and $[T_o, t]$. Therefore, demand distributions will be different. Finally, we sum the expected profit function for the old and the new product to obtain the expected profit function of the firm over all of the selling period, $[0, t]$.

From now on, all the derivations made are for the old product. It will be stated clearly when we derive the expected profit function for the new product.

Our methodology to derive the expression for expected profit function is based on conditioning. We condition on the demand in the first time zone, $X_o^{(1)}$, to derive the expected profit function for the old product. Note that the old product is in the market during the first and the second time zones, $[0, T_n]$ and $[T_n, T_o]$. Therefore, we may also condition on the demand in the second time zone, $X_o^{(2)}$, if necessary.

We begin by deriving the expression for expected salvage value. If demand during the first time zone is at least as large as the initial stock (i.e., $X_o^{(1)} \geq Q_1$), then the firm gains more revenue from salvaging the old product, because firm does not have any excess amount of this product at time T_o. Therefore, salvage value is 0, if $X_o^{(1)} \geq Q_1$. If demand during the first time zone is less than the initial stock (i.e., $X_o^{(1)} < Q_1$), then salvage value depends on the demand in the second time zone $[T_n, T_o]$. If demand in the second time zone is greater than or equal to the remaining stock (i.e., $X_o^{(2)} \geq Q_1 - X_o^{(1)}$), then the salvage value is again 0 because no item is left on hand at time T_o. However, if demand in the second time zone is less than the remaining stock (i.e., $X_o^{(2)} < Q_1 - X_o^{(1)}$), then we have $Q_1 - X_o^{(1)} - X_o^{(2)}$ unsold items to be salvaged at time T_o. Therefore, salvage value is $v_o[Q_1 - X_o^{(1)} - X_o^{(2)}]^+$ if $X_o^{(1)} \leq Q_1$, where $[\ \cdot\ ]^+ = max\{\cdot, 0\}$. We can write the expected salvage value as

$$\begin{aligned} E[\text{salvage value}] &= E[\text{salvage value}|X_o^{(1)} < Q_1]P\{X_o^{(1)} < Q_1\} \\ &\quad + E[\text{salvage value}|X_o^{(1)} \geq Q_1]P\{X_o^{(1)} \geq Q_1\}. \\ &= \sum_{k=0}^{Q_1-1} E[\text{salvage value}|X_o^{(1)} = k]P\{X_o^{(1)} = k\}. \end{aligned}$$

since $E[\text{salvage value}|X_o^{(1)} \geq Q_1] = 0$. Therefore,

$$E[\text{salvage value}] = \sum_{k=0}^{Q_1-1} v_o E[(Q_1 - k - X_o^{(2)})^+]P\{X_o^{(1)} = k\}.$$

We need to derive $E[(Q_1 - k - X_o^{(2)})^+]$ and plug it in above equation to get the expression for expected salvage value.

$$E[(Q_1 - k - X_o^{(2)})^+] = \sum_{j=0}^{Q_1-k-1} E[(Q_1 - k - X_o^{(2)})^+|X_o^{(2)} = j]P\{X_o^{(2)} = j\}.$$

since $E[(Q_1 - k - X_o^{(2)})^+] = 0$ if $X_o^{(2)} \geq Q_1 - k$. Then, we have

$$E[(Q_1 - k - X_o^{(2)})^+] = \sum_{j=0}^{Q_1-k-1} (Q_1 - k - j)P\{X_o^{(2)} = j\}.$$

Therefore, expected salvage value can be written as

$$E[\text{salvage value}] = v_o \sum_{k=0}^{Q_1-1} \sum_{j=0}^{Q_1-k-1} (Q_1 - k - j)P\{X_o^{(2)} = j\}P\{X_o^{(1)} = k\}. \tag{3.2}$$

We derive the expression for the expected lost sale cost in a similar fashion. If demand during the first time zone is at least as large as the initial stock (i.e., $X_o^{(1)} \geq Q_1$), then for each product demanded after all of the initial stock has finished, the firm pays a lost sale cost. Moreover, since all of the initial stock has finished in the first time zone, there will not be any for the second time zone $[T_n, T_o]$. In other words, all of the demand will be lost in this period. Therefore, the lost sale cost for this case can be written as $b_o\left((X_o^{(1)} - Q_1) + X_o^{(2)}\right)$. If demand during the first time zone is less than the initial stock (i.e., $X_o^{(1)} < Q_1$), then firm pays a lost sale cost if demand during the second period, $X_o^{(2)}$, is greater than the remaining stock, $Q_1 - X_o^{(1)}$. Therefore, lost sale cost in this case can be written as $b_o\left(X_o^{(2)} - (Q_1 - X_o^{(1)})\right)^+$, where $[\,\cdot\,]^+ = max\{\cdot, 0\}$. We can write the expected lost sale cost as

$$\begin{aligned} E[\text{Lost sale cost}] = b_o \sum_{k=0}^{Q_1-1} & E[(X_o^{(2)} - (Q_1 - X_o^{(1)}))^+ | X_o^{(1)} = k] P\{X_o^{(1)} = k\} \\ & + b_o \sum_{k=Q_1}^{\infty} E[X_o^{(1)} - Q_1 + X_o^{(2)} | X_o^{(1)} = k] P\{X_o^{(1)} = k\}. \\ = b_o \sum_{k=0}^{Q_1-1} & E[(X_o^{(2)} - (Q_1 - k))^+] P\{X_o^{(1)} = k\} \\ & + b_o \sum_{k=Q_1}^{\infty} E[k - Q_1 + X_o^{(2)}] P\{X_o^{(1)} = k\}. \end{aligned}$$

The simplifications in conditional expectation terms follow from the fact that $X_o^{(1)}$ and $X_o^{(2)}$ are independent random variables. Therefore, expected lost sale cost can be further simplified as

$$\begin{aligned} E[\text{Lost sale cost}] &= b_o \sum_{k=0}^{Q_1-1} E[(X_o^{(2)} - (Q_1 - k))^+] P\{X_o^{(1)} = k\} \\ &\quad + b_o \sum_{k=Q_1}^{\infty} \left(k - Q_1 + E[X_o^{(2)}]\right) P\{X_o^{(1)} = k\}. \\ &= b_o \sum_{k=0}^{Q_1-1} E[(X_o^{(2)} - (Q_1 - k))^+] P\{X_o^{(1)} = k\} \\ &\quad + b_o \sum_{k=Q_1}^{\infty} \left(k - Q_1 + \lambda_o^{(2)}(T_o - T_n)\right) P\{X_o^{(1)} = k\}. \end{aligned}$$

Now, we need to derive $E[(X_o^{(2)} - (Q_1 - k))^+]$ to get the expression for expected lost sale cost.

$$\begin{aligned} E[(X_o^{(2)} - (Q_1 - k))^+] &= E[(X_o^{(2)} - (Q_1 - k))^+ | X_o^{(2)} \le Q_1 - k] P\{X_o^{(2)} \le Q_1 - k\} \\ &\quad + E[(X_o^{(2)} - (Q_1 - k))^+ | X_o^{(2)} > Q_1 - k] P\{X_o^{(2)} > Q_1 - k\}. \\ &= \sum_{j=Q_1-k+1}^{\infty} (j - Q_1 - k)\, P\{X_o^{(2)} = j\}. \end{aligned}$$

since $E[(X_o^{(2)} - (Q_1 - k))^+ | X_o^{(2)} \leq Q_1 - k] = 0$. Therefore, we have

$$E[\text{Lost sale cost}] = b_o \sum_{k=0}^{Q_1-1} \sum_{j=Q_1-k+1}^{\infty} (j - Q_1 - k)\, P\{X_o^{(2)} = j\} P\{X_o^{(1)} = k\} + b_o \sum_{k=Q_1}^{\infty} \left(k - Q_1 + \lambda_o^{(2)}(T_o - T_n)\right) P\{X_o^{(1)} = k\}. \tag{3.3}$$

To derive an expression for the expected revenue, we go through similar steps as we did earlier. We will condition on demand in the first time zone, $X_o^{(1)}$. If demand is at least as large as the initial stock (i.e., $X_o^{(1)} \geq Q_1$), then the revenue that the firm makes is $p_o Q_1$ regardless of the demand in the second time zone. All of the demand in the second time zone is lost in this case. However, if demand in the first time zone is less than the initial stock (i.e., $X_o^{(1)} < Q_1$), then the revenue that the firm makes depends on demand in the second time zone. If demand in the the second time zone plus demand in the first time zone is at least as large as the initial stock (i.e., $X_o^{(1)} + X_o^{(2)} \geq Q_1$), then firm gains $p_o Q_1$. If demand in the second time zone plus demand in the first time zone is less than the initial stock (i.e., $X_o^{(1)} + X_o^{(2)} < Q_1$), then the firm gains $p_o \left(X_o^{(1)} + X_o^{(2)}\right)$. Therefore, if demand in the first time zone is less than the initial stock $\left(X_o^{(1)} < Q_1\right)$, then the firm gains $p_o \cdot min\{Q_1,\ (X_o^{(1)} + X_o^{(2)})\}$. We can write expected revenue as

$$\begin{aligned} E[\text{Revenue}] &= E[\text{Revenue}|X_o^{(1)} < Q_1]P\{X_o^{(1)} < Q_1\} \\ &\quad + E[\text{Revenue}|X_o^{(1)} \geq Q_1]P\{X_o^{(1)} \geq Q_1\}. \\ &= \sum_{k=0}^{Q_1-1} p_o E[min\{Q_1,\ X_o^{(1)} + X_o^{(2)}\}|X_o^{(1)} = k]P\{X_o^{(1)} = k\} \\ &\quad + \sum_{k=Q_1}^{\infty} p_o E[min\{Q_1,\ X_o^{(1)} + X_o^{(2)}\}|X_o^{(1)} = k]P\{X_o^{(1)} = k\}. \\ &= \sum_{k=0}^{Q_1-1} p_o E[min\{Q_1,\ k + X_o^{(2)}\}]P\{X_o^{(1)} = k\} + \sum_{k=Q_1}^{\infty} p_o Q_1 P\{X_o^{(1)} = k\}. \end{aligned}$$

Again, in obtaining the last expression, we use the independence of $X_o^{(1)}$ and $X_o^{(2)}$.

Now, we need to derive $E[min\{Q_1,\ k+X_o^{(2)}\}]$ which is

$$E[min\{Q_1, k+X_o^{(2)}\}] = \sum_{j=0}^{Q_1-k-1}(k+j)P\{X_o^{(2)}=j\} + \sum_{j=Q_1-k}^{\infty} Q_1 P\{X_o^{(2)}=j\}.$$

Therefore, expected revenue can be written as

$$\begin{aligned}
&E[\text{Revenue}] = \\
&+ p_o \sum_{k=0}^{Q_1-1}\left(\sum_{j=0}^{Q_1-k-1}(k+j)P\{X_o^{(2)}=j\} + \sum_{j=Q_1-k}^{\infty} Q_1 P\{X_o^{(2)}=j\}\right) P\{X_o^{(1)}=k\} \\
&+ \sum_{k=Q_1}^{\infty} p_o Q_1 P\{X_o^{(1)}=k\}. \\
&= p_o \sum_{k=0}^{Q_1-1}\sum_{j=0}^{Q_1-k-1}(k+j)P\{X_o^{(2)}=j\}P\{X_o^{(1)}=k\} \\
&+ \sum_{k=0}^{Q_1-1}\sum_{j=Q_1-k}^{\infty} p_o Q_1 P\{X_o^{(2)}=j\}P\{X_o^{(1)}=k\} + \sum_{k=Q_1}^{\infty} p_o Q_1 P\{X_o^{(1)}=k\}.
\end{aligned} \tag{3.4}$$

To derive an expression for the expected holding cost, our methodology is again conditioning on demand in the first time zone, $X_o^{(1)}$. We will find an expression for E[Holding cost] by using the following formula:

$$\begin{aligned}
E[\text{Holding cost}] = &\sum_{k=0}^{Q_1-1} E[\text{Holding cost}|X_o^{(1)}=k]P\{X_o^{(1)}=k\} \\
&+ \sum_{k=Q_1}^{\infty} E[\text{Holding cost}|X_o^{(1)}=k]P\{X_o^{(1)}=k\}.
\end{aligned} \tag{3.5}$$

We first examine the case where demand in the first time zone is at least as large as initial stock ($X_o^{(1)} \geq Q_1$). In this case, all of the initial stock depletes in the first time zone and the firm incurs a holding cost of $\sum_{i=1}^{Q_1} h_o S_i$ where S_i is the arrival time of the i^{th} demand. Recall that h_o is holding cost/unit/unit-time and that is the reason why we use the arrival times in the calculation of holding cost.

For $X_o^{(1)} \geq Q_1$, we have

$$\sum_{k=Q_1}^{\infty} E[\text{Holding cost}|X_o^{(1)} = k]P\{X_o^{(1)} = k\}$$
$$= \sum_{k=Q_1}^{\infty} E\left[\sum_{i=1}^{Q_1} h_o S_i \middle| X_o^{(1)} = k\right] P\{X_o^{(1)} = k\}.$$
$$= \sum_{k=Q_1}^{\infty} h_o \sum_{i=1}^{Q_1} E\left[S_i|X_o^{(1)} = k\right] P\{X_o^{(1)} = k\}.$$
$$= \sum_{k=Q_1}^{\infty} h_o \sum_{i=1}^{Q_1} E\left[\overline{U}_i\right] P\{X_o^{(1)} = k\}.$$

where $\overline{U}_i$ is the i^{th} order statistic of the i.i.d uniform random variables $U_1, U_2, \ldots, U_k$ distributed over $[0, T_n]$. Therefore,

$$\sum_{k=Q_1}^{\infty} E[\text{Holding cost}|X_o^{(1)} = k]P\{X_o^{(1)} = k\} = \sum_{k=Q_1}^{\infty} \left(h_o \sum_{i=1}^{Q_1} \frac{i \cdot T_n}{(k+1)}\right) P\{X_o^{(1)} = k\}.$$

Above expression follows from the results (R1) and (R2) that we mentioned earlier. We can further simplify the expression as

$$\sum_{k=Q_1}^{\infty} \left(h_o \sum_{i=1}^{Q_1} \frac{i \cdot T_n}{(k+1)}\right) P\{X_o^{(1)} = k\} = \sum_{k=Q_1}^{\infty} \left(h_o \frac{T_n}{(k+1)} \sum_{i=1}^{Q_1} i\right) P\{X_o^{(1)} = k\}.$$
$$= \sum_{k=Q_1}^{\infty} \left(h_o \frac{Q_1(Q_1+1)T_n}{2(k+1)}\right) P\{X_o^{(1)} = k\}.$$
$$= h_o \frac{Q_1(Q_1+1)T_n}{2} \sum_{k=Q_1}^{\infty} \frac{1}{(k+1)} \cdot P\{X_o^{(1)} = k\}.$$

Having defined the expression for expected holding cost in the case of $X_o^{(1)} \geq Q_1$, another case which we shall consider is the case $X_o^{(1)} < Q_1$. Given that $X_o^{(1)} < Q_1$, expected holding cost can be calculated as

$$\sum_{k=0}^{Q_1-1} E[\text{Holding cost}|X_o^{(1)} = k]P\{X_o^{(1)} = k\}.$$

We need to derive $E[\text{Holding cost}|X_o^{(1)} = k]$. To do that, we condition on the demand in the second time zone, $X_o^{(2)}$.

$$E[\text{Holding cost}|X_o^{(1)} = k] = \sum_{j=0}^{\infty} E[\text{Holding cost}|X_o^{(1)} = k, X_o^{(2)} = j]P\{X_o^{(2)} = j\}.$$

$$= E[\text{Holding cost}|X_o^{(1)} = k, X_o^{(2)} = 0]P\{X_o^{(2)} = 0\}$$
$$+ \sum_{j=1}^{Q_1-k} E[\text{Holding cost}|X_o^{(1)} = k, X_o^{(2)} = j]P\{X_o^{(2)} = j\}$$
$$+ \sum_{j=Q_1-k+1}^{\infty} E[\text{Holding cost}|X_o^{(1)} = k, X_o^{(2)} = j]P\{X_o^{(2)} = j\}.$$

Since $X_o^{(1)}$ and $X_o^{(2)}$ are independent, $P\{X_o^{(2)} = j|X_o^{(1)} = k\} = P\{X_o^{(2)} = j\}$. Hence the above expression follows.

Consider the case where no demand arrives in the second time zone ($X_o^{(2)} = 0$). Also, recall that the demand realized in the first time zone is less than the initial stock ($X_o^{(1)} < Q_1$). Therefore, at the end of the selling period–at time T_o–the firm has $(Q_1 - X_o^{(1)})$ items left on hand which has not been sold, and therefore, has been hold in the inventory throughout whole selling period. Thus, the firm incurs a holding cost of $h_o(Q_1 - X_o^{(1)})T_o$. In addition, the firm incurs a holding cost for sold items, too. For a sold item, firm incurs a cost for holding it in the inventory until it is sold. Thus, holding cost of sold items can be calculated as $\sum_{i=1}^{X_o^{(1)}} h_o S_i$ where S_i's are the arrival times of demands. Overall, firm incurs a total of $h_o\left(\sum_{i=1}^{X_o^{(1)}} S_i + (Q_1 - X_o^{(1)})T_o\right)$.

Suppose that demand in the second time zone is less than or equal to the remaining inventory at the beginning of second period, i.e., $0 < X_o^{(2)} \leq Q_1 - X_o^{(1)}$. Then, in this case, firm holds some of the items in the inventory throughout whole selling period. For those items, firm incurs a cost of $h_o(Q_1 - X_o^{(1)} - X_o^{(2)})T_o$. For the sold items, the same reasoning in the previous paragraph applies here. For the items sold in the first time zone, firm incurs a cost of $\sum_{i=1}^{X_o^{(1)}} h_o S_i$ and, similarly, for the items sold in the second time zone it incurs a cost of $\sum_{l=1}^{X_o^{(2)}} h_o(T_n + T_l)$ where T_l's denote the time until the arrival of l^{th} demand after T_n. For instance, the arrival time of the first event after T_n is $T_n + T_1$. Similarly, the arrival time of the second event after T_n is $T_n + T_2$.

Finally, if demand in the second time zone exceeds the remaining inventory at the beginning of second period, then this means all of the initial stock has been sold during the selling period. Therefore, firm does not have any inventory left at the end of the selling period (i.e., at time T_o). In this setting, firm incurs a cost for holding the items until they are sold. Holding cost for those items can be calculated as $\sum_{i=1}^{X_o^{(1)}} h_o S_i + \sum_{l=1}^{Q_1 - X_o^{(1)}} h_o (T_n + T_l)$ where definition of T_l's are the same as those in the previous paragraph.

In light of above discussion, expected holding cost when the demand in the first time zone is less than the initial stock, (i.e., $X_o^{(1)} < Q_1$), can be calculated as

$$
\begin{aligned}
& E\left[h_o \sum_{i=1}^{X_o^{(1)}} S_i + h_o (Q_1 - X_o^{(1)}) T_o \,\middle|\, X_o^{(1)} = k, X_o^{(2)} = 0 \right] P\{X_o^{(2)} = 0\} \\
& + \sum_{j=1}^{Q_1 - k} E\left[h_o \sum_{i=1}^{X_o^{(1)}} S_i + h_o \sum_{l=1}^{X_o^{(2)}} (T_n + T_l) \,\middle|\, X_o^{(1)} = k, X_o^{(2)} = j \right] P\{X_o^{(2)} = j\} \\
& + \sum_{j=1}^{Q_1 - k} E\left[h_o (Q_1 - X_o^{(1)} - X_o^{(2)}) T_o \,\middle|\, X_o^{(1)} = k, X_o^{(2)} = j \right] P\{X_o^{(2)} = j\} \\
& + \sum_{j=Q_1 - k + 1}^{\infty} E\left[h_o \sum_{i=1}^{X_o^{(1)}} S_i + h_o \sum_{l=1}^{Q_1 - X_o^{(1)}} (T_n + T_l) \,\middle|\, X_o^{(1)} = k, X_o^{(2)} = j \right] P\{X_o^{(2)} = j\}.
\end{aligned}
\tag{3.6}
$$

We need to derive expressions for the conditional expectations in the above equation. We start with the first one which is

$$
E\left[h_o \sum_{i=1}^{X_o^{(1)}} S_i + h_o (Q_1 - X_o^{(1)}) T_o \,\middle|\, X_o^{(1)} = k, X_o^{(2)} = 0 \right].
$$

Note that the holding cost in this case is independent of the event that $\{X_o^{(2)} = 0\}$. Therefore, above expression reduces to

$$E\left[h_o \sum_{i=1}^{X_o^{(1)}} S_i + h_o(Q_1 - X_o^{(1)})T_o \;\middle|\; X_o^{(1)} = k\right] = E\left[h_o \sum_{i=1}^{X_o^{(1)}} S_i \;\middle|\; X_o^{(1)} = k\right]$$
$$+ E\left[h_o(Q_1 - X_o^{(1)})T_o \;\middle|\; X_o^{(1)} = k\right].$$
$$= h_o E\left[\sum_{i=1}^{k} S_i \;\middle|\; X_o^{(1)} = k\right] + h_o(Q_1 - k)T_o.$$
$$= h_o E\left[\sum_{i=1}^{k} \overline{U}_i\right] + h_o(Q_1 - k)T_o.$$

where $\overline{U}_i$ is the i^{th} order statistic of i.i.d. uniform random variables U_1, ..., U_k defined over $[0, T_n]$ (see (R1)). We can rewrite the above expression as

$$h_o E\left[\sum_{i=1}^{k} U_i\right] + h_o(Q_1 - k)T_o.$$

We can replace $\overline{U}_i$ with U_i since the summation of random variables does not depend on whether they are ordered or not. Therefore,

$$E\left[h_o \sum_{i=1}^{X_o^{(1)}} S_i + h_o(Q_1 - X_o^{(1)})T_o \;\middle|\; X_o^{(1)} = k\right] = h_o E\left[\sum_{i=1}^{k} U_i\right] + h_o(Q_1 - k)T_o.$$
$$= h_o \cdot k \cdot \frac{T_n}{2} + h_o(Q_1 - k)T_o.$$

Now, we shall derive an expression for the following expectation which is the second term in (3.6).

$$E\left[h_o \sum_{i=1}^{X_o^{(1)}} S_i + h_o \sum_{l=1}^{X_o^{(2)}} (T_n + T_l) + h_o(Q_1 - X_o^{(1)} - X_o^{(2)})T_o \;\middle|\; X_o^{(1)} = k, X_o^{(2)} = j\right].$$

Note that above expectation is valid under the assumption that $1 \leq X_o^{(2)} \leq Q_1 - k$. We can write it as

$$h_o E\left[\sum_{i=1}^{X_o^{(1)}} S_i \middle| X_o^{(1)} = k\right] + h_o E\left[\sum_{l=1}^{X_o^{(2)}} (T_n + T_l) \middle| X_o^{(2)} = j\right] + h_o E\left[(Q_1 - k - j)T_o\right]$$

by using the independence of $X_o^{(1)}$ and $X_o^{(2)}$ and of $X_o^{(1)}$ and T_l, and $X_o^{(2)}$ and S_i. This gives us

$$h_o E\left[\sum_{i=1}^{k} \overline{U}_i\right] + h_o \cdot j \cdot T_n + h_o E\left[\sum_{l=1}^{j} \overline{V}_l\right] + h_o(Q_1 - k - j)T_o$$

where $\overline{U}_i$ is the i^{th} order statistic of i.i.d. uniform random variables U_1, ..., U_k defined over $[0, T_n]$ and $\overline{V}_l$ is the l^{th} order statistic of i.i.d. uniform random variables V_1, ..., V_j defined over $[T_n, T_o]$ (see (R1)). Then, we have

$$h_o E\left[\sum_{i=1}^{k} U_i\right] + h_o \cdot j \cdot T_n + h_o E\left[\sum_{l=1}^{j} V_l\right] + h_o(Q_1 - k - j)T_o$$

which is equal to

$$h_o \cdot k \cdot \frac{T_n}{2} + h_o \cdot j \cdot T_n + h_o \cdot j \cdot \frac{(T_o - T_n)}{2} + h_o(Q_1 - k - j)T_o.$$

So far, we have derived the expressions for the first two conditional expectations in (3.6). As the last step, we need to derive the expression for the third conditional expectation in (3.6). Note that this expectation has been derived under the assumption that $X_o^{(2)} > Q_1 - k$. Therefore, we have

$$\begin{aligned}
E\left[h_o \sum_{i=1}^{X_o^{(1)}} S_i + \sum_{l=1}^{Q_1 - X_o^{(1)}} (T_n + T_l) \;\middle|\; X_o^{(1)} = k, X_o^{(2)} = j\right] &= h_o E\left[\sum_{i=1}^{k} S_i \middle| X_o^{(1)} = k\right] \\
&\quad + h_o E\left[\sum_{l=1}^{Q_1 - k} (T_n + T_l) \;\middle|\; X_o^{(2)} = j\right]. \\
&= h_o E\left[\sum_{i=1}^{k} \overline{U}_i\right] + h_o(Q_1 - k)T_n + h_o E\left[\sum_{l=1}^{Q_1 - k} \overline{V}_l\right]. \\
&= h_o E\left[\sum_{i=1}^{k} U_i\right] + h_o(Q_1 - k)T_n + h_o \sum_{l=1}^{Q_1 - k} E\left[\overline{V}_l\right]. \\
&= h_o \cdot k \cdot \frac{T_n}{2} + h_o(Q_1 - k)T_n + h_o \sum_{l=1}^{Q_1 - k} \frac{l(T_o - T_n)}{(j+1)}. \\
&= h_o \cdot k \cdot \frac{T_n}{2} + h_o(Q_1 - k)T_n + h_o \cdot \frac{(Q_1 - k)(Q_1 - k + 1)}{2} \cdot \frac{(T_o - T_n)}{(j+1)}.
\end{aligned}$$

We have derived all of the three conditional expectations in (3.6). Now, we can plug them in to get the expression for $E[\text{Holding cost}|X_o^{(1)} = k]$. As a result of some algebraic manipulations, we get the the following expression.

$$
\begin{aligned}
&E[\text{Holding cost}|X_o^{(1)} = k] = h_o \cdot k \cdot \frac{T_n}{2} \\
&+ h_o(Q_1 - k)T_o P\{X_o^{(2)} = 0\} + \sum_{j=1}^{Q_1-k} h_o T_n \cdot j P\{X_o^{(2)} = j\} \\
&+ \sum_{j=1}^{Q_1-k} \left(\frac{h_o(T_o - T_n)}{2} \cdot j + h_o(Q_1 - k - j)T_o \right) P\{X_o^{(2)} = j\} \\
&+ \sum_{j=Q_1-k+1}^{\infty} h_o(Q_1 - k)T_n P\{X_o^{(2)} = j\} \\
&+ \sum_{j=Q_1-k+1}^{\infty} \frac{h_o(Q_1 - k)(Q_1 - k + 1)(T_o - T_n)}{2} \cdot \frac{1}{(j+1)} P\{X_o^{(2)} = j\}.
\end{aligned}
$$

Finally, in order to be able to find the expression for the expected holding cost, we need to plug $E[\text{Holding cost}|X_o^{(1)} = k]$ into (3.5). As a result, we have

$$
\begin{aligned}
&E[\text{Holding cost}] = h_o \cdot \frac{T_n}{2} \sum_{k=0}^{Q_1-1} k P\{X_o^{(1)} = k\} \\
&+ \sum_{k=0}^{Q_1-1} \sum_{j=0}^{Q_1-k} h_o T_n j P\{X_o^{(2)} = j\} P\{X_o^{(1)} = k\} \\
&+ \sum_{k=0}^{Q_1-1} \sum_{j=0}^{Q_1-k} \left(\frac{h_o(T_o - T_n)}{2} \cdot j + h_o(Q_1 - k - j)T_o \right) P\{X_o^{(2)} = j\} P\{X_o^{(1)} = k\} \\
&+ \sum_{k=0}^{Q_1-1} \sum_{j=Q_1-k+1}^{\infty} h_o(Q_1 - k)T_n P\{X_o^{(2)} = j\} P\{X_o^{(1)} = k\} \\
&+ \sum_{k=0}^{Q_1-1} \sum_{j=Q_1-k+1}^{\infty} \frac{h_o(Q_1 - k)(Q_1 - k + 1)(T_o - T_n)}{2} \cdot \frac{1}{(j+1)} P\{X_o^{(2)} = j\} P\{X_o^{(1)} = k\} \\
&+ h_o \frac{Q_1(Q_1 + 1)T_n}{2} \sum_{k=Q_1}^{\infty} \frac{1}{(k+1)} \cdot P\{X_o^{(1)} = k\}.
\end{aligned}
\tag{3.7}
$$

We have derived the expressions for the cost/revenue components to be used in the expression for the expected profit function for the old product. By using those expressions, we can simply write the expected profit function for the old product as

$$E[\text{Profit}] = E[\text{Revenue}] + E[\text{Salvage value}] - E[\text{Lost sale cost}] - E[\text{Holding cost}].$$

As a function of Q_1, T_o and T_n, the expected profit function, $\Pi_o(Q_1, T_o, T_n)$, can be written as

$$\begin{aligned}\Pi_o(Q_1, T_o, T_n) &= \sum_{k=0}^{Q_1-1}\sum_{j=0}^{Q_1-k} f_o(k,j)P\{X_o^{(2)} = j\}P\{X_o^{(1)} = k\} \\ &+ \sum_{k=0}^{Q_1-1}\sum_{j=Q_1-k+1}^{\infty} g_o(k,j)P\{X_o^{(2)} = j\}P\{X_o^{(1)} = k\} \\ &- \sum_{k=0}^{Q_1-1}\frac{h_oT_n}{2}kP\{X_o^{(1)} = k\} + \sum_{k=Q_1}^{\infty} h_o(k)P\{X_o^{(1)} = k\}\end{aligned} \tag{3.8}$$

where

$$f_o(k,j) = v_o(Q_1 - k - j) + p_o(k+j) + h_o\frac{(T_o - T_n)}{2}\cdot j - h_o(Q_1 - k)T_o$$

and

$$\begin{aligned}g_o(k,j) = p_oQ_1 - b_o(j - Q_1 - k) - h_o(Q_1 - k)T_n \\ - \frac{h_o(Q_1-k)(Q_1-k+1)}{2}\frac{(T_o - T_n)}{(j+1)}\end{aligned}$$

and

$$h_o(k) = p_oQ_1 - b_o(k - Q_1 + \lambda_o^{(2)}(T_o - T_n)) - \frac{h_oQ_1(Q_1+1)T_n}{2(k+1)}.$$

The derivation of the expected profit function for the new product is very similar. All of the steps that have been gone through need to be repeated for the new product. One of the differences in this case is that the new product will be in the market during the second and the third time zones, $[T_n, T_o]$ and $[T_o, t]$, and therefore, the distribution of demand that the firm faces will be different. With a minor adjustment, we can handle this easily. Recall that the expected profit for the old product has been derived by conditioning on demand during first two time zones, $X_o^{(1)}$ and $X_o^{(2)}$. For the new product, we need to condition on the demands during second and the third time zones which are $X_n^{(2)}$ and $X_n^{(3)}$. Therefore, if we replace $X_o^{(1)}$ with $X_n^{(2)}$ and $X_o^{(2)}$ with $X_n^{(3)}$, then we will be done.

Another issue that we should mention before writing the expected profit function for the new product is that we have two more cost components associated with the new product. We consider procurement cost c_n and fixed ordering cost K_n of the new product explicitly in our model. Recall that we assumed, at the beginning of this chapter, procurement cost and fixed ordering cost of the old product as sunk costs. Therefore, we did not write these costs explicitly in (3.8). However, we do not assume procurement cost and fixed ordering cost of the new product as sunk costs. Therefore, we need to incorporate these two cost components in our model. Firm incurs a cost of $\$c_n$ for each product that they order (manufacture). Therefore, $c_n Q_2$ is the total procurement cost of the new product. In addition, if the firm orders (manufactures) a positive amount of the new product, it incurs a fixed cost of $\$K_n$.

Therefore, the expected profit function for the new product is

$$\begin{aligned}
\Pi_n(Q_2, T_o, T_n) &= -c_n Q_2 - K_n \cdot \kappa(Q_2) \\
&+ \sum_{i=0}^{Q_2-1} \sum_{m=0}^{Q_2-i} f_n(i,m) P\{X_n^{(3)} = m\} P\{X_n^{(2)} = i\} \\
&+ \sum_{i=0}^{Q_2-1} \sum_{m=Q_2-i+1}^{\infty} g_n(i,m) P\{X_n^{(3)} = m\} P\{X_n^{(2)} = i\} \\
&- \sum_{i=0}^{Q_2-1} \frac{h_o(T_o - T_n)}{2} i P\{X_n^{(2)} = i\} + \sum_{i=Q_2}^{\infty} h_n(i) P\{X_n^{(2)} = i\}
\end{aligned} \tag{3.9}$$

where

$$f_n(i,m) = v_n(Q_2 - i - m) + p_n(i+m) + h_n \frac{(t - T_o)}{2} \cdot m - h_n(Q_2 - i)(t - T_n)$$

and

$$\begin{aligned}
g_n(i,m) = p_n Q_2 - b_n(m - Q_2 - i) - h_n(Q_2 - i)(T_o - T_n) \\
- \frac{h_n(Q_2 - i)(Q_2 - i + 1)}{2} \frac{(t - T_o)}{(m+1)}.
\end{aligned}$$

and

$$h_n(i) = p_n Q_2 - b_n(i - Q_2 + \lambda_n^{(3)}(t - T_o)) - \frac{h_n Q_2 (Q_2 + 1)(T_o - T_n)}{2(i+1)}.$$

In expression (3.9), $\kappa(Q_2)$ is an indicator variable which takes the value 1 whenever $Q_2 > 0$ and takes 0 otherwise.

Now, we incorporate cannibalization into our model by using parameters γ_o and γ_n as defined in Table 3.1. We simply multiply the demand rate of the old product in the second time zone, i.e. $\lambda_o^{(2)}$, by γ_o and the demand rate of the new product in the second time zone, i.e. $\lambda_n^{(2)}$, by γ_n. We do not multiply any of $\lambda_o^{(1)}$, $\lambda_n^{(3)}$ by γ_o and γ_n because cannibalization can happen only if both products are in the market at the same time. Therefore, we have the following demand distributions for both products in the corresponding time zones after cannibalization is incorporated:

$$P\{X_o^{(1)} = k\} = \frac{[\lambda_o^{(1)} T_n]^k}{k!} e^{-\lambda_o^{(1)} T_n}.$$

$$P\{X_o^{(2)} = k\} = \frac{[\gamma_o \lambda_o^{(2)} (T_o - T_n)]^k}{k!} e^{-\gamma_o \lambda_o^{(2)} (T_o - T_n)}.$$

$$P\{X_n^{(2)} = k\} = \frac{[\gamma_n \lambda_n^{(2)} (T_o - T_n)]^k}{k!} e^{-\gamma_n \lambda_o^{(2)} (T_o - T_n)}.$$

$$P\{X_n^{(3)} = k\} = \frac{[\lambda_n^{(3)} (t - T_o)]^k}{k!} e^{-\lambda_n^{(3)} (t - T_o)}.$$

We assume that $0 \leq \gamma_o \leq 1$ and $0 \leq \gamma_n \leq 1$. Note that if $\gamma_o < 1$ ($\gamma_n < 1$), then the demand rate of the old (new) product decreases. In other words, the presence of the new (old) product *cannibalizes* the sales of the old (new) product. We may have the following cases regarding the effects of cannibalization: (1) None of the products cannibalizes the sales of the other (i.e., $\gamma_o = 1,\ \gamma_n = 1$) or (2) only the new product cannibalizes the sales of the old product (i.e., $\gamma_o < 1,\ \gamma_n = 1$) or (3) only the old product cannibalizes the sales of the new product (i.e., $\gamma_o = 1,\ \gamma_n < 1$) or (4) both products cannibalize the sales of each other (i.e., $\gamma_o < 1,\ \gamma_n < 1$). The last case can be further decomposed into three cases in which the new product cannibalizes the sales of the old product more than the old product does (i.e., $\gamma_o < \gamma_n$), or, the old product cannibalizes the sales of the new product more than the new product does (i.e., $\gamma_o > \gamma_n$), or, both products cannibalizes each other's sales equally (i.e., $\gamma_o = \gamma_n$). It is important to note that, in our way of modeling cannibalization, the total demand rate for both product types is not necessarily constant. Please see Chapter 5 for further discussion.

We have all of the components necessary to write the expression for the expected profit function of the firm. All we need to do is to sum the expected profit function for the old product and for the new product. Recall that our decision variables were Q_2, T_o and T_n. Therefore, as a function of these decision variables, the expected profit function of the firm for the dual product rollover case is

$$\Pi(Q_1, Q_2, T_o, T_n) = \Pi_o(Q_1, T_o, T_n) + \Pi_n(Q_2, T_o, T_n) \tag{3.10}$$

Chapter 4

Experimental Study

In this chapter, our objective is to gain insights into the behavior of optimal introduction timing and order quantity under different instances and to obtain some managerial implications for both the single and the dual product rollover strategies.

One of the characteristics of our models for both the single product rollover and the dual product rollover is that the order (production) quantity for the new product (Q_2) takes nonnegative *integer* values (i.e., $Q_2 \in \{0\} \cup \mathbb{Z}^+$). For this reason, we cannot derive a closed form equation for the optimal Q_2. If we could have derived an equation for the optimal Q_2, we would have plugged it into the expected profit function so that it would be a function of the introduction time T only. This makes things challenging for us to obtain analytical results.

Another issue that makes our problem complicated is the number of parameters in both models. In the model for the single product rollover, we have 13 parameters - seven of them are associated with the new product and the remaining six parameters are associated with the old product. In the model for the dual product rollover, we have two additional parameters related to the *cannibalization* and another two parameters for the demand in the second time zone. The structure of the expected profit function with respect to T heavily depends on the values of those parameters. We observed that for some set of parameters the expected profit is not concave in T (see Figure 4.1). Therefore, it is not easy to obtain a general expression, which holds for all set of values of the parameters, for the optimal T. However, as it is shown in Toptal and Çetinkaya [21], the expected profit function $\Pi(Q,T)$ as revisited in Chapter 3, is concave in Q for fixed T. Therefore, in the case of single product rollovers, our expected profit function is also concave in Q_2 for a given value of T.

Example (Single Product Rollover): Figure 4.1 is the graph of expected profit as a function of introduction timing T and the order quantity of the new product Q_2. In this example parameters have the following values: $p_o = 1400$, $h_o = 90$, $v_o = 280$, $Q_1 = 10$, $b_o = 250$, $\lambda_o^{(1)} = 10$, $p_n = 1000$, $h_n = 300$, $v_n = 600$, $c_n = 700$, $b_n = 100$, $K_n = 200$, $\lambda_o^{(2)} = 20$ and $t = 12$.

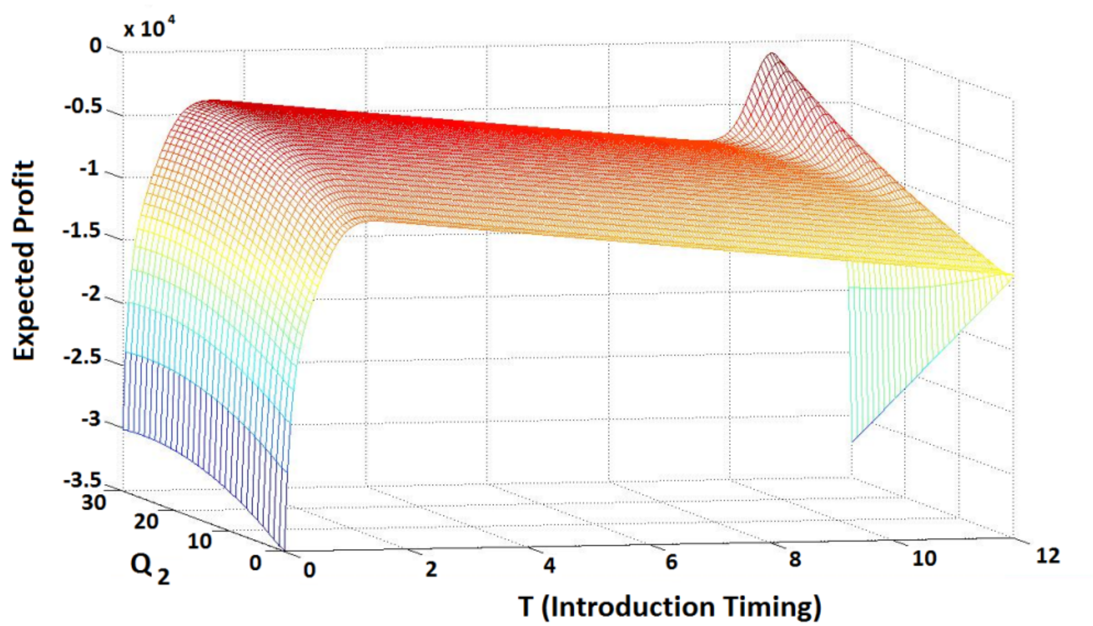

Figure 4.1: An example where expected profit is neither convex nor concave as a function of (Q_2, T) jointly.

Due to the above reasons, we conduct an experimental study to gain insights into the behavior of the optimal expected profit function and of the optimal introduction timing for the single product rollover model. We determined three levels (low-medium-high) for each parameter associated with the new product except Q_2. We did not predetermine any level for the order (production) quantity Q_2 because it is a decision variable. As for the old product under single product rollover strategy, values of the parameters other than Q_1 and $\lambda_o^{(1)}$ are set to a single level. We assigned three different values to Q_1 as well as $\lambda_o^{(1)}$ because the effect of both initial inventory and demand rates on optimal introduction timing is an important aspect of our analysis. Due to the computational complexity, we preferred to set single values to the parameters associated with the old product (except Q_1 and $\lambda_o^{(1)}$) and to change the levels of the parameters of the new product. Overall, for the single product rollover case, we have eight parameters whose different levels to be compared by running a full-factorial experimental design. The selection of parameter levels generates a total of $3^8 = 6561$ instances.

Recall that our decison variables are Q_2 and T for the single product rollover model. Therefore, in our analysis, we consider (Q_2, T) *jointly* as the decision variable and we evaluate the optimal (Q_2^*, T^*) pair for all instances. Throughout our analysis, we assume that the length of the selling period t is 12 months and the demand rates $\lambda_o^{(1)}$, $\lambda_o^{(2)}$, $\lambda_n^{(2)}$, $\lambda_n^{(3)}$ are monthly rates. To determine the optimal (Q_2^*, T^*) pair, we fixed 361 equally-distant candidates for introduction timing including the very beginning (time 0) and the very end of the selling period ($t = 12$). At each candidate (time) epoch, we find the optimal ordering quantity Q_2^* by using the results in Toptal and Çetinkaya [21]. Given that the length of the selling period is 12 months, the distance between any two candidate epochs corresponds to a day.

The details of the experimental study that we designed for the dual product rollover model will be explained later in a different subsection. Now, we explain the details of the experimental study for the single product rollover and discuss the results that we obtained.

Our main objective in doing an extensive numerical analysis is to search for answers to the following managerial questions for both product rollover strategies:

(Q1) How does each parameter affect the optimal introduction timing and optimal order quantity?

(Q2) In particular, how does the holding cost, thereby, liquidation of the initial inventory, and the cannibalization affect the optimal introduction timing and optimal order quantity?

(Q3) Do higher profit margin and higher demand imply early withdrawal (introduction) of the old (new) product? Conversely, if the profit margin of and demand for the new product is low, does this always imply a late introduction of the new product?

(Q4) Under what circumstances is dual product rollover strategy more profitable than the single product rollover strategy and vice versa?

(Q5) Can the dual product rollover strategy still be adventageous than the single product rollover strategy in the presence of cannibalization?

4.1 Single Product Rollover

In choosing the data for the experimental design, we avoid extreme cases because, otherwise, it becomes harder to observe the effects of changes in parameters on the optimal introduction timing and on the optimal profit. For instance, if the price per unit of the new product p_n were too high, the optimal introduction timing would be 0 (i.e., do not sell the old product at all) for all of the different combinations of the parameters. In such a case, it is very profitable to sell the new product and all of the changes in other parameters can be compensated by the revenue obtained by selling the new product. Therefore, in order to get as much information as possible from our experimental study, we have excluded extreme data. Table 4.1 summarizes the parameters settings used.

Parameters	p_n	c_n	h_n	v_n	b_n	Q_1	λ_o	λ_n
Low	1000	700	90	280	100	10	10	15
Medium	1200	800	185	400	175	15	20	20
High	1400	900	300	600	250	20	25	30

Table 4.1: The values of the parameters used in the numerical analysis for the single product rollover

As stated earlier, we only change the parameters of the new product, the initial inventory and the demand rate of the old product. We have kept the parameters except Q_1 and $\lambda_o^{(1)}$ of the old product unchanged to reduce the computational complexity. The levels for those parameters are set to the following values: $p_o = 1000$, $c_o = 700$, $h_o = 140$ (20% of the procurement cost per unit), $v_o = 400$ (40% of the per-unit price) and $b_o = 100$ (10% of the per-unit price).

The levels for the price of the new product, p_n, were selected such that the profit margins range from 11% to 100% of the procurement cost c_n. In addition to those extremes, there are seven different profit margins as intermediate levels when all combinations are considered. For instance, when p_n is low and c_n is at medium level, the profit margin is 25% or when both p_n and c_n are at medium level, the profit margin is 50%. An interesting case regarding the optimal introduction timing is when both products have the same price and profit margin. To cover this case in our data set, we set the low values of p_n and c_n same as p_o and c_o. Thus, we are able to examine the behavior of the optimal introduction timing for this case (i.e. $p_n = p_o$, $c_n = c_o$) in $3^6 = 729$ different instances. This also means that we have $3^7 = 2187$ instances where prices of the products are equal ($p_n = p_o$) and $3^7 = 2187$ instances where per-unit procurement costs of the products are equal ($c_n = c_o$).

We have made an implicit assumption while setting the values of p_n. We set the minimum value of p_n equal to p_o. Therefore, in all of 6561 instances, p_n is at least as large as p_o. The reason why we set the values that way is because we assume that the new product is superior in quality, and therefore, more value is added to it compared to the old product.

The levels for the holding cost per unit of the new product, h_n, are such that holding cost / procurement cost ratio ranges between 10% and 42.85%, which is a considerably high percentage as far as per-unit holding costs are concerned. In between those extremes, this ratio takes the values 11.25%, 12.85%, 20.55%, 23.125%, 26.43%, 33.33%, 37.5% and 42%. Thus, our data set covers a wide range of instances. We set the levels of the salvage value per unit of the new product considering salvage value / price ratio. The salvage value / price ratio of the new product, v_n, ranges between 20% and 60%. The medium value of v_n is the same as the salvage value per unit of the old product v_o in order to be able compare the case where $v_o = v_n$ regarding the behavior of optimal introduction timing. This refers to $3^7 = 2187$ instances in which the per-unit salvage values of both products are the same. The levels of the lost sale cost per unit of the new product b_n are set in a similar fashion. The lost-sale cost / price ratio ranges between 7.14% and 25%. Low level of b_n is set such that it is the same as b_o.

Results of the Numerical Analysis for the Case of Single Product Rollover

In 6561 instances, optimal introduction timing T^* never takes values 0 (i.e., do not sell the old product at all) and, it takes the value t (i.e., never introduce the new product) only in 69 instances. One reason why this is the case might be that we do not have extreme enough cases. If the price of the new product were extremely high, then since it would be very profitable to sell the new product, the optimal introduction timing would be $T^* = 0$. Although our data does not have extreme enough cases that would make $T^* = 0$, it has fairly extreme cases. For instance, we have instances where the selling price of the product is two times the procurement cost, holding cost per unit is almost 10% of the procurement cost and the lost sale cost per unit is only 7% of the selling price. Conversely, in some instances, the profit margin is very low and holding cost per unit is 30% of the procurement cost per unit etc. Therefore, we believe that our experimental design covers a variety of scenarios to characterize the trade-off between the liquidation of the on-hand inventory of the old product and the chance of gaining higher revenue by selling the new product.

Impact of prices on the optimal introduction timing and order quantity

In this section, we present our findings that answer Question (Q3) and part of Question (Q1) and Question (Q2).

We have 1458 instances where profit margin of the new product $(p_n - c_n)$ and the profit margin of the old product $(p_o - c_o)$ are the same. In half of these instances, the selling price and the procurement cost per unit of the new product are at their low value (i.e., $p_n = 1000$ and $c_n = 700$). Note that, in these instances, the per-unit selling prices and the procurement costs of both products are the same (i.e., $p_n = p_o$, $c_n = c_o$). In the other half of the instances, we have $p_n = 1200$ and $c_n = 900$. For both halves of the instances, we have observed that, in all but 234 instances, the optimal introduction timing T^* is greater than 6 months. In other words, in more than 83% of the instances (1224 of 1458), it is optimal to keep the old product in the market for more than half of the selling period when profit margins of the old and the new product are the same. Interestingly, in these instances, the level of the initial inventory Q_1 does not seem to have a significant impact on T^* because all of the three levels of Q_1 are observed as much as any other. It is expected that a certain level of the parameter is observed much more than the other levels if that parameter has a significant impact on the decision variable. In 216 of 234 instances where it is optimal to introduce the new product earlier than 6 months, the lost sale cost per unit of the new product b_n is at its lowest value. In all of the remaining 18 cases, the lost sale cost per unit of the new product is at its medium level. Moreover, in none of 234 instances, the demand rate of the new product $\lambda_n^{(2)}$ is at its highest value and the demand rate of the old product $\lambda_o^{(1)}$ is at its lowest value. Under these conditions, probability of having a lost sale is relatively higher for the old product and relatively lower for the new product. This suggests that, if the per-unit lost-sale cost is high for the old and is low for the new product, introducing the new product earlier is a better solution when the profit margins are the same. Therefore, we can conclude that unit lost sales has an important role on the optimal introduction timing when the profit margins are the same (see Tables A.1 - A.6).

Additionally, for those 234 instances, we analyze the effects of the change in the holding cost per unit of the new product on the optimal introduction timing T^*. As it turns out, changing holding cost per unit does not change T^* in the majority of the instances (216 of 234), however, it changes the optimal order quantity Q_2^* for the new product. The optimal order quantity Q_2^* decreases as holding cost per unit increases (see Tables A.1 - A.6). We can infer that the loss due to a change in the introduction timing is greater than the additional cost created by an increase in the holding cost per unit. In the remaining 18 instances where optimal introduction timing changes, it increases in all of them. In other words, it is more profitable to postpone the introduction of the new product. The common characteristic of those cases is that the profit margins, the lost sale costs per unit and the demand rates for both products are the same. Therefore, unless the products are alike in the sense that their revenue and cost components are similar, it is better to change the optimal order quantity than to change the introduction timing.

Now, let us analyze the cases where the demand for the new product is the highest whereas the demand for the old product is the lowest and the profit margin for the new product is highest (81 cases). Intuitively, it seems reasonable to introduce the new product to the market earlier because the profit margin is at its highest possible level and the demand is high which means a greater chance of making more revenue. Very surprisingly, majority of the instances (66%) do *not* support this intuition. Only 33% (27 of 81) of the instances result in an early introduction of the new product. When we further analyzed this situation, we realized that, in all of the instances where the early introduction of the new product is optimal, the holding cost per unit of the new product h_n is at its low level. In the remaining instances, h_n takes medium or high values but *never* takes low value. Other than the per-unit holding cost, none of the other parameters seem to have a significant effect on such behavior of T^* (see Table 4.2).

Parameters	h_n	v_n	b_n	Q_1
Percentage of low level	100%	33%	33%	33%
Percentage of medium level	0%	33%	33%	33%
Percentage of high level	0%	33%	33%	33%

Table 4.2: Distribution of the 27 instances where early introduction is optimal given that $\lambda_n = 30$, $\lambda_o = 10$, $p_n = 1400$, $c_n = 700$

The above discussion illustrates the impact of the holding cost on the optimal introduction timing and shows that the holding cost is an important factor that need to be considered in timing decisions.

Now we analyze the instances which show opposite characteristics that are described in the previous paragraph. In the instances considered in this paragraph, the demand for the new product is the lowest whereas the demand for the old product is the highest and the profit margin for the new product is the lowest (81 cases). Intuitively, it seems reasonable to introduce the new product to the market later. As it turns out, 66% (54 of 81) of the instances supports this intuition. In these instances, the old product is kept in the market for at least 8 months. However, remaining 33% (27 of 81) results in a very early introduction of the new product. The new product is introduced to market in the first month at the latest. We have observed that, in all of those instances, the lost-sale cost of the new product b_n is at its low level and the expected profit due to the old product is very high (see Table 4.3). Therefore, if the lost-sale cost for the new product is sufficently low, it is possible to compensate the losses due to early introduction of the new product by making large enough profit from the sales of the old product. Under the circumstances where it is least profitable to sell the new product, the lost-sale cost plays a crucial role in determining T^*.

Impact of other problem parameters on the optimal introduction timing and order quantity

Contrary to the findings of [15], optimal introduction timing T^* is *not* necessarily

Parameters	h_n	v_n	b_n	Q_1
Percentage of low level	33%	33%	100%	33%
Percentage of medium level	33%	33%	0%	33%
Percentage of high level	33%	33%	0%	33%

Table 4.3: Distribution of the 27 instances where early introduction is optimal given that $\lambda_n = 15$, $\lambda_o = 25$, $p_n = 1000$, $c_n = 900$

increasing in c_n. In our numerical analysis, the optimal introduction timing T^* never decreases (i.e., do not stay longer in the market) as c_n increases, however, there are cases in which T^* stays the same. This behavior can be explained by the fact that Q_2 is also a decision variable as well as T in our model. As seen in Tables A.7 - A.24, in all of those cases (270 of 2187) in which T^* stays the same, Q_2 decreases as c_n increases. This tells us that, in some cases, it is possible to compensate the additional cost that results from keeping a costlier product longer in the market by decreasing Q_2. We are also able to observe the circumstances in which such a behavior of (Q_2^*, T^*) is more profitable than postponing the introduction. In all of 270 cases that we mention, T^* is relatively small (very small in most of the cases), the per-unit lost sale cost b_n of the new product is at its lowest level and the expected profit gained out of the sales of the old product is relatively high. This means that if the lost sale cost per unit of the new product is small enough so that keeping the new product in the market for a long time is justifiable (i.e., profit made out of the sales of the old product is sufficient to cover the loss), then introducing a relatively costly product without postponing the introduction may be a plausible decision.

Interestingly enough, initial inventory of the old product Q_1 does not seem to have much of an impact on the optimal introduction timing T^*. In the majority of the instances (1830 of 2187), increasing Q_1 from it's low to high level does not change T^*. It does not cause a change in the optimal Q_2 either. This means that our model is not quite sensitive with respect to the values of Q_1 that we use in our numerical analysis. However, in the remaining instances (357 of 2187) where change in Q_1 causes a change in T^*, we observed that T^* always increases as Q_1 increases. That is, it is better to postpone the introduction timing of the new product if the initial inventory is high. Overall, the results of the numerical analysis tell us that higher level of initial inventory of the old product does *not always* imply a late introduction of the new product.

Here, we present other observations that we obtained from our numerical analysis. We look for answers for the following questions: Does higher price/salvage value imply an early introduction of the new product? Does higher holding cost/lost-sale cost per unit imply a late introduction of the new product? To find answers to these questions we investigate the marginal impact of the change in the problem parameters on the optimal introduction timing. In other words, we keep all the parameters fixed except one and observe the impact of the change in that parameter on the optimal introduction timing. We also analyze the behavior of the parameters under certain circumstances to gain insights into how much of an impact that the parameters make on optimal introduction timing under those circumstances. We use the same approach as in [7]. We keep the record of the number of cases (in terms of percentages) that each level of a parameter is observed in order to be able see if there is a significant impact of that parameter. If the impact of a parameter is not significant, then we expect to see frequency values that are close to each other (33.33% in our case because we have 3 levels for each parameter).

Intuitively, we expect that the optimal introduction timing decreases as the price of the product increases (assuming that all of the other parameters are fixed). This is the case in 1923 of 2187 (87.93%) instances. In the remaining instances, T^* never increases (i.e., do not postpone the introduction of the new product). Therefore, it stays the same in all of 264 instances which corresponds to 12.07% the total instances (see Tables A.25 - A.42). We are able to have a general insights into the circumstances which leads to such behavior of T^*. In the instances in which T^* remains the same, T^* happens to take small values. This results in the gain of higher profit out of the sales of the old product (see Tables A.25 - A.42). In addition, for those cases, the per unit lost sale cost of the new product is always at its lowest level, the demand rate of the new product is not too high and the demand rate of the old product is not too low (see Table 4.4). Therefore, we can infer that postponing the introduction of a relatively expensive product is a plausible decision if there is a high chance that the expected lost sale cost of the new product will be small and the demand for the old product is low.

Parameters	c_n	h_n	v_n	b_n	Q_1	$\lambda_o^{(1)}$	$\lambda_n^{(2)}$
Percentage of low level	31.06%	27.65%	33.33%	100%	32.95%	0%	58.33%
Percentage of medium level	31.44%	34.85%	33.33%	0%	34.09%	38.64%	41.67%
Percentage of high level	37.50%	37.50%	33.33%	0%	32.95%	61.36%	0%

Table 4.4: Distribution of the 264 instances where T^* does not change as p_n increases

As for the behavior of T^* with respect to h_n, T^* does not decrease (i.e., do not withdraw the old product earlier) in any of 2187 cases in which the holding cost per unit of the new product h_n increases. However, in 253 of 2187 cases (11.57%), T^* remains the same (see Tables A.43 - A.60). All of 253 cases show very similar characteristics to those that we discussed in previous paragraph. The old product stays in the market for a short time so that the expected profit made by the sales of it is considerably high. The loss due to earlier introduction of the new product (to make the most profit out of the old product) is minimized by decreasing the order quantity Q_2 (see Tables A.43 - A.60). Of course, this is a reasonable solution if the lost sale cost per unit of the new product is sufficiently low so that the loss due to early introduction of the new product is compensated by the profit made by the sales of the old product. Note that in Table 4.5, the demand rate of the new product is not too high and the demand rate of the old product is not too low. As a result, we can conclude that it may still be as profitable to introduce the new product, despite its higher per-unit holding cost, without postponing the introduction timing if there is a high chance that the expected lost sale cost of the new product will be small and the demand for the old product is low.

We further investigated the behavior of the optimal introduction timing and order quantity on one of the instances. We chose the instance in which all of the parameters other than λ_o are set to their medium levels. We set λ_o to its low value. Then we picked 90 equally-distant values in the interval $[120, 565]$. The

Parameters	p_n	c_n	v_n	b_n	Q_1	$\lambda_o^{(1)}$	$\lambda_n^{(2)}$
Percentage of low level	39.13%	28.86%	33.2%	100%	33.2%	0%	60.87%
Percentage of medium level	32.02%	35.57%	33.2%	0%	33.6%	35.97%	39.13%
Percentage of high level	28.85%	35.57%	33.6%	0%	33.2%	64.03%	0%

Table 4.5: Distribution of the 253 instances where T^* does not change as h_n increases

behavior of T^* is shown in Figure 4.2.

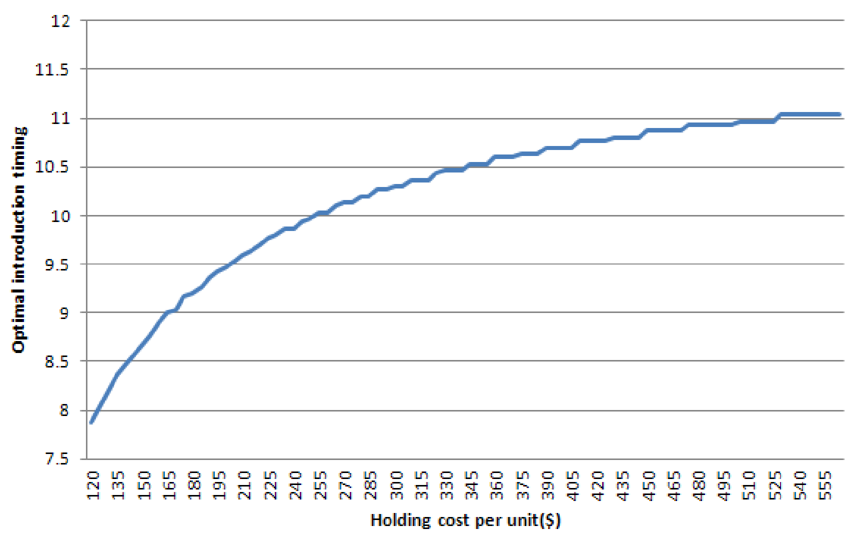

Figure 4.2: The behavior of T^* as h_n increases when $p_n = 1200$, $n_n = 800$, $v_n = 400$, $b_n = 175$, $Q_1 = 20$, $\lambda_o = 10$, $\lambda_n = 20$

As seen in the figure, the holding cost has a diminishing effect on the behavior of the optimal introduction timing. That is, for smaller values of h_n, the impact of a change on T^* is larger than the impact of that on T^* for larger values of h_n. In addition, T^* is nonincreasing in h_n as expected. The optimal order quantity Q_2^* shows a similar diminishing behavior as h_n increases (see Figure 4.3).

The results of the numerical analysis show that T^* does not decrease (i.e., do not withdraw the old product earlier) in any of 2187 instances as the salvage value per unit of the new product v_n increases. However, in 364 of 2187 cases (16.64%),

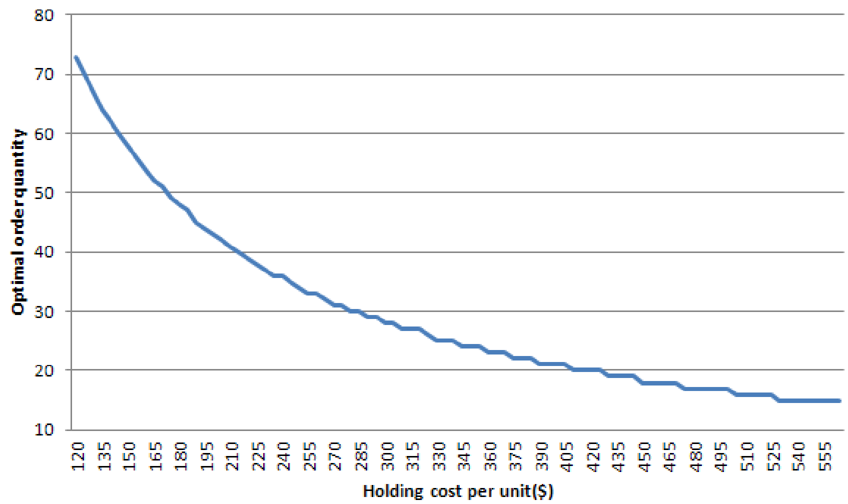

Figure 4.3: The behavior of Q_2^* as h_n increases when $p_n = 1200$, $n_n = 800$, $v_n = 400$, $b_n = 175$, $Q_1 = 20$, $\lambda_o = 10$, $\lambda_n = 20$

T^* remains the same. Although it is not as clear as it is in the previous two cases, the behavior of T^* seem to happen under very similar circumstances mentioned in the above paragraphs (see Table 4.6). Therefore, we can make a similar inference: It may still be as profitable to introduce the new product without postponing the introduction timing if there is a high chance that the expected lost sale cost of the new product will be small and the demand for the old product is low.

Parameters	p_n	c_n	h_n	b_n	Q_1	$\lambda_o^{(1)}$	$\lambda_n^{(2)}$
Percentage of low level	42.03%	29.12%	26.37%	88.19%	33.79%	11.54%	48.63%
Percentage of medium level	28.85%	28.57%	34.89%	5.22%	33.24%	42.03%	46.43%
Percentage of high level	29.12%	42.31%	38.74%	6.59%	32.97%	46.43%	4.94%

Table 4.6: Distribution of the 364 instances where T^* does not change as v_n increases

Finally, in all of the cases, T^* strictly increases (postpone the introduction of the new product) as the lost-sale cost of the new product b_n increases. When we further analyze the impact of b_n, however, we observed that T^* is not necessarily strictly increasing. For some values of b_n, it remains unchanged and, surprisingly, for some values of b_n decreases. To observe this, we considered only a single instance, which is the same instance that was used for the analysis of h_n, and changed the value of b_n while keeping the other parameters fixed. The behavior of T^* is shown in Figure 4.4.

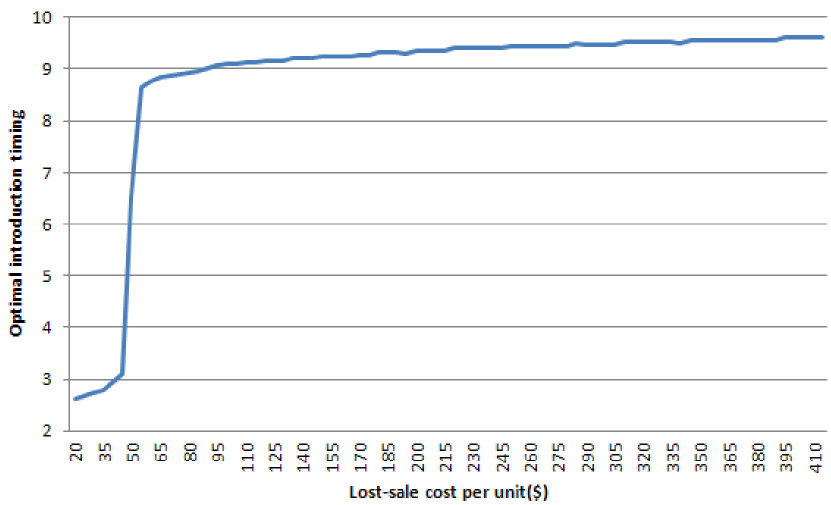

Figure 4.4: The behavior of T^* and Q_2^* as b_n increases when $p_n = 1200$, $c_n = 800$, $v_n = 400$, $h_n = 185$, $Q_1 = 20$, $\lambda_o = 10$, $\lambda_n = 20$

The impact of b_n on T^* is very significant for the low values of it. As seen in the figure, there is a threshold up to which a change in b_n effects T^* drastically. The behavior of T^* stabilizes for the values of b_n larger than the threshold value. It is also possible to observe the diminishing impact of b_n once the threshold value is exceeded. The behavior of Q_2^* is quite interesting. As seen in Figure 4.5, for the small values of b_n, Q_2^* is nondecreasing. After a threshold value is hit, Q_2^* shows a nonincreasing trend. Interestingly, we observe sudden changes (spikes) in the behavior Q_2^*. When we further investigate, we realized that T^* decreases, which is contrary to the general behavior of it, for those particular values of b_n.

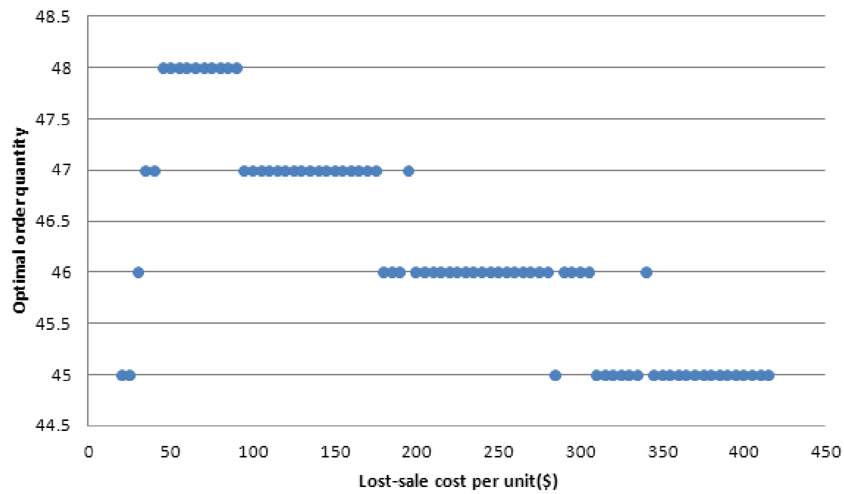

Figure 4.5: The behavior of T^* and Q_2^* as b_n increases when $p_n = 1200$, $c_n = 800$, $v_n = 400$, $h_n = 185$, $Q_1 = 20$, $\lambda_o = 10$, $\lambda_n = 20$

4.2 Dual Product Rollover

There are major differences between the dual product rollover and the single product rollover models we developed. The first and the most important difference is that now we have two decision variables associated with the introduction timing of the new product and the withdrawal timing of the old product unlike the case in single product rollover model. Recall that in single product rollover model the introduction timing of the new product and the withdrawal timing of the old product are the same ($T = T_n = T_o$). We no longer have that constraint in the dual product rollover case. We have two variables T_o and T_n which satisfy $T_n \leq T_o$ (see Figure 3.2 and Table 3.1). In addition to those variables, order quantity of the new product Q_2 is also a decision variable for the dual product rollover model. Therefore, the decision variable in the dual product rollover model is the triplet (Q_2,T_n,T_o).

The other major differences between two models are the number of time zones and the cannibalization effect. As mentioned earlier, there are three time zones in the dual product rollover case in which both products coexist in the second time zone and may cannibalize the demand (sales) of each other. In order to be able to observe the effects of cannibalization, we define two new parameters, which are not present in the single rollover model, γ_o and γ_n (see Table 3.1).

Having two more parameters and three decision variable makes dual product rollover model more complicated than the single product rollover model. Therefore, as in the case of single product rollover, we design an experimental study to gain insights into the behavior of optimal introduction and withdrawal timing and to specify some managerial implications that might be useful. Before getting into the details of the experimental study, we shall mention about an issue that plays a crucial role in the design of the experimental study. Since the single product rollover model is relatively simpler, we were able to find the optimal Q_2 for a given introduction timing T easily. Our strategy to find the optimal (Q_2^*, T^*) pair was to enumurate (Q_2^*, T) for each T and to pick the one with the highest expected profit. Unfortunely, the expected profit function in the dual product rollover is not necessarily concave with respect to Q_2 for a given T_n and T_o. Therefore, we do a three-dimensional search to find the optimal (Q_2^*, T_n^*, T_o^*) triplet.

A drawback of doing a three-dimensional search is its computational burden. We designed our experimental study in such a way that we tried to lower the computational burden as much as possible. First of all, we lowered the number of different instances. We determined two levels for each of the eight parameters that are also present in the single product rollover model and determined three levels for the parameters associated with cannibalization (γ_o, γ_n). Therefore, we have $2^8 \times 3^2 = 2304$ different instances. Secondly, we set $\lambda_o^{(2)} = \gamma_o \lambda_o^{(1)}$ and $\lambda_n^{(2)} = \gamma_n \lambda_n^{(3)}$. We could have set $\lambda_o^{(2)}$ and $\lambda_n^{(2)}$ to different values, however, in that case, the number of parameters would have increased by two and we would have had $2^{10} \times 3^2 = 9216$ instances which would have taken very long time. Also, we believe that it is easier to observe the effects of cannibalization when $\lambda_o^{(2)} = \gamma_o \lambda_o^{(1)}$ and $\lambda_n^{(2)} = \gamma_n \lambda_n^{(3)}$. Thirdly, we set an upper bound on Q_2 to keep the number of candidate triplets (Q_2, T_n, T_o) to be compared for each instance at a reasonable level. We set the upper bound on Q_2 to 50. This seems to be a restrictive constraint, however, we tried to determine the levels of the parameters accordingly to get as much useful information as possible out of the experimental study.

We obtained the results of 2304 instances on a computer which has a processor of Intel Core i7 870 CPU running at 2.93GHz. The run time of all of 2304 instances on such a computer is approximately 12 days.

We used a slightly different subset of the data that we had used in the experimental study for the single product rollover model. We selected low and medium levels of all of the parameters except Q_1, which are common in both models, to be used in the experimental study of the dual product rollover model and we made slight changes (see Table 4.7). We set higher values for Q_1. The reason why we chose low and medium levels and higher Q_1 values is that under those circumstances, the optimal order quantity Q_2^* tends to be lower (< 50) which is desirable because Q_2 falls into the interval that we search. Of course, this does not guarantee that an (local) optimal Q_2, which happens to fall into our interval of interest, is the global optimum. However, we have a better chance to observe the behavior of the dual product rollover model and to obtain useful information. The claim that we make above is based on observation, however, it is essential for us to rely on that observation and design the experimental study accordingly in order to have some results in a reasonable time frame.

The levels of the parameters that we use in the experimental study for the dual product rollover model are as seen in Table 4.7.

Parameters	p_n	c_n	h_n	v_n	b_n	Q_1	$\lambda_o^{(1)}$	$\lambda_n^{(3)}$	γ_o	γ_n
Low	1000	700	90	280	100	75	10	10	0.25	0.50
Medium	1200	800	180	400	175	80	15	15	0.50	0.75
High	-	-	-	-	-	-	-	-	0.75	0.90

Table 4.7: The values of the parameters used in the numerical analysis for the dual product rollover

We continue to use the same values for the parameters of the old product as the ones that we use in the single product rollover model. Recall that the values for those parameters are set to the following values: $p_o = 1000$, $c_o = 700$, $h_o = 140$ (20% of the procurement cost per unit), $v_o = 400$ (40% of the price) and $b_o = 100$

(10% of the price).

The set of data presented in Table 4.7 contains interesting cases in which the behavior of optimal introduction timing as well as the optimal order quantity of the new product and the optimal withdrawal timing of the old product may be of interest. For instance, some of the cases of interest may be the ones in which the profit margins or the prices or the per-unit procurement costs of both products are the same. When p_n and c_n are at their low values, the profit margins of the products are the same. Furthermore, the prices and the per-unit procurement costs are the same in those cases at the same time. Therefore, we are able to observe the behavior of optimal (Q_2^*, T_n^*, T_o^*) in $2^6 \times 3^2 = 576$ instances in which the profit margins of both products are the same.

The levels for the holding cost per unit of the new product, h_n, are such that holding cost / procurement cost ratio ranges between 11.25% and 25.71%. In between those extremes, this ratio takes the values 12.85%, 22.5%. We set the levels of the salvage value per unit of the new product considering salvage value / price ratio. The salvage value / price ratio of the new product, v_n, ranges between 23.33% and 40%. The medium value of v_n is set to be the same as the salvage value per unit of the old product v_o in order to be able compare the case where $v_o = v_n$ regarding the behavior of optimal introduction timing. This refers to $2^7 \times 3^2 = 1152$ instances in which the per-unit salvage values of both products are the same. The levels of the lost sale cost per unit of the new product b_n are set in a similar fashion. The lost-sale cost / price ratio ranges between 8.33% and 17.5%. Low level of b_n is set such that it is the same as b_o.

We model the effects of cannibalization by using the parameters γ_o and γ_n. Recall that we multiply γ_o by $\lambda_o^{(1)}$ to denote the demand for the old product in the second time zone (i.e., $\lambda_o^{(2)} = \gamma_o \lambda_o^{(1)}$). Similarly, we denote the demand for the new product in the second time zone as $\lambda_n^{(2)} = \gamma_n \lambda_n^{(3)}$. The values of the parameters γ_o and γ_n are selected such that they include all possible variations that can happen. When γ_o is at its medium (high) level and γ_n is at its low (medium) level and $\lambda_o^{(1)} = \lambda_n^{(3)}$, each product cannibalizes the sales of the other equally (see

Table 4.7). We have 256 such cases. In addition to those cases, we have cases in which the sales of the old product reduces significantly. By full analogy, we have cases in which the sales of the new product reduces significantly. Also the cases in which the sales of the old product more than that of the new product are covered. Note that the demand for both products in the second time zone depends on two parameters ($\lambda_o^{(2)} = \gamma_o \lambda_o^{(1)}$ and $\lambda_n^{(2)} = \gamma_n \lambda_n^{(3)}$). Since for each $(\lambda_o^{(1)}, \lambda_n^{(3)})$ pair we have $3^2 = 9$ possible (γ_o, γ_n) pairs, we have a total of $3^2 \times 2^2 = 36$ possible demand rate combinations. Therefore, in essence, we try 36 different demand rates that are realizable in the second time zone for a given p_n, c_n, h_n, v_n, b_n and Q_1.

Results of the Numerical Analysis for the case of Dual Product Rollover

In this section, we continue to search for answers to the questions (Q1)-(Q5) that we raised earlier in the chapter. In the following subsection, we try to find answers to the questions (Q1)-(Q3) specifically for the dual product rollover model. Then, in another subsection, we compare the single product and the dual product rollover models.

Impact of cannibalization on the optimal introduction timing, withdrawal timing and order quantity

A change in a single parameter in the dual product rollover model may cause the following changes in the optimal T_n^*, T_o^*: (1) T_n^*, T_o^* both decrease, or, (2) T_n^* decreases, T_o^* increases, or, (3) T_n^* increases, T_o^* decreases, or, (4) T_n^*, T_o^* both increase, or, (5) T_n^* stays the same, T_o^* changes, or, (6) T_n^* changes, T_o^* stays the same, or, (7) T_n^*, T_o^* both stay the same. We consider all of those possible outcomes in our analysis for both γ_o, γ_n.

Recall that we determined three levels for γ_o, γ_n. Therefore, we have $\frac{2304}{3} = 768$ different instances in which only the cannibalization parameters change. From those instances, we eliminate the cases in which the numerical analysis yields the optimal order quantity Q_2^* equal to 50. The reason is that these cases may contain misleading information because Q_2^* is at its upper bound which indicates the possibility that the algorithm terminates because it hits the boundaries and that the actual Q_2^* may be out of search region. After eliminating the cases in which $Q_2^* = 50$, there are 476 instances that remain for the analysis of γ_o and 364 instances that remain for the analysis of γ_n.

First, we examine the marginal impact of γ_o on the T_n^*, T_o^* and Q_2^*. In other words, for each instance, we change only the value of γ_o (keep the other parameters unchanged) throughout the analysis presented below.

Impact of γ_o:

In 196 of 476 instances, both T_n^* and T_o^* decrease as γ_o increases. In other words, in those instances, it is optimal to introduce the new product and withdraw the old product earlier as the cannibalization effect of the new product on the old product reduces. Note that, as a result of changes in T_n^* and T_o^*, the length of the second time zone either gets smaller or gets larger or remains unchanged. We examined the behavior of the optimal order quantity Q_2^* by considering how the length of the second time zone changes when γ_o increases. We observed that Q_2^* increases whenever the interval length of the second time zone $(T_o^* - T_n^*)$ increases. However, converse is not true. Q_2^* does not necessarily decrease whenever the interval length of the second time zone $(T_o^* - T_n^*)$ decreases. As the results of our study show, it may either decrease or increase or remain unchanged if $(T_o^* - T_n^*)$ decreases.

In 12 of remaining 280 instances, T_n^* decreases whereas T_o^* remains unchanged as γ_o increases. In other words, it is optimal to introduce the new product earlier while keeping the withdrawal time of the old product same. It seems that this strategy is optimal if the price and the holding cost per unit of the new product are low and the demand for the new product is high whereas the demand for the old product is low. In all of those cases, Q_2^* either increases or stays the same. Therefore, Q_2^* shows a nondecreasing behavior if T_o^* is fixed and T_n^* decreases (see Table A.61- A.62).

In the remaining 268 instances, which are different from all of the instances mentioned above, we are unable to observe a significant pattern regarding the behavior of $(T_n^*,\ T_o^*)$ pair. $(T_n^*,\ T_o^*)$ shows different kind of behavior as γ_o increases from its low level to medium level, compared to its behavior as γ_o increases from its medium level to high level. For instance, for a specific instance, T_n^* and T_o^* may both decrease as γ_o increases from low to medium level whereas T_n^* may increase and T_o^* decrease as γ_o increases from medium to high level. Therefore, we observed that the behavior of $(T_n^*,\ T_o^*)$ heavily depends on the parameters and it is hard to categorize the instances based on the similarity of the results they give.

Finally, it is worth mentioning that we did not observe any case in which one of the following happens: (1) Both T_n^*, T_o^* increase, (2) T_n^* increases, T_o^* remains unchanged, (3) T_n^* remains unchanged, T_o^* increases and (4) Both T_n^*, T_o^* remain unchanged.

Now we present the results of analysis that we made to examine the marginal impact of γ_n. In other words, for each instance, we change only the value of γ_n (keep the other parameters unchanged) throughout the analysis presented below.

Impact of γ_n:

In 13 of 364 instances, T_n^* decreases and T_o^* remains unchanged as γ_n increases. In other words, in those instances, it is optimal to introduce the new product earlier while keeping the withdrawal time of the old product the same as the cannibalization effect of the old product on the new product reduces. Regarding the behavior of Q_2^*, we observed that Q_2^* always increases as γ_n increases (see Table A.63- A.64). As it is seen in the same table, the profit margin $(p_n - c_n)$ of the new product is at its highest value in almost all instances. Moreover, the holding cost per unit of the new product h_n is at its lowest value in all cases. Additionally, the demand rate of the old product $\lambda_o^{(1)}$ is at its lowest value. Therefore, those 13 instances are some of the instances in which selling the new product is very profitable and liquidating the inventory takes time (due to low demand). We can infer that, under such circumstances, it is optimal to introduce the new product to gain more profit out of the sales of it while keeping the old product to liquidate the on-hand inventory.

In 40 of remaining 351 instances, none of T_n^*, T_o^* changes as γ_n increases. Only Q_2^* changes as a response to the change in γ_n. When we observed the cases that give rise to such a behavior of T_n^*, T_o^*, we realized that, for the new product, the holding cost per unit is high and the demand is low (see Table A.65- A.68). Under such circumstances, it may be too costly to change the optimal introduction timing of the new product and/or the withdrawal timing of the old product for the sake of making additional profit by exploiting less cannibalized environment. Therefore, increasing Q_2 turns out to be the optimal strategy under those circumstances.

In the remaining 311 instances, which are different from all of the instances mentioned above, we are unable to observe a significant pattern regarding the behavior of (T_n^*, T_o^*) pair. (T_n^*, T_o^*) shows different kind of behavior as γ_n increases from its low level to medium level than it shows as γ_o increases from its medium level to medium level. For instance, for a specific instance, T_n^* and T_o^* may both decrease as γ_n increases from low to medium level whereas T_n^* may increase and T_o^* decrease as γ_n increases from medium to high level. Therefore, we observed that the behavior of (T_n^*, T_o^*) heavily depends on the parameters and it is hard to categorize the instances based on the similarity of the results they give.

Impact of other parameters on the optimal introduction timing and withdrawal timing

In this section, we present the impact of p_n, c_n, h_n, v_n, b_n and Q_1 on T_n^* and T_o^*. We simply summarize our findings in Tables 4.8 - 4.13. In these tables, the percentage corresponding to each type of behavior of (T_n^*, T_o^*) denote the number of occurrences of that particular behavior as a response to the change in the parameter of interest. The reason why we did this analysis is to be able to gain insights into the general behavior of $(T_n^*,\ T_o^*)$.

T_n^*	T_o^*	Percentages
Decreases	Decreases	0.27%
Decreases	Increases	7.41%
Increases	Decreases	10.38%
Increases	Increases	0.54%
Decreases	Same	0%
Increases	Same	41.91%
Same	Decreases	12.8%
Same	Increases	0.54%
Same	Same	26.15%

Table 4.8: Percentage of instances corresponding to each type of behavior of T_n^* and T_o^* as c_n increases

In 68.06% of the instances, the optimal withdrawal timing of the old product T_o^* is not affected by the increase in c_n. In 23.45% of the remaining instances T_o^* decreases. Therefore, only in 8.49% of the instances T_o^* increases. In all of the instances in which T_n^* decreases and T_o^* increases, holding cost per unit of the new product is high whereas in the instances in which T_n^* either increases or remains unchanged and T_o^* increases, holding cost per unit of the new product is low. Therefore, holding cost seems to be the dominant factor affecting T_n^* in the instances in which T_o^* increases. T_n^* increases or remains unchanged in most of the instances (92.32%). Only in 7.68% of the instances T_n^* decreases. Increasing T_n while keeping T_o unchanged is the most frequently observed optimal decision.

In 75.58% of the instances, an increase in p_n causes a decrease in T_n^*. In other words, it is optimal to keep a more profitable product longer in the market most of the time. Note that in all of the instances in which T_n^* increases (14.71%), T_o^* behaves in a unique way. It always decreases. In the remaining 9.71% instances, T_n^* remains unchanged. In 50.72% of instances, T_o^* does not change as p_n increases whereas T_o^* increases in 32.43% of the instances. Therefore, only in 16.85% it decreases. Decreasing T_n while keeping T_o unchanged is the decision which happens to be optimal most frequently.

T_n^*	T_o^*	Percentages
Decreases	Decreases	1.86%
Decreases	Increases	29.43%
Increases	Decreases	14.71%
Increases	Increases	0%
Decreases	Same	44.29%
Increases	Same	0%
Same	Decreases	0.28%
Same	Increases	3%
Same	Same	6.43%

Table 4.9: Percentage of instances corresponding to each type of behavior of T_n^* and T_o^* as p_n increases

T_n^*	T_o^*	Percentages
Decreases	Decreases	0%
Decreases	Increases	18.52%
Increases	Decreases	43.4%
Increases	Increases	0%
Decreases	Same	0%
Increases	Same	33.79%
Same	Decreases	0%
Same	Increases	3.26%
Same	Same	1.03%

Table 4.10: Percentage of instances corresponding to each type of behavior of T_n^* and T_o^* as h_n increases

In majority of the instances (77.19%), T_n^* increases as the holding cost per unit of the new product increases. In other words, it is optimal to keep the new product for a shorter time period in the market. Note that in all of the instances in which T_n^* decreases, T_o^* increases. In very few of the instances (4.29%), T_n^* remains the same. T_o^* increases in 21.78% of the instances whereas it decreases in 43.4% and remains unchaged in 34.82% of the instances. Increasing T_n and decreasing T_o is the most frequently observed optimal decision.

We further investigated the impact of h_n on T_n^*, T_o^* and Q_2^* by considering more values of h_n. We chose a single instance and picked 30 equally-distant values of h_n in the interval $[120, 265]$. Then we observed the behavior of T_n^*, T_o^* and Q_2^* by keeping all of the other parameters fixed. The reason why we made such an analysis is to see whether optimal timings and order quantity behave in a certain pattern (nonincreasing, nondecreasing, monotonicity etc.) or not.

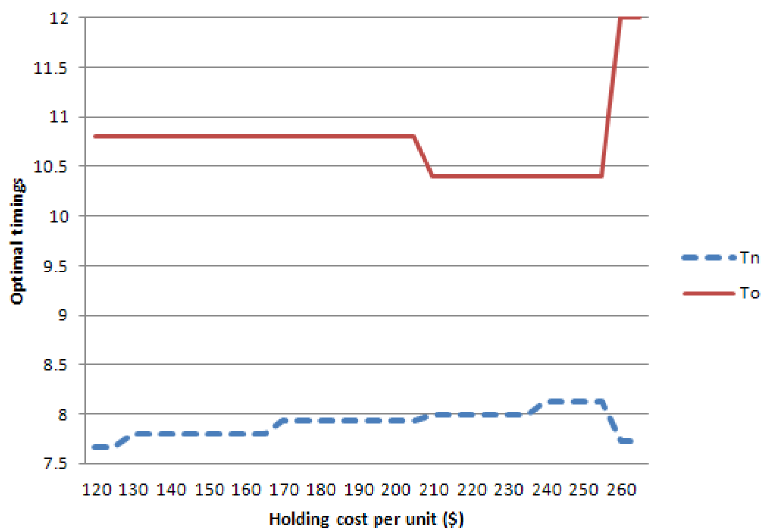

Figure 4.6: The behavior of T^* as h_n increases when $p_n = 1200$, $c_n = 800$, $v_n = 400$, $b_n = 120$, $Q_1 = 80$, $\lambda_o^{(1)} = 10$, $\lambda_o^{(1)} = 10$, $\gamma_o = 0.25$, $\gamma_n = 0.75$

As seen in Figure 4.6, both T_n^* and T_o^* are neither nonincreasing nor nondecreasing. T_n^* is nondecreasing in h_n until a threshold value, which makes $T_o^* = t = 12$, is hit. We observed that Q_2^* is nonincreasing in h_n (see Figure 4.7).

T_n^*	T_o^*	Percentages
Decreases	Decreases	0%
Decreases	Increases	0.13%
Increases	Decreases	0.13%
Increases	Increases	0.77%
Decreases	Same	2.07%
Increases	Same	2.32%
Same	Decreases	0%
Same	Increases	0.26%
Same	Same	94.32%

Table 4.11: Percentage of instances corresponding to each type of behavior of T_n^* and T_o^* as v_n increases

In almost all instances, increasing salvage value per unit of the new product does

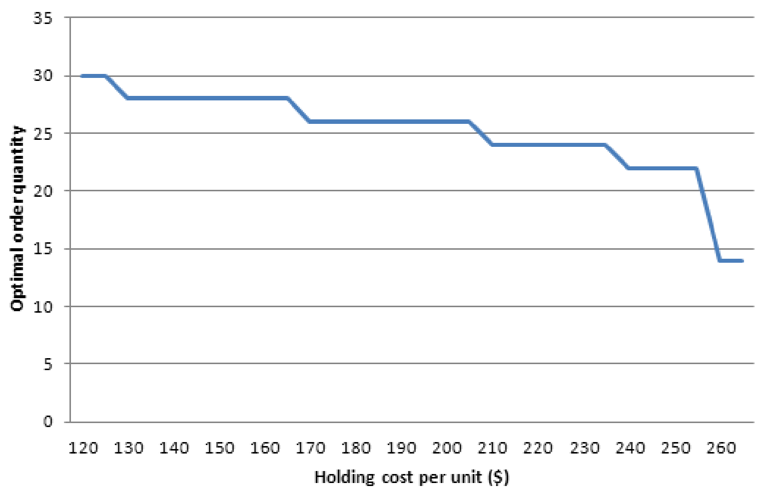

Figure 4.7: The behavior of Q_2^* as h_n increases when $p_n = 1200$, $c_n = 800$, $v_n = 400$, $b_n = 120$, $Q_1 = 80$, $\lambda_o^{(1)} = 10$, $\lambda_o^{(1)} = 10$, $\gamma_o = 0.25$, $\gamma_n = 0.75$

not seem to have much of a impact on T_n^* and T_o^*. The explanation of this can be the choice of the data that we used as the levels of the parameters.

T_n^*	T_o^*	Percentages
Decreases	Decreases	3.67%
Decreases	Increases	12.98%
Increases	Decreases	16.93%
Increases	Increases	1.55%
Decreases	Same	31.17%
Increases	Same	2.96%
Same	Decreases	0.56%
Same	Increases	18.33%
Same	Same	11.85%

Table 4.12: Percentage of instances corresponding to each type of behavior of T_n^* and T_o^* as b_n increases

In 47.82% of the instances T_n^* decreases whereas increases in 21.44% and remains unchanged in 30.74%. In most of the cases (45.98%), T_o^* remains unchanged. In 32.86% of the remaining instances T_o^* increases while it decreases in 21.16%. Decreasing T_n and keeping T_o unchanged is the most frequently observed optimal decision.

T_n^*	T_o^*	Percentages
Decreases	Decreases	0 %
Decreases	Increases	0 %
Increases	Decreases	0.67 %
Increases	Increases	57.16 %
Decreases	Same	0 %
Increases	Same	42.17 %
Same	Decreases	0 %
Same	Increases	0 %
Same	Same	0 %

Table 4.13: Percentage of instances corresponding to each type of behavior of T_n^* and T_o^* as Q_1 increases

As seen in Table 4.13, there are two dominant decisions that are optimal. The first one is the decision in which both T_n and T_o are increased (57.16%). In the second one T_n increases while T_o remains the same (42.17%). Note that in all of the instances T_n^* increases as Q_1 increases. This can be explained by the cannibalization effect. In order to liquidate a higher amount of initial inventory, the old product needs to spend longer time in the market. Another factor that affects the liquidation of the initial inventory is the demand rate, which is affected by the cannibalization. Therefore, the later the new product is introduced, the faster the liquidation of the initial inventory is.

In this section, our main goal was to observe the dominant response of the optimal timings and order quantity with respect to marginal changes in some parameters. We also attempted to identify circumstances which may possibly have a significant effect on the observed behavior of the optimal timings. We observed that T_o^* may increase as c_n increases. In these instances, the holding cost per unit has a significant impact on the behavior of T_n^*. In a small group of instances an increase in p_n resulted in an increase in T_n^*. In these cases, T_o^* always decreases. T_n^* decreases when the holding cost per unit of the new product is high and increases when holding cost per unit of the new product is low. We also observed that T_n^* increases as Q_1 increases.

Comparison of the single product rollover model and the dual product rollover

In this section, we find answers to questions (Q4) and (Q5) and summarize the other results obtained by the comparison of two product rollover models. Before getting into the comparison, we omit 755 of 2304 instances because Q_2^* is equal to 50, which is the upper bound on Q_2, in those cases. The information obtained from those instances tend to be misleading because having $Q_2^* = 50$ indicates a possibility that the actual optimal solution is out of the boundaries of our search.

Recall that Question (Q4) is as follows: Under what circumstances is the dual product rollover strategy more profitable than single product rollover strategy and vice versa? In all of 2304 instances, the dual product rollover strategy is the optimal strategy as opposed to the single product rollover strategy. This means that dual product rollover strategy can be more profitable than the single product rollover strategy even in the presence of high level of cannibalization effect. Another reason might be that the initial inventory of the old product Q_1 is considerably high compared to the demand rates. The demand rates in our experiment refer to monthly average demands. Therefore, in all instances, the firm has a 7 or 8-month supply (on average) of the old product which has to be liquidated (probably by keeping the old product in the market for a long time). This may be one of the reasons why dual product rollover strategy is optimal for all instances. Note that this also answers Question (Q5) which is: Can the dual product rollover strategy still be advantageous than the single product rollover strategy in the presence of cannibalization?

Now, we compare both models based on their profits and try to gain insights into the behavior of the optimal profit. We observed that in all of 1549 instances, the expected profit gained out of the sales of the old product under the dual product rollover strategy is *always* higher than that of the old product under the single product rollover strategy. We can say that the dual product rollover strategy allows for gain of considerable amount of profit out of the sales of the old product. In other words, the firm has to sacrifice from a considerable amount of potential profit in order to sell the newer version of the product under single product rollover strategy. To demonstrate how much this sacrificed profit may be, we present another observation: In 1057 instances (69% of all instances), the profit made out of the sales of the new product under dual product rollover strategy is *less* than that of the new product under the single product rollover strategy. Therefore, in all of those cases, the profit made out of the sales of the old product is enough to compensate the loss of profit out of the sales of the new product. We believe that those cases illustrate how much of a difference the liquidation of the initial inventory can make in the determination of product rollover strategy and optimal introduction and withdrawal timing.

Regarding the behavior of the optimal introduction and withdrawal timings, it is expected that the optimal introduction timing of the new product under the dual product rollover strategy is earlier than that of the new product under the single product rollover strategy (i.e., $T_n^* < T^*$). Similarly, it is expected that the optimal withdrawal timing of the old product under the dual product rollover strategy is later than that of the new product under the single product rollover strategy (i.e., $T^* < T_o^*$). Of course, these statements are valid for the cases in which the dual product rollover strategy gives better results than the single product rollover strategy. The reason why $T_n^* < T^* < T_o^*$ is expected to hold is that when the constraint $T_o = T_n$ is relaxed, the firm has a better chance of gaining higher profit by selling the new product in a longer time frame and of liquidating the inventory of the old product. Although, majority of the instances supports this intuition, a considerable number of instances supports what is counterintuitive.

There are 446 scenarios in which $T^* \notin (T_n^*,\ T_o^*)$. We analyzed these instances by using a similar method as in [7].

As seen in Table 4.14 and Table 4.15, $T^* > T_o^* > T_n^*$ very often happens in the instances in which the old product is very profitable and new product is least profitable.

	p_n	c_n	h_n	v_n	b_n	Q_1	$\lambda_o^{(1)}$	$\lambda_n^{(3)}$	γ_o	γ_n
Low	64.13	40.81	13.45	50.00	56.50	50.22	8.97	66.37	8.07	35.43
Medium	35.87	59.19	86.55	50.00	43.50	49.78	91.03	33.63	38.12	33.63
High	-	-	-	-	-	-	-	-	53.81	30.94

Table 4.14: Levels of the parameters (in percentages) in the cases where $T^* \notin (T_n^*,\ T_o^*)$

	$\Pi_o(Q_1, T_o^*, T_n^*)$	$\Pi_n(Q_2^*, T_o^*, T_n^*)$	T_n^*	T_o^*
min	35703.27	-8943.60	4.07	6.4
25^{th} percentile	56369.34	-3487.45	4.28	7.2
median	57204.24	-695.04	4.47	7.6
75^{th} percentile	58606.82	2109.93	4.67	8.4
max	59421.42	9367.42	7.80	10.0

Table 4.15: Basic statistics associated with the cases where $T^* \notin (T_n^*,\ T_o^*)$

The most important result of the analysis in this section is that the dual product rollover can be advantageous even if the sales of both products are significantly cannibalized. The dual product rollover strategy can be very profitable especially when the initial inventory of the old product is high because there is more time to liquidate the initial inventory.

Chapter 5

Conclusion

In this thesis, we study the problem of determining the optimal withdrawal timing of the existing product and the optimal introduction timing of the next generation of the existing product. We compare two basic product rollover strategies, namely single product rollover and dual product rollover, in this context. We developed two models for each of these strategies. The setting for both problems has the following characteristics: A firm faces stochastic demand over a finite time horizon and it has an initial inventory of the existing product at the beginning of that horizon. In addition to the price and procurement cost, a product of each type (existing and new generation) has a holding cost, salvage value and a lost sale cost. In our models for both product rollover strategies, our objective is to maximize the expected profit over the finite time horizon. The decision variables in the model for single product rollover strategy are the order quantity of the new product and the introduction timing of the next generation, which coincides with the witdrawal timing of the existing product. The decision variables for the dual product rollover strategy are the order quantity of the new product, the introduction timing of the next generation and the withdrawal timing of the existing product because product rollover does not have to be simultaneously. Specifically for the dual product rollover model, we define parameters to model the cannibalization of one product on the other. Since one of the objectives of this study is to analyze the impact of liquidation of inventory on timing decisions, we model holding cost in a detailed manner for both models.

In addition, an experimental study is conducted to investigate the behavior of optimal introduction and withdrawal timing. Impact of the parameters, especially one associated with cannibalization, on the behavior of optimal introduction and withdrawal timing is investigated. Additionally, some special cases and the optimal policies that can be implemented under those cases are analyzed. The results of both models are compared.

For the single product rollover strategy, experimental analysis shows that the optimal introduction timing T^* is not necessarily increasing in the procurement cost per unit of the new product, high level of initial inventory of the old product does not always imply a late introduction of the new product, higher price for the new product does not necessarily mean a longer stay in the market for the new product, higher holding cost or higher salvage value for the new product does not necessarily mean a shorter stay in the market for the new product. Unlike the case for the above parameters, higher lost sale cost per unit of the new product implies late introduction of the new product. We also decribe the circumstances under which these results are observed. We observed that above results are obtained if there is a high chance that the expected lost sale cost of the new product will be small and the demand for the old product is low. We also investigated some speceial cases that may be of interest. We found out that lost sale cost per unit of the new product has a crucial role on the optimal introduction timing when the profit margins of the products are the same. Moreover, we observed that unless the products are alike in the sense that their revenue and cost components are similar, it is better to change the optimal order quantity than to change the introduction timing. We analyzed the instances where the demand for the new product is the high, the demand for the old product is low and the profit margin for the new product is high. We observed that the holding cost rate of the new product is the dominant factor on the optimal timing and order quantity.

For the dual product rollover strategy, we made a similar analysis to the one explained in the above paragraph for the single product rollover strategy with more concentration in the cannibalization issue. Results of the experimental analysis indicate that in about half of the instances it is possible to describe the optimal behavior of the decision variables (Q_2, T_n, T_o) under cannibalization. For the cannibalization effect of the new product on the old product, we observed that, in almost half of the instances, both the optimal introduction timing of the new product and the withdrawal timing of the old product T_o decrease as cannibalization effect on the old product decreases. Moreover, the optimal order quantity increases whenever the interval length of the second time zone increases. However, in the remaining instances, it is hard to describe the optimal behavior of the decision variables. Regarding the cannibalization effect of the old product on the new product, it is hard to describe the optimal behavior of the decision variables for the majority of the instances. In the remaining instances, we observed that the introduction timing of the new product decreases, the withdrawal timing of the new product remains unchanged and the optimal order quantity always increases as the cannibalization effect on the new product decreases.

Finally, we compare the performances of single product rollover and the dual product rollover strategies by using the same set of data. We examine circumstances under which the dual product rollover strategy is more advantageous than single product rollover strategy and vice versa. For the set of data we use, dual product rollover strategy turns out to be optimal in all cases.

This study can be extended by relaxing the assumption that the demands of both products in the second time zone, in which they coexist, are independent. Another extension to our study can be modeling the cannibalization in a different way. In our modeling of cannibalization, we do not assume that the market size, and hence the total demand rate, stays constant at all times. By allowing for a wide range of values for γ_o and γ_n (see Chapter 3), we model a situation where the total market size increases due to the existence of two product types in the market at the same time. We believe this may occur as a result of increased customer exposure to advertisements and/or perceived popularity of the product among customers. Cannibalization effect among the two products could as well be modeled by using multinomial logit (MNL) models by taking the market size constant. We refer to Gruca and Sudharshan [8] and Basuroy and Nyugen [9] for applications of MNL models to characterize the market share among different products. In addition, a model that allows substitution of the old product with the new product can be considered as an extension. In such a model, if the inventory of the old product depletes before its withdrawal, the demand can be replaced by the new product (see [13]). Also a dynamic model which allows multiple replenishment opportunities for the new product can be considered. Finally, as a possible extension, pricing issues can be incorporated into the models for both scenarios and/or into the experimental analysis.

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Appendix A

Results of Computational Studies

In this section, we provide tables regarding the experimental analysis.

Table A.1: Scenarios where optimal introduction timing T^* is less than 6 months when profit margins are the same ($p_2 = 1000,\ c_2 = 700$).

Parameters						$p_2 = 1000,\ c_2 = 700$				
h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
90	280	100	10	20	15	8909.38	-3791	5118.38	0.83	66
185	280	100	10	20	15	8909.38	-10637	-1727.62	0.83	32
300	280	100	10	20	15	8909.38	-13125	-4215.62	0.83	20
90	400	100	10	20	15	8909.38	-3791	5118.38	0.83	66
185	400	100	10	20	15	8909.38	-10637	-1727.62	0.83	32
300	400	100	10	20	15	8909.38	-13125	-4215.62	0.83	20
90	600	100	10	20	15	8909.38	-3791	5118.38	0.83	66
185	600	100	10	20	15	8909.38	-10637	-1727.62	0.83	32
300	600	100	10	20	15	8909.38	-13125	-4215.62	0.83	20
90	280	100	15	20	15	13340.91	-3341	9999.91	1.13	66
185	280	100	15	20	15	13340.91	-10187	3153.91	1.13	32
300	280	100	15	20	15	13340.91	-12675	665.91	1.13	20
90	400	100	15	20	15	13340.91	-3341	9999.91	1.13	66
185	400	100	15	20	15	13340.91	-10187	3153.91	1.13	32
300	400	100	15	20	15	13340.91	-12675	665.91	1.13	20
90	600	100	15	20	15	13340.91	-3341	9999.91	1.13	66
185	600	100	15	20	15	13340.91	-10187	3153.91	1.13	32
300	600	100	15	20	15	13340.91	-12675	665.91	1.13	20
90	280	100	20	20	15	17603.07	-2891	14712.07	1.43	66
185	280	100	20	20	15	17603.07	-9737	7866.07	1.43	32
300	280	100	20	20	15	17603.07	-12225	5378.07	1.43	20
90	400	100	20	20	15	17603.07	-2891	14712.07	1.43	66
185	400	100	20	20	15	17603.07	-9737	7866.07	1.43	32
300	400	100	20	20	15	17603.07	-12225	5378.07	1.43	20
90	600	100	20	20	15	17603.07	-2891	14712.07	1.43	66
185	600	100	20	20	15	17603.07	-9737	7866.07	1.43	32
300	600	100	20	20	15	17603.07	-12225	5378.07	1.43	20
90	280	100	10	25	15	9097.61	-4141	4956.61	0.6	66
185	280	100	10	25	15	9097.61	-10987	-1889.39	0.6	32
300	280	100	10	25	15	9097.61	-13475	-4377.39	0.6	20
90	400	100	10	25	15	9097.61	-4141	4956.61	0.6	66
185	400	100	10	25	15	9097.61	-10987	-1889.39	0.6	32
300	400	100	10	25	15	9097.61	-13475	-4377.39	0.6	20
90	600	100	10	25	15	9097.61	-4141	4956.61	0.6	66
185	600	100	10	25	15	9097.61	-10987	-1889.39	0.6	32
300	600	100	10	25	15	9097.61	-13475	-4377.39	0.6	20
90	280	175	10	25	15	-2808	1026.76	-1781.24	5.4	77
90	400	175	10	25	15	-2891.33	1114.52	-1776.81	5.43	77
90	600	175	10	25	15	-3141.33	1373.88	-1767.45	5.53	77
90	280	100	15	25	15	13577.91	-3741	9836.91	0.87	66
185	280	100	15	25	15	13577.91	-10587	2990.91	0.87	32
300	280	100	15	25	15	13577.91	-13075	502.91	0.87	20
90	400	100	15	25	15	13577.91	-3741	9836.91	0.87	66
185	400	100	15	25	15	13577.91	-10587	2990.91	0.87	32
300	400	100	15	25	15	13577.91	-13075	502.91	0.87	20
90	600	100	15	25	15	13577.91	-3741	9836.91	0.87	66
185	600	100	15	25	15	13577.91	-10587	2990.91	0.87	32

Table A.2: Scenarios where optimal introduction timing T^* is less than 6 months when profit margins are the same ($p_2 = 1000,\ c_2 = 700$). (cont'd)

Parameters						$p_2 = 1000,\ c_2 = 700$				
h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
300	600	100	15	25	15	13577.91	-13075	502.91	0.87	20
90	280	175	15	25	15	2328	1026.76	3354.76	5.4	77
90	400	175	15	25	15	2244.67	1114.52	3359.19	5.43	77
90	600	175	15	25	15	1994.67	1373.88	3368.55	5.53	77
90	280	100	20	25	15	17976.1	-3391	14585.1	1.1	66
185	280	100	20	25	15	17976.1	-10237	7739.1	1.1	32
300	280	100	20	25	15	17976.1	-12725	5251.1	1.1	20
90	400	100	20	25	15	17976.1	-3391	14585.1	1.1	66
185	400	100	20	25	15	17976.1	-10237	7739.1	1.1	32
300	400	100	20	25	15	17976.1	-12725	5251.1	1.1	20
90	600	100	20	25	15	17976.1	-3391	14585.1	1.1	66
185	600	100	20	25	15	17976.1	-10237	7739.1	1.1	32
300	600	100	20	25	15	17976.1	-12725	5251.1	1.1	20
90	280	175	20	25	15	7324	1026.76	8350.76	5.4	77
90	400	175	20	25	15	7240.67	1114.52	8355.19	5.43	77
90	600	175	20	25	15	6990.67	1373.88	8364.55	5.53	77
90	280	100	10	20	20	5015	-997	4018	2.8	88
185	280	100	10	20	20	3881.67	-8992.17	-5110.5	3.37	43
300	280	100	10	20	20	3881.67	-12306.67	-8425	3.37	26
90	400	100	10	20	20	5015	-997	4018	2.8	88
185	400	100	10	20	20	3881.67	-8992.17	-5110.5	3.37	43
300	400	100	10	20	20	3881.67	-12306.67	-8425	3.37	26
90	600	100	10	20	20	4748.33	-730.33	4018	2.93	88
185	600	100	10	20	20	3881.67	-8992.17	-5110.5	3.37	43
300	600	100	10	20	20	3881.67	-12306.67	-8425	3.37	26
90	280	100	15	20	20	9326.67	-263.67	9063	3.17	88
185	280	100	15	20	20	8793.33	-8858.83	-65.5	3.43	43
300	280	100	15	20	20	8793.33	-12173.33	-3380	3.43	26
90	400	100	15	20	20	9326.67	-263.67	9063	3.17	88
185	400	100	15	20	20	8793.33	-8858.83	-65.5	3.43	43
300	400	100	15	20	20	8793.33	-12173.33	-3380	3.43	26
90	600	100	15	20	20	9260	-197	9063	3.2	88
185	600	100	15	20	20	8793.33	-8858.83	-65.5	3.43	43
300	600	100	15	20	20	8793.33	-12173.33	-3380	3.43	26
90	280	100	20	20	20	13663.33	269.67	13933	3.43	88
185	280	100	20	20	20	12663.33	-7858.83	4804.5	3.93	43
300	280	100	20	20	20	12663.33	-11173.33	1490	3.93	26
90	400	100	20	20	20	13596.67	336.33	13933	3.47	88
185	400	100	20	20	20	12663.33	-7858.83	4804.5	3.93	43
300	400	100	20	20	20	12663.33	-11173.33	1490	3.93	26
90	600	100	20	20	20	13596.67	336.33	13933	3.47	88
185	600	100	20	20	20	12663.33	-7858.83	4804.5	3.93	43
300	600	100	20	20	20	12663.33	-11173.33	1490	3.93	26
90	280	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88
185	280	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43
300	280	100	10	25	20	8986.25	-17706.67	-8720.42	0.67	26
90	400	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88

Table A.3: Scenarios where optimal introduction timing T^* is less than 6 months when profit margins are the same ($p_2 = 1000,\ c_2 = 700$). (cont'd)

Parameters						$p_2 = 1000,\ c_2 = 700$				
h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
185	400	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43
300	400	100	10	25	20	8986.25	-17706.67	-8720.42	0.67	26
90	600	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88
185	600	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43
300	600	100	10	25	20	8986.25	-17706.67	-8720.42	0.67	26
90	280	100	15	25	20	13456.33	-4730.33	8726	0.93	88
185	280	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43
300	280	100	15	25	20	13456.33	-17173.33	-3717	0.93	26
90	400	100	15	25	20	13456.33	-4730.33	8726	0.93	88
185	400	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43
300	400	100	15	25	20	13456.33	-17173.33	-3717	0.93	26
90	600	100	15	25	20	13456.33	-4730.33	8726	0.93	88
185	600	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43
300	600	100	15	25	20	13456.33	-17173.33	-3717	0.93	26
90	280	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88
185	280	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43
300	280	100	20	25	20	17858.39	-16706.67	1151.73	1.17	26
90	400	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88
185	400	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43
300	400	100	20	25	20	17858.39	-16706.67	1151.73	1.17	26
90	600	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88
185	600	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43
300	600	100	20	25	20	17858.39	-16706.67	1151.73	1.17	26

Table A.4: Scenarios where optimal introduction timing T^* is less than 6 months when profit margins are the same ($p_2 = 1200,\ c_2 = 900$).

Parameters						$p_2 = 1200,\ c_2 = 900$				
h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
90	280	100	10	20	15	8909.38	-3791	5118.38	0.83	66
185	280	100	10	20	15	8909.38	-10637	-1727.62	0.83	32
300	280	100	10	20	15	8909.38	-13125	-4215.62	0.83	20
90	400	100	10	20	15	8909.38	-3791	5118.38	0.83	66
185	400	100	10	20	15	8909.38	-10637	-1727.62	0.83	32
300	400	100	10	20	15	8909.38	-13125	-4215.62	0.83	20
90	600	100	10	20	15	8909.38	-3791	5118.38	0.83	66
185	600	100	10	20	15	8909.38	-10637	-1727.62	0.83	32
300	600	100	10	20	15	8909.38	-13125	-4215.62	0.83	20
90	280	100	15	20	15	13340.91	-3341	9999.91	1.13	66
185	280	100	15	20	15	13340.91	-10187	3153.91	1.13	32
300	280	100	15	20	15	13340.91	-12675	665.91	1.13	20
90	400	100	15	20	15	13340.91	-3341	9999.91	1.13	66
185	400	100	15	20	15	13340.91	-10187	3153.91	1.13	32
300	400	100	15	20	15	13340.91	-12675	665.91	1.13	20
90	600	100	15	20	15	13340.91	-3341	9999.91	1.13	66
185	600	100	15	20	15	13340.91	-10187	3153.91	1.13	32
300	600	100	15	20	15	13340.91	-12675	665.91	1.13	20
90	280	100	20	20	15	17603.07	-2891	14712.07	1.43	66
185	280	100	20	20	15	17603.07	-9737	7866.07	1.43	32
300	280	100	20	20	15	17603.07	-12225	5378.07	1.43	20
90	400	100	20	20	15	17603.07	-2891	14712.07	1.43	66
185	400	100	20	20	15	17603.07	-9737	7866.07	1.43	32
300	400	100	20	20	15	17603.07	-12225	5378.07	1.43	20
90	600	100	20	20	15	17603.07	-2891	14712.07	1.43	66
185	600	100	20	20	15	17603.07	-9737	7866.07	1.43	32
300	600	100	20	20	15	17603.07	-12225	5378.07	1.43	20
90	280	100	10	25	15	9097.61	-4141	4956.61	0.6	66
185	280	100	10	25	15	9097.61	-10987	-1889.39	0.6	32
300	280	100	10	25	15	9097.61	-13475	-4377.39	0.6	20
90	400	100	10	25	15	9097.61	-4141	4956.61	0.6	66
185	400	100	10	25	15	9097.61	-10987	-1889.39	0.6	32
300	400	100	10	25	15	9097.61	-13475	-4377.39	0.6	20
90	600	100	10	25	15	9097.61	-4141	4956.61	0.6	66
185	600	100	10	25	15	9097.61	-10987	-1889.39	0.6	32
300	600	100	10	25	15	9097.61	-13475	-4377.39	0.6	20
90	280	175	10	25	15	-2641.33	853.99	-1787.34	5.33	77
90	400	175	10	25	15	-2724.67	940.82	-1783.85	5.37	77
90	600	175	10	25	15	-2891.33	1114.52	-1776.81	5.43	77
90	280	100	15	25	15	13577.91	-3741	9836.91	0.87	66
185	280	100	15	25	15	13577.91	-10587	2990.91	0.87	32
300	280	100	15	25	15	13577.91	-13075	502.91	0.87	20
90	400	100	15	25	15	13577.91	-3741	9836.91	0.87	66
185	400	100	15	25	15	13577.91	-10587	2990.91	0.87	32
300	400	100	15	25	15	13577.91	-13075	502.91	0.87	20
90	600	100	15	25	15	13577.91	-3741	9836.91	0.87	66

Table A.5: Scenarios where optimal introduction timing T^* is less than 6 months when profit margins are the same ($p_2 = 1200,\ c_2 = 900$). (cont'd)

Parameters						$p_2 = 1200,\ c_2 = 900$				
h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
185	600	100	15	25	15	13577.91	-10587	2990.91	0.87	32
300	600	100	15	25	15	13577.91	-13075	502.91	0.87	20
90	280	175	15	25	15	2494.67	853.99	3348.66	5.33	77
90	400	175	15	25	15	2411.33	940.82	3352.15	5.37	77
90	600	175	15	25	15	2244.67	1114.52	3359.19	5.43	77
90	280	100	20	25	15	17976.1	-3391	14585.1	1.1	66
185	280	100	20	25	15	17976.1	-10237	7739.1	1.1	32
300	280	100	20	25	15	17976.1	-12725	5251.1	1.1	20
90	400	100	20	25	15	17976.1	-3391	14585.1	1.1	66
185	400	100	20	25	15	17976.1	-10237	7739.1	1.1	32
300	400	100	20	25	15	17976.1	-12725	5251.1	1.1	20
90	600	100	20	25	15	17976.1	-3391	14585.1	1.1	66
185	600	100	20	25	15	17976.1	-10237	7739.1	1.1	32
300	600	100	20	25	15	17976.1	-12725	5251.1	1.1	20
90	280	175	20	25	15	7490.67	853.99	8344.66	5.33	77
90	400	175	20	25	15	7407.33	940.82	8348.15	5.37	77
90	600	175	20	25	15	7240.67	1114.52	8355.19	5.43	77
90	280	100	10	20	20	5015	-997	4018	2.8	88
185	280	100	10	20	20	3881.67	-8992.17	-5110.5	3.37	43
300	280	100	10	20	20	3881.67	-12306.67	-8425	3.37	26
90	400	100	10	20	20	5015	-997	4018	2.8	88
185	400	100	10	20	20	3881.67	-8992.17	-5110.5	3.37	43
300	400	100	10	20	20	3881.67	-12306.67	-8425	3.37	26
90	600	100	10	20	20	5015	-997	4018	2.8	88
185	600	100	10	20	20	3881.67	-8992.17	-5110.5	3.37	43
300	600	100	10	20	20	3881.67	-12306.67	-8425	3.37	26
90	280	100	15	20	20	9326.67	-263.67	9063	3.17	88
185	280	100	15	20	20	8793.33	-8858.83	-65.5	3.43	43
300	280	100	15	20	20	8793.33	-12173.33	-3380	3.43	26
90	400	100	15	20	20	9326.67	-263.67	9063	3.17	88
185	400	100	15	20	20	8793.33	-8858.83	-65.5	3.43	43
300	400	100	15	20	20	8793.33	-12173.33	-3380	3.43	26
90	600	100	15	20	20	9326.67	-263.67	9063	3.17	88
185	600	100	15	20	20	8793.33	-8858.83	-65.5	3.43	43
300	600	100	15	20	20	8793.33	-12173.33	-3380	3.43	26
90	280	100	20	20	20	13663.33	269.67	13933	3.43	88
185	280	100	20	20	20	12663.33	-7858.83	4804.5	3.93	43
300	280	100	20	20	20	12663.33	-11173.33	1490	3.93	26
90	400	100	20	20	20	13663.33	269.67	13933	3.43	88
185	400	100	20	20	20	12663.33	-7858.83	4804.5	3.93	43
300	400	100	20	20	20	12663.33	-11173.33	1490	3.93	26
90	600	100	20	20	20	13596.67	336.33	13933	3.47	88
185	600	100	20	20	20	12663.33	-7858.83	4804.5	3.93	43
300	600	100	20	20	20	12663.33	-11173.33	1490	3.93	26
90	280	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88
185	280	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43

Table A.6: Scenarios where optimal introduction timing T^* is less than 6 months when profit margins are the same ($p_2 = 1200,\ c_2 = 900$). (cont'd)

Parameters						$p_2 = 1200,\ c_2 = 900$				
h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
300	280	100	10	25	20	8986.25	-17706.67	-8720.42	0.67	26
90	400	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88
185	400	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43
300	400	100	10	25	20	8986.25	-17706.67	-8720.42	0.67	26
90	600	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88
185	600	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43
300	600	100	10	25	20	8986.25	-17706.67	-8720.42	0.67	26
90	280	100	15	25	20	13456.33	-4730.33	8726	0.93	88
185	280	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43
300	280	100	15	25	20	13456.33	-17173.33	-3717	0.93	26
90	400	100	15	25	20	13456.33	-4730.33	8726	0.93	88
185	400	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43
300	400	100	15	25	20	13456.33	-17173.33	-3717	0.93	26
90	600	100	15	25	20	13456.33	-4730.33	8726	0.93	88
185	600	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43
300	600	100	15	25	20	13456.33	-17173.33	-3717	0.93	26
90	280	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88
185	280	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43
300	280	100	20	25	20	17858.39	-16706.67	1151.73	1.17	26
90	400	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88
185	400	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43
300	400	100	20	25	20	17858.39	-16706.67	1151.73	1.17	26
90	600	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88
185	600	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43
300	600	100	20	25	20	17858.39	-16706.67	1151.73	1.17	26

Table A.7: Scenarios where optimal introduction timing T^* is not increasing as c_n increases from 700(low) to 800(medium)

Parameters							$c_2 = 700$					$c_2 = 800$				
p_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1000	90	280	100	10	20	15	8909.38	-3791	5118.38	0.83	66	8909.38	-9575	-665.62	0.83	50
1200	90	280	100	10	20	15	8909.38	12775	21684.38	0.83	99	8909.38	3659	12568.38	0.83	83
1000	185	280	100	10	20	15	8909.38	-10637	-1727.62	0.83	32	8909.38	-13425	-4515.62	0.83	24
1200	185	280	100	10	20	15	8909.38	-2629	6280.38	0.83	48	8909.38	-7038.33	1871.05	0.83	40
1400	185	280	100	10	20	15	8909.38	8621.67	17531.05	0.83	64	8909.38	2591	11500.38	0.83	56
1000	300	280	100	10	20	15	8909.38	-13125	-4215.62	0.83	20	8909.38	-14825	-5915.62	0.83	15
1200	300	280	100	10	20	15	8909.38	-8225	684.38	0.83	30	8909.38	-10925	-2015.62	0.83	25
1400	300	280	100	10	20	15	8909.38	-1325	7584.38	0.83	40	8909.38	-5025	3884.38	0.83	35
1000	90	400	100	10	20	15	8909.38	-3791	5118.38	0.83	66	8909.38	-9575	-665.62	0.83	50
1200	90	400	100	10	20	15	8909.38	12775	21684.38	0.83	99	8909.38	3659	12568.38	0.83	83
1000	185	400	100	10	20	15	8909.38	-10637	-1727.62	0.83	32	8909.38	-13425	-4515.62	0.83	24
1200	185	400	100	10	20	15	8909.38	-2629	6280.38	0.83	48	8909.38	-7038.33	1871.05	0.83	40
1400	185	400	100	10	20	15	8909.38	8621.67	17531.05	0.83	64	8909.38	2591	11500.38	0.83	56
1000	300	400	100	10	20	15	8909.38	-13125	-4215.62	0.83	20	8909.38	-14825	-5915.62	0.83	15
1200	300	400	100	10	20	15	8909.38	-8225	684.38	0.83	30	8909.38	-10925	-2015.62	0.83	25
1400	300	400	100	10	20	15	8909.38	-1325	7584.38	0.83	40	8909.38	-5025	3884.38	0.83	35
1000	90	600	100	10	20	15	8909.38	-3791	5118.38	0.83	66	8909.38	-9575	-665.62	0.83	50
1200	90	600	100	10	20	15	8909.38	12775	21684.38	0.83	99	8909.38	3659	12568.38	0.83	83
1000	185	600	100	10	20	15	8909.38	-10637	-1727.62	0.83	32	8909.38	-13425	-4515.62	0.83	24
1200	185	600	100	10	20	15	8909.38	-2629	6280.38	0.83	48	8909.38	-7038.33	1871.05	0.83	40
1400	185	600	100	10	20	15	8909.38	8621.67	17531.05	0.83	64	8909.38	2591	11500.38	0.83	56
1000	300	600	100	10	20	15	8909.38	-13125	-4215.62	0.83	20	8909.38	-14825	-5915.62	0.83	15
1200	300	600	100	10	20	15	8909.38	-8225	684.38	0.83	30	8909.38	-10925	-2015.62	0.83	25
1400	300	600	100	10	20	15	8909.38	-1325	7584.38	0.83	40	8909.38	-5025	3884.38	0.83	35
1000	90	280	100	15	20	15	13340.91	-3341	9999.91	1.13	66	13340.91	-9125	4215.91	1.13	50
1200	90	280	100	15	20	15	13340.91	13225	26565.91	1.13	99	13340.91	4109	17449.91	1.13	83
1000	185	280	100	15	20	15	13340.91	-10187	3153.91	1.13	32	13340.91	-12975	365.91	1.13	24
1200	185	280	100	15	20	15	13340.91	-2179	11161.91	1.13	48	13340.91	-6588.33	6752.58	1.13	40
1400	185	280	100	15	20	15	13340.91	9071.67	22412.58	1.13	64	13340.91	3041	16381.91	1.13	56
1000	300	280	100	15	20	15	13340.91	-12675	665.91	1.13	20	13340.91	-14375	-1034.09	1.13	15

Table A.8: Scenarios where optimal introduction timing T^* is not increasing as c_n increases from 700(low) to 800(medium) (cont'd)

Parameters							$c_2 = 700$					$c_2 = 800$				
p_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1200	300	280	100	15	20	15	13340.91	-7775	5565.91	1.13	30	13340.91	-10475	2865.91	1.13	25
1400	300	280	100	15	20	15	13340.91	-875	12465.91	1.13	40	13340.91	-4575	8765.91	1.13	35
1000	90	400	100	15	20	15	13340.91	-3341	9999.91	1.13	66	13340.91	-9125	4215.91	1.13	50
1200	90	400	100	15	20	15	13340.91	13225	26565.91	1.13	99	13340.91	4109	17449.91	1.13	83
1000	185	400	100	15	20	15	13340.91	-10187	3153.91	1.13	32	13340.91	-12975	365.91	1.13	24
1200	185	400	100	15	20	15	13340.91	-2179	11161.91	1.13	48	13340.91	-6588.33	6752.58	1.13	40
1400	185	400	100	15	20	15	13340.91	9071.67	22412.58	1.13	64	13340.91	3041	16381.91	1.13	56
1000	300	400	100	15	20	15	13340.91	-12675	665.91	1.13	20	13340.91	-14375	-1034.09	1.13	15
1200	300	400	100	15	20	15	13340.91	-7775	5565.91	1.13	30	13340.91	-10475	2865.91	1.13	25
1400	300	400	100	15	20	15	13340.91	-875	12465.91	1.13	40	13340.91	-4575	8765.91	1.13	35
1000	90	600	100	15	20	15	13340.91	-3341	9999.91	1.13	66	13340.91	-9125	4215.91	1.13	50
1200	90	600	100	15	20	15	13340.91	13225	26565.91	1.13	99	13340.91	4109	17449.91	1.13	83
1400	90	600	100	15	20	15	13340.91	36436.23	49777.14	1.13	132	13340.91	24008.87	37349.78	1.13	116
1000	185	600	100	15	20	15	13340.91	-10187	3153.91	1.13	32	13340.91	-12975	365.91	1.13	24
1200	185	600	100	15	20	15	13340.91	-2179	11161.91	1.13	48	13340.91	-6588.33	6752.58	1.13	40
1400	185	600	100	15	20	15	13340.91	9071.67	22412.58	1.13	64	13340.91	3041	16381.91	1.13	56
1000	300	600	100	15	20	15	13340.91	-12675	665.91	1.13	20	13340.91	-14375	-1034.09	1.13	15
1200	300	600	100	15	20	15	13340.91	-7775	5565.91	1.13	30	13340.91	-10475	2865.91	1.13	25
1400	300	600	100	15	20	15	13340.91	-875	12465.91	1.13	40	13340.91	-4575	8765.91	1.13	35
1000	90	280	100	20	20	15	17603.07	-2891	14712.07	1.43	66	17603.07	-8675	8928.07	1.43	50
1200	90	280	100	20	20	15	17603.07	13675	31278.07	1.43	99	17603.07	4559	22162.07	1.43	83
1000	185	280	100	20	20	15	17603.07	-9737	7866.07	1.43	32	17603.07	-12525	5078.07	1.43	24
1200	185	280	100	20	20	15	17603.07	-1729	15874.07	1.43	48	17603.07	-6138.33	11464.74	1.43	40
1400	185	280	100	20	20	15	17603.07	9521.67	27124.74	1.43	64	17603.07	3491	21094.07	1.43	56
1000	300	280	100	20	20	15	17603.07	-12225	5378.07	1.43	20	17603.07	-13925	3678.07	1.43	15
1200	300	280	100	20	20	15	17603.07	-7325	10278.07	1.43	30	17603.07	-10025	7578.07	1.43	25
1400	300	280	100	20	20	15	17603.07	-425	17178.07	1.43	40	17603.07	-4125	13478.07	1.43	35
1000	90	400	100	20	20	15	17603.07	-2891	14712.07	1.43	66	17603.07	-8675	8928.07	1.43	50
1200	90	400	100	20	20	15	17603.07	13675	31278.07	1.43	99	17603.07	4559	22162.07	1.43	83
1000	185	400	100	20	20	15	17603.07	-9737	7866.07	1.43	32	17603.07	-12525	5078.07	1.43	24

Table A.9: Scenarios where optimal introduction timing T^* is not increasing as c_n increases from 700(low) to 800(medium) (cont'd)

Parameters							$c_2 = 700$					$c_2 = 800$				
p_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1200	185	400	100	20	20	15	17603.07	-1729	15874.07	1.43	48	17603.07	-6138.33	11464.74	1.43	40
1400	185	400	100	20	20	15	17603.07	9521.67	27124.74	1.43	64	17603.07	3491	21094.07	1.43	56
1000	300	400	100	20	20	15	17603.07	-12225	5378.07	1.43	20	17603.07	-13925	3678.07	1.43	15
1200	300	400	100	20	20	15	17603.07	-7325	10278.07	1.43	30	17603.07	-10025	7578.07	1.43	25
1400	300	400	100	20	20	15	17603.07	-425	17178.07	1.43	40	17603.07	-4125	13478.07	1.43	35
1000	90	600	100	20	20	15	17603.07	-2891	14712.07	1.43	66	17603.07	-8675	8928.07	1.43	50
1200	90	600	100	20	20	15	17603.07	13675	31278.07	1.43	99	17603.07	4559	22162.07	1.43	83
1000	185	600	100	20	20	15	17603.07	-9737	7866.07	1.43	32	17603.07	-12525	5078.07	1.43	24
1200	185	600	100	20	20	15	17603.07	-1729	15874.07	1.43	48	17603.07	-6138.33	11464.74	1.43	40
1400	185	600	100	20	20	15	17603.07	9521.67	27124.74	1.43	64	17603.07	3491	21094.07	1.43	56
1000	300	600	100	20	20	15	17603.07	-12225	5378.07	1.43	20	17603.07	-13925	3678.07	1.43	15
1200	300	600	100	20	20	15	17603.07	-7325	10278.07	1.43	30	17603.07	-10025	7578.07	1.43	25
1400	300	600	100	20	20	15	17603.07	-425	17178.07	1.43	40	17603.07	-4125	13478.07	1.43	35
1000	90	280	100	10	25	15	9097.61	-4141	4956.61	0.6	66	9097.61	-9925	-827.39	0.6	50
1200	90	280	100	10	25	15	9097.61	12425	21522.61	0.6	99	9097.61	3309	12406.61	0.6	83
1400	90	280	100	10	25	15	9097.61	35653.77	44751.38	0.6	133	9097.61	23208.99	32306.6	0.6	116
1000	185	280	100	10	25	15	9097.61	-10987	-1889.39	0.6	32	9097.61	-13775	-4677.39	0.6	24
1200	185	280	100	10	25	15	9097.61	-2979	6118.61	0.6	48	9097.61	-7388.33	1709.28	0.6	40
1400	185	280	100	10	25	15	9097.61	8271.67	17369.28	0.6	64	9097.61	2241	11338.61	0.6	56
1000	300	280	100	10	25	15	9097.61	-13475	-4377.39	0.6	20	9097.61	-15175	-6077.39	0.6	15
1200	300	280	100	10	25	15	9097.61	-8575	522.61	0.6	30	9097.61	-11275	-2177.39	0.6	25
1400	300	280	100	10	25	15	9097.61	-1675	7422.61	0.6	40	9097.61	-5375	3722.61	0.6	35
1000	90	400	100	10	25	15	9097.61	-4141	4956.61	0.6	66	9097.61	-9925	-827.39	0.6	50
1200	90	400	100	10	25	15	9097.61	12425	21522.61	0.6	99	9097.61	3309	12406.61	0.6	83
1400	90	400	100	10	25	15	9097.61	35654.29	44751.91	0.6	133	9097.61	23208.99	32306.6	0.6	116
1000	185	400	100	10	25	15	9097.61	-10987	-1889.39	0.6	32	9097.61	-13775	-4677.39	0.6	24
1200	185	400	100	10	25	15	9097.61	-2979	6118.61	0.6	48	9097.61	-7388.33	1709.28	0.6	40
1400	185	400	100	10	25	15	9097.61	8271.67	17369.28	0.6	64	9097.61	2241	11338.61	0.6	56
1000	300	400	100	10	25	15	9097.61	-13475	-4377.39	0.6	20	9097.61	-15175	-6077.39	0.6	15
1200	300	400	100	10	25	15	9097.61	-8575	522.61	0.6	30	9097.61	-11275	-2177.39	0.6	25

Table A.10: Scenarios where optimal introduction timing T^* is not increasing as c_n increases from 700(low) to 800(medium) (cont'd)

Parameters							$c_2 = 700$					$c_2 = 800$				
p_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1400	300	400	100	10	25	15	9097.61	-1675	7422.61	0.6	40	9097.61	-5375	3722.61	0.6	35
1000	90	600	100	10	25	15	9097.61	-4141	4956.61	0.6	66	9097.61	-9925	-827.39	0.6	50
1200	90	600	100	10	25	15	9097.61	12425	21522.61	0.6	99	9097.61	3309	12406.61	0.6	83
1400	90	600	100	10	25	15	9097.61	35655.17	44752.78	0.6	133	9097.61	23208.99	32306.61	0.6	116
1000	185	600	100	10	25	15	9097.61	-10987	-1889.39	0.6	32	9097.61	-13775	-4677.39	0.6	24
1200	185	600	100	10	25	15	9097.61	-2979	6118.61	0.6	48	9097.61	-7388.33	1709.28	0.6	40
1400	185	600	100	10	25	15	9097.61	8271.67	17369.28	0.6	64	9097.61	2241	11338.61	0.6	56
1000	300	600	100	10	25	15	9097.61	-13475	-4377.39	0.6	20	9097.61	-15175	-6077.39	0.6	15
1200	300	600	100	10	25	15	9097.61	-8575	522.61	0.6	30	9097.61	-11275	-2177.39	0.6	25
1400	300	600	100	10	25	15	9097.61	-1675	7422.61	0.6	40	9097.61	-5375	3722.61	0.6	35
1000	90	280	100	15	25	15	13577.91	-3741	9836.91	0.87	66	13577.91	-9525	4052.91	0.87	50
1200	90	280	100	15	25	15	13577.91	12825	26402.91	0.87	99	13577.91	3709	17286.91	0.87	83
1400	90	280	100	15	25	15	13577.91	36046.19	49624.1	0.87	132	13577.91	23608.95	37186.86	0.87	116
1000	185	280	100	15	25	15	13577.91	-10587	2990.91	0.87	32	13577.91	-13375	202.91	0.87	24
1200	185	280	100	15	25	15	13577.91	-2579	10998.91	0.87	48	13577.91	-6988.33	6589.57	0.87	40
1400	185	280	100	15	25	15	13577.91	8671.67	22249.57	0.87	64	13577.91	2641	16218.91	0.87	56
1000	300	280	100	15	25	15	13577.91	-13075	502.91	0.87	20	13577.91	-14775	-1197.09	0.87	15
1200	300	280	100	15	25	15	13577.91	-8175	5402.91	0.87	30	13577.91	-10875	2702.91	0.87	25
1400	300	280	100	15	25	15	13577.91	-1275	12302.91	0.87	40	13577.91	-4975	8602.91	0.87	35
1000	90	400	100	15	25	15	13577.91	-3741	9836.91	0.87	66	13577.91	-9525	4052.91	0.87	50
1200	90	400	100	15	25	15	13577.91	12825	26402.91	0.87	99	13577.91	3709	17286.91	0.87	83
1400	90	400	100	15	25	15	13577.91	36047.27	49625.18	0.87	132	13577.91	23608.96	37186.87	0.87	116
1000	185	400	100	15	25	15	13577.91	-10587	2990.91	0.87	32	13577.91	-13375	202.91	0.87	24
1200	185	400	100	15	25	15	13577.91	-2579	10998.91	0.87	48	13577.91	-6988.33	6589.57	0.87	40
1400	185	400	100	15	25	15	13577.91	8671.67	22249.57	0.87	64	13577.91	2641	16218.91	0.87	56
1000	300	400	100	15	25	15	13577.91	-13075	502.91	0.87	20	13577.91	-14775	-1197.09	0.87	15
1200	300	400	100	15	25	15	13577.91	-8175	5402.91	0.87	30	13577.91	-10875	2702.91	0.87	25
1400	300	400	100	15	25	15	13577.91	-1275	12302.91	0.87	40	13577.91	-4975	8602.91	0.87	35
1000	90	600	100	15	25	15	13577.91	-3741	9836.91	0.87	66	13577.91	-9525	4052.91	0.87	50
1200	90	600	100	15	25	15	13577.91	12825	26402.91	0.87	99	13577.91	3709	17286.91	0.87	83

Table A.11: Scenarios where optimal introduction timing T^* is not increasing as c_n increases from 700(low) to 800(medium) (cont'd)

Parameters							$c_2 = 700$					$c_2 = 800$				
p_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1400	90	600	100	15	25	15	13577.91	36049.08	49626.99	0.87	132	13577.91	23608.97	37186.87	0.87	116
1000	185	600	100	15	25	15	13577.91	-10587	2990.91	0.87	32	13577.91	-13375	202.91	0.87	24
1200	185	600	100	15	25	15	13577.91	-2579	10998.91	0.87	48	13577.91	-6988.33	6589.57	0.87	40
1400	185	600	100	15	25	15	13577.91	8671.67	22249.57	0.87	64	13577.91	2641	16218.91	0.87	56
1000	300	600	100	15	25	15	13577.91	-13075	502.91	0.87	20	13577.91	-14775	-1197.09	0.87	15
1200	300	600	100	15	25	15	13577.91	-8175	5402.91	0.87	30	13577.91	-10875	2702.91	0.87	25
1400	300	600	100	15	25	15	13577.91	-1275	12302.91	0.87	40	13577.91	-4975	8602.91	0.87	35
1000	90	280	100	20	25	15	17976.1	-3391	14585.1	1.1	66	17976.1	-9175	8801.1	1.1	50
1200	90	280	100	20	25	15	17976.1	13175	31151.1	1.1	99	17976.1	4059	22035.1	1.1	83
1400	90	280	100	20	25	15	17976.1	36381.78	54357.87	1.1	132	17976.1	23958.85	41934.95	1.1	116
1000	185	280	100	20	25	15	17976.1	-10237	7739.1	1.1	32	17976.1	-13025	4951.1	1.1	24
1200	185	280	100	20	25	15	17976.1	-2229	15747.1	1.1	48	17976.1	-6638.33	11337.77	1.1	40
1400	185	280	100	20	25	15	17976.1	9021.67	26997.77	1.1	64	17976.1	2991	20967.1	1.1	56
1000	300	280	100	20	25	15	17976.1	-12725	5251.1	1.1	20	17976.1	-14425	3551.1	1.1	15
1200	300	280	100	20	25	15	17976.1	-7825	10151.1	1.1	30	17976.1	-10525	7451.1	1.1	25
1400	300	280	100	20	25	15	17976.1	-925	17051.1	1.1	40	17976.1	-4625	13351.1	1.1	35
1000	90	400	100	20	25	15	17976.1	-3391	14585.1	1.1	66	17976.1	-9175	8801.1	1.1	50
1200	90	400	100	20	25	15	17976.1	13175	31151.1	1.1	99	17976.1	4059	22035.1	1.1	83
1400	90	400	100	20	25	15	17976.1	36384.31	54360.41	1.1	132	17976.1	23958.87	41934.97	1.1	116
1000	185	400	100	20	25	15	17976.1	-10237	7739.1	1.1	32	17976.1	-13025	4951.1	1.1	24
1200	185	400	100	20	25	15	17976.1	-2229	15747.1	1.1	48	17976.1	-6638.33	11337.77	1.1	40
1400	185	400	100	20	25	15	17976.1	9021.67	26997.77	1.1	64	17976.1	2991	20967.1	1.1	56
1000	300	400	100	20	25	15	17976.1	-12725	5251.1	1.1	20	17976.1	-14425	3551.1	1.1	15
1200	300	400	100	20	25	15	17976.1	-7825	10151.1	1.1	30	17976.1	-10525	7451.1	1.1	25
1400	300	400	100	20	25	15	17976.1	-925	17051.1	1.1	40	17976.1	-4625	13351.1	1.1	35
1000	90	600	100	20	25	15	17976.1	-3391	14585.1	1.1	66	17976.1	-9175	8801.1	1.1	50
1200	90	600	100	20	25	15	17976.1	13175	31151.1	1.1	99	17976.1	4059	22035.1	1.1	83
1400	90	600	100	20	25	15	17976.1	36388.52	54364.62	1.1	132	17976.1	23958.89	41934.99	1.1	116
1000	185	600	100	20	25	15	17976.1	-10237	7739.1	1.1	32	17976.1	-13025	4951.1	1.1	24

Table A.12: Scenarios where optimal introduction timing T^* is not increasing as c_n increases from 700(low) to 800(medium) (cont'd)

Parameters							$c_2 = 700$					$c_2 = 800$				
p_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1200	185	600	100	20	25	15	17976.1	-2229	15747.1	1.1	48	17976.1	-6638.33	11337.77	1.1	40
1400	185	600	100	20	25	15	17976.1	9021.67	26997.77	1.1	64	17976.1	2991	20967.1	1.1	56
1000	300	600	100	20	25	15	17976.1	-12725	5251.1	1.1	20	17976.1	-14425	3551.1	1.1	15
1200	300	600	100	20	25	15	17976.1	-7825	10151.1	1.1	30	17976.1	-10525	7451.1	1.1	25
1400	300	600	100	20	25	15	17976.1	-925	17051.1	1.1	40	17976.1	-4625	13351.1	1.1	35
1000	185	280	100	10	20	20	3881.67	-8992.17	-5110.5	3.37	43	3881.67	-12725.67	-8844	3.37	32
1200	185	280	100	10	20	20	2081.67	3518.33	5600	4.27	64	3881.67	-4177.92	-296.25	3.37	54
1000	300	280	100	10	20	20	3881.67	-12306.67	-8425	3.37	26	3881.67	-14591.67	-10710	3.37	20
1400	300	280	100	10	20	20	3881.67	3493.33	7375	3.37	53	3881.67	-1456.67	2425	3.37	46
1000	185	400	100	10	20	20	3881.67	-8992.17	-5110.5	3.37	43	3881.67	-12725.67	-8844	3.37	32
1200	185	400	100	10	20	20	2081.67	3518.33	5600	4.27	64	3881.67	-4177.92	-296.25	3.37	54
1000	300	400	100	10	20	20	3881.67	-12306.67	-8425	3.37	26	3881.67	-14591.67	-10710	3.37	20
1400	300	400	100	10	20	20	3881.67	3493.33	7375	3.37	53	3881.67	-1456.67	2425	3.37	46
1000	185	600	100	10	20	20	3881.67	-8992.17	-5110.5	3.37	43	3881.67	-12725.67	-8844	3.37	32
1200	185	600	100	10	20	20	2081.67	3518.33	5600	4.27	64	3881.67	-4177.92	-296.25	3.37	54
1000	300	600	100	10	20	20	3881.67	-12306.67	-8425	3.37	26	3881.67	-14591.67	-10710	3.37	20
1400	300	600	100	10	20	20	3881.67	3493.33	7375	3.37	53	3881.67	-1456.67	2425	3.37	46
1000	185	280	100	15	20	20	8793.33	-8858.83	-65.5	3.43	43	8793.33	-12592.33	-3799	3.43	32
1200	185	280	100	15	20	20	7126.67	3518.33	10645	4.27	64	8793.33	-4044.58	4748.75	3.43	54
1000	300	280	100	15	20	20	8793.33	-12173.33	-3380	3.43	26	8793.33	-14458.33	-5665	3.43	20
1400	300	280	100	15	20	20	5726.67	6693.33	12420	4.97	53	8793.33	-1323.33	7470	3.43	46
1000	185	400	100	15	20	20	8793.33	-8858.83	-65.5	3.43	43	8793.33	-12592.33	-3799	3.43	32
1200	185	400	100	15	20	20	7126.67	3518.33	10645	4.27	64	8793.33	-4044.58	4748.75	3.43	54
1000	300	400	100	15	20	20	8793.33	-12173.33	-3380	3.43	26	8793.33	-14458.33	-5665	3.43	20
1400	300	400	100	15	20	20	5726.67	6693.33	12420	4.97	53	8793.33	-1323.33	7470	3.43	46
1000	185	600	100	15	20	20	8793.33	-8858.83	-65.5	3.43	43	8793.33	-12592.33	-3799	3.43	32
1000	300	600	100	15	20	20	8793.33	-12173.33	-3380	3.43	26	8793.33	-14458.33	-5665	3.43	20
1400	300	600	100	15	20	20	5726.67	6693.33	12420	4.97	53	8793.33	-1323.33	7470	3.43	46
1000	185	280	100	20	20	20	12663.33	-7858.83	4804.5	3.93	43	12663.33	-11592.33	1071	3.93	32
1200	185	280	100	20	20	20	12196.67	3318.33	15515	4.17	64	12663.33	-3044.58	9618.75	3.93	54

Table A.13: Scenarios where optimal introduction timing T^* is not increasing as c_n increases from 700(low) to 800(medium) (cont'd)

Parameters							$c_2 = 700$					$c_2 = 800$				
p_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1000	300	280	100	20	20	20	12663.33	-11173.33	1490	3.93	26	12663.33	-13458.33	-795	3.93	20
1400	300	280	100	20	20	20	10596.67	6693.33	17290	4.97	53	12663.33	-323.33	12340	3.93	46
1000	185	400	100	20	20	20	12663.33	-7858.83	4804.5	3.93	43	12663.33	-11592.33	1071	3.93	32
1200	185	400	100	20	20	20	12196.67	3318.33	15515	4.17	64	12663.33	-3044.58	9618.75	3.93	54
1000	300	400	100	20	20	20	12663.33	-11173.33	1490	3.93	26	12663.33	-13458.33	-795	3.93	20
1400	300	400	100	20	20	20	10596.67	6693.33	17290	4.97	53	12663.33	-323.33	12340	3.93	46
1000	185	600	100	20	20	20	12663.33	-7858.83	4804.5	3.93	43	12663.33	-11592.33	1071	3.93	32
1200	185	600	100	20	20	20	12196.67	3318.33	15515	4.17	64	12663.33	-3044.58	9618.75	3.93	54
1000	300	600	100	20	20	20	12663.33	-11173.33	1490	3.93	26	12663.33	-13458.33	-795	3.93	20
1400	300	600	100	20	20	20	10596.67	6693.33	17290	4.97	53	12663.33	-323.33	12340	3.93	46
1000	90	280	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88	8986.25	-12991.17	-4004.92	0.67	66
1200	90	280	100	10	25	20	8986.25	16858.83	25845.08	0.67	133	8986.25	4686.33	13672.58	0.67	111
1400	90	280	100	10	25	20	8986.25	47868.51	56854.76	0.67	177	8986.25	31253.33	40239.58	0.67	155
1000	185	280	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43	8986.25	-18125.67	-9139.42	0.67	32
1200	185	280	100	10	25	20	8986.25	-3681.67	5304.58	0.67	64	8986.25	-9577.92	-591.67	0.67	54
1400	185	280	100	10	25	20	8986.25	11354.08	20340.33	0.67	86	8986.25	3295.83	12282.08	0.67	75
1000	300	280	100	10	25	20	8986.25	-17706.67	-8720.42	0.67	26	8986.25	-19991.67	-11005.42	0.67	20
1200	300	280	100	10	25	20	8986.25	-11141.67	-2155.42	0.67	40	8986.25	-14756.67	-5770.42	0.67	33
1400	300	280	100	10	25	20	8986.25	-1906.67	7079.58	0.67	53	8986.25	-6856.67	2129.58	0.67	46
1000	90	400	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88	8986.25	-12991.17	-4004.92	0.67	66
1200	90	400	100	10	25	20	8986.25	16858.83	25845.08	0.67	133	8986.25	4686.33	13672.58	0.67	111
1400	90	400	100	10	25	20	8986.25	47868.64	56854.89	0.67	177	8986.25	31253.33	40239.58	0.67	155
1000	185	400	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43	8986.25	-18125.67	-9139.42	0.67	32
1200	185	400	100	10	25	20	8986.25	-3681.67	5304.58	0.67	64	8986.25	-9577.92	-591.67	0.67	54
1400	185	400	100	10	25	20	8986.25	11354.08	20340.33	0.67	86	8986.25	3295.83	12282.08	0.67	75
1000	300	400	100	10	25	20	8986.25	-17706.67	-8720.42	0.67	26	8986.25	-19991.67	-11005.42	0.67	20
1200	300	400	100	10	25	20	8986.25	-11141.67	-2155.42	0.67	40	8986.25	-14756.67	-5770.42	0.67	33
1400	300	400	100	10	25	20	8986.25	-1906.67	7079.58	0.67	53	8986.25	-6856.67	2129.58	0.67	46
1000	90	600	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88	8986.25	-12991.17	-4004.92	0.67	66
1200	90	600	100	10	25	20	8986.25	16858.83	25845.08	0.67	133	8986.25	4686.33	13672.58	0.67	111

Table A.14: Scenarios where optimal introduction timing T^* is not increasing as c_n increases from 700(low) to 800(medium) (cont'd)

Parameters							$c_2 = 700$					$c_2 = 800$				
p_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1400	90	600	100	10	25	20	8986.25	47868.86	56855.11	0.67	177	8986.25	31253.33	40239.58	0.67	155
1000	185	600	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43	8986.25	-18125.67	-9139.42	0.67	32
1200	185	600	100	10	25	20	8986.25	-3681.67	5304.58	0.67	64	8986.25	-9577.92	-591.67	0.67	54
1400	185	600	100	10	25	20	8986.25	11354.08	20340.33	0.67	86	8986.25	3295.83	12282.08	0.67	75
1000	300	600	100	10	25	20	8986.25	-17706.67	-8720.42	0.67	26	8986.25	-19991.67	-11005.42	0.67	20
1200	300	600	100	10	25	20	8986.25	-11141.67	-2155.42	0.67	40	8986.25	-14756.67	-5770.42	0.67	33
1400	300	600	100	10	25	20	8986.25	-1906.67	7079.58	0.67	53	8986.25	-6856.67	2129.58	0.67	46
1000	90	280	100	15	25	20	13456.33	-4730.33	8726	0.93	88	13456.33	-12457.83	998.5	0.93	66
1200	90	280	100	15	25	20	13456.33	17392.17	30848.5	0.93	133	13456.33	5219.67	18676	0.93	111
1400	90	280	100	15	25	20	13456.33	48398.39	61854.72	0.93	177	13456.33	31786.66	45243	0.93	155
1000	185	280	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43	13456.33	-17592.33	-4136	0.93	32
1200	185	280	100	15	25	20	13456.33	-3148.33	10308	0.93	64	13456.33	-9044.58	4411.75	0.93	54
1400	185	280	100	15	25	20	13456.33	11887.42	25343.75	0.93	86	13456.33	3829.17	17285.5	0.93	75
1000	300	280	100	15	25	20	13456.33	-17173.33	-3717	0.93	26	13456.33	-19458.33	-6002	0.93	20
1200	300	280	100	15	25	20	13456.33	-10608.33	2848	0.93	40	13456.33	-14223.33	-767	0.93	33
1400	300	280	100	15	25	20	13456.33	-1373.33	12083	0.93	53	13456.33	-6323.33	7133	0.93	46
1000	90	400	100	15	25	20	13456.33	-4730.33	8726	0.93	88	13456.33	-12457.83	998.5	0.93	66
1200	90	400	100	15	25	20	13456.33	17392.17	30848.5	0.93	133	13456.33	5219.67	18676	0.93	111
1400	90	400	100	15	25	20	13456.33	48398.87	61855.2	0.93	177	13456.33	31786.66	45243	0.93	155
1000	185	400	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43	13456.33	-17592.33	-4136	0.93	32
1200	185	400	100	15	25	20	13456.33	-3148.33	10308	0.93	64	13456.33	-9044.58	4411.75	0.93	54
1400	185	400	100	15	25	20	13456.33	11887.42	25343.75	0.93	86	13456.33	3829.17	17285.5	0.93	75
1000	300	400	100	15	25	20	13456.33	-17173.33	-3717	0.93	26	13456.33	-19458.33	-6002	0.93	20
1200	300	400	100	15	25	20	13456.33	-10608.33	2848	0.93	40	13456.33	-14223.33	-767	0.93	33
1400	300	400	100	15	25	20	13456.33	-1373.33	12083	0.93	53	13456.33	-6323.33	7133	0.93	46
1000	90	600	100	15	25	20	13456.33	-4730.33	8726	0.93	88	13456.33	-12457.83	998.5	0.93	66
1200	90	600	100	15	25	20	13456.33	17392.17	30848.5	0.93	133	13456.33	5219.67	18676	0.93	111
1400	90	600	100	15	25	20	13456.33	48399.66	61856	0.93	177	13456.33	31786.66	45243	0.93	155
1000	185	600	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43	13456.33	-17592.33	-4136	0.93	32
1200	185	600	100	15	25	20	13456.33	-3148.33	10308	0.93	64	13456.33	-9044.58	4411.75	0.93	54

Table A.15: Scenarios where optimal introduction timing T^* is not increasing as c_n increases from 700(low) to 800(medium) (cont'd)

Parameters							$c_2 = 700$					$c_2 = 800$				
p_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1400	185	600	100	15	25	20	13456.33	11887.42	25343.75	0.93	86	13456.33	3829.17	17285.5	0.93	75
1000	300	600	100	15	25	20	13456.33	-17173.33	-3717	0.93	26	13456.33	-19458.33	-6002	0.93	20
1200	300	600	100	15	25	20	13456.33	-10608.33	2848	0.93	40	13456.33	-14223.33	-767	0.93	33
1400	300	600	100	15	25	20	13456.33	-1373.33	12083	0.93	53	13456.33	-6323.33	7133	0.93	46
1000	90	280	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88	17858.39	-11991.17	5867.23	1.17	66
1200	90	280	100	20	25	20	17858.39	17858.83	35717.23	1.17	133	17858.39	5686.33	23544.73	1.17	111
1400	90	280	100	20	25	20	17858.39	48856.16	66714.55	1.17	177	17858.39	32253.32	50111.71	1.17	155
1000	185	280	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43	17858.39	-17125.67	732.73	1.17	32
1200	185	280	100	20	25	20	17858.39	-2681.67	15176.73	1.17	64	17858.39	-8577.92	9280.48	1.17	54
1400	185	280	100	20	25	20	17858.39	12354.08	30212.48	1.17	86	17858.39	4295.83	22154.23	1.17	75
1000	300	280	100	20	25	20	17858.39	-16706.67	1151.73	1.17	26	17858.39	-18991.67	-1133.27	1.17	20
1200	300	280	100	20	25	20	17858.39	-10141.67	7716.73	1.17	40	17858.39	-13756.67	4101.73	1.17	33
1400	300	280	100	20	25	20	17858.39	-906.67	16951.73	1.17	53	17858.39	-5856.67	12001.73	1.17	46
1000	90	400	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88	17858.39	-11991.17	5867.23	1.17	66
1200	90	400	100	20	25	20	17858.39	17858.83	35717.23	1.17	133	17858.39	5686.33	23544.73	1.17	111
1400	90	400	100	20	25	20	17858.39	48857.53	66715.92	1.17	177	17858.39	32253.32	50111.71	1.17	155
1000	185	400	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43	17858.39	-17125.67	732.73	1.17	32
1200	185	400	100	20	25	20	17858.39	-2681.67	15176.73	1.17	64	17858.39	-8577.92	9280.48	1.17	54
1400	185	400	100	20	25	20	17858.39	12354.08	30212.48	1.17	86	17858.39	4295.83	22154.23	1.17	75
1000	300	400	100	20	25	20	17858.39	-16706.67	1151.73	1.17	26	17858.39	-18991.67	-1133.27	1.17	20
1200	300	400	100	20	25	20	17858.39	-10141.67	7716.73	1.17	40	17858.39	-13756.67	4101.73	1.17	33
1400	300	400	100	20	25	20	17858.39	-906.67	16951.73	1.17	53	17858.39	-5856.67	12001.73	1.17	46
1000	90	600	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88	17858.39	-11991.17	5867.23	1.17	66
1200	90	600	100	20	25	20	17858.39	17858.83	35717.23	1.17	133	17858.39	5686.33	23544.73	1.17	111
1400	90	600	100	20	25	20	17858.39	48859.81	66718.2	1.17	177	17858.39	32253.32	50111.71	1.17	155
1000	185	600	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43	17858.39	-17125.67	732.73	1.17	32
1200	185	600	100	20	25	20	17858.39	-2681.67	15176.73	1.17	64	17858.39	-8577.92	9280.48	1.17	54
1400	185	600	100	20	25	20	17858.39	12354.08	30212.48	1.17	86	17858.39	4295.83	22154.23	1.17	75
1000	300	600	100	20	25	20	17858.39	-16706.67	1151.73	1.17	26	17858.39	-18991.67	-1133.27	1.17	20
1200	300	600	100	20	25	20	17858.39	-10141.67	7716.73	1.17	40	17858.39	-13756.67	4101.73	1.17	33
1400	300	600	100	20	25	20	17858.39	-906.67	16951.73	1.17	53	17858.39	-5856.67	12001.73	1.17	46

Table A.16: Scenarios where optimal introduction timing T^* is not increasing as c_n increases from 800(medium) to 900(high)

Parameters							$c_2 = 800$					$c_2 = 900$				
p_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1000	90	280	100	10	20	15	8909.38	-9575	-665.62	0.83	50	8909.38	-13691	-4781.62	0.83	33
1200	90	280	100	10	20	15	8909.38	3659	12568.38	0.83	83	8909.38	-3791	5118.38	0.83	66
1000	185	280	100	10	20	15	8909.38	-13425	-4515.62	0.83	24	8909.38	-15402.33	-6492.95	0.83	16
1200	185	280	100	10	20	15	8909.38	-7038.33	1871.05	0.83	40	8909.38	-10637	-1727.62	0.83	32
1400	185	280	100	10	20	15	8909.38	2591	11500.38	0.83	56	8909.38	-2629	6280.38	0.83	48
1000	300	280	100	10	20	15	8909.38	-14825	-5915.62	0.83	15	8909.38	-16025	-7115.62	0.83	10
1200	300	280	100	10	20	15	8909.38	-10925	-2015.62	0.83	25	8909.38	-13125	-4215.62	0.83	20
1400	300	280	100	10	20	15	8909.38	-5025	3884.38	0.83	35	8909.38	-8225	684.38	0.83	30
1000	90	400	100	10	20	15	8909.38	-9575	-665.62	0.83	50	8909.38	-13691	-4781.62	0.83	33
1200	90	400	100	10	20	15	8909.38	3659	12568.38	0.83	83	8909.38	-3791	5118.38	0.83	66
1000	185	400	100	10	20	15	8909.38	-13425	-4515.62	0.83	24	8909.38	-15402.33	-6492.95	0.83	16
1200	185	400	100	10	20	15	8909.38	-7038.33	1871.05	0.83	40	8909.38	-10637	-1727.62	0.83	32
1400	185	400	100	10	20	15	8909.38	2591	11500.38	0.83	56	8909.38	-2629	6280.38	0.83	48
1000	300	400	100	10	20	15	8909.38	-14825	-5915.62	0.83	15	8909.38	-16025	-7115.62	0.83	10
1200	300	400	100	10	20	15	8909.38	-10925	-2015.62	0.83	25	8909.38	-13125	-4215.62	0.83	20
1400	300	400	100	10	20	15	8909.38	-5025	3884.38	0.83	35	8909.38	-8225	684.38	0.83	30
1000	90	600	100	10	20	15	8909.38	-9575	-665.62	0.83	50	8909.38	-13691	-4781.62	0.83	33
1200	90	600	100	10	20	15	8909.38	3659	12568.38	0.83	83	8909.38	-3791	5118.38	0.83	66
1000	185	600	100	10	20	15	8909.38	-13425	-4515.62	0.83	24	8909.38	-15402.33	-6492.95	0.83	16
1200	185	600	100	10	20	15	8909.38	-7038.33	1871.05	0.83	40	8909.38	-10637	-1727.62	0.83	32
1400	185	600	100	10	20	15	8909.38	2591	11500.38	0.83	56	8909.38	-2629	6280.38	0.83	48
1000	300	600	100	10	20	15	8909.38	-14825	-5915.62	0.83	15	8909.38	-16025	-7115.62	0.83	10
1200	300	600	100	10	20	15	8909.38	-10925	-2015.62	0.83	25	8909.38	-13125	-4215.62	0.83	20
1400	300	600	100	10	20	15	8909.38	-5025	3884.38	0.83	35	8909.38	-8225	684.38	0.83	30
1000	90	280	100	15	20	15	13340.91	-9125	4215.91	1.13	50	13340.91	-13241	99.91	1.13	33
1200	90	280	100	15	20	15	13340.91	4109	17449.91	1.13	83	13340.91	-3341	9999.91	1.13	66
1000	185	280	100	15	20	15	13340.91	-12975	365.91	1.13	24	13340.91	-14952.33	-1611.42	1.13	16
1200	185	280	100	15	20	15	13340.91	-6588.33	6752.58	1.13	40	13340.91	-10187	3153.91	1.13	32
1400	185	280	100	15	20	15	13340.91	3041	16381.91	1.13	56	13340.91	-2179	11161.91	1.13	48
1000	300	280	100	15	20	15	13340.91	-14375	-1034.09	1.13	15	13340.91	-15575	-2234.09	1.13	10

Table A.17: Scenarios where optimal introduction timing T^* is not increasing as c_n increases from 800(medium) to 900(high) (cont'd)

Parameters							$c_2 = 800$					$c_2 = 900$				
p_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1200	300	280	100	15	20	15	13340.91	-10475	2865.91	1.13	25	13340.91	-12675	665.91	1.13	20
1400	300	280	100	15	20	15	13340.91	-4575	8765.91	1.13	35	13340.91	-7775	5565.91	1.13	30
1000	90	400	100	15	20	15	13340.91	-9125	4215.91	1.13	50	13340.91	-13241	99.91	1.13	33
1200	90	400	100	15	20	15	13340.91	4109	17449.91	1.13	83	13340.91	-3341	9999.91	1.13	66
1000	185	400	100	15	20	15	13340.91	-12975	365.91	1.13	24	13340.91	-14952.33	-1611.42	1.13	16
1200	185	400	100	15	20	15	13340.91	-6588.33	6752.58	1.13	40	13340.91	-10187	3153.91	1.13	32
1400	185	400	100	15	20	15	13340.91	3041	16381.91	1.13	56	13340.91	-2179	11161.91	1.13	48
1000	300	400	100	15	20	15	13340.91	-14375	-1034.09	1.13	15	13340.91	-15575	-2234.09	1.13	10
1200	300	400	100	15	20	15	13340.91	-10475	2865.91	1.13	25	13340.91	-12675	665.91	1.13	20
1400	300	400	100	15	20	15	13340.91	-4575	8765.91	1.13	35	13340.91	-7775	5565.91	1.13	30
1000	90	600	100	15	20	15	13340.91	-9125	4215.91	1.13	50	13340.91	-13241	99.91	1.13	33
1200	90	600	100	15	20	15	13340.91	4109	17449.91	1.13	83	13340.91	-3341	9999.91	1.13	66
1400	90	600	100	15	20	15	13340.91	24008.87	37349.78	1.13	116	13340.91	13225	26565.91	1.13	99
1000	185	600	100	15	20	15	13340.91	-12975	365.91	1.13	24	13340.91	-14952.33	-1611.42	1.13	16
1200	185	600	100	15	20	15	13340.91	-6588.33	6752.58	1.13	40	13340.91	-10187	3153.91	1.13	32
1400	185	600	100	15	20	15	13340.91	3041	16381.91	1.13	56	13340.91	-2179	11161.91	1.13	48
1000	300	600	100	15	20	15	13340.91	-14375	-1034.09	1.13	15	13340.91	-15575	-2234.09	1.13	10
1200	300	600	100	15	20	15	13340.91	-10475	2865.91	1.13	25	13340.91	-12675	665.91	1.13	20
1400	300	600	100	15	20	15	13340.91	-4575	8765.91	1.13	35	13340.91	-7775	5565.91	1.13	30
1000	90	280	100	20	20	15	17603.07	-8675	8928.07	1.43	50	17603.07	-12791	4812.07	1.43	33
1200	90	280	100	20	20	15	17603.07	4559	22162.07	1.43	83	17603.07	-2891	14712.07	1.43	66
1000	185	280	100	20	20	15	17603.07	-12525	5078.07	1.43	24	17603.07	-14502.33	3100.74	1.43	16
1200	185	280	100	20	20	15	17603.07	-6138.33	11464.74	1.43	40	17603.07	-9737	7866.07	1.43	32
1400	185	280	100	20	20	15	17603.07	3491	21094.07	1.43	56	17603.07	-1729	15874.07	1.43	48
1000	300	280	100	20	20	15	17603.07	-13925	3678.07	1.43	15	17603.07	-15125	2478.07	1.43	10
1200	300	280	100	20	20	15	17603.07	-10025	7578.07	1.43	25	17603.07	-12225	5378.07	1.43	20
1400	300	280	100	20	20	15	17603.07	-4125	13478.07	1.43	35	17603.07	-7325	10278.07	1.43	30
1000	90	400	100	20	20	15	17603.07	-8675	8928.07	1.43	50	17603.07	-12791	4812.07	1.43	33
1200	90	400	100	20	20	15	17603.07	4559	22162.07	1.43	83	17603.07	-2891	14712.07	1.43	66
1000	185	400	100	20	20	15	17603.07	-12525	5078.07	1.43	24	17603.07	-14502.33	3100.74	1.43	16

Table A.18: Scenarios where optimal introduction timing T^* is not increasing as c_n increases from 800(medium) to 900(high) (cont'd)

Parameters							$c_2 = 800$					$c_2 = 900$				
p_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1200	185	400	100	20	20	15	17603.07	-6138.33	11464.74	1.43	40	17603.07	-9737	7866.07	1.43	32
1400	185	400	100	20	20	15	17603.07	3491	21094.07	1.43	56	17603.07	-1729	15874.07	1.43	48
1000	300	400	100	20	20	15	17603.07	-13925	3678.07	1.43	15	17603.07	-15125	2478.07	1.43	10
1200	300	400	100	20	20	15	17603.07	-10025	7578.07	1.43	25	17603.07	-12225	5378.07	1.43	20
1400	300	400	100	20	20	15	17603.07	-4125	13478.07	1.43	35	17603.07	-7325	10278.07	1.43	30
1000	90	600	100	20	20	15	17603.07	-8675	8928.07	1.43	50	17603.07	-12791	4812.07	1.43	33
1200	90	600	100	20	20	15	17603.07	4559	22162.07	1.43	83	17603.07	-2891	14712.07	1.43	66
1000	185	600	100	20	20	15	17603.07	-12525	5078.07	1.43	24	17603.07	-14502.33	3100.74	1.43	16
1200	185	600	100	20	20	15	17603.07	-6138.33	11464.74	1.43	40	17603.07	-9737	7866.07	1.43	32
1400	185	600	100	20	20	15	17603.07	3491	21094.07	1.43	56	17603.07	-1729	15874.07	1.43	48
1000	300	600	100	20	20	15	17603.07	-13925	3678.07	1.43	15	17603.07	-15125	2478.07	1.43	10
1200	300	600	100	20	20	15	17603.07	-10025	7578.07	1.43	25	17603.07	-12225	5378.07	1.43	20
1400	300	600	100	20	20	15	17603.07	-4125	13478.07	1.43	35	17603.07	-7325	10278.07	1.43	30
1000	90	280	100	10	25	15	9097.61	-9925	-827.39	0.6	50	9097.61	-14041	-4943.39	0.6	33
1200	90	280	100	10	25	15	9097.61	3309	12406.61	0.6	83	9097.61	-4141	4956.61	0.6	66
1400	90	280	100	10	25	15	9097.61	23208.99	32306.6	0.6	116	9097.61	12425	21522.61	0.6	99
1000	185	280	100	10	25	15	9097.61	-13775	-4677.39	0.6	24	9097.61	-15752.33	-6654.72	0.6	16
1200	185	280	100	10	25	15	9097.61	-7388.33	1709.28	0.6	40	9097.61	-10987	-1889.39	0.6	32
1400	185	280	100	10	25	15	9097.61	2241	11338.61	0.6	56	9097.61	-2979	6118.61	0.6	48
1000	300	280	100	10	25	15	9097.61	-15175	-6077.39	0.6	15	9097.61	-16375	-7277.39	0.6	10
1200	300	280	100	10	25	15	9097.61	-11275	-2177.39	0.6	25	9097.61	-13475	-4377.39	0.6	20
1400	300	280	100	10	25	15	9097.61	-5375	3722.61	0.6	35	9097.61	-8575	522.61	0.6	30
1000	90	400	100	10	25	15	9097.61	-9925	-827.39	0.6	50	9097.61	-14041	-4943.39	0.6	33
1200	90	400	100	10	25	15	9097.61	3309	12406.61	0.6	83	9097.61	-4141	4956.61	0.6	66
1400	90	400	100	10	25	15	9097.61	23208.99	32306.6	0.6	116	9097.61	12425	21522.61	0.6	99
1000	185	400	100	10	25	15	9097.61	-13775	-4677.39	0.6	24	9097.61	-15752.33	-6654.72	0.6	16
1200	185	400	100	10	25	15	9097.61	-7388.33	1709.28	0.6	40	9097.61	-10987	-1889.39	0.6	32
1400	185	400	100	10	25	15	9097.61	2241	11338.61	0.6	56	9097.61	-2979	6118.61	0.6	48
1000	300	400	100	10	25	15	9097.61	-15175	-6077.39	0.6	15	9097.61	-16375	-7277.39	0.6	10
1200	300	400	100	10	25	15	9097.61	-11275	-2177.39	0.6	25	9097.61	-13475	-4377.39	0.6	20

Table A.19: Scenarios where optimal introduction timing T^* is not increasing as c_n increases from 800(medium) to 900(high) (cont'd)

Parameters							$c_2 = 800$					$c_2 = 900$				
p_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*,T^*)$	$\Pi_n(Q_2^*,T^*)$	$\Pi(Q_2^*,T^*)$	T^*	Q^*	$\Pi_o(Q_2^*,T^*)$	$\Pi_n(Q_2^*,T^*)$	$\Pi(Q_2^*,T^*)$	T^*	Q^*
1400	300	400	100	10	25	15	9097.61	-5375	3722.61	0.6	35	9097.61	-8575	522.61	0.6	30
1000	90	600	100	10	25	15	9097.61	-9925	-827.39	0.6	50	9097.61	-14041	-4943.39	0.6	33
1200	90	600	100	10	25	15	9097.61	3309	12406.61	0.6	83	9097.61	-4141	4956.61	0.6	66
1400	90	600	100	10	25	15	9097.61	23208.99	32306.61	0.6	116	9097.61	12425	21522.61	0.6	99
1000	185	600	100	10	25	15	9097.61	-13775	-4677.39	0.6	24	9097.61	-15752.33	-6654.72	0.6	16
1200	185	600	100	10	25	15	9097.61	-7388.33	1709.28	0.6	40	9097.61	-10987	-1889.39	0.6	32
1400	185	600	100	10	25	15	9097.61	2241	11338.61	0.6	56	9097.61	-2979	6118.61	0.6	48
1000	300	600	100	10	25	15	9097.61	-15175	-6077.39	0.6	15	9097.61	-16375	-7277.39	0.6	10
1200	300	600	100	10	25	15	9097.61	-11275	-2177.39	0.6	25	9097.61	-13475	-4377.39	0.6	20
1400	300	600	100	10	25	15	9097.61	-5375	3722.61	0.6	35	9097.61	-8575	522.61	0.6	30
1000	90	280	100	15	25	15	13577.91	-9525	4052.91	0.87	50	13577.91	-13641	-63.09	0.87	33
1200	90	280	100	15	25	15	13577.91	3709	17286.91	0.87	83	13577.91	-3741	9836.91	0.87	66
1400	90	280	100	15	25	15	13577.91	23608.95	37186.86	0.87	116	13577.91	12825	26402.91	0.87	99
1000	185	280	100	15	25	15	13577.91	-13375	202.91	0.87	24	13577.91	-15352.33	-1774.43	0.87	16
1200	185	280	100	15	25	15	13577.91	-6988.33	6589.57	0.87	40	13577.91	-10587	2990.91	0.87	32
1400	185	280	100	15	25	15	13577.91	2641	16218.91	0.87	56	13577.91	-2579	10998.91	0.87	48
1000	300	280	100	15	25	15	13577.91	-14775	-1197.09	0.87	15	13577.91	-15975	-2397.09	0.87	10
1200	300	280	100	15	25	15	13577.91	-10875	2702.91	0.87	25	13577.91	-13075	502.91	0.87	20
1400	300	280	100	15	25	15	13577.91	-4975	8602.91	0.87	35	13577.91	-8175	5402.91	0.87	30
1000	90	400	100	15	25	15	13577.91	-9525	4052.91	0.87	50	13577.91	-13641	-63.09	0.87	33
1200	90	400	100	15	25	15	13577.91	3709	17286.91	0.87	83	13577.91	-3741	9836.91	0.87	66
1400	90	400	100	15	25	15	13577.91	23608.96	37186.87	0.87	116	13577.91	12825	26402.91	0.87	99
1000	185	400	100	15	25	15	13577.91	-13375	202.91	0.87	24	13577.91	-15352.33	-1774.43	0.87	16
1200	185	400	100	15	25	15	13577.91	-6988.33	6589.57	0.87	40	13577.91	-10587	2990.91	0.87	32
1400	185	400	100	15	25	15	13577.91	2641	16218.91	0.87	56	13577.91	-2579	10998.91	0.87	48
1000	300	400	100	15	25	15	13577.91	-14775	-1197.09	0.87	15	13577.91	-15975	-2397.09	0.87	10
1200	300	400	100	15	25	15	13577.91	-10875	2702.91	0.87	25	13577.91	-13075	502.91	0.87	20
1400	300	400	100	15	25	15	13577.91	-4975	8602.91	0.87	35	13577.91	-8175	5402.91	0.87	30
1000	90	600	100	15	25	15	13577.91	-9525	4052.91	0.87	50	13577.91	-13641	-63.09	0.87	33
1200	90	600	100	15	25	15	13577.91	3709	17286.91	0.87	83	13577.91	-3741	9836.91	0.87	66

Table A.20: Scenarios where optimal introduction timing T^* is not increasing as c_n increases from 800(medium) to 900(high) (cont'd)

Parameters							$c_2 = 800$					$c_2 = 900$				
p_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1400	90	600	100	15	25	15	13577.91	23608.97	37186.87	0.87	116	13577.91	12825	26402.91	0.87	99
1000	185	600	100	15	25	15	13577.91	-13375	202.91	0.87	24	13577.91	-15352.33	-1774.43	0.87	16
1200	185	600	100	15	25	15	13577.91	-6988.33	6589.57	0.87	40	13577.91	-10587	2990.91	0.87	32
1400	185	600	100	15	25	15	13577.91	2641	16218.91	0.87	56	13577.91	-2579	10998.91	0.87	48
1000	300	600	100	15	25	15	13577.91	-14775	-1197.09	0.87	15	13577.91	-15975	-2397.09	0.87	10
1200	300	600	100	15	25	15	13577.91	-10875	2702.91	0.87	25	13577.91	-13075	502.91	0.87	20
1400	300	600	100	15	25	15	13577.91	-4975	8602.91	0.87	35	13577.91	-8175	5402.91	0.87	30
1000	90	280	100	20	25	15	17976.1	-9175	8801.1	1.1	50	17976.1	-13291	4685.1	1.1	33
1200	90	280	100	20	25	15	17976.1	4059	22035.1	1.1	83	17976.1	-3391	14585.1	1.1	66
1400	90	280	100	20	25	15	17976.1	23958.85	41934.95	1.1	116	17976.1	13175	31151.1	1.1	99
1000	185	280	100	20	25	15	17976.1	-13025	4951.1	1.1	24	17976.1	-15002.33	2973.77	1.1	16
1200	185	280	100	20	25	15	17976.1	-6638.33	11337.77	1.1	40	17976.1	-10237	7739.1	1.1	32
1400	185	280	100	20	25	15	17976.1	2991	20967.1	1.1	56	17976.1	-2229	15747.1	1.1	48
1000	300	280	100	20	25	15	17976.1	-14425	3551.1	1.1	15	17976.1	-15625	2351.1	1.1	10
1200	300	280	100	20	25	15	17976.1	-10525	7451.1	1.1	25	17976.1	-12725	5251.1	1.1	20
1400	300	280	100	20	25	15	17976.1	-4625	13351.1	1.1	35	17976.1	-7825	10151.1	1.1	30
1000	90	400	100	20	25	15	17976.1	-9175	8801.1	1.1	50	17976.1	-13291	4685.1	1.1	33
1200	90	400	100	20	25	15	17976.1	4059	22035.1	1.1	83	17976.1	-3391	14585.1	1.1	66
1400	90	400	100	20	25	15	17976.1	23958.87	41934.97	1.1	116	17976.1	13175	31151.1	1.1	99
1000	185	400	100	20	25	15	17976.1	-13025	4951.1	1.1	24	17976.1	-15002.33	2973.77	1.1	16
1200	185	400	100	20	25	15	17976.1	-6638.33	11337.77	1.1	40	17976.1	-10237	7739.1	1.1	32
1400	185	400	100	20	25	15	17976.1	2991	20967.1	1.1	56	17976.1	-2229	15747.1	1.1	48
1000	300	400	100	20	25	15	17976.1	-14425	3551.1	1.1	15	17976.1	-15625	2351.1	1.1	10
1200	300	400	100	20	25	15	17976.1	-10525	7451.1	1.1	25	17976.1	-12725	5251.1	1.1	20
1400	300	400	100	20	25	15	17976.1	-4625	13351.1	1.1	35	17976.1	-7825	10151.1	1.1	30
1000	90	600	100	20	25	15	17976.1	-9175	8801.1	1.1	50	17976.1	-13291	4685.1	1.1	33
1200	90	600	100	20	25	15	17976.1	4059	22035.1	1.1	83	17976.1	-3391	14585.1	1.1	66
1400	90	600	100	20	25	15	17976.1	23958.89	41934.99	1.1	116	17976.1	13175	31151.1	1.1	99
1000	185	600	100	20	25	15	17976.1	-13025	4951.1	1.1	24	17976.1	-15002.33	2973.77	1.1	16
1200	185	600	100	20	25	15	17976.1	-6638.33	11337.77	1.1	40	17976.1	-10237	7739.1	1.1	32

Table A.21: Scenarios where optimal introduction timing T^* is not increasing as c_n increases from 800(medium) to 900(high) (cont'd)

Parameters							$c_2 = 800$					$c_2 = 900$				
p_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1400	185	600	100	20	25	15	17976.1	2991	20967.1	1.1	56	17976.1	-2229	15747.1	1.1	48
1000	300	600	100	20	25	15	17976.1	-14425	3551.1	1.1	15	17976.1	-15625	2351.1	1.1	10
1200	300	600	100	20	25	15	17976.1	-10525	7451.1	1.1	25	17976.1	-12725	5251.1	1.1	20
1400	300	600	100	20	25	15	17976.1	-4625	13351.1	1.1	35	17976.1	-7825	10151.1	1.1	30
1000	185	280	100	10	20	20	3881.67	-12725.67	-8844	3.37	32	3881.67	-15378.42	-11496.75	3.37	21
1200	185	280	100	10	20	20	3881.67	-4177.92	-296.25	3.37	54	3881.67	-8992.17	-5110.5	3.37	43
1000	300	280	100	10	20	20	3881.67	-14591.67	-10710	3.37	20	3881.67	-16206.67	-12325	3.37	13
1400	300	280	100	10	20	20	3881.67	-1456.67	2425	3.37	46	3881.67	-5741.67	-1860	3.37	40
1000	185	400	100	10	20	20	3881.67	-12725.67	-8844	3.37	32	3881.67	-15378.42	-11496.75	3.37	21
1200	185	400	100	10	20	20	3881.67	-4177.92	-296.25	3.37	54	3881.67	-8992.17	-5110.5	3.37	43
1000	300	400	100	10	20	20	3881.67	-14591.67	-10710	3.37	20	3881.67	-16206.67	-12325	3.37	13
1400	300	400	100	10	20	20	3881.67	-1456.67	2425	3.37	46	3881.67	-5741.67	-1860	3.37	40
1000	185	600	100	10	20	20	3881.67	-12725.67	-8844	3.37	32	3881.67	-15378.42	-11496.75	3.37	21
1200	185	600	100	10	20	20	3881.67	-4177.92	-296.25	3.37	54	3881.67	-8992.17	-5110.5	3.37	43
1000	300	600	100	10	20	20	3881.67	-14591.67	-10710	3.37	20	3881.67	-16206.67	-12325	3.37	13
1400	300	600	100	10	20	20	3881.67	-1456.67	2425	3.37	46	3881.67	-5741.67	-1860	3.37	40
1000	185	280	100	15	20	20	8793.33	-12592.33	-3799	3.43	32	8793.33	-15245.08	-6451.75	3.43	21
1200	185	280	100	15	20	20	8793.33	-4044.58	4748.75	3.43	54	8793.33	-8858.83	-65.5	3.43	43
1000	300	280	100	15	20	20	8793.33	-14458.33	-5665	3.43	20	8793.33	-16073.33	-7280	3.43	13
1400	300	280	100	15	20	20	8793.33	-1323.33	7470	3.43	46	8793.33	-5608.33	3185	3.43	40
1000	185	400	100	15	20	20	8793.33	-12592.33	-3799	3.43	32	8793.33	-15245.08	-6451.75	3.43	21
1200	185	400	100	15	20	20	8793.33	-4044.58	4748.75	3.43	54	8793.33	-8858.83	-65.5	3.43	43
1000	300	400	100	15	20	20	8793.33	-14458.33	-5665	3.43	20	8793.33	-16073.33	-7280	3.43	13
1400	300	400	100	15	20	20	8793.33	-1323.33	7470	3.43	46	8793.33	-5608.33	3185	3.43	40
1000	185	600	100	15	20	20	8793.33	-12592.33	-3799	3.43	32	8793.33	-15245.08	-6451.75	3.43	21
1000	300	600	100	15	20	20	8793.33	-14458.33	-5665	3.43	20	8793.33	-16073.33	-7280	3.43	13
1400	300	600	100	15	20	20	8793.33	-1323.33	7470	3.43	46	8793.33	-5608.33	3185	3.43	40
1000	185	280	100	20	20	20	12663.33	-11592.33	1071	3.93	32	12663.33	-14245.08	-1581.75	3.93	21
1200	185	280	100	20	20	20	12663.33	-3044.58	9618.75	3.93	54	12663.33	-7858.83	4804.5	3.93	43
1000	300	280	100	20	20	20	12663.33	-13458.33	-795	3.93	20	12663.33	-15073.33	-2410	3.93	13

Table A.22: Scenarios where optimal introduction timing T^* is not increasing as c_n increases from 800(medium) to 900(high) (cont'd)

Parameters							$c_2 = 800$					$c_2 = 900$				
p_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1400	300	280	100	20	20	20	12663.33	-323.33	12340	3.93	46	12663.33	-4608.33	8055	3.93	40
1000	185	400	100	20	20	20	12663.33	-11592.33	1071	3.93	32	12663.33	-14245.08	-1581.75	3.93	21
1200	185	400	100	20	20	20	12663.33	-3044.58	9618.75	3.93	54	12663.33	-7858.83	4804.5	3.93	43
1000	300	400	100	20	20	20	12663.33	-13458.33	-795	3.93	20	12663.33	-15073.33	-2410	3.93	13
1400	300	400	100	20	20	20	12663.33	-323.33	12340	3.93	46	12663.33	-4608.33	8055	3.93	40
1000	185	600	100	20	20	20	12663.33	-11592.33	1071	3.93	32	12663.33	-14245.08	-1581.75	3.93	21
1200	185	600	100	20	20	20	12663.33	-3044.58	9618.75	3.93	54	12663.33	-7858.83	4804.5	3.93	43
1000	300	600	100	20	20	20	12663.33	-13458.33	-795	3.93	20	12663.33	-15073.33	-2410	3.93	13
1400	300	600	100	20	20	20	12663.33	-323.33	12340	3.93	46	12663.33	-4608.33	8055	3.93	40
1000	90	280	100	10	25	20	8986.25	-12991.17	-4004.92	0.67	66	8986.25	-18496.67	-9510.42	0.67	44
1200	90	280	100	10	25	20	8986.25	4686.33	13672.58	0.67	111	8986.25	-5263.67	3722.58	0.67	88
1400	90	280	100	10	25	20	8986.25	31253.33	40239.58	0.67	155	8986.25	16858.83	25845.08	0.67	133
1000	185	280	100	10	25	20	8986.25	-18125.67	-9139.42	0.67	32	8986.25	-20778.42	-11792.17	0.67	21
1200	185	280	100	10	25	20	8986.25	-9577.92	-591.67	0.67	54	8986.25	-14392.17	-5405.92	0.67	43
1400	185	280	100	10	25	20	8986.25	3295.83	12282.08	0.67	75	8986.25	-3681.67	5304.58	0.67	64
1000	300	280	100	10	25	20	8986.25	-19991.67	-11005.42	0.67	20	8986.25	-21606.67	-12620.42	0.67	13
1200	300	280	100	10	25	20	8986.25	-14756.67	-5770.42	0.67	33	8986.25	-17706.67	-8720.42	0.67	26
1400	300	280	100	10	25	20	8986.25	-6856.67	2129.58	0.67	46	8986.25	-11141.67	-2155.42	0.67	40
1000	90	400	100	10	25	20	8986.25	-12991.17	-4004.92	0.67	66	8986.25	-18496.67	-9510.42	0.67	44
1200	90	400	100	10	25	20	8986.25	4686.33	13672.58	0.67	111	8986.25	-5263.67	3722.58	0.67	88
1400	90	400	100	10	25	20	8986.25	31253.33	40239.58	0.67	155	8986.25	16858.83	25845.08	0.67	133
1000	185	400	100	10	25	20	8986.25	-18125.67	-9139.42	0.67	32	8986.25	-20778.42	-11792.17	0.67	21
1200	185	400	100	10	25	20	8986.25	-9577.92	-591.67	0.67	54	8986.25	-14392.17	-5405.92	0.67	43
1400	185	400	100	10	25	20	8986.25	3295.83	12282.08	0.67	75	8986.25	-3681.67	5304.58	0.67	64
1000	300	400	100	10	25	20	8986.25	-19991.67	-11005.42	0.67	20	8986.25	-21606.67	-12620.42	0.67	13
1200	300	400	100	10	25	20	8986.25	-14756.67	-5770.42	0.67	33	8986.25	-17706.67	-8720.42	0.67	26
1400	300	400	100	10	25	20	8986.25	-6856.67	2129.58	0.67	46	8986.25	-11141.67	-2155.42	0.67	40
1000	90	600	100	10	25	20	8986.25	-12991.17	-4004.92	0.67	66	8986.25	-18496.67	-9510.42	0.67	44
1200	90	600	100	10	25	20	8986.25	4686.33	13672.58	0.67	111	8986.25	-5263.67	3722.58	0.67	88
1400	90	600	100	10	25	20	8986.25	31253.33	40239.58	0.67	155	8986.25	16858.83	25845.08	0.67	133

Table A.23: Scenarios where optimal introduction timing T^* is not increasing as c_n increases from 800(medium) to 900(high) (cont'd)

Parameters							$c_2 = 800$					$c_2 = 900$				
p_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1000	185	600	100	10	25	20	8986.25	-18125.67	-9139.42	0.67	32	8986.25	-20778.42	-11792.17	0.67	21
1200	185	600	100	10	25	20	8986.25	-9577.92	-591.67	0.67	54	8986.25	-14392.17	-5405.92	0.67	43
1400	185	600	100	10	25	20	8986.25	3295.83	12282.08	0.67	75	8986.25	-3681.67	5304.58	0.67	64
1000	300	600	100	10	25	20	8986.25	-19991.67	-11005.42	0.67	20	8986.25	-21606.67	-12620.42	0.67	13
1200	300	600	100	10	25	20	8986.25	-14756.67	-5770.42	0.67	33	8986.25	-17706.67	-8720.42	0.67	26
1400	300	600	100	10	25	20	8986.25	-6856.67	2129.58	0.67	46	8986.25	-11141.67	-2155.42	0.67	40
1000	90	280	100	15	25	20	13456.33	-12457.83	998.5	0.93	66	13456.33	-17963.33	-4507	0.93	44
1200	90	280	100	15	25	20	13456.33	5219.67	18676	0.93	111	13456.33	-4730.33	8726	0.93	88
1400	90	280	100	15	25	20	13456.33	31786.66	45243	0.93	155	13456.33	17392.17	30848.5	0.93	133
1000	185	280	100	15	25	20	13456.33	-17592.33	-4136	0.93	32	13456.33	-20245.08	-6788.75	0.93	21
1200	185	280	100	15	25	20	13456.33	-9044.58	4411.75	0.93	54	13456.33	-13858.83	-402.5	0.93	43
1400	185	280	100	15	25	20	13456.33	3829.17	17285.5	0.93	75	13456.33	-3148.33	10308	0.93	64
1000	300	280	100	15	25	20	13456.33	-19458.33	-6002	0.93	20	13456.33	-21073.33	-7617	0.93	13
1200	300	280	100	15	25	20	13456.33	-14223.33	-767	0.93	33	13456.33	-17173.33	-3717	0.93	26
1400	300	280	100	15	25	20	13456.33	-6323.33	7133	0.93	46	13456.33	-10608.33	2848	0.93	40
1000	90	400	100	15	25	20	13456.33	-12457.83	998.5	0.93	66	13456.33	-17963.33	-4507	0.93	44
1200	90	400	100	15	25	20	13456.33	5219.67	18676	0.93	111	13456.33	-4730.33	8726	0.93	88
1400	90	400	100	15	25	20	13456.33	31786.66	45243	0.93	155	13456.33	17392.17	30848.5	0.93	133
1000	185	400	100	15	25	20	13456.33	-17592.33	-4136	0.93	32	13456.33	-20245.08	-6788.75	0.93	21
1200	185	400	100	15	25	20	13456.33	-9044.58	4411.75	0.93	54	13456.33	-13858.83	-402.5	0.93	43
1400	185	400	100	15	25	20	13456.33	3829.17	17285.5	0.93	75	13456.33	-3148.33	10308	0.93	64
1000	300	400	100	15	25	20	13456.33	-19458.33	-6002	0.93	20	13456.33	-21073.33	-7617	0.93	13
1200	300	400	100	15	25	20	13456.33	-14223.33	-767	0.93	33	13456.33	-17173.33	-3717	0.93	26
1400	300	400	100	15	25	20	13456.33	-6323.33	7133	0.93	46	13456.33	-10608.33	2848	0.93	40
1000	90	600	100	15	25	20	13456.33	-12457.83	998.5	0.93	66	13456.33	-17963.33	-4507	0.93	44
1200	90	600	100	15	25	20	13456.33	5219.67	18676	0.93	111	13456.33	-4730.33	8726	0.93	88
1400	90	600	100	15	25	20	13456.33	31786.66	45243	0.93	155	13456.33	17392.17	30848.5	0.93	133
1000	185	600	100	15	25	20	13456.33	-17592.33	-4136	0.93	32	13456.33	-20245.08	-6788.75	0.93	21
1200	185	600	100	15	25	20	13456.33	-9044.58	4411.75	0.93	54	13456.33	-13858.83	-402.5	0.93	43
1400	185	600	100	15	25	20	13456.33	3829.17	17285.5	0.93	75	13456.33	-3148.33	10308	0.93	64

Table A.24: Scenarios where optimal introduction timing T^* is not increasing as c_n increases from 800(medium) to 900(high) (cont'd)

Parameters							$c_2 = 800$					$c_2 = 900$				
p_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1000	300	600	100	15	25	20	13456.33	-19458.33	-6002	0.93	20	13456.33	-21073.33	-7617	0.93	13
1200	300	600	100	15	25	20	13456.33	-14223.33	-767	0.93	33	13456.33	-17173.33	-3717	0.93	26
1400	300	600	100	15	25	20	13456.33	-6323.33	7133	0.93	46	13456.33	-10608.33	2848	0.93	40
1000	90	280	100	20	25	20	17858.39	-11991.17	5867.23	1.17	66	17858.39	-17496.67	361.73	1.17	44
1200	90	280	100	20	25	20	17858.39	5686.33	23544.73	1.17	111	17858.39	-4263.67	13594.73	1.17	88
1400	90	280	100	20	25	20	17858.39	32253.32	50111.71	1.17	155	17858.39	17858.83	35717.23	1.17	133
1000	185	280	100	20	25	20	17858.39	-17125.67	732.73	1.17	32	17858.39	-19778.42	-1920.02	1.17	21
1200	185	280	100	20	25	20	17858.39	-8577.92	9280.48	1.17	54	17858.39	-13392.17	4466.23	1.17	43
1400	185	280	100	20	25	20	17858.39	4295.83	22154.23	1.17	75	17858.39	-2681.67	15176.73	1.17	64
1000	300	280	100	20	25	20	17858.39	-18991.67	-1133.27	1.17	20	17858.39	-20606.67	-2748.27	1.17	13
1200	300	280	100	20	25	20	17858.39	-13756.67	4101.73	1.17	33	17858.39	-16706.67	1151.73	1.17	26
1400	300	280	100	20	25	20	17858.39	-5856.67	12001.73	1.17	46	17858.39	-10141.67	7716.73	1.17	40
1000	90	400	100	20	25	20	17858.39	-11991.17	5867.23	1.17	66	17858.39	-17496.67	361.73	1.17	44
1200	90	400	100	20	25	20	17858.39	5686.33	23544.73	1.17	111	17858.39	-4263.67	13594.73	1.17	88
1400	90	400	100	20	25	20	17858.39	32253.32	50111.71	1.17	155	17858.39	17858.83	35717.23	1.17	133
1000	185	400	100	20	25	20	17858.39	-17125.67	732.73	1.17	32	17858.39	-19778.42	-1920.02	1.17	21
1200	185	400	100	20	25	20	17858.39	-8577.92	9280.48	1.17	54	17858.39	-13392.17	4466.23	1.17	43
1400	185	400	100	20	25	20	17858.39	4295.83	22154.23	1.17	75	17858.39	-2681.67	15176.73	1.17	64
1000	300	400	100	20	25	20	17858.39	-18991.67	-1133.27	1.17	20	17858.39	-20606.67	-2748.27	1.17	13
1200	300	400	100	20	25	20	17858.39	-13756.67	4101.73	1.17	33	17858.39	-16706.67	1151.73	1.17	26
1400	300	400	100	20	25	20	17858.39	-5856.67	12001.73	1.17	46	17858.39	-10141.67	7716.73	1.17	40
1000	90	600	100	20	25	20	17858.39	-11991.17	5867.23	1.17	66	17858.39	-17496.67	361.73	1.17	44
1200	90	600	100	20	25	20	17858.39	5686.33	23544.73	1.17	111	17858.39	-4263.67	13594.73	1.17	88
1400	90	600	100	20	25	20	17858.39	32253.32	50111.71	1.17	155	17858.39	17858.83	35717.23	1.17	133
1000	185	600	100	20	25	20	17858.39	-17125.67	732.73	1.17	32	17858.39	-19778.42	-1920.02	1.17	21
1200	185	600	100	20	25	20	17858.39	-8577.92	9280.48	1.17	54	17858.39	-13392.17	4466.23	1.17	43
1400	185	600	100	20	25	20	17858.39	4295.83	22154.23	1.17	75	17858.39	-2681.67	15176.73	1.17	64
1000	300	600	100	20	25	20	17858.39	-18991.67	-1133.27	1.17	20	17858.39	-20606.67	-2748.27	1.17	13
1200	300	600	100	20	25	20	17858.39	-13756.67	4101.73	1.17	33	17858.39	-16706.67	1151.73	1.17	26
1400	300	600	100	20	25	20	17858.39	-5856.67	12001.73	1.17	46	17858.39	-10141.67	7716.73	1.17	40

Table A.25: Scenarios where optimal introduction timing T^* increases as p_n increases from 1000(low) to 1200(medium)

Parameters							$p_2 = 1000$					$p_2 = 1200$				
c_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
800	90	280	100	10	20	15	8909.38	-9575	-665.62	0.83	50	8909.38	3659	12568.38	0.83	83
900	90	280	100	10	20	15	8909.38	-13691	-4781.62	0.83	33	8909.38	-3791	5118.38	0.83	66
700	185	280	100	10	20	15	8909.38	-10637	-1727.62	0.83	32	8909.38	-2629	6280.38	0.83	48
800	185	280	100	10	20	15	8909.38	-13425	-4515.62	0.83	24	8909.38	-7038.33	1871.05	0.83	40
900	185	280	100	10	20	15	8909.38	-15402.33	-6492.95	0.83	16	8909.38	-10637	-1727.62	0.83	32
700	300	280	100	10	20	15	8909.38	-13125	-4215.62	0.83	20	8909.38	-8225	684.38	0.83	30
800	300	280	100	10	20	15	8909.38	-14825	-5915.62	0.83	15	8909.38	-10925	-2015.62	0.83	25
900	300	280	100	10	20	15	8909.38	-16025	-7115.62	0.83	10	8909.38	-13125	-4215.62	0.83	20
800	90	400	100	10	20	15	8909.38	-9575	-665.62	0.83	50	8909.38	3659	12568.38	0.83	83
900	90	400	100	10	20	15	8909.38	-13691	-4781.62	0.83	33	8909.38	-3791	5118.38	0.83	66
700	185	400	100	10	20	15	8909.38	-10637	-1727.62	0.83	32	8909.38	-2629	6280.38	0.83	48
800	185	400	100	10	20	15	8909.38	-13425	-4515.62	0.83	24	8909.38	-7038.33	1871.05	0.83	40
900	185	400	100	10	20	15	8909.38	-15402.33	-6492.95	0.83	16	8909.38	-10637	-1727.62	0.83	32
700	300	400	100	10	20	15	8909.38	-13125	-4215.62	0.83	20	8909.38	-8225	684.38	0.83	30
800	300	400	100	10	20	15	8909.38	-14825	-5915.62	0.83	15	8909.38	-10925	-2015.62	0.83	25
900	300	400	100	10	20	15	8909.38	-16025	-7115.62	0.83	10	8909.38	-13125	-4215.62	0.83	20
800	90	600	100	10	20	15	8909.38	-9575	-665.62	0.83	50	8909.38	3659	12568.38	0.83	83
900	90	600	100	10	20	15	8909.38	-13691	-4781.62	0.83	33	8909.38	-3791	5118.38	0.83	66
700	185	600	100	10	20	15	8909.38	-10637	-1727.62	0.83	32	8909.38	-2629	6280.38	0.83	48
800	185	600	100	10	20	15	8909.38	-13425	-4515.62	0.83	24	8909.38	-7038.33	1871.05	0.83	40
900	185	600	100	10	20	15	8909.38	-15402.33	-6492.95	0.83	16	8909.38	-10637	-1727.62	0.83	32
700	300	600	100	10	20	15	8909.38	-13125	-4215.62	0.83	20	8909.38	-8225	684.38	0.83	30
800	300	600	100	10	20	15	8909.38	-14825	-5915.62	0.83	15	8909.38	-10925	-2015.62	0.83	25
900	300	600	100	10	20	15	8909.38	-16025	-7115.62	0.83	10	8909.38	-13125	-4215.62	0.83	20
800	90	280	100	15	20	15	13340.91	-9125	4215.91	1.13	50	13340.91	4109	17449.91	1.13	83
900	90	280	100	15	20	15	13340.91	-13241	99.91	1.13	33	13340.91	-3341	9999.91	1.13	66
700	185	280	100	15	20	15	13340.91	-10187	3153.91	1.13	32	13340.91	-2179	11161.91	1.13	48
800	185	280	100	15	20	15	13340.91	-12975	365.91	1.13	24	13340.91	-6588.33	6752.58	1.13	40
900	185	280	100	15	20	15	13340.91	-14952.33	-1611.42	1.13	16	13340.91	-10187	3153.91	1.13	32
700	300	280	100	15	20	15	13340.91	-12675	665.91	1.13	20	13340.91	-7775	5565.91	1.13	30

Table A.26: Scenarios where optimal introduction timing T^* increases as p_n increases from 1000(low) to 1200(medium) (cont'd)

Parameters							$p_2 = 1000$					$p_2 = 1200$				
c_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
800	300	280	100	15	20	15	13340.91	-14375	-1034.09	1.13	15	13340.91	-10475	2865.91	1.13	25
900	300	280	100	15	20	15	13340.91	-15575	-2234.09	1.13	10	13340.91	-12675	665.91	1.13	20
800	90	400	100	15	20	15	13340.91	-9125	4215.91	1.13	50	13340.91	4109	17449.91	1.13	83
900	90	400	100	15	20	15	13340.91	-13241	99.91	1.13	33	13340.91	-3341	9999.91	1.13	66
700	185	400	100	15	20	15	13340.91	-10187	3153.91	1.13	32	13340.91	-2179	11161.91	1.13	48
800	185	400	100	15	20	15	13340.91	-12975	365.91	1.13	24	13340.91	-6588.33	6752.58	1.13	40
900	185	400	100	15	20	15	13340.91	-14952.33	-1611.42	1.13	16	13340.91	-10187	3153.91	1.13	32
700	300	400	100	15	20	15	13340.91	-12675	665.91	1.13	20	13340.91	-7775	5565.91	1.13	30
800	300	400	100	15	20	15	13340.91	-14375	-1034.09	1.13	15	13340.91	-10475	2865.91	1.13	25
900	300	400	100	15	20	15	13340.91	-15575	-2234.09	1.13	10	13340.91	-12675	665.91	1.13	20
700	90	600	100	15	20	15	13340.91	-3341	9999.91	1.13	66	13340.91	13225	26565.91	1.13	99
800	90	600	100	15	20	15	13340.91	-9125	4215.91	1.13	50	13340.91	4109	17449.91	1.13	83
900	90	600	100	15	20	15	13340.91	-13241	99.91	1.13	33	13340.91	-3341	9999.91	1.13	66
700	185	600	100	15	20	15	13340.91	-10187	3153.91	1.13	32	13340.91	-2179	11161.91	1.13	48
800	185	600	100	15	20	15	13340.91	-12975	365.91	1.13	24	13340.91	-6588.33	6752.58	1.13	40
900	185	600	100	15	20	15	13340.91	-14952.33	-1611.42	1.13	16	13340.91	-10187	3153.91	1.13	32
700	300	600	100	15	20	15	13340.91	-12675	665.91	1.13	20	13340.91	-7775	5565.91	1.13	30
800	300	600	100	15	20	15	13340.91	-14375	-1034.09	1.13	15	13340.91	-10475	2865.91	1.13	25
900	300	600	100	15	20	15	13340.91	-15575	-2234.09	1.13	10	13340.91	-12675	665.91	1.13	20
800	90	280	100	20	20	15	17603.07	-8675	8928.07	1.43	50	17603.07	4559	22162.07	1.43	83
900	90	280	100	20	20	15	17603.07	-12791	4812.07	1.43	33	17603.07	-2891	14712.07	1.43	66
700	185	280	100	20	20	15	17603.07	-9737	7866.07	1.43	32	17603.07	-1729	15874.07	1.43	48
800	185	280	100	20	20	15	17603.07	-12525	5078.07	1.43	24	17603.07	-6138.33	11464.74	1.43	40
900	185	280	100	20	20	15	17603.07	-14502.33	3100.74	1.43	16	17603.07	-9737	7866.07	1.43	32
700	300	280	100	20	20	15	17603.07	-12225	5378.07	1.43	20	17603.07	-7325	10278.07	1.43	30
800	300	280	100	20	20	15	17603.07	-13925	3678.07	1.43	15	17603.07	-10025	7578.07	1.43	25
900	300	280	100	20	20	15	17603.07	-15125	2478.07	1.43	10	17603.07	-12225	5378.07	1.43	20
800	90	400	100	20	20	15	17603.07	-8675	8928.07	1.43	50	17603.07	4559	22162.07	1.43	83
900	90	400	100	20	20	15	17603.07	-12791	4812.07	1.43	33	17603.07	-2891	14712.07	1.43	66

Table A.27: Scenarios where optimal introduction timing T^* increases as p_n increases from 1000(low) to 1200(medium) (cont'd)

Parameters							$p_2 = 1000$					$p_2 = 1200$				
c_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
700	185	400	100	20	20	15	17603.07	-9737	7866.07	1.43	32	17603.07	-1729	15874.07	1.43	48
800	185	400	100	20	20	15	17603.07	-12525	5078.07	1.43	24	17603.07	-6138.33	11464.74	1.43	40
900	185	400	100	20	20	15	17603.07	-14502.33	3100.74	1.43	16	17603.07	-9737	7866.07	1.43	32
700	300	400	100	20	20	15	17603.07	-12225	5378.07	1.43	20	17603.07	-7325	10278.07	1.43	30
800	300	400	100	20	20	15	17603.07	-13925	3678.07	1.43	15	17603.07	-10025	7578.07	1.43	25
900	300	400	100	20	20	15	17603.07	-15125	2478.07	1.43	10	17603.07	-12225	5378.07	1.43	20
800	90	600	100	20	20	15	17603.07	-8675	8928.07	1.43	50	17603.07	4559	22162.07	1.43	83
900	90	600	100	20	20	15	17603.07	-12791	4812.07	1.43	33	17603.07	-2891	14712.07	1.43	66
700	185	600	100	20	20	15	17603.07	-9737	7866.07	1.43	32	17603.07	-1729	15874.07	1.43	48
800	185	600	100	20	20	15	17603.07	-12525	5078.07	1.43	24	17603.07	-6138.33	11464.74	1.43	40
900	185	600	100	20	20	15	17603.07	-14502.33	3100.74	1.43	16	17603.07	-9737	7866.07	1.43	32
700	300	600	100	20	20	15	17603.07	-12225	5378.07	1.43	20	17603.07	-7325	10278.07	1.43	30
800	300	600	100	20	20	15	17603.07	-13925	3678.07	1.43	15	17603.07	-10025	7578.07	1.43	25
900	300	600	100	20	20	15	17603.07	-15125	2478.07	1.43	10	17603.07	-12225	5378.07	1.43	20
700	90	280	100	10	25	15	9097.61	-4141	4956.61	0.6	66	9097.61	12425	21522.61	0.6	99
800	90	280	100	10	25	15	9097.61	-9925	-827.39	0.6	50	9097.61	3309	12406.61	0.6	83
900	90	280	100	10	25	15	9097.61	-14041	-4943.39	0.6	33	9097.61	-4141	4956.61	0.6	66
700	185	280	100	10	25	15	9097.61	-10987	-1889.39	0.6	32	9097.61	-2979	6118.61	0.6	48
800	185	280	100	10	25	15	9097.61	-13775	-4677.39	0.6	24	9097.61	-7388.33	1709.28	0.6	40
900	185	280	100	10	25	15	9097.61	-15752.33	-6654.72	0.6	16	9097.61	-10987	-1889.39	0.6	32
700	300	280	100	10	25	15	9097.61	-13475	-4377.39	0.6	20	9097.61	-8575	522.61	0.6	30
800	300	280	100	10	25	15	9097.61	-15175	-6077.39	0.6	15	9097.61	-11275	-2177.39	0.6	25
900	300	280	100	10	25	15	9097.61	-16375	-7277.39	0.6	10	9097.61	-13475	-4377.39	0.6	20
700	90	400	100	10	25	15	9097.61	-4141	4956.61	0.6	66	9097.61	12425	21522.61	0.6	99
800	90	400	100	10	25	15	9097.61	-9925	-827.39	0.6	50	9097.61	3309	12406.61	0.6	83
900	90	400	100	10	25	15	9097.61	-14041	-4943.39	0.6	33	9097.61	-4141	4956.61	0.6	66
700	185	400	100	10	25	15	9097.61	-10987	-1889.39	0.6	32	9097.61	-2979	6118.61	0.6	48
800	185	400	100	10	25	15	9097.61	-13775	-4677.39	0.6	24	9097.61	-7388.33	1709.28	0.6	40
900	185	400	100	10	25	15	9097.61	-15752.33	-6654.72	0.6	16	9097.61	-10987	-1889.39	0.6	32

Table A.28: Scenarios where optimal introduction timing T^* increases as p_n increases from 1000(low) to 1200(medium) (cont'd)

Parameters							$p_2 = 1000$					$p_2 = 1200$				
c_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
700	300	400	100	10	25	15	9097.61	-13475	-4377.39	0.6	20	9097.61	-8575	522.61	0.6	30
800	300	400	100	10	25	15	9097.61	-15175	-6077.39	0.6	15	9097.61	-11275	-2177.39	0.6	25
900	300	400	100	10	25	15	9097.61	-16375	-7277.39	0.6	10	9097.61	-13475	-4377.39	0.6	20
700	90	600	100	10	25	15	9097.61	-4141	4956.61	0.6	66	9097.61	12425	21522.61	0.6	99
800	90	600	100	10	25	15	9097.61	-9925	-827.39	0.6	50	9097.61	3309	12406.61	0.6	83
900	90	600	100	10	25	15	9097.61	-14041	-4943.39	0.6	33	9097.61	-4141	4956.61	0.6	66
700	185	600	100	10	25	15	9097.61	-10987	-1889.39	0.6	32	9097.61	-2979	6118.61	0.6	48
800	185	600	100	10	25	15	9097.61	-13775	-4677.39	0.6	24	9097.61	-7388.33	1709.28	0.6	40
900	185	600	100	10	25	15	9097.61	-15752.33	-6654.72	0.6	16	9097.61	-10987	-1889.39	0.6	32
700	300	600	100	10	25	15	9097.61	-13475	-4377.39	0.6	20	9097.61	-8575	522.61	0.6	30
800	300	600	100	10	25	15	9097.61	-15175	-6077.39	0.6	15	9097.61	-11275	-2177.39	0.6	25
900	300	600	100	10	25	15	9097.61	-16375	-7277.39	0.6	10	9097.61	-13475	-4377.39	0.6	20
700	90	280	100	15	25	15	13577.91	-3741	9836.91	0.87	66	13577.91	12825	26402.91	0.87	99
800	90	280	100	15	25	15	13577.91	-9525	4052.91	0.87	50	13577.91	3709	17286.91	0.87	83
900	90	280	100	15	25	15	13577.91	-13641	-63.09	0.87	33	13577.91	-3741	9836.91	0.87	66
700	185	280	100	15	25	15	13577.91	-10587	2990.91	0.87	32	13577.91	-2579	10998.91	0.87	48
800	185	280	100	15	25	15	13577.91	-13375	202.91	0.87	24	13577.91	-6988.33	6589.57	0.87	40
900	185	280	100	15	25	15	13577.91	-15352.33	-1774.43	0.87	16	13577.91	-10587	2990.91	0.87	32
700	300	280	100	15	25	15	13577.91	-13075	502.91	0.87	20	13577.91	-8175	5402.91	0.87	30
800	300	280	100	15	25	15	13577.91	-14775	-1197.09	0.87	15	13577.91	-10875	2702.91	0.87	25
900	300	280	100	15	25	15	13577.91	-15975	-2397.09	0.87	10	13577.91	-13075	502.91	0.87	20
700	90	400	100	15	25	15	13577.91	-3741	9836.91	0.87	66	13577.91	12825	26402.91	0.87	99
800	90	400	100	15	25	15	13577.91	-9525	4052.91	0.87	50	13577.91	3709	17286.91	0.87	83
900	90	400	100	15	25	15	13577.91	-13641	-63.09	0.87	33	13577.91	-3741	9836.91	0.87	66
700	185	400	100	15	25	15	13577.91	-10587	2990.91	0.87	32	13577.91	-2579	10998.91	0.87	48
800	185	400	100	15	25	15	13577.91	-13375	202.91	0.87	24	13577.91	-6988.33	6589.57	0.87	40
900	185	400	100	15	25	15	13577.91	-15352.33	-1774.43	0.87	16	13577.91	-10587	2990.91	0.87	32
700	300	400	100	15	25	15	13577.91	-13075	502.91	0.87	20	13577.91	-8175	5402.91	0.87	30
800	300	400	100	15	25	15	13577.91	-14775	-1197.09	0.87	15	13577.91	-10875	2702.91	0.87	25

Table A.29: Scenarios where optimal introduction timing T^* increases as p_n increases from 1000(low) to 1200(medium) (cont'd)

Parameters							$p_2 = 1000$					$p_2 = 1200$				
c_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
900	300	400	100	15	25	15	13577.91	-15975	-2397.09	0.87	10	13577.91	-13075	502.91	0.87	20
700	90	600	100	15	25	15	13577.91	-3741	9836.91	0.87	66	13577.91	12825	26402.91	0.87	99
800	90	600	100	15	25	15	13577.91	-9525	4052.91	0.87	50	13577.91	3709	17286.91	0.87	83
900	90	600	100	15	25	15	13577.91	-13641	-63.09	0.87	33	13577.91	-3741	9836.91	0.87	66
700	185	600	100	15	25	15	13577.91	-10587	2990.91	0.87	32	13577.91	-2579	10998.91	0.87	48
800	185	600	100	15	25	15	13577.91	-13375	202.91	0.87	24	13577.91	-6988.33	6589.57	0.87	40
900	185	600	100	15	25	15	13577.91	-15352.33	-1774.43	0.87	16	13577.91	-10587	2990.91	0.87	32
700	300	600	100	15	25	15	13577.91	-13075	502.91	0.87	20	13577.91	-8175	5402.91	0.87	30
800	300	600	100	15	25	15	13577.91	-14775	-1197.09	0.87	15	13577.91	-10875	2702.91	0.87	25
900	300	600	100	15	25	15	13577.91	-15975	-2397.09	0.87	10	13577.91	-13075	502.91	0.87	20
700	90	280	100	20	25	15	17976.1	-3391	14585.1	1.1	66	17976.1	13175	31151.1	1.1	99
800	90	280	100	20	25	15	17976.1	-9175	8801.1	1.1	50	17976.1	4059	22035.1	1.1	83
900	90	280	100	20	25	15	17976.1	-13291	4685.1	1.1	33	17976.1	-3391	14585.1	1.1	66
700	185	280	100	20	25	15	17976.1	-10237	7739.1	1.1	32	17976.1	-2229	15747.1	1.1	48
800	185	280	100	20	25	15	17976.1	-13025	4951.1	1.1	24	17976.1	-6638.33	11337.77	1.1	40
900	185	280	100	20	25	15	17976.1	-15002.33	2973.77	1.1	16	17976.1	-10237	7739.1	1.1	32
700	300	280	100	20	25	15	17976.1	-12725	5251.1	1.1	20	17976.1	-7825	10151.1	1.1	30
800	300	280	100	20	25	15	17976.1	-14425	3551.1	1.1	15	17976.1	-10525	7451.1	1.1	25
900	300	280	100	20	25	15	17976.1	-15625	2351.1	1.1	10	17976.1	-12725	5251.1	1.1	20
700	90	400	100	20	25	15	17976.1	-3391	14585.1	1.1	66	17976.1	13175	31151.1	1.1	99
800	90	400	100	20	25	15	17976.1	-9175	8801.1	1.1	50	17976.1	4059	22035.1	1.1	83
900	90	400	100	20	25	15	17976.1	-13291	4685.1	1.1	33	17976.1	-3391	14585.1	1.1	66
700	185	400	100	20	25	15	17976.1	-10237	7739.1	1.1	32	17976.1	-2229	15747.1	1.1	48
800	185	400	100	20	25	15	17976.1	-13025	4951.1	1.1	24	17976.1	-6638.33	11337.77	1.1	40
900	185	400	100	20	25	15	17976.1	-15002.33	2973.77	1.1	16	17976.1	-10237	7739.1	1.1	32
700	300	400	100	20	25	15	17976.1	-12725	5251.1	1.1	20	17976.1	-7825	10151.1	1.1	30
800	300	400	100	20	25	15	17976.1	-14425	3551.1	1.1	15	17976.1	-10525	7451.1	1.1	25
900	300	400	100	20	25	15	17976.1	-15625	2351.1	1.1	10	17976.1	-12725	5251.1	1.1	20
700	90	600	100	20	25	15	17976.1	-3391	14585.1	1.1	66	17976.1	13175	31151.1	1.1	99

Table A.30: Scenarios where optimal introduction timing T^* increases as p_n increases from 1000(low) to 1200(medium) (cont'd)

Parameters							$p_2 = 1000$					$p_2 = 1200$				
c_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
800	90	600	100	20	25	15	17976.1	-9175	8801.1	1.1	50	17976.1	4059	22035.1	1.1	83
900	90	600	100	20	25	15	17976.1	-13291	4685.1	1.1	33	17976.1	-3391	14585.1	1.1	66
700	185	600	100	20	25	15	17976.1	-10237	7739.1	1.1	32	17976.1	-2229	15747.1	1.1	48
800	185	600	100	20	25	15	17976.1	-13025	4951.1	1.1	24	17976.1	-6638.33	11337.77	1.1	40
900	185	600	100	20	25	15	17976.1	-15002.33	2973.77	1.1	16	17976.1	-10237	7739.1	1.1	32
700	300	600	100	20	25	15	17976.1	-12725	5251.1	1.1	20	17976.1	-7825	10151.1	1.1	30
800	300	600	100	20	25	15	17976.1	-14425	3551.1	1.1	15	17976.1	-10525	7451.1	1.1	25
900	300	600	100	20	25	15	17976.1	-15625	2351.1	1.1	10	17976.1	-12725	5251.1	1.1	20
900	185	280	100	10	20	20	3881.67	-15378.42	-11496.75	3.37	21	3881.67	-8992.17	-5110.5	3.37	43
700	300	280	100	10	20	20	3881.67	-12306.67	-8425	3.37	26	3881.67	-5741.67	-1860	3.37	40
900	300	280	100	10	20	20	3881.67	-16206.67	-12325	3.37	13	3881.67	-12306.67	-8425	3.37	26
900	185	400	100	10	20	20	3881.67	-15378.42	-11496.75	3.37	21	3881.67	-8992.17	-5110.5	3.37	43
700	300	400	100	10	20	20	3881.67	-12306.67	-8425	3.37	26	3881.67	-5741.67	-1860	3.37	40
900	300	400	100	10	20	20	3881.67	-16206.67	-12325	3.37	13	3881.67	-12306.67	-8425	3.37	26
900	185	600	100	10	20	20	3881.67	-15378.42	-11496.75	3.37	21	3881.67	-8992.17	-5110.5	3.37	43
700	300	600	100	10	20	20	3881.67	-12306.67	-8425	3.37	26	3881.67	-5741.67	-1860	3.37	40
900	300	600	100	10	20	20	3881.67	-16206.67	-12325	3.37	13	3881.67	-12306.67	-8425	3.37	26
800	185	280	100	15	20	20	8793.33	-12592.33	-3799	3.43	32	8793.33	-4044.58	4748.75	3.43	54
900	185	280	100	15	20	20	8793.33	-15245.08	-6451.75	3.43	21	8793.33	-8858.83	-65.5	3.43	43
700	300	280	100	15	20	20	8793.33	-12173.33	-3380	3.43	26	8793.33	-5608.33	3185	3.43	40
900	300	280	100	15	20	20	8793.33	-16073.33	-7280	3.43	13	8793.33	-12173.33	-3380	3.43	26
800	185	400	100	15	20	20	8793.33	-12592.33	-3799	3.43	32	8793.33	-4044.58	4748.75	3.43	54
900	185	400	100	15	20	20	8793.33	-15245.08	-6451.75	3.43	21	8793.33	-8858.83	-65.5	3.43	43
700	300	400	100	15	20	20	8793.33	-12173.33	-3380	3.43	26	8793.33	-5608.33	3185	3.43	40
900	300	400	100	15	20	20	8793.33	-16073.33	-7280	3.43	13	8793.33	-12173.33	-3380	3.43	26
900	185	600	100	15	20	20	8793.33	-15245.08	-6451.75	3.43	21	8793.33	-8858.83	-65.5	3.43	43
700	300	600	100	15	20	20	8793.33	-12173.33	-3380	3.43	26	8793.33	-5608.33	3185	3.43	40
900	300	600	100	15	20	20	8793.33	-16073.33	-7280	3.43	13	8793.33	-12173.33	-3380	3.43	26
900	185	280	100	20	20	20	12663.33	-14245.08	-1581.75	3.93	21	12663.33	-7858.83	4804.5	3.93	43

Table A.31: Scenarios where optimal introduction timing T^* increases as p_n increases from 1000(low) to 1200(medium) (cont'd)

Parameters							$p_2 = 1000$					$p_2 = 1200$				
c_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
700	300	280	100	20	20	20	12663.33	-11173.33	1490	3.93	26	12663.33	-4608.33	8055	3.93	40
900	300	280	100	20	20	20	12663.33	-15073.33	-2410	3.93	13	12663.33	-11173.33	1490	3.93	26
900	185	400	100	20	20	20	12663.33	-14245.08	-1581.75	3.93	21	12663.33	-7858.83	4804.5	3.93	43
700	300	400	100	20	20	20	12663.33	-11173.33	1490	3.93	26	12663.33	-4608.33	8055	3.93	40
900	300	400	100	20	20	20	12663.33	-15073.33	-2410	3.93	13	12663.33	-11173.33	1490	3.93	26
900	185	600	100	20	20	20	12663.33	-14245.08	-1581.75	3.93	21	12663.33	-7858.83	4804.5	3.93	43
700	300	600	100	20	20	20	12663.33	-11173.33	1490	3.93	26	12663.33	-4608.33	8055	3.93	40
900	300	600	100	20	20	20	12663.33	-15073.33	-2410	3.93	13	12663.33	-11173.33	1490	3.93	26
700	90	280	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88	8986.25	16858.83	25845.08	0.67	133
800	90	280	100	10	25	20	8986.25	-12991.17	-4004.92	0.67	66	8986.25	4686.33	13672.58	0.67	111
900	90	280	100	10	25	20	8986.25	-18496.67	-9510.42	0.67	44	8986.25	-5263.67	3722.58	0.67	88
700	185	280	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43	8986.25	-3681.67	5304.58	0.67	64
800	185	280	100	10	25	20	8986.25	-18125.67	-9139.42	0.67	32	8986.25	-9577.92	-591.67	0.67	54
900	185	280	100	10	25	20	8986.25	-20778.42	-11792.17	0.67	21	8986.25	-14392.17	-5405.92	0.67	43
700	300	280	100	10	25	20	8986.25	-17706.67	-8720.42	0.67	26	8986.25	-11141.67	-2155.42	0.67	40
800	300	280	100	10	25	20	8986.25	-19991.67	-11005.42	0.67	20	8986.25	-14756.67	-5770.42	0.67	33
900	300	280	100	10	25	20	8986.25	-21606.67	-12620.42	0.67	13	8986.25	-17706.67	-8720.42	0.67	26
700	90	400	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88	8986.25	16858.83	25845.08	0.67	133
800	90	400	100	10	25	20	8986.25	-12991.17	-4004.92	0.67	66	8986.25	4686.33	13672.58	0.67	111
900	90	400	100	10	25	20	8986.25	-18496.67	-9510.42	0.67	44	8986.25	-5263.67	3722.58	0.67	88
700	185	400	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43	8986.25	-3681.67	5304.58	0.67	64
800	185	400	100	10	25	20	8986.25	-18125.67	-9139.42	0.67	32	8986.25	-9577.92	-591.67	0.67	54
900	185	400	100	10	25	20	8986.25	-20778.42	-11792.17	0.67	21	8986.25	-14392.17	-5405.92	0.67	43
700	300	400	100	10	25	20	8986.25	-17706.67	-8720.42	0.67	26	8986.25	-11141.67	-2155.42	0.67	40
800	300	400	100	10	25	20	8986.25	-19991.67	-11005.42	0.67	20	8986.25	-14756.67	-5770.42	0.67	33
900	300	400	100	10	25	20	8986.25	-21606.67	-12620.42	0.67	13	8986.25	-17706.67	-8720.42	0.67	26
700	90	600	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88	8986.25	16858.83	25845.08	0.67	133
800	90	600	100	10	25	20	8986.25	-12991.17	-4004.92	0.67	66	8986.25	4686.33	13672.58	0.67	111
900	90	600	100	10	25	20	8986.25	-18496.67	-9510.42	0.67	44	8986.25	-5263.67	3722.58	0.67	88

Table A.32: Scenarios where optimal introduction timing T^* increases as p_n increases from 1000(low) to 1200(medium) (cont'd)

Parameters							$p_2 = 1000$					$p_2 = 1200$				
c_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
700	185	600	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43	8986.25	-3681.67	5304.58	0.67	64
800	185	600	100	10	25	20	8986.25	-18125.67	-9139.42	0.67	32	8986.25	-9577.92	-591.67	0.67	54
900	185	600	100	10	25	20	8986.25	-20778.42	-11792.17	0.67	21	8986.25	-14392.17	-5405.92	0.67	43
700	300	600	100	10	25	20	8986.25	-17706.67	-8720.42	0.67	26	8986.25	-11141.67	-2155.42	0.67	40
800	300	600	100	10	25	20	8986.25	-19991.67	-11005.42	0.67	20	8986.25	-14756.67	-5770.42	0.67	33
900	300	600	100	10	25	20	8986.25	-21606.67	-12620.42	0.67	13	8986.25	-17706.67	-8720.42	0.67	26
700	90	280	100	15	25	20	13456.33	-4730.33	8726	0.93	88	13456.33	17392.17	30848.5	0.93	133
800	90	280	100	15	25	20	13456.33	-12457.83	998.5	0.93	66	13456.33	5219.67	18676	0.93	111
900	90	280	100	15	25	20	13456.33	-17963.33	-4507	0.93	44	13456.33	-4730.33	8726	0.93	88
700	185	280	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43	13456.33	-3148.33	10308	0.93	64
800	185	280	100	15	25	20	13456.33	-17592.33	-4136	0.93	32	13456.33	-9044.58	4411.75	0.93	54
900	185	280	100	15	25	20	13456.33	-20245.08	-6788.75	0.93	21	13456.33	-13858.83	-402.5	0.93	43
700	300	280	100	15	25	20	13456.33	-17173.33	-3717	0.93	26	13456.33	-10608.33	2848	0.93	40
800	300	280	100	15	25	20	13456.33	-19458.33	-6002	0.93	20	13456.33	-14223.33	-767	0.93	33
900	300	280	100	15	25	20	13456.33	-21073.33	-7617	0.93	13	13456.33	-17173.33	-3717	0.93	26
700	90	400	100	15	25	20	13456.33	-4730.33	8726	0.93	88	13456.33	17392.17	30848.5	0.93	133
800	90	400	100	15	25	20	13456.33	-12457.83	998.5	0.93	66	13456.33	5219.67	18676	0.93	111
900	90	400	100	15	25	20	13456.33	-17963.33	-4507	0.93	44	13456.33	-4730.33	8726	0.93	88
700	185	400	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43	13456.33	-3148.33	10308	0.93	64
800	185	400	100	15	25	20	13456.33	-17592.33	-4136	0.93	32	13456.33	-9044.58	4411.75	0.93	54
900	185	400	100	15	25	20	13456.33	-20245.08	-6788.75	0.93	21	13456.33	-13858.83	-402.5	0.93	43
700	300	400	100	15	25	20	13456.33	-17173.33	-3717	0.93	26	13456.33	-10608.33	2848	0.93	40
800	300	400	100	15	25	20	13456.33	-19458.33	-6002	0.93	20	13456.33	-14223.33	-767	0.93	33
900	300	400	100	15	25	20	13456.33	-21073.33	-7617	0.93	13	13456.33	-17173.33	-3717	0.93	26
700	90	600	100	15	25	20	13456.33	-4730.33	8726	0.93	88	13456.33	17392.17	30848.5	0.93	133
800	90	600	100	15	25	20	13456.33	-12457.83	998.5	0.93	66	13456.33	5219.67	18676	0.93	111
900	90	600	100	15	25	20	13456.33	-17963.33	-4507	0.93	44	13456.33	-4730.33	8726	0.93	88
700	185	600	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43	13456.33	-3148.33	10308	0.93	64
800	185	600	100	15	25	20	13456.33	-17592.33	-4136	0.93	32	13456.33	-9044.58	4411.75	0.93	54

Table A.33: Scenarios where optimal introduction timing T^* increases as p_n increases from 1000(low) to 1200(medium) (cont'd)

Parameters							$p_2 = 1000$					$p_2 = 1200$				
c_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
900	185	600	100	15	25	20	13456.33	-20245.08	-6788.75	0.93	21	13456.33	-13858.83	-402.5	0.93	43
700	300	600	100	15	25	20	13456.33	-17173.33	-3717	0.93	26	13456.33	-10608.33	2848	0.93	40
800	300	600	100	15	25	20	13456.33	-19458.33	-6002	0.93	20	13456.33	-14223.33	-767	0.93	33
900	300	600	100	15	25	20	13456.33	-21073.33	-7617	0.93	13	13456.33	-17173.33	-3717	0.93	26
700	90	280	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88	17858.39	17858.83	35717.23	1.17	133
800	90	280	100	20	25	20	17858.39	-11991.17	5867.23	1.17	66	17858.39	5686.33	23544.73	1.17	111
900	90	280	100	20	25	20	17858.39	-17496.67	361.73	1.17	44	17858.39	-4263.67	13594.73	1.17	88
700	185	280	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43	17858.39	-2681.67	15176.73	1.17	64
800	185	280	100	20	25	20	17858.39	-17125.67	732.73	1.17	32	17858.39	-8577.92	9280.48	1.17	54
900	185	280	100	20	25	20	17858.39	-19778.42	-1920.02	1.17	21	17858.39	-13392.17	4466.23	1.17	43
700	300	280	100	20	25	20	17858.39	-16706.67	1151.73	1.17	26	17858.39	-10141.67	7716.73	1.17	40
800	300	280	100	20	25	20	17858.39	-18991.67	-1133.27	1.17	20	17858.39	-13756.67	4101.73	1.17	33
900	300	280	100	20	25	20	17858.39	-20606.67	-2748.27	1.17	13	17858.39	-16706.67	1151.73	1.17	26
700	90	400	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88	17858.39	17858.83	35717.23	1.17	133
800	90	400	100	20	25	20	17858.39	-11991.17	5867.23	1.17	66	17858.39	5686.33	23544.73	1.17	111
900	90	400	100	20	25	20	17858.39	-17496.67	361.73	1.17	44	17858.39	-4263.67	13594.73	1.17	88
700	185	400	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43	17858.39	-2681.67	15176.73	1.17	64
800	185	400	100	20	25	20	17858.39	-17125.67	732.73	1.17	32	17858.39	-8577.92	9280.48	1.17	54
900	185	400	100	20	25	20	17858.39	-19778.42	-1920.02	1.17	21	17858.39	-13392.17	4466.23	1.17	43
700	300	400	100	20	25	20	17858.39	-16706.67	1151.73	1.17	26	17858.39	-10141.67	7716.73	1.17	40
800	300	400	100	20	25	20	17858.39	-18991.67	-1133.27	1.17	20	17858.39	-13756.67	4101.73	1.17	33
900	300	400	100	20	25	20	17858.39	-20606.67	-2748.27	1.17	13	17858.39	-16706.67	1151.73	1.17	26
700	90	600	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88	17858.39	17858.83	35717.23	1.17	133
800	90	600	100	20	25	20	17858.39	-11991.17	5867.23	1.17	66	17858.39	5686.33	23544.73	1.17	111
900	90	600	100	20	25	20	17858.39	-17496.67	361.73	1.17	44	17858.39	-4263.67	13594.73	1.17	88
700	185	600	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43	17858.39	-2681.67	15176.73	1.17	64
800	185	600	100	20	25	20	17858.39	-17125.67	732.73	1.17	32	17858.39	-8577.92	9280.48	1.17	54
900	185	600	100	20	25	20	17858.39	-19778.42	-1920.02	1.17	21	17858.39	-13392.17	4466.23	1.17	43
700	300	600	100	20	25	20	17858.39	-16706.67	1151.73	1.17	26	17858.39	-10141.67	7716.73	1.17	40
800	300	600	100	20	25	20	17858.39	-18991.67	-1133.27	1.17	20	17858.39	-13756.67	4101.73	1.17	33
900	300	600	100	20	25	20	17858.39	-20606.67	-2748.27	1.17	13	17858.39	-16706.67	1151.73	1.17	26

Table A.34: Scenarios where optimal introduction timing T^* increases as p_n increases from 1200(medium) to 1400(high)

Parameters							$p_2 = 1200$					$p_2 = 1400$				
c_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
800	90	280	100	10	20	15	8909.38	3659	12568.38	0.83	83	8909.38	23558.96	32468.34	0.83	116
900	90	280	100	10	20	15	8909.38	-3791	5118.38	0.83	66	8909.38	12775	21684.38	0.83	99
700	185	280	100	10	20	15	8909.38	-2629	6280.38	0.83	48	8909.38	8621.67	17531.05	0.83	64
800	185	280	100	10	20	15	8909.38	-7038.33	1871.05	0.83	40	8909.38	2591	11500.38	0.83	56
900	185	280	100	10	20	15	8909.38	-10637	-1727.62	0.83	32	8909.38	-2629	6280.38	0.83	48
700	300	280	100	10	20	15	8909.38	-8225	684.38	0.83	30	8909.38	-1325	7584.38	0.83	40
800	300	280	100	10	20	15	8909.38	-10925	-2015.62	0.83	25	8909.38	-5025	3884.38	0.83	35
900	300	280	100	10	20	15	8909.38	-13125	-4215.62	0.83	20	8909.38	-8225	684.38	0.83	30
800	90	400	100	10	20	15	8909.38	3659	12568.38	0.83	83	8909.38	23558.96	32468.35	0.83	116
900	90	400	100	10	20	15	8909.38	-3791	5118.38	0.83	66	8909.38	12775	21684.38	0.83	99
700	185	400	100	10	20	15	8909.38	-2629	6280.38	0.83	48	8909.38	8621.67	17531.05	0.83	64
800	185	400	100	10	20	15	8909.38	-7038.33	1871.05	0.83	40	8909.38	2591	11500.38	0.83	56
900	185	400	100	10	20	15	8909.38	-10637	-1727.62	0.83	32	8909.38	-2629	6280.38	0.83	48
700	300	400	100	10	20	15	8909.38	-8225	684.38	0.83	30	8909.38	-1325	7584.38	0.83	40
800	300	400	100	10	20	15	8909.38	-10925	-2015.62	0.83	25	8909.38	-5025	3884.38	0.83	35
900	300	400	100	10	20	15	8909.38	-13125	-4215.62	0.83	20	8909.38	-8225	684.38	0.83	30
800	90	600	100	10	20	15	8909.38	3659	12568.38	0.83	83	8909.38	23558.97	32468.35	0.83	116
900	90	600	100	10	20	15	8909.38	-3791	5118.38	0.83	66	8909.38	12775	21684.38	0.83	99
700	185	600	100	10	20	15	8909.38	-2629	6280.38	0.83	48	8909.38	8621.67	17531.05	0.83	64
800	185	600	100	10	20	15	8909.38	-7038.33	1871.05	0.83	40	8909.38	2591	11500.38	0.83	56
900	185	600	100	10	20	15	8909.38	-10637	-1727.62	0.83	32	8909.38	-2629	6280.38	0.83	48
700	300	600	100	10	20	15	8909.38	-8225	684.38	0.83	30	8909.38	-1325	7584.38	0.83	40
800	300	600	100	10	20	15	8909.38	-10925	-2015.62	0.83	25	8909.38	-5025	3884.38	0.83	35
900	300	600	100	10	20	15	8909.38	-13125	-4215.62	0.83	20	8909.38	-8225	684.38	0.83	30
800	90	280	100	15	20	15	13340.91	4109	17449.91	1.13	83	13340.91	24008.83	37349.74	1.13	116
900	90	280	100	15	20	15	13340.91	-3341	9999.91	1.13	66	13340.91	13225	26565.91	1.13	99
700	185	280	100	15	20	15	13340.91	-2179	11161.91	1.13	48	13340.91	9071.67	22412.58	1.13	64
800	185	280	100	15	20	15	13340.91	-6588.33	6752.58	1.13	40	13340.91	3041	16381.91	1.13	56
900	185	280	100	15	20	15	13340.91	-10187	3153.91	1.13	32	13340.91	-2179	11161.91	1.13	48

Table A.35: Scenarios where optimal introduction timing T^* increases as p_n increases from 1200(medium) to 1400(high) (cont'd)

Parameters							$p_2 = 1200$					$p_2 = 1400$				
c_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
700	300	280	100	15	20	15	13340.91	-7775	5565.91	1.13	30	13340.91	-875	12465.91	1.13	40
800	300	280	100	15	20	15	13340.91	-10475	2865.91	1.13	25	13340.91	-4575	8765.91	1.13	35
900	300	280	100	15	20	15	13340.91	-12675	665.91	1.13	20	13340.91	-7775	5565.91	1.13	30
800	90	400	100	15	20	15	13340.91	4109	17449.91	1.13	83	13340.91	24008.85	37349.76	1.13	116
900	90	400	100	15	20	15	13340.91	-3341	9999.91	1.13	66	13340.91	13225	26565.91	1.13	99
700	185	400	100	15	20	15	13340.91	-2179	11161.91	1.13	48	13340.91	9071.67	22412.58	1.13	64
800	185	400	100	15	20	15	13340.91	-6588.33	6752.58	1.13	40	13340.91	3041	16381.91	1.13	56
900	185	400	100	15	20	15	13340.91	-10187	3153.91	1.13	32	13340.91	-2179	11161.91	1.13	48
700	300	400	100	15	20	15	13340.91	-7775	5565.91	1.13	30	13340.91	-875	12465.91	1.13	40
800	300	400	100	15	20	15	13340.91	-10475	2865.91	1.13	25	13340.91	-4575	8765.91	1.13	35
900	300	400	100	15	20	15	13340.91	-12675	665.91	1.13	20	13340.91	-7775	5565.91	1.13	30
700	90	600	100	15	20	15	13340.91	13225	26565.91	1.13	99	13340.91	36436.23	49777.14	1.13	132
800	90	600	100	15	20	15	13340.91	4109	17449.91	1.13	83	13340.91	24008.87	37349.78	1.13	116
900	90	600	100	15	20	15	13340.91	-3341	9999.91	1.13	66	13340.91	13225	26565.91	1.13	99
700	185	600	100	15	20	15	13340.91	-2179	11161.91	1.13	48	13340.91	9071.67	22412.58	1.13	64
800	185	600	100	15	20	15	13340.91	-6588.33	6752.58	1.13	40	13340.91	3041	16381.91	1.13	56
900	185	600	100	15	20	15	13340.91	-10187	3153.91	1.13	32	13340.91	-2179	11161.91	1.13	48
700	300	600	100	15	20	15	13340.91	-7775	5565.91	1.13	30	13340.91	-875	12465.91	1.13	40
800	300	600	100	15	20	15	13340.91	-10475	2865.91	1.13	25	13340.91	-4575	8765.91	1.13	35
900	300	600	100	15	20	15	13340.91	-12675	665.91	1.13	20	13340.91	-7775	5565.91	1.13	30
800	90	280	100	20	20	15	17603.07	4559	22162.07	1.43	83	17603.07	24458.31	42061.38	1.43	116
900	90	280	100	20	20	15	17603.07	-2891	14712.07	1.43	66	17603.07	13675	31278.07	1.43	99
700	185	280	100	20	20	15	17603.07	-1729	15874.07	1.43	48	17603.07	9521.67	27124.74	1.43	64
800	185	280	100	20	20	15	17603.07	-6138.33	11464.74	1.43	40	17603.07	3491	21094.07	1.43	56
900	185	280	100	20	20	15	17603.07	-9737	7866.07	1.43	32	17603.07	-1729	15874.07	1.43	48
700	300	280	100	20	20	15	17603.07	-7325	10278.07	1.43	30	17603.07	-425	17178.07	1.43	40
800	300	280	100	20	20	15	17603.07	-10025	7578.07	1.43	25	17603.07	-4125	13478.07	1.43	35
900	300	280	100	20	20	15	17603.07	-12225	5378.07	1.43	20	17603.07	-7325	10278.07	1.43	30
800	90	400	100	20	20	15	17603.07	4559	22162.07	1.43	83	17603.07	24458.38	42061.45	1.43	116

Table A.36: Scenarios where optimal introduction timing T^* increases as p_n increases from 1200(medium) to 1400(high) (cont'd)

Parameters							$p_2 = 1200$					$p_2 = 1400$				
c_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
900	90	400	100	20	20	15	17603.07	-2891	14712.07	1.43	66	17603.07	13675	31278.07	1.43	99
700	185	400	100	20	20	15	17603.07	-1729	15874.07	1.43	48	17603.07	9521.67	27124.74	1.43	64
800	185	400	100	20	20	15	17603.07	-6138.33	11464.74	1.43	40	17603.07	3491	21094.07	1.43	56
900	185	400	100	20	20	15	17603.07	-9737	7866.07	1.43	32	17603.07	-1729	15874.07	1.43	48
700	300	400	100	20	20	15	17603.07	-7325	10278.07	1.43	30	17603.07	-425	17178.07	1.43	40
800	300	400	100	20	20	15	17603.07	-10025	7578.07	1.43	25	17603.07	-4125	13478.07	1.43	35
900	300	400	100	20	20	15	17603.07	-12225	5378.07	1.43	20	17603.07	-7325	10278.07	1.43	30
800	90	600	100	20	20	15	17603.07	4559	22162.07	1.43	83	17603.07	24458.49	42061.56	1.43	116
900	90	600	100	20	20	15	17603.07	-2891	14712.07	1.43	66	17603.07	13675	31278.07	1.43	99
700	185	600	100	20	20	15	17603.07	-1729	15874.07	1.43	48	17603.07	9521.67	27124.74	1.43	64
800	185	600	100	20	20	15	17603.07	-6138.33	11464.74	1.43	40	17603.07	3491	21094.07	1.43	56
900	185	600	100	20	20	15	17603.07	-9737	7866.07	1.43	32	17603.07	-1729	15874.07	1.43	48
700	300	600	100	20	20	15	17603.07	-7325	10278.07	1.43	30	17603.07	-425	17178.07	1.43	40
800	300	600	100	20	20	15	17603.07	-10025	7578.07	1.43	25	17603.07	-4125	13478.07	1.43	35
900	300	600	100	20	20	15	17603.07	-12225	5378.07	1.43	20	17603.07	-7325	10278.07	1.43	30
700	90	280	100	10	25	15	9097.61	12425	21522.61	0.6	99	9097.61	35653.77	44751.38	0.6	133
800	90	280	100	10	25	15	9097.61	3309	12406.61	0.6	83	9097.61	23208.99	32306.6	0.6	116
900	90	280	100	10	25	15	9097.61	-4141	4956.61	0.6	66	9097.61	12425	21522.61	0.6	99
700	185	280	100	10	25	15	9097.61	-2979	6118.61	0.6	48	9097.61	8271.67	17369.28	0.6	64
800	185	280	100	10	25	15	9097.61	-7388.33	1709.28	0.6	40	9097.61	2241	11338.61	0.6	56
900	185	280	100	10	25	15	9097.61	-10987	-1889.39	0.6	32	9097.61	-2979	6118.61	0.6	48
700	300	280	100	10	25	15	9097.61	-8575	522.61	0.6	30	9097.61	-1675	7422.61	0.6	40
800	300	280	100	10	25	15	9097.61	-11275	-2177.39	0.6	25	9097.61	-5375	3722.61	0.6	35
900	300	280	100	10	25	15	9097.61	-13475	-4377.39	0.6	20	9097.61	-8575	522.61	0.6	30
700	90	400	100	10	25	15	9097.61	12425	21522.61	0.6	99	9097.61	35654.29	44751.91	0.6	133
800	90	400	100	10	25	15	9097.61	3309	12406.61	0.6	83	9097.61	23208.99	32306.6	0.6	116
900	90	400	100	10	25	15	9097.61	-4141	4956.61	0.6	66	9097.61	12425	21522.61	0.6	99
700	185	400	100	10	25	15	9097.61	-2979	6118.61	0.6	48	9097.61	8271.67	17369.28	0.6	64
800	185	400	100	10	25	15	9097.61	-7388.33	1709.28	0.6	40	9097.61	2241	11338.61	0.6	56

Table A.37: Scenarios where optimal introduction timing T^* increases as p_n increases from 1200(medium) to 1400(high) (cont'd)

Parameters							$p_2 = 1200$					$p_2 = 1400$				
c_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
900	185	400	100	10	25	15	9097.61	-10987	-1889.39	0.6	32	9097.61	-2979	6118.61	0.6	48
700	300	400	100	10	25	15	9097.61	-8575	522.61	0.6	30	9097.61	-1675	7422.61	0.6	40
800	300	400	100	10	25	15	9097.61	-11275	-2177.39	0.6	25	9097.61	-5375	3722.61	0.6	35
900	300	400	100	10	25	15	9097.61	-13475	-4377.39	0.6	20	9097.61	-8575	522.61	0.6	30
700	90	600	100	10	25	15	9097.61	12425	21522.61	0.6	99	9097.61	35655.17	44752.78	0.6	133
800	90	600	100	10	25	15	9097.61	3309	12406.61	0.6	83	9097.61	23208.99	32306.61	0.6	116
900	90	600	100	10	25	15	9097.61	-4141	4956.61	0.6	66	9097.61	12425	21522.61	0.6	99
700	185	600	100	10	25	15	9097.61	-2979	6118.61	0.6	48	9097.61	8271.67	17369.28	0.6	64
800	185	600	100	10	25	15	9097.61	-7388.33	1709.28	0.6	40	9097.61	2241	11338.61	0.6	56
900	185	600	100	10	25	15	9097.61	-10987	-1889.39	0.6	32	9097.61	-2979	6118.61	0.6	48
700	300	600	100	10	25	15	9097.61	-8575	522.61	0.6	30	9097.61	-1675	7422.61	0.6	40
800	300	600	100	10	25	15	9097.61	-11275	-2177.39	0.6	25	9097.61	-5375	3722.61	0.6	35
900	300	600	100	10	25	15	9097.61	-13475	-4377.39	0.6	20	9097.61	-8575	522.61	0.6	30
700	90	280	100	15	25	15	13577.91	12825	26402.91	0.87	99	13577.91	36046.19	49624.1	0.87	132
800	90	280	100	15	25	15	13577.91	3709	17286.91	0.87	83	13577.91	23608.95	37186.86	0.87	116
900	90	280	100	15	25	15	13577.91	-3741	9836.91	0.87	66	13577.91	12825	26402.91	0.87	99
700	185	280	100	15	25	15	13577.91	-2579	10998.91	0.87	48	13577.91	8671.67	22249.57	0.87	64
800	185	280	100	15	25	15	13577.91	-6988.33	6589.57	0.87	40	13577.91	2641	16218.91	0.87	56
900	185	280	100	15	25	15	13577.91	-10587	2990.91	0.87	32	13577.91	-2579	10998.91	0.87	48
700	300	280	100	15	25	15	13577.91	-8175	5402.91	0.87	30	13577.91	-1275	12302.91	0.87	40
800	300	280	100	15	25	15	13577.91	-10875	2702.91	0.87	25	13577.91	-4975	8602.91	0.87	35
900	300	280	100	15	25	15	13577.91	-13075	502.91	0.87	20	13577.91	-8175	5402.91	0.87	30
700	90	400	100	15	25	15	13577.91	12825	26402.91	0.87	99	13577.91	36047.27	49625.18	0.87	132
800	90	400	100	15	25	15	13577.91	3709	17286.91	0.87	83	13577.91	23608.96	37186.87	0.87	116
900	90	400	100	15	25	15	13577.91	-3741	9836.91	0.87	66	13577.91	12825	26402.91	0.87	99
700	185	400	100	15	25	15	13577.91	-2579	10998.91	0.87	48	13577.91	8671.67	22249.57	0.87	64
800	185	400	100	15	25	15	13577.91	-6988.33	6589.57	0.87	40	13577.91	2641	16218.91	0.87	56
900	185	400	100	15	25	15	13577.91	-10587	2990.91	0.87	32	13577.91	-2579	10998.91	0.87	48
700	300	400	100	15	25	15	13577.91	-8175	5402.91	0.87	30	13577.91	-1275	12302.91	0.87	40

Table A.38: Scenarios where optimal introduction timing T^* increases as p_n increases from 1200(medium) to 1400(high) (cont'd)

Parameters							$p_2 = 1200$					$p_2 = 1400$				
c_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
800	300	400	100	15	25	15	13577.91	-10875	2702.91	0.87	25	13577.91	-4975	8602.91	0.87	35
900	300	400	100	15	25	15	13577.91	-13075	502.91	0.87	20	13577.91	-8175	5402.91	0.87	30
700	90	600	100	15	25	15	13577.91	12825	26402.91	0.87	99	13577.91	36049.08	49626.99	0.87	132
800	90	600	100	15	25	15	13577.91	3709	17286.91	0.87	83	13577.91	23608.97	37186.87	0.87	116
900	90	600	100	15	25	15	13577.91	-3741	9836.91	0.87	66	13577.91	12825	26402.91	0.87	99
700	185	600	100	15	25	15	13577.91	-2579	10998.91	0.87	48	13577.91	8671.67	22249.57	0.87	64
800	185	600	100	15	25	15	13577.91	-6988.33	6589.57	0.87	40	13577.91	2641	16218.91	0.87	56
900	185	600	100	15	25	15	13577.91	-10587	2990.91	0.87	32	13577.91	-2579	10998.91	0.87	48
700	300	600	100	15	25	15	13577.91	-8175	5402.91	0.87	30	13577.91	-1275	12302.91	0.87	40
800	300	600	100	15	25	15	13577.91	-10875	2702.91	0.87	25	13577.91	-4975	8602.91	0.87	35
900	300	600	100	15	25	15	13577.91	-13075	502.91	0.87	20	13577.91	-8175	5402.91	0.87	30
700	90	280	100	20	25	15	17976.1	13175	31151.1	1.1	99	17976.1	36381.78	54357.87	1.1	132
800	90	280	100	20	25	15	17976.1	4059	22035.1	1.1	83	17976.1	23958.85	41934.95	1.1	116
900	90	280	100	20	25	15	17976.1	-3391	14585.1	1.1	66	17976.1	13175	31151.1	1.1	99
700	185	280	100	20	25	15	17976.1	-2229	15747.1	1.1	48	17976.1	9021.67	26997.77	1.1	64
800	185	280	100	20	25	15	17976.1	-6638.33	11337.77	1.1	40	17976.1	2991	20967.1	1.1	56
900	185	280	100	20	25	15	17976.1	-10237	7739.1	1.1	32	17976.1	-2229	15747.1	1.1	48
700	300	280	100	20	25	15	17976.1	-7825	10151.1	1.1	30	17976.1	-925	17051.1	1.1	40
800	300	280	100	20	25	15	17976.1	-10525	7451.1	1.1	25	17976.1	-4625	13351.1	1.1	35
900	300	280	100	20	25	15	17976.1	-12725	5251.1	1.1	20	17976.1	-7825	10151.1	1.1	30
700	90	400	100	20	25	15	17976.1	13175	31151.1	1.1	99	17976.1	36384.31	54360.41	1.1	132
800	90	400	100	20	25	15	17976.1	4059	22035.1	1.1	83	17976.1	23958.87	41934.97	1.1	116
900	90	400	100	20	25	15	17976.1	-3391	14585.1	1.1	66	17976.1	13175	31151.1	1.1	99
700	185	400	100	20	25	15	17976.1	-2229	15747.1	1.1	48	17976.1	9021.67	26997.77	1.1	64
800	185	400	100	20	25	15	17976.1	-6638.33	11337.77	1.1	40	17976.1	2991	20967.1	1.1	56
900	185	400	100	20	25	15	17976.1	-10237	7739.1	1.1	32	17976.1	-2229	15747.1	1.1	48
700	300	400	100	20	25	15	17976.1	-7825	10151.1	1.1	30	17976.1	-925	17051.1	1.1	40
800	300	400	100	20	25	15	17976.1	-10525	7451.1	1.1	25	17976.1	-4625	13351.1	1.1	35
900	300	400	100	20	25	15	17976.1	-12725	5251.1	1.1	20	17976.1	-7825	10151.1	1.1	30

Table A.39: Scenarios where optimal introduction timing T^* increases as p_n increases from 1200(medium) to 1400(high) (cont'd)

Parameters							$p_2 = 1200$					$p_2 = 1400$				
c_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
700	90	600	100	20	25	15	17976.1	13175	31151.1	1.1	99	17976.1	36388.52	54364.62	1.1	132
800	90	600	100	20	25	15	17976.1	4059	22035.1	1.1	83	17976.1	23958.89	41934.99	1.1	116
900	90	600	100	20	25	15	17976.1	-3391	14585.1	1.1	66	17976.1	13175	31151.1	1.1	99
700	185	600	100	20	25	15	17976.1	-2229	15747.1	1.1	48	17976.1	9021.67	26997.77	1.1	64
800	185	600	100	20	25	15	17976.1	-6638.33	11337.77	1.1	40	17976.1	2991	20967.1	1.1	56
900	185	600	100	20	25	15	17976.1	-10237	7739.1	1.1	32	17976.1	-2229	15747.1	1.1	48
700	300	600	100	20	25	15	17976.1	-7825	10151.1	1.1	30	17976.1	-925	17051.1	1.1	40
800	300	600	100	20	25	15	17976.1	-10525	7451.1	1.1	25	17976.1	-4625	13351.1	1.1	35
900	300	600	100	20	25	15	17976.1	-12725	5251.1	1.1	20	17976.1	-7825	10151.1	1.1	30
900	185	280	100	10	20	20	3881.67	-8992.17	-5110.5	3.37	43	2081.67	3518.33	5600	4.27	64
700	300	280	100	10	20	20	3881.67	-5741.67	-1860	3.37	40	3881.67	3493.33	7375	3.37	53
900	300	280	100	10	20	20	3881.67	-12306.67	-8425	3.37	26	3881.67	-5741.67	-1860	3.37	40
900	185	400	100	10	20	20	3881.67	-8992.17	-5110.5	3.37	43	2081.67	3518.33	5600	4.27	64
700	300	400	100	10	20	20	3881.67	-5741.67	-1860	3.37	40	3881.67	3493.33	7375	3.37	53
900	300	400	100	10	20	20	3881.67	-12306.67	-8425	3.37	26	3881.67	-5741.67	-1860	3.37	40
900	185	600	100	10	20	20	3881.67	-8992.17	-5110.5	3.37	43	2081.67	3518.33	5600	4.27	64
700	300	600	100	10	20	20	3881.67	-5741.67	-1860	3.37	40	3881.67	3493.33	7375	3.37	53
900	300	600	100	10	20	20	3881.67	-12306.67	-8425	3.37	26	3881.67	-5741.67	-1860	3.37	40
800	185	280	100	15	20	20	8793.33	-4044.58	4748.75	3.43	54	8726.67	8895.83	17622.5	3.47	75
900	185	280	100	15	20	20	8793.33	-8858.83	-65.5	3.43	43	7126.67	3518.33	10645	4.27	64
700	300	280	100	15	20	20	8793.33	-5608.33	3185	3.43	40	5726.67	6693.33	12420	4.97	53
900	300	280	100	15	20	20	8793.33	-12173.33	-3380	3.43	26	8793.33	-5608.33	3185	3.43	40
800	185	400	100	15	20	20	8793.33	-4044.58	4748.75	3.43	54	8726.67	8895.83	17622.5	3.47	75
900	185	400	100	15	20	20	8793.33	-8858.83	-65.5	3.43	43	7126.67	3518.33	10645	4.27	64
700	300	400	100	15	20	20	8793.33	-5608.33	3185	3.43	40	5726.67	6693.33	12420	4.97	53
900	300	400	100	15	20	20	8793.33	-12173.33	-3380	3.43	26	8793.33	-5608.33	3185	3.43	40
900	185	600	100	15	20	20	8793.33	-8858.83	-65.5	3.43	43	7126.67	3518.33	10645	4.27	64
700	300	600	100	15	20	20	8793.33	-5608.33	3185	3.43	40	5726.67	6693.33	12420	4.97	53
900	300	600	100	15	20	20	8793.33	-12173.33	-3380	3.43	26	8793.33	-5608.33	3185	3.43	40

Table A.40: Scenarios where optimal introduction timing T^* increases as p_n increases from 1200(medium) to 1400(high) (cont'd)

Parameters							$p_2 = 1200$					$p_2 = 1400$				
c_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*,T^*)$	$\Pi_n(Q_2^*,T^*)$	$\Pi(Q_2^*,T^*)$	T^*	Q^*	$\Pi_o(Q_2^*,T^*)$	$\Pi_n(Q_2^*,T^*)$	$\Pi(Q_2^*,T^*)$	T^*	Q^*
900	185	280	100	20	20	20	12663.33	-7858.83	4804.5	3.93	43	12196.67	3318.33	15515	4.17	64
700	300	280	100	20	20	20	12663.33	-4608.33	8055	3.93	40	10596.67	6693.33	17290	4.97	53
900	300	280	100	20	20	20	12663.33	-11173.33	1490	3.93	26	12663.33	-4608.33	8055	3.93	40
900	185	400	100	20	20	20	12663.33	-7858.83	4804.5	3.93	43	12196.67	3318.33	15515	4.17	64
700	300	400	100	20	20	20	12663.33	-4608.33	8055	3.93	40	10596.67	6693.33	17290	4.97	53
900	300	400	100	20	20	20	12663.33	-11173.33	1490	3.93	26	12663.33	-4608.33	8055	3.93	40
900	185	600	100	20	20	20	12663.33	-7858.83	4804.5	3.93	43	12196.67	3318.33	15515	4.17	64
700	300	600	100	20	20	20	12663.33	-4608.33	8055	3.93	40	10596.67	6693.33	17290	4.97	53
900	300	600	100	20	20	20	12663.33	-11173.33	1490	3.93	26	12663.33	-4608.33	8055	3.93	40
700	90	280	100	10	25	20	8986.25	16858.83	25845.08	0.67	133	8986.25	47868.51	56854.76	0.67	177
800	90	280	100	10	25	20	8986.25	4686.33	13672.58	0.67	111	8986.25	31253.33	40239.58	0.67	155
900	90	280	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88	8986.25	16858.83	25845.08	0.67	133
700	185	280	100	10	25	20	8986.25	-3681.67	5304.58	0.67	64	8986.25	11354.08	20340.33	0.67	86
800	185	280	100	10	25	20	8986.25	-9577.92	-591.67	0.67	54	8986.25	3295.83	12282.08	0.67	75
900	185	280	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43	8986.25	-3681.67	5304.58	0.67	64
700	300	280	100	10	25	20	8986.25	-11141.67	-2155.42	0.67	40	8986.25	-1906.67	7079.58	0.67	53
800	300	280	100	10	25	20	8986.25	-14756.67	-5770.42	0.67	33	8986.25	-6856.67	2129.58	0.67	46
900	300	280	100	10	25	20	8986.25	-17706.67	-8720.42	0.67	26	8986.25	-11141.67	-2155.42	0.67	40
700	90	400	100	10	25	20	8986.25	16858.83	25845.08	0.67	133	8986.25	47868.64	56854.89	0.67	177
800	90	400	100	10	25	20	8986.25	4686.33	13672.58	0.67	111	8986.25	31253.33	40239.58	0.67	155
900	90	400	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88	8986.25	16858.83	25845.08	0.67	133
700	185	400	100	10	25	20	8986.25	-3681.67	5304.58	0.67	64	8986.25	11354.08	20340.33	0.67	86
800	185	400	100	10	25	20	8986.25	-9577.92	-591.67	0.67	54	8986.25	3295.83	12282.08	0.67	75
900	185	400	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43	8986.25	-3681.67	5304.58	0.67	64
700	300	400	100	10	25	20	8986.25	-11141.67	-2155.42	0.67	40	8986.25	-1906.67	7079.58	0.67	53
800	300	400	100	10	25	20	8986.25	-14756.67	-5770.42	0.67	33	8986.25	-6856.67	2129.58	0.67	46
900	300	400	100	10	25	20	8986.25	-17706.67	-8720.42	0.67	26	8986.25	-11141.67	-2155.42	0.67	40
700	90	600	100	10	25	20	8986.25	16858.83	25845.08	0.67	133	8986.25	47868.86	56855.11	0.67	177
800	90	600	100	10	25	20	8986.25	4686.33	13672.58	0.67	111	8986.25	31253.33	40239.58	0.67	155

Table A.41: Scenarios where optimal introduction timing T^* increases as p_n increases from 1200(medium) to 1400(high) (cont'd)

Parameters							$p_2 = 1200$					$p_2 = 1400$				
c_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
900	90	600	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88	8986.25	16858.83	25845.08	0.67	133
700	185	600	100	10	25	20	8986.25	-3681.67	5304.58	0.67	64	8986.25	11354.08	20340.33	0.67	86
800	185	600	100	10	25	20	8986.25	-9577.92	-591.67	0.67	54	8986.25	3295.83	12282.08	0.67	75
900	185	600	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43	8986.25	-3681.67	5304.58	0.67	64
700	300	600	100	10	25	20	8986.25	-11141.67	-2155.42	0.67	40	8986.25	-1906.67	7079.58	0.67	53
800	300	600	100	10	25	20	8986.25	-14756.67	-5770.42	0.67	33	8986.25	-6856.67	2129.58	0.67	46
900	300	600	100	10	25	20	8986.25	-17706.67	-8720.42	0.67	26	8986.25	-11141.67	-2155.42	0.67	40
700	90	280	100	15	25	20	13456.33	17392.17	30848.5	0.93	133	13456.33	48398.39	61854.72	0.93	177
800	90	280	100	15	25	20	13456.33	5219.67	18676	0.93	111	13456.33	31786.66	45243	0.93	155
900	90	280	100	15	25	20	13456.33	-4730.33	8726	0.93	88	13456.33	17392.17	30848.5	0.93	133
700	185	280	100	15	25	20	13456.33	-3148.33	10308	0.93	64	13456.33	11887.42	25343.75	0.93	86
800	185	280	100	15	25	20	13456.33	-9044.58	4411.75	0.93	54	13456.33	3829.17	17285.5	0.93	75
900	185	280	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43	13456.33	-3148.33	10308	0.93	64
700	300	280	100	15	25	20	13456.33	-10608.33	2848	0.93	40	13456.33	-1373.33	12083	0.93	53
800	300	280	100	15	25	20	13456.33	-14223.33	-767	0.93	33	13456.33	-6323.33	7133	0.93	46
900	300	280	100	15	25	20	13456.33	-17173.33	-3717	0.93	26	13456.33	-10608.33	2848	0.93	40
700	90	400	100	15	25	20	13456.33	17392.17	30848.5	0.93	133	13456.33	48398.87	61855.2	0.93	177
800	90	400	100	15	25	20	13456.33	5219.67	18676	0.93	111	13456.33	31786.66	45243	0.93	155
900	90	400	100	15	25	20	13456.33	-4730.33	8726	0.93	88	13456.33	17392.17	30848.5	0.93	133
700	185	400	100	15	25	20	13456.33	-3148.33	10308	0.93	64	13456.33	11887.42	25343.75	0.93	86
800	185	400	100	15	25	20	13456.33	-9044.58	4411.75	0.93	54	13456.33	3829.17	17285.5	0.93	75
900	185	400	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43	13456.33	-3148.33	10308	0.93	64
700	300	400	100	15	25	20	13456.33	-10608.33	2848	0.93	40	13456.33	-1373.33	12083	0.93	53
800	300	400	100	15	25	20	13456.33	-14223.33	-767	0.93	33	13456.33	-6323.33	7133	0.93	46
900	300	400	100	15	25	20	13456.33	-17173.33	-3717	0.93	26	13456.33	-10608.33	2848	0.93	40
700	90	600	100	15	25	20	13456.33	17392.17	30848.5	0.93	133	13456.33	48399.66	61856	0.93	177
800	90	600	100	15	25	20	13456.33	5219.67	18676	0.93	111	13456.33	31786.66	45243	0.93	155
900	90	600	100	15	25	20	13456.33	-4730.33	8726	0.93	88	13456.33	17392.17	30848.5	0.93	133
700	185	600	100	15	25	20	13456.33	-3148.33	10308	0.93	64	13456.33	11887.42	25343.75	0.93	86

Table A.42: Scenarios where optimal introduction timing T^* increases as p_n increases from 1200(medium) to 1400(high) (cont'd)

Parameters							$p_2 = 1200$					$p_2 = 1400$				
c_2	h_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
800	185	600	100	15	25	20	13456.33	-9044.58	4411.75	0.93	54	13456.33	3829.17	17285.5	0.93	75
900	185	600	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43	13456.33	-3148.33	10308	0.93	64
700	300	600	100	15	25	20	13456.33	-10608.33	2848	0.93	40	13456.33	-1373.33	12083	0.93	53
800	300	600	100	15	25	20	13456.33	-14223.33	-767	0.93	33	13456.33	-6323.33	7133	0.93	46
900	300	600	100	15	25	20	13456.33	-17173.33	-3717	0.93	26	13456.33	-10608.33	2848	0.93	40
700	90	280	100	20	25	20	17858.39	17858.83	35717.23	1.17	133	17858.39	48856.16	66714.55	1.17	177
800	90	280	100	20	25	20	17858.39	5686.33	23544.73	1.17	111	17858.39	32253.32	50111.71	1.17	155
900	90	280	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88	17858.39	17858.83	35717.23	1.17	133
700	185	280	100	20	25	20	17858.39	-2681.67	15176.73	1.17	64	17858.39	12354.08	30212.48	1.17	86
800	185	280	100	20	25	20	17858.39	-8577.92	9280.48	1.17	54	17858.39	4295.83	22154.23	1.17	75
900	185	280	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43	17858.39	-2681.67	15176.73	1.17	64
700	300	280	100	20	25	20	17858.39	-10141.67	7716.73	1.17	40	17858.39	-906.67	16951.73	1.17	53
800	300	280	100	20	25	20	17858.39	-13756.67	4101.73	1.17	33	17858.39	-5856.67	12001.73	1.17	46
900	300	280	100	20	25	20	17858.39	-16706.67	1151.73	1.17	26	17858.39	-10141.67	7716.73	1.17	40
700	90	400	100	20	25	20	17858.39	17858.83	35717.23	1.17	133	17858.39	48857.53	66715.92	1.17	177
800	90	400	100	20	25	20	17858.39	5686.33	23544.73	1.17	111	17858.39	32253.32	50111.71	1.17	155
900	90	400	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88	17858.39	17858.83	35717.23	1.17	133
700	185	400	100	20	25	20	17858.39	-2681.67	15176.73	1.17	64	17858.39	12354.08	30212.48	1.17	86
800	185	400	100	20	25	20	17858.39	-8577.92	9280.48	1.17	54	17858.39	4295.83	22154.23	1.17	75
900	185	400	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43	17858.39	-2681.67	15176.73	1.17	64
700	300	400	100	20	25	20	17858.39	-10141.67	7716.73	1.17	40	17858.39	-906.67	16951.73	1.17	53
800	300	400	100	20	25	20	17858.39	-13756.67	4101.73	1.17	33	17858.39	-5856.67	12001.73	1.17	46
900	300	400	100	20	25	20	17858.39	-16706.67	1151.73	1.17	26	17858.39	-10141.67	7716.73	1.17	40
700	90	600	100	20	25	20	17858.39	17858.83	35717.23	1.17	133	17858.39	48859.81	66718.2	1.17	177
800	90	600	100	20	25	20	17858.39	5686.33	23544.73	1.17	111	17858.39	32253.32	50111.71	1.17	155
900	90	600	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88	17858.39	17858.83	35717.23	1.17	133
700	185	600	100	20	25	20	17858.39	-2681.67	15176.73	1.17	64	17858.39	12354.08	30212.48	1.17	86
800	185	600	100	20	25	20	17858.39	-8577.92	9280.48	1.17	54	17858.39	4295.83	22154.23	1.17	75
900	185	600	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43	17858.39	-2681.67	15176.73	1.17	64
700	300	600	100	20	25	20	17858.39	-10141.67	7716.73	1.17	40	17858.39	-906.67	16951.73	1.17	53
800	300	600	100	20	25	20	17858.39	-13756.67	4101.73	1.17	33	17858.39	-5856.67	12001.73	1.17	46
900	300	600	100	20	25	20	17858.39	-16706.67	1151.73	1.17	26	17858.39	-10141.67	7716.73	1.17	40

Table A.43: Scenarios where optimal introduction timing T^* does not change as h_n increases from 90(low) to 185(medium)

Parameters							$h_2 = 90$					$h_2 = 185$				
p_2	c_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1000	700	280	100	10	20	15	8909.38	-3791	5118.38	0.83	66	8909.38	-10637	-1727.62	0.83	32
1200	700	280	100	10	20	15	8909.38	12775	21684.38	0.83	99	8909.38	-2629	6280.38	0.83	48
1000	800	280	100	10	20	15	8909.38	-9575	-665.62	0.83	50	8909.38	-13425	-4515.62	0.83	24
1200	800	280	100	10	20	15	8909.38	3659	12568.38	0.83	83	8909.38	-7038.33	1871.05	0.83	40
1400	800	280	100	10	20	15	8909.38	23558.96	32468.34	0.83	116	8909.38	2591	11500.38	0.83	56
1000	900	280	100	10	20	15	8909.38	-13691	-4781.62	0.83	33	8909.38	-15402.33	-6492.95	0.83	16
1200	900	280	100	10	20	15	8909.38	-3791	5118.38	0.83	66	8909.38	-10637	-1727.62	0.83	32
1400	900	280	100	10	20	15	8909.38	12775	21684.38	0.83	99	8909.38	-2629	6280.38	0.83	48
1000	700	400	100	10	20	15	8909.38	-3791	5118.38	0.83	66	8909.38	-10637	-1727.62	0.83	32
1200	700	400	100	10	20	15	8909.38	12775	21684.38	0.83	99	8909.38	-2629	6280.38	0.83	48
1000	800	400	100	10	20	15	8909.38	-9575	-665.62	0.83	50	8909.38	-13425	-4515.62	0.83	24
1200	800	400	100	10	20	15	8909.38	3659	12568.38	0.83	83	8909.38	-7038.33	1871.05	0.83	40
1400	800	400	100	10	20	15	8909.38	23558.96	32468.35	0.83	116	8909.38	2591	11500.38	0.83	56
1000	900	400	100	10	20	15	8909.38	-13691	-4781.62	0.83	33	8909.38	-15402.33	-6492.95	0.83	16
1200	900	400	100	10	20	15	8909.38	-3791	5118.38	0.83	66	8909.38	-10637	-1727.62	0.83	32
1400	900	400	100	10	20	15	8909.38	12775	21684.38	0.83	99	8909.38	-2629	6280.38	0.83	48
1000	700	600	100	10	20	15	8909.38	-3791	5118.38	0.83	66	8909.38	-10637	-1727.62	0.83	32
1200	700	600	100	10	20	15	8909.38	12775	21684.38	0.83	99	8909.38	-2629	6280.38	0.83	48
1000	800	600	100	10	20	15	8909.38	-9575	-665.62	0.83	50	8909.38	-13425	-4515.62	0.83	24
1200	800	600	100	10	20	15	8909.38	3659	12568.38	0.83	83	8909.38	-7038.33	1871.05	0.83	40
1400	800	600	100	10	20	15	8909.38	23558.97	32468.35	0.83	116	8909.38	2591	11500.38	0.83	56
1000	900	600	100	10	20	15	8909.38	-13691	-4781.62	0.83	33	8909.38	-15402.33	-6492.95	0.83	16
1200	900	600	100	10	20	15	8909.38	-3791	5118.38	0.83	66	8909.38	-10637	-1727.62	0.83	32
1400	900	600	100	10	20	15	8909.38	12775	21684.38	0.83	99	8909.38	-2629	6280.38	0.83	48
1000	700	280	100	15	20	15	13340.91	-3341	9999.91	1.13	66	13340.91	-10187	3153.91	1.13	32
1200	700	280	100	15	20	15	13340.91	13225	26565.91	1.13	99	13340.91	-2179	11161.91	1.13	48
1000	800	280	100	15	20	15	13340.91	-9125	4215.91	1.13	50	13340.91	-12975	365.91	1.13	24
1200	800	280	100	15	20	15	13340.91	4109	17449.91	1.13	83	13340.91	-6588.33	6752.58	1.13	40
1400	800	280	100	15	20	15	13340.91	24008.83	37349.74	1.13	116	13340.91	3041	16381.91	1.13	56

Table A.44: Scenarios where optimal introduction timing T^* does not change as h_n increases from 90(low) to 185(medium) (cont'd)

Parameters							$h_2 = 90$					$h_2 = 185$				
p_2	c_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1000	900	280	100	15	20	15	13340.91	-13241	99.91	1.13	33	13340.91	-14952.33	-1611.42	1.13	16
1200	900	280	100	15	20	15	13340.91	-3341	9999.91	1.13	66	13340.91	-10187	3153.91	1.13	32
1400	900	280	100	15	20	15	13340.91	13225	26565.91	1.13	99	13340.91	-2179	11161.91	1.13	48
1000	700	400	100	15	20	15	13340.91	-3341	9999.91	1.13	66	13340.91	-10187	3153.91	1.13	32
1200	700	400	100	15	20	15	13340.91	13225	26565.91	1.13	99	13340.91	-2179	11161.91	1.13	48
1000	800	400	100	15	20	15	13340.91	-9125	4215.91	1.13	50	13340.91	-12975	365.91	1.13	24
1200	800	400	100	15	20	15	13340.91	4109	17449.91	1.13	83	13340.91	-6588.33	6752.58	1.13	40
1400	800	400	100	15	20	15	13340.91	24008.85	37349.76	1.13	116	13340.91	3041	16381.91	1.13	56
1000	900	400	100	15	20	15	13340.91	-13241	99.91	1.13	33	13340.91	-14952.33	-1611.42	1.13	16
1200	900	400	100	15	20	15	13340.91	-3341	9999.91	1.13	66	13340.91	-10187	3153.91	1.13	32
1400	900	400	100	15	20	15	13340.91	13225	26565.91	1.13	99	13340.91	-2179	11161.91	1.13	48
1000	700	600	100	15	20	15	13340.91	-3341	9999.91	1.13	66	13340.91	-10187	3153.91	1.13	32
1200	700	600	100	15	20	15	13340.91	13225	26565.91	1.13	99	13340.91	-2179	11161.91	1.13	48
1400	700	600	100	15	20	15	13340.91	36436.23	49777.14	1.13	132	13340.91	9071.67	22412.58	1.13	64
1000	800	600	100	15	20	15	13340.91	-9125	4215.91	1.13	50	13340.91	-12975	365.91	1.13	24
1200	800	600	100	15	20	15	13340.91	4109	17449.91	1.13	83	13340.91	-6588.33	6752.58	1.13	40
1400	800	600	100	15	20	15	13340.91	24008.87	37349.78	1.13	116	13340.91	3041	16381.91	1.13	56
1000	900	600	100	15	20	15	13340.91	-13241	99.91	1.13	33	13340.91	-14952.33	-1611.42	1.13	16
1200	900	600	100	15	20	15	13340.91	-3341	9999.91	1.13	66	13340.91	-10187	3153.91	1.13	32
1400	900	600	100	15	20	15	13340.91	13225	26565.91	1.13	99	13340.91	-2179	11161.91	1.13	48
1000	700	280	100	20	20	15	17603.07	-2891	14712.07	1.43	66	17603.07	-9737	7866.07	1.43	32
1200	700	280	100	20	20	15	17603.07	13675	31278.07	1.43	99	17603.07	-1729	15874.07	1.43	48
1000	800	280	100	20	20	15	17603.07	-8675	8928.07	1.43	50	17603.07	-12525	5078.07	1.43	24
1200	800	280	100	20	20	15	17603.07	4559	22162.07	1.43	83	17603.07	-6138.33	11464.74	1.43	40
1400	800	280	100	20	20	15	17603.07	24458.31	42061.38	1.43	116	17603.07	3491	21094.07	1.43	56
1000	900	280	100	20	20	15	17603.07	-12791	4812.07	1.43	33	17603.07	-14502.33	3100.74	1.43	16
1200	900	280	100	20	20	15	17603.07	-2891	14712.07	1.43	66	17603.07	-9737	7866.07	1.43	32
1400	900	280	100	20	20	15	17603.07	13675	31278.07	1.43	99	17603.07	-1729	15874.07	1.43	48
1000	700	400	100	20	20	15	17603.07	-2891	14712.07	1.43	66	17603.07	-9737	7866.07	1.43	32

Table A.45: Scenarios where optimal introduction timing T^* does not change as h_n increases from 90(low) to 185(medium) (cont'd)

Parameters							$h_2 = 90$					$h_2 = 185$				
p_2	c_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1200	700	400	100	20	20	15	17603.07	13675	31278.07	1.43	99	17603.07	-1729	15874.07	1.43	48
1000	800	400	100	20	20	15	17603.07	-8675	8928.07	1.43	50	17603.07	-12525	5078.07	1.43	24
1200	800	400	100	20	20	15	17603.07	4559	22162.07	1.43	83	17603.07	-6138.33	11464.74	1.43	40
1400	800	400	100	20	20	15	17603.07	24458.38	42061.45	1.43	116	17603.07	3491	21094.07	1.43	56
1000	900	400	100	20	20	15	17603.07	-12791	4812.07	1.43	33	17603.07	-14502.33	3100.74	1.43	16
1200	900	400	100	20	20	15	17603.07	-2891	14712.07	1.43	66	17603.07	-9737	7866.07	1.43	32
1400	900	400	100	20	20	15	17603.07	13675	31278.07	1.43	99	17603.07	-1729	15874.07	1.43	48
1000	700	600	100	20	20	15	17603.07	-2891	14712.07	1.43	66	17603.07	-9737	7866.07	1.43	32
1200	700	600	100	20	20	15	17603.07	13675	31278.07	1.43	99	17603.07	-1729	15874.07	1.43	48
1000	800	600	100	20	20	15	17603.07	-8675	8928.07	1.43	50	17603.07	-12525	5078.07	1.43	24
1200	800	600	100	20	20	15	17603.07	4559	22162.07	1.43	83	17603.07	-6138.33	11464.74	1.43	40
1400	800	600	100	20	20	15	17603.07	24458.49	42061.56	1.43	116	17603.07	3491	21094.07	1.43	56
1000	900	600	100	20	20	15	17603.07	-12791	4812.07	1.43	33	17603.07	-14502.33	3100.74	1.43	16
1200	900	600	100	20	20	15	17603.07	-2891	14712.07	1.43	66	17603.07	-9737	7866.07	1.43	32
1400	900	600	100	20	20	15	17603.07	13675	31278.07	1.43	99	17603.07	-1729	15874.07	1.43	48
1000	700	280	100	10	25	15	9097.61	-4141	4956.61	0.6	66	9097.61	-10987	-1889.39	0.6	32
1200	700	280	100	10	25	15	9097.61	12425	21522.61	0.6	99	9097.61	-2979	6118.61	0.6	48
1400	700	280	100	10	25	15	9097.61	35653.77	44751.38	0.6	133	9097.61	8271.67	17369.28	0.6	64
1000	800	280	100	10	25	15	9097.61	-9925	-827.39	0.6	50	9097.61	-13775	-4677.39	0.6	24
1200	800	280	100	10	25	15	9097.61	3309	12406.61	0.6	83	9097.61	-7388.33	1709.28	0.6	40
1400	800	280	100	10	25	15	9097.61	23208.99	32306.6	0.6	116	9097.61	2241	11338.61	0.6	56
1000	900	280	100	10	25	15	9097.61	-14041	-4943.39	0.6	33	9097.61	-15752.33	-6654.72	0.6	16
1200	900	280	100	10	25	15	9097.61	-4141	4956.61	0.6	66	9097.61	-10987	-1889.39	0.6	32
1400	900	280	100	10	25	15	9097.61	12425	21522.61	0.6	99	9097.61	-2979	6118.61	0.6	48
1000	700	400	100	10	25	15	9097.61	-4141	4956.61	0.6	66	9097.61	-10987	-1889.39	0.6	32
1200	700	400	100	10	25	15	9097.61	12425	21522.61	0.6	99	9097.61	-2979	6118.61	0.6	48
1400	700	400	100	10	25	15	9097.61	35654.29	44751.91	0.6	133	9097.61	8271.67	17369.28	0.6	64
1000	800	400	100	10	25	15	9097.61	-9925	-827.39	0.6	50	9097.61	-13775	-4677.39	0.6	24
1200	800	400	100	10	25	15	9097.61	3309	12406.61	0.6	83	9097.61	-7388.33	1709.28	0.6	40

Table A.46: Scenarios where optimal introduction timing T^* does not change as h_n increases from 90(low) to 185(medium) (cont'd)

Parameters							$h_2 = 90$					$h_2 = 185$				
p_2	c_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1400	800	400	100	10	25	15	9097.61	23208.99	32306.6	0.6	116	9097.61	2241	11338.61	0.6	56
1000	900	400	100	10	25	15	9097.61	-14041	-4943.39	0.6	33	9097.61	-15752.33	-6654.72	0.6	16
1200	900	400	100	10	25	15	9097.61	-4141	4956.61	0.6	66	9097.61	-10987	-1889.39	0.6	32
1400	900	400	100	10	25	15	9097.61	12425	21522.61	0.6	99	9097.61	-2979	6118.61	0.6	48
1000	700	600	100	10	25	15	9097.61	-4141	4956.61	0.6	66	9097.61	-10987	-1889.39	0.6	32
1200	700	600	100	10	25	15	9097.61	12425	21522.61	0.6	99	9097.61	-2979	6118.61	0.6	48
1400	700	600	100	10	25	15	9097.61	35655.17	44752.78	0.6	133	9097.61	8271.67	17369.28	0.6	64
1000	800	600	100	10	25	15	9097.61	-9925	-827.39	0.6	50	9097.61	-13775	-4677.39	0.6	24
1200	800	600	100	10	25	15	9097.61	3309	12406.61	0.6	83	9097.61	-7388.33	1709.28	0.6	40
1400	800	600	100	10	25	15	9097.61	23208.99	32306.61	0.6	116	9097.61	2241	11338.61	0.6	56
1000	900	600	100	10	25	15	9097.61	-14041	-4943.39	0.6	33	9097.61	-15752.33	-6654.72	0.6	16
1200	900	600	100	10	25	15	9097.61	-4141	4956.61	0.6	66	9097.61	-10987	-1889.39	0.6	32
1400	900	600	100	10	25	15	9097.61	12425	21522.61	0.6	99	9097.61	-2979	6118.61	0.6	48
1000	700	280	100	15	25	15	13577.91	-3741	9836.91	0.87	66	13577.91	-10587	2990.91	0.87	32
1200	700	280	100	15	25	15	13577.91	12825	26402.91	0.87	99	13577.91	-2579	10998.91	0.87	48
1400	700	280	100	15	25	15	13577.91	36046.19	49624.1	0.87	132	13577.91	8671.67	22249.57	0.87	64
1000	800	280	100	15	25	15	13577.91	-9525	4052.91	0.87	50	13577.91	-13375	202.91	0.87	24
1200	800	280	100	15	25	15	13577.91	3709	17286.91	0.87	83	13577.91	-6988.33	6589.57	0.87	40
1400	800	280	100	15	25	15	13577.91	23608.95	37186.86	0.87	116	13577.91	2641	16218.91	0.87	56
1000	900	280	100	15	25	15	13577.91	-13641	-63.09	0.87	33	13577.91	-15352.33	-1774.43	0.87	16
1200	900	280	100	15	25	15	13577.91	-3741	9836.91	0.87	66	13577.91	-10587	2990.91	0.87	32
1400	900	280	100	15	25	15	13577.91	12825	26402.91	0.87	99	13577.91	-2579	10998.91	0.87	48
1000	700	400	100	15	25	15	13577.91	-3741	9836.91	0.87	66	13577.91	-10587	2990.91	0.87	32
1200	700	400	100	15	25	15	13577.91	12825	26402.91	0.87	99	13577.91	-2579	10998.91	0.87	48
1400	700	400	100	15	25	15	13577.91	36047.27	49625.18	0.87	132	13577.91	8671.67	22249.57	0.87	64
1000	800	400	100	15	25	15	13577.91	-9525	4052.91	0.87	50	13577.91	-13375	202.91	0.87	24
1200	800	400	100	15	25	15	13577.91	3709	17286.91	0.87	83	13577.91	-6988.33	6589.57	0.87	40
1400	800	400	100	15	25	15	13577.91	23608.96	37186.87	0.87	116	13577.91	2641	16218.91	0.87	56
1000	900	400	100	15	25	15	13577.91	-13641	-63.09	0.87	33	13577.91	-15352.33	-1774.43	0.87	16

Table A.47: Scenarios where optimal introduction timing T^* does not change as h_n increases from 90(low) to 185(medium) (cont'd)

Parameters							$h_2 = 90$					$h_2 = 185$				
p_2	c_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1200	900	400	100	15	25	15	13577.91	-3741	9836.91	0.87	66	13577.91	-10587	2990.91	0.87	32
1400	900	400	100	15	25	15	13577.91	12825	26402.91	0.87	99	13577.91	-2579	10998.91	0.87	48
1000	700	600	100	15	25	15	13577.91	-3741	9836.91	0.87	66	13577.91	-10587	2990.91	0.87	32
1200	700	600	100	15	25	15	13577.91	12825	26402.91	0.87	99	13577.91	-2579	10998.91	0.87	48
1400	700	600	100	15	25	15	13577.91	36049.08	49626.99	0.87	132	13577.91	8671.67	22249.57	0.87	64
1000	800	600	100	15	25	15	13577.91	-9525	4052.91	0.87	50	13577.91	-13375	202.91	0.87	24
1200	800	600	100	15	25	15	13577.91	3709	17286.91	0.87	83	13577.91	-6988.33	6589.57	0.87	40
1400	800	600	100	15	25	15	13577.91	23608.97	37186.87	0.87	116	13577.91	2641	16218.91	0.87	56
1000	900	600	100	15	25	15	13577.91	-13641	-63.09	0.87	33	13577.91	-15352.33	-1774.43	0.87	16
1200	900	600	100	15	25	15	13577.91	-3741	9836.91	0.87	66	13577.91	-10587	2990.91	0.87	32
1400	900	600	100	15	25	15	13577.91	12825	26402.91	0.87	99	13577.91	-2579	10998.91	0.87	48
1000	700	280	100	20	25	15	17976.1	-3391	14585.1	1.1	66	17976.1	-10237	7739.1	1.1	32
1200	700	280	100	20	25	15	17976.1	13175	31151.1	1.1	99	17976.1	-2229	15747.1	1.1	48
1400	700	280	100	20	25	15	17976.1	36381.78	54357.87	1.1	132	17976.1	9021.67	26997.77	1.1	64
1000	800	280	100	20	25	15	17976.1	-9175	8801.1	1.1	50	17976.1	-13025	4951.1	1.1	24
1200	800	280	100	20	25	15	17976.1	4059	22035.1	1.1	83	17976.1	-6638.33	11337.77	1.1	40
1400	800	280	100	20	25	15	17976.1	23958.85	41934.95	1.1	116	17976.1	2991	20967.1	1.1	56
1000	900	280	100	20	25	15	17976.1	-13291	4685.1	1.1	33	17976.1	-15002.33	2973.77	1.1	16
1200	900	280	100	20	25	15	17976.1	-3391	14585.1	1.1	66	17976.1	-10237	7739.1	1.1	32
1400	900	280	100	20	25	15	17976.1	13175	31151.1	1.1	99	17976.1	-2229	15747.1	1.1	48
1000	700	400	100	20	25	15	17976.1	-3391	14585.1	1.1	66	17976.1	-10237	7739.1	1.1	32
1200	700	400	100	20	25	15	17976.1	13175	31151.1	1.1	99	17976.1	-2229	15747.1	1.1	48
1400	700	400	100	20	25	15	17976.1	36384.31	54360.41	1.1	132	17976.1	9021.67	26997.77	1.1	64
1000	800	400	100	20	25	15	17976.1	-9175	8801.1	1.1	50	17976.1	-13025	4951.1	1.1	24
1200	800	400	100	20	25	15	17976.1	4059	22035.1	1.1	83	17976.1	-6638.33	11337.77	1.1	40
1400	800	400	100	20	25	15	17976.1	23958.87	41934.97	1.1	116	17976.1	2991	20967.1	1.1	56
1000	900	400	100	20	25	15	17976.1	-13291	4685.1	1.1	33	17976.1	-15002.33	2973.77	1.1	16
1200	900	400	100	20	25	15	17976.1	-3391	14585.1	1.1	66	17976.1	-10237	7739.1	1.1	32
1400	900	400	100	20	25	15	17976.1	13175	31151.1	1.1	99	17976.1	-2229	15747.1	1.1	48

Table A.48: Scenarios where optimal introduction timing T^* does not change as h_n increases from 90(low) to 185(medium) (cont'd)

Parameters							$h_2 = 90$					$h_2 = 185$				
p_2	c_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1000	700	600	100	20	25	15	17976.1	-3391	14585.1	1.1	66	17976.1	-10237	7739.1	1.1	32
1200	700	600	100	20	25	15	17976.1	13175	31151.1	1.1	99	17976.1	-2229	15747.1	1.1	48
1400	700	600	100	20	25	15	17976.1	36388.52	54364.62	1.1	132	17976.1	9021.67	26997.77	1.1	64
1000	800	600	100	20	25	15	17976.1	-9175	8801.1	1.1	50	17976.1	-13025	4951.1	1.1	24
1200	800	600	100	20	25	15	17976.1	4059	22035.1	1.1	83	17976.1	-6638.33	11337.77	1.1	40
1400	800	600	100	20	25	15	17976.1	23958.89	41934.99	1.1	116	17976.1	2991	20967.1	1.1	56
1000	900	600	100	20	25	15	17976.1	-13291	4685.1	1.1	33	17976.1	-15002.33	2973.77	1.1	16
1200	900	600	100	20	25	15	17976.1	-3391	14585.1	1.1	66	17976.1	-10237	7739.1	1.1	32
1400	900	600	100	20	25	15	17976.1	13175	31151.1	1.1	99	17976.1	-2229	15747.1	1.1	48
1000	800	280	100	10	20	20	3881.67	-7591.17	-3709.5	3.37	66	3881.67	-12725.67	-8844	3.37	32
1000	900	280	100	10	20	20	3881.67	-13096.67	-9215	3.37	44	3881.67	-15378.42	-11496.75	3.37	21
1000	800	400	100	10	20	20	3881.67	-7591.17	-3709.5	3.37	66	3881.67	-12725.67	-8844	3.37	32
1000	900	400	100	10	20	20	3881.67	-13096.67	-9215	3.37	44	3881.67	-15378.42	-11496.75	3.37	21
1000	800	600	100	10	20	20	3881.67	-7591.17	-3709.5	3.37	66	3881.67	-12725.67	-8844	3.37	32
1000	900	600	100	10	20	20	3881.67	-13096.67	-9215	3.37	44	3881.67	-15378.42	-11496.75	3.37	21
1000	800	280	100	15	20	20	7793.33	-6457.83	1335.5	3.93	66	8793.33	-12592.33	-3799	3.43	32
1000	900	280	100	15	20	20	8793.33	-12963.33	-4170	3.43	44	8793.33	-15245.08	-6451.75	3.43	21
1000	800	400	100	15	20	20	7793.33	-6457.83	1335.5	3.93	66	8793.33	-12592.33	-3799	3.43	32
1000	900	400	100	15	20	20	8793.33	-12963.33	-4170	3.43	44	8793.33	-15245.08	-6451.75	3.43	21
1000	800	600	100	15	20	20	7793.33	-6457.83	1335.5	3.93	66	8793.33	-12592.33	-3799	3.43	32
1000	900	600	100	15	20	20	8793.33	-12963.33	-4170	3.43	44	8793.33	-15245.08	-6451.75	3.43	21
1000	800	280	100	20	20	20	12530	-6324.5	6205.5	4	66	12663.33	-11592.33	1071	3.93	32
1000	900	280	100	20	20	20	12663.33	-11963.33	700	3.93	44	12663.33	-14245.08	-1581.75	3.93	21
1000	800	400	100	20	20	20	12530	-6324.5	6205.5	4	66	12663.33	-11592.33	1071	3.93	32
1000	900	400	100	20	20	20	12663.33	-11963.33	700	3.93	44	12663.33	-14245.08	-1581.75	3.93	21
1000	800	600	100	20	20	20	12530	-6324.5	6205.5	4	66	12663.33	-11592.33	1071	3.93	32
1000	900	600	100	20	20	20	12663.33	-11963.33	700	3.93	44	12663.33	-14245.08	-1581.75	3.93	21
1000	700	280	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88	8986.25	-14392.17	-5405.92	0.67	43
1200	700	280	100	10	25	20	8986.25	16858.83	25845.08	0.67	133	8986.25	-3681.67	5304.58	0.67	64

Table A.49: Scenarios where optimal introduction timing T^* does not change as h_n increases from 90(low) to 185(medium) (cont'd)

Parameters							$h_2 = 90$					$h_2 = 185$				
p_2	c_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*,T^*)$	$\Pi_n(Q_2^*,T^*)$	$\Pi(Q_2^*,T^*)$	T^*	Q^*	$\Pi_o(Q_2^*,T^*)$	$\Pi_n(Q_2^*,T^*)$	$\Pi(Q_2^*,T^*)$	T^*	Q^*
1400	700	280	100	10	25	20	8986.25	47868.51	56854.76	0.67	177	8986.25	11354.08	20340.33	0.67	86
1000	800	280	100	10	25	20	8986.25	-12991.17	-4004.92	0.67	66	8986.25	-18125.67	-9139.42	0.67	32
1200	800	280	100	10	25	20	8986.25	4686.33	13672.58	0.67	111	8986.25	-9577.92	-591.67	0.67	54
1400	800	280	100	10	25	20	8986.25	31253.33	40239.58	0.67	155	8986.25	3295.83	12282.08	0.67	75
1000	900	280	100	10	25	20	8986.25	-18496.67	-9510.42	0.67	44	8986.25	-20778.42	-11792.17	0.67	21
1200	900	280	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88	8986.25	-14392.17	-5405.92	0.67	43
1400	900	280	100	10	25	20	8986.25	16858.83	25845.08	0.67	133	8986.25	-3681.67	5304.58	0.67	64
1000	700	400	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88	8986.25	-14392.17	-5405.92	0.67	43
1200	700	400	100	10	25	20	8986.25	16858.83	25845.08	0.67	133	8986.25	-3681.67	5304.58	0.67	64
1400	700	400	100	10	25	20	8986.25	47868.64	56854.89	0.67	177	8986.25	11354.08	20340.33	0.67	86
1000	800	400	100	10	25	20	8986.25	-12991.17	-4004.92	0.67	66	8986.25	-18125.67	-9139.42	0.67	32
1200	800	400	100	10	25	20	8986.25	4686.33	13672.58	0.67	111	8986.25	-9577.92	-591.67	0.67	54
1400	800	400	100	10	25	20	8986.25	31253.33	40239.58	0.67	155	8986.25	3295.83	12282.08	0.67	75
1000	900	400	100	10	25	20	8986.25	-18496.67	-9510.42	0.67	44	8986.25	-20778.42	-11792.17	0.67	21
1200	900	400	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88	8986.25	-14392.17	-5405.92	0.67	43
1400	900	400	100	10	25	20	8986.25	16858.83	25845.08	0.67	133	8986.25	-3681.67	5304.58	0.67	64
1000	700	600	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88	8986.25	-14392.17	-5405.92	0.67	43
1200	700	600	100	10	25	20	8986.25	16858.83	25845.08	0.67	133	8986.25	-3681.67	5304.58	0.67	64
1400	700	600	100	10	25	20	8986.25	47868.86	56855.11	0.67	177	8986.25	11354.08	20340.33	0.67	86
1000	800	600	100	10	25	20	8986.25	-12991.17	-4004.92	0.67	66	8986.25	-18125.67	-9139.42	0.67	32
1200	800	600	100	10	25	20	8986.25	4686.33	13672.58	0.67	111	8986.25	-9577.92	-591.67	0.67	54
1400	800	600	100	10	25	20	8986.25	31253.33	40239.58	0.67	155	8986.25	3295.83	12282.08	0.67	75
1000	900	600	100	10	25	20	8986.25	-18496.67	-9510.42	0.67	44	8986.25	-20778.42	-11792.17	0.67	21
1200	900	600	100	10	25	20	8986.25	-5263.67	3722.58	0.67	88	8986.25	-14392.17	-5405.92	0.67	43
1400	900	600	100	10	25	20	8986.25	16858.83	25845.08	0.67	133	8986.25	-3681.67	5304.58	0.67	64
1000	700	280	100	15	25	20	13456.33	-4730.33	8726	0.93	88	13456.33	-13858.83	-402.5	0.93	43
1200	700	280	100	15	25	20	13456.33	17392.17	30848.5	0.93	133	13456.33	-3148.33	10308	0.93	64
1400	700	280	100	15	25	20	13456.33	48398.39	61854.72	0.93	177	13456.33	11887.42	25343.75	0.93	86
1000	800	280	100	15	25	20	13456.33	-12457.83	998.5	0.93	66	13456.33	-17592.33	-4136	0.93	32

Table A.50: Scenarios where optimal introduction timing T^* does not change as h_n increases from 90(low) to 185(medium) (cont'd)

Parameters							$h_2 = 90$					$h_2 = 185$				
p_2	c_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1200	800	280	100	15	25	20	13456.33	5219.67	18676	0.93	111	13456.33	-9044.58	4411.75	0.93	54
1400	800	280	100	15	25	20	13456.33	31786.66	45243	0.93	155	13456.33	3829.17	17285.5	0.93	75
1000	900	280	100	15	25	20	13456.33	-17963.33	-4507	0.93	44	13456.33	-20245.08	-6788.75	0.93	21
1200	900	280	100	15	25	20	13456.33	-4730.33	8726	0.93	88	13456.33	-13858.83	-402.5	0.93	43
1400	900	280	100	15	25	20	13456.33	17392.17	30848.5	0.93	133	13456.33	-3148.33	10308	0.93	64
1000	700	400	100	15	25	20	13456.33	-4730.33	8726	0.93	88	13456.33	-13858.83	-402.5	0.93	43
1200	700	400	100	15	25	20	13456.33	17392.17	30848.5	0.93	133	13456.33	-3148.33	10308	0.93	64
1400	700	400	100	15	25	20	13456.33	48398.87	61855.2	0.93	177	13456.33	11887.42	25343.75	0.93	86
1000	800	400	100	15	25	20	13456.33	-12457.83	998.5	0.93	66	13456.33	-17592.33	-4136	0.93	32
1200	800	400	100	15	25	20	13456.33	5219.67	18676	0.93	111	13456.33	-9044.58	4411.75	0.93	54
1400	800	400	100	15	25	20	13456.33	31786.66	45243	0.93	155	13456.33	3829.17	17285.5	0.93	75
1000	900	400	100	15	25	20	13456.33	-17963.33	-4507	0.93	44	13456.33	-20245.08	-6788.75	0.93	21
1200	900	400	100	15	25	20	13456.33	-4730.33	8726	0.93	88	13456.33	-13858.83	-402.5	0.93	43
1400	900	400	100	15	25	20	13456.33	17392.17	30848.5	0.93	133	13456.33	-3148.33	10308	0.93	64
1000	700	600	100	15	25	20	13456.33	-4730.33	8726	0.93	88	13456.33	-13858.83	-402.5	0.93	43
1200	700	600	100	15	25	20	13456.33	17392.17	30848.5	0.93	133	13456.33	-3148.33	10308	0.93	64
1400	700	600	100	15	25	20	13456.33	48399.66	61856	0.93	177	13456.33	11887.42	25343.75	0.93	86
1000	800	600	100	15	25	20	13456.33	-12457.83	998.5	0.93	66	13456.33	-17592.33	-4136	0.93	32
1200	800	600	100	15	25	20	13456.33	5219.67	18676	0.93	111	13456.33	-9044.58	4411.75	0.93	54
1400	800	600	100	15	25	20	13456.33	31786.66	45243	0.93	155	13456.33	3829.17	17285.5	0.93	75
1000	900	600	100	15	25	20	13456.33	-17963.33	-4507	0.93	44	13456.33	-20245.08	-6788.75	0.93	21
1200	900	600	100	15	25	20	13456.33	-4730.33	8726	0.93	88	13456.33	-13858.83	-402.5	0.93	43
1400	900	600	100	15	25	20	13456.33	17392.17	30848.5	0.93	133	13456.33	-3148.33	10308	0.93	64
1000	700	280	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88	17858.39	-13392.17	4466.23	1.17	43
1200	700	280	100	20	25	20	17858.39	17858.83	35717.23	1.17	133	17858.39	-2681.67	15176.73	1.17	64
1400	700	280	100	20	25	20	17858.39	48856.16	66714.55	1.17	177	17858.39	12354.08	30212.48	1.17	86
1000	800	280	100	20	25	20	17858.39	-11991.17	5867.23	1.17	66	17858.39	-17125.67	732.73	1.17	32
1200	800	280	100	20	25	20	17858.39	5686.33	23544.73	1.17	111	17858.39	-8577.92	9280.48	1.17	54
1400	800	280	100	20	25	20	17858.39	32253.32	50111.71	1.17	155	17858.39	4295.83	22154.23	1.17	75

Table A.51: Scenarios where optimal introduction timing T^* does not change as h_n increases from 90(low) to 185(medium) (cont'd)

Parameters							$h_2 = 90$					$h_2 = 185$				
p_2	c_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1000	900	280	100	20	25	20	17858.39	-17496.67	361.73	1.17	44	17858.39	-19778.42	-1920.02	1.17	21
1200	900	280	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88	17858.39	-13392.17	4466.23	1.17	43
1400	900	280	100	20	25	20	17858.39	17858.83	35717.23	1.17	133	17858.39	-2681.67	15176.73	1.17	64
1000	700	400	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88	17858.39	-13392.17	4466.23	1.17	43
1200	700	400	100	20	25	20	17858.39	17858.83	35717.23	1.17	133	17858.39	-2681.67	15176.73	1.17	64
1400	700	400	100	20	25	20	17858.39	48857.53	66715.92	1.17	177	17858.39	12354.08	30212.48	1.17	86
1000	800	400	100	20	25	20	17858.39	-11991.17	5867.23	1.17	66	17858.39	-17125.67	732.73	1.17	32
1200	800	400	100	20	25	20	17858.39	5686.33	23544.73	1.17	111	17858.39	-8577.92	9280.48	1.17	54
1400	800	400	100	20	25	20	17858.39	32253.32	50111.71	1.17	155	17858.39	4295.83	22154.23	1.17	75
1000	900	400	100	20	25	20	17858.39	-17496.67	361.73	1.17	44	17858.39	-19778.42	-1920.02	1.17	21
1200	900	400	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88	17858.39	-13392.17	4466.23	1.17	43
1400	900	400	100	20	25	20	17858.39	17858.83	35717.23	1.17	133	17858.39	-2681.67	15176.73	1.17	64
1000	700	600	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88	17858.39	-13392.17	4466.23	1.17	43
1200	700	600	100	20	25	20	17858.39	17858.83	35717.23	1.17	133	17858.39	-2681.67	15176.73	1.17	64
1400	700	600	100	20	25	20	17858.39	48859.81	66718.2	1.17	177	17858.39	12354.08	30212.48	1.17	86
1000	800	600	100	20	25	20	17858.39	-11991.17	5867.23	1.17	66	17858.39	-17125.67	732.73	1.17	32
1200	800	600	100	20	25	20	17858.39	5686.33	23544.73	1.17	111	17858.39	-8577.92	9280.48	1.17	54
1400	800	600	100	20	25	20	17858.39	32253.32	50111.71	1.17	155	17858.39	4295.83	22154.23	1.17	75
1000	900	600	100	20	25	20	17858.39	-17496.67	361.73	1.17	44	17858.39	-19778.42	-1920.02	1.17	21
1200	900	600	100	20	25	20	17858.39	-4263.67	13594.73	1.17	88	17858.39	-13392.17	4466.23	1.17	43
1400	900	600	100	20	25	20	17858.39	17858.83	35717.23	1.17	133	17858.39	-2681.67	15176.73	1.17	64

Table A.52: Scenarios where optimal introduction timing T^* does not change as h_n increases from 185(medium) to 300(high)

Parameters							$h_2 = 185$					$h_2 = 300$				
p_2	c_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1000	700	280	100	10	20	15	8909.38	-10637	-1727.62	0.83	32	8909.38	-13125	-4215.62	0.83	20
1200	700	280	100	10	20	15	8909.38	-2629	6280.38	0.83	48	8909.38	-8225	684.38	0.83	30
1000	800	280	100	10	20	15	8909.38	-13425	-4515.62	0.83	24	8909.38	-14825	-5915.62	0.83	15
1200	800	280	100	10	20	15	8909.38	-7038.33	1871.05	0.83	40	8909.38	-10925	-2015.62	0.83	25
1400	800	280	100	10	20	15	8909.38	2591	11500.38	0.83	56	8909.38	-5025	3884.38	0.83	35
1000	900	280	100	10	20	15	8909.38	-15402.33	-6492.95	0.83	16	8909.38	-16025	-7115.62	0.83	10
1200	900	280	100	10	20	15	8909.38	-10637	-1727.62	0.83	32	8909.38	-13125	-4215.62	0.83	20
1400	900	280	100	10	20	15	8909.38	-2629	6280.38	0.83	48	8909.38	-8225	684.38	0.83	30
1000	700	400	100	10	20	15	8909.38	-10637	-1727.62	0.83	32	8909.38	-13125	-4215.62	0.83	20
1200	700	400	100	10	20	15	8909.38	-2629	6280.38	0.83	48	8909.38	-8225	684.38	0.83	30
1000	800	400	100	10	20	15	8909.38	-13425	-4515.62	0.83	24	8909.38	-14825	-5915.62	0.83	15
1200	800	400	100	10	20	15	8909.38	-7038.33	1871.05	0.83	40	8909.38	-10925	-2015.62	0.83	25
1400	800	400	100	10	20	15	8909.38	2591	11500.38	0.83	56	8909.38	-5025	3884.38	0.83	35
1000	900	400	100	10	20	15	8909.38	-15402.33	-6492.95	0.83	16	8909.38	-16025	-7115.62	0.83	10
1200	900	400	100	10	20	15	8909.38	-10637	-1727.62	0.83	32	8909.38	-13125	-4215.62	0.83	20
1400	900	400	100	10	20	15	8909.38	-2629	6280.38	0.83	48	8909.38	-8225	684.38	0.83	30
1000	700	600	100	10	20	15	8909.38	-10637	-1727.62	0.83	32	8909.38	-13125	-4215.62	0.83	20
1200	700	600	100	10	20	15	8909.38	-2629	6280.38	0.83	48	8909.38	-8225	684.38	0.83	30
1000	800	600	100	10	20	15	8909.38	-13425	-4515.62	0.83	24	8909.38	-14825	-5915.62	0.83	15
1200	800	600	100	10	20	15	8909.38	-7038.33	1871.05	0.83	40	8909.38	-10925	-2015.62	0.83	25
1400	800	600	100	10	20	15	8909.38	2591	11500.38	0.83	56	8909.38	-5025	3884.38	0.83	35
1000	900	600	100	10	20	15	8909.38	-15402.33	-6492.95	0.83	16	8909.38	-16025	-7115.62	0.83	10
1200	900	600	100	10	20	15	8909.38	-10637	-1727.62	0.83	32	8909.38	-13125	-4215.62	0.83	20
1400	900	600	100	10	20	15	8909.38	-2629	6280.38	0.83	48	8909.38	-8225	684.38	0.83	30
1000	700	280	100	15	20	15	13340.91	-10187	3153.91	1.13	32	13340.91	-12675	665.91	1.13	20
1200	700	280	100	15	20	15	13340.91	-2179	11161.91	1.13	48	13340.91	-7775	5565.91	1.13	30
1000	800	280	100	15	20	15	13340.91	-12975	365.91	1.13	24	13340.91	-14375	-1034.09	1.13	15
1200	800	280	100	15	20	15	13340.91	-6588.33	6752.58	1.13	40	13340.91	-10475	2865.91	1.13	25
1400	800	280	100	15	20	15	13340.91	3041	16381.91	1.13	56	13340.91	-4575	8765.91	1.13	35
1000	900	280	100	15	20	15	13340.91	-14952.33	-1611.42	1.13	16	13340.91	-15575	-2234.09	1.13	10

Table A.53: Scenarios where optimal introduction timing T^* does not change as h_n increases from 185(medium) to 300(high) (cont'd)

Parameters							$h_2 = 185$					$h_2 = 300$				
p_2	c_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1200	900	280	100	15	20	15	13340.91	-10187	3153.91	1.13	32	13340.91	-12675	665.91	1.13	20
1400	900	280	100	15	20	15	13340.91	-2179	11161.91	1.13	48	13340.91	-7775	5565.91	1.13	30
1000	700	400	100	15	20	15	13340.91	-10187	3153.91	1.13	32	13340.91	-12675	665.91	1.13	20
1200	700	400	100	15	20	15	13340.91	-2179	11161.91	1.13	48	13340.91	-7775	5565.91	1.13	30
1000	800	400	100	15	20	15	13340.91	-12975	365.91	1.13	24	13340.91	-14375	-1034.09	1.13	15
1200	800	400	100	15	20	15	13340.91	-6588.33	6752.58	1.13	40	13340.91	-10475	2865.91	1.13	25
1400	800	400	100	15	20	15	13340.91	3041	16381.91	1.13	56	13340.91	-4575	8765.91	1.13	35
1000	900	400	100	15	20	15	13340.91	-14952.33	-1611.42	1.13	16	13340.91	-15575	-2234.09	1.13	10
1200	900	400	100	15	20	15	13340.91	-10187	3153.91	1.13	32	13340.91	-12675	665.91	1.13	20
1400	900	400	100	15	20	15	13340.91	-2179	11161.91	1.13	48	13340.91	-7775	5565.91	1.13	30
1000	700	600	100	15	20	15	13340.91	-10187	3153.91	1.13	32	13340.91	-12675	665.91	1.13	20
1200	700	600	100	15	20	15	13340.91	-2179	11161.91	1.13	48	13340.91	-7775	5565.91	1.13	30
1400	700	600	100	15	20	15	13340.91	9071.67	22412.58	1.13	64	13340.91	-875	12465.91	1.13	40
1000	800	600	100	15	20	15	13340.91	-12975	365.91	1.13	24	13340.91	-14375	-1034.09	1.13	15
1200	800	600	100	15	20	15	13340.91	-6588.33	6752.58	1.13	40	13340.91	-10475	2865.91	1.13	25
1400	800	600	100	15	20	15	13340.91	3041	16381.91	1.13	56	13340.91	-4575	8765.91	1.13	35
1000	900	600	100	15	20	15	13340.91	-14952.33	-1611.42	1.13	16	13340.91	-15575	-2234.09	1.13	10
1200	900	600	100	15	20	15	13340.91	-10187	3153.91	1.13	32	13340.91	-12675	665.91	1.13	20
1400	900	600	100	15	20	15	13340.91	-2179	11161.91	1.13	48	13340.91	-7775	5565.91	1.13	30
1000	700	280	100	20	20	15	17603.07	-9737	7866.07	1.43	32	17603.07	-12225	5378.07	1.43	20
1200	700	280	100	20	20	15	17603.07	-1729	15874.07	1.43	48	17603.07	-7325	10278.07	1.43	30
1000	800	280	100	20	20	15	17603.07	-12525	5078.07	1.43	24	17603.07	-13925	3678.07	1.43	15
1200	800	280	100	20	20	15	17603.07	-6138.33	11464.74	1.43	40	17603.07	-10025	7578.07	1.43	25
1400	800	280	100	20	20	15	17603.07	3491	21094.07	1.43	56	17603.07	-4125	13478.07	1.43	35
1000	900	280	100	20	20	15	17603.07	-14502.33	3100.74	1.43	16	17603.07	-15125	2478.07	1.43	10
1200	900	280	100	20	20	15	17603.07	-9737	7866.07	1.43	32	17603.07	-12225	5378.07	1.43	20
1400	900	280	100	20	20	15	17603.07	-1729	15874.07	1.43	48	17603.07	-7325	10278.07	1.43	30
1000	700	400	100	20	20	15	17603.07	-9737	7866.07	1.43	32	17603.07	-12225	5378.07	1.43	20
1200	700	400	100	20	20	15	17603.07	-1729	15874.07	1.43	48	17603.07	-7325	10278.07	1.43	30

Table A.54: Scenarios where optimal introduction timing T^* does not change as h_n increases from 185(medium) to 300(high) (cont'd)

Parameters							$h_2 = 185$					$h_2 = 300$				
p_2	c_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1000	800	400	100	20	20	15	17603.07	-12525	5078.07	1.43	24	17603.07	-13925	3678.07	1.43	15
1200	800	400	100	20	20	15	17603.07	-6138.33	11464.74	1.43	40	17603.07	-10025	7578.07	1.43	25
1400	800	400	100	20	20	15	17603.07	3491	21094.07	1.43	56	17603.07	-4125	13478.07	1.43	35
1000	900	400	100	20	20	15	17603.07	-14502.33	3100.74	1.43	16	17603.07	-15125	2478.07	1.43	10
1200	900	400	100	20	20	15	17603.07	-9737	7866.07	1.43	32	17603.07	-12225	5378.07	1.43	20
1400	900	400	100	20	20	15	17603.07	-1729	15874.07	1.43	48	17603.07	-7325	10278.07	1.43	30
1000	700	600	100	20	20	15	17603.07	-9737	7866.07	1.43	32	17603.07	-12225	5378.07	1.43	20
1200	700	600	100	20	20	15	17603.07	-1729	15874.07	1.43	48	17603.07	-7325	10278.07	1.43	30
1000	800	600	100	20	20	15	17603.07	-12525	5078.07	1.43	24	17603.07	-13925	3678.07	1.43	15
1200	800	600	100	20	20	15	17603.07	-6138.33	11464.74	1.43	40	17603.07	-10025	7578.07	1.43	25
1400	800	600	100	20	20	15	17603.07	3491	21094.07	1.43	56	17603.07	-4125	13478.07	1.43	35
1000	900	600	100	20	20	15	17603.07	-14502.33	3100.74	1.43	16	17603.07	-15125	2478.07	1.43	10
1200	900	600	100	20	20	15	17603.07	-9737	7866.07	1.43	32	17603.07	-12225	5378.07	1.43	20
1400	900	600	100	20	20	15	17603.07	-1729	15874.07	1.43	48	17603.07	-7325	10278.07	1.43	30
1000	700	280	100	10	25	15	9097.61	-10987	-1889.39	0.6	32	9097.61	-13475	-4377.39	0.6	20
1200	700	280	100	10	25	15	9097.61	-2979	6118.61	0.6	48	9097.61	-8575	522.61	0.6	30
1400	700	280	100	10	25	15	9097.61	8271.67	17369.28	0.6	64	9097.61	-1675	7422.61	0.6	40
1000	800	280	100	10	25	15	9097.61	-13775	-4677.39	0.6	24	9097.61	-15175	-6077.39	0.6	15
1200	800	280	100	10	25	15	9097.61	-7388.33	1709.28	0.6	40	9097.61	-11275	-2177.39	0.6	25
1400	800	280	100	10	25	15	9097.61	2241	11338.61	0.6	56	9097.61	-5375	3722.61	0.6	35
1000	900	280	100	10	25	15	9097.61	-15752.33	-6654.72	0.6	16	9097.61	-16375	-7277.39	0.6	10
1200	900	280	100	10	25	15	9097.61	-10987	-1889.39	0.6	32	9097.61	-13475	-4377.39	0.6	20
1400	900	280	100	10	25	15	9097.61	-2979	6118.61	0.6	48	9097.61	-8575	522.61	0.6	30
1000	700	400	100	10	25	15	9097.61	-10987	-1889.39	0.6	32	9097.61	-13475	-4377.39	0.6	20
1200	700	400	100	10	25	15	9097.61	-2979	6118.61	0.6	48	9097.61	-8575	522.61	0.6	30
1400	700	400	100	10	25	15	9097.61	8271.67	17369.28	0.6	64	9097.61	-1675	7422.61	0.6	40
1000	800	400	100	10	25	15	9097.61	-13775	-4677.39	0.6	24	9097.61	-15175	-6077.39	0.6	15
1200	800	400	100	10	25	15	9097.61	-7388.33	1709.28	0.6	40	9097.61	-11275	-2177.39	0.6	25
1400	800	400	100	10	25	15	9097.61	2241	11338.61	0.6	56	9097.61	-5375	3722.61	0.6	35

Table A.55: Scenarios where optimal introduction timing T^* does not change as h_n increases from 185(medium) to 300(high) (cont'd)

Parameters							$h_2 = 185$					$h_2 = 300$				
p_2	c_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1000	900	400	100	10	25	15	9097.61	-15752.33	-6654.72	0.6	16	9097.61	-16375	-7277.39	0.6	10
1200	900	400	100	10	25	15	9097.61	-10987	-1889.39	0.6	32	9097.61	-13475	-4377.39	0.6	20
1400	900	400	100	10	25	15	9097.61	-2979	6118.61	0.6	48	9097.61	-8575	522.61	0.6	30
1000	700	600	100	10	25	15	9097.61	-10987	-1889.39	0.6	32	9097.61	-13475	-4377.39	0.6	20
1200	700	600	100	10	25	15	9097.61	-2979	6118.61	0.6	48	9097.61	-8575	522.61	0.6	30
1400	700	600	100	10	25	15	9097.61	8271.67	17369.28	0.6	64	9097.61	-1675	7422.61	0.6	40
1000	800	600	100	10	25	15	9097.61	-13775	-4677.39	0.6	24	9097.61	-15175	-6077.39	0.6	15
1200	800	600	100	10	25	15	9097.61	-7388.33	1709.28	0.6	40	9097.61	-11275	-2177.39	0.6	25
1400	800	600	100	10	25	15	9097.61	2241	11338.61	0.6	56	9097.61	-5375	3722.61	0.6	35
1000	900	600	100	10	25	15	9097.61	-15752.33	-6654.72	0.6	16	9097.61	-16375	-7277.39	0.6	10
1200	900	600	100	10	25	15	9097.61	-10987	-1889.39	0.6	32	9097.61	-13475	-4377.39	0.6	20
1400	900	600	100	10	25	15	9097.61	-2979	6118.61	0.6	48	9097.61	-8575	522.61	0.6	30
1000	700	280	100	15	25	15	13577.91	-10587	2990.91	0.87	32	13577.91	-13075	502.91	0.87	20
1200	700	280	100	15	25	15	13577.91	-2579	10998.91	0.87	48	13577.91	-8175	5402.91	0.87	30
1400	700	280	100	15	25	15	13577.91	8671.67	22249.57	0.87	64	13577.91	-1275	12302.91	0.87	40
1000	800	280	100	15	25	15	13577.91	-13375	202.91	0.87	24	13577.91	-14775	-1197.09	0.87	15
1200	800	280	100	15	25	15	13577.91	-6988.33	6589.57	0.87	40	13577.91	-10875	2702.91	0.87	25
1400	800	280	100	15	25	15	13577.91	2641	16218.91	0.87	56	13577.91	-4975	8602.91	0.87	35
1000	900	280	100	15	25	15	13577.91	-15352.33	-1774.43	0.87	16	13577.91	-15975	-2397.09	0.87	10
1200	900	280	100	15	25	15	13577.91	-10587	2990.91	0.87	32	13577.91	-13075	502.91	0.87	20
1400	900	280	100	15	25	15	13577.91	-2579	10998.91	0.87	48	13577.91	-8175	5402.91	0.87	30
1000	700	400	100	15	25	15	13577.91	-10587	2990.91	0.87	32	13577.91	-13075	502.91	0.87	20
1200	700	400	100	15	25	15	13577.91	-2579	10998.91	0.87	48	13577.91	-8175	5402.91	0.87	30
1400	700	400	100	15	25	15	13577.91	8671.67	22249.57	0.87	64	13577.91	-1275	12302.91	0.87	40
1000	800	400	100	15	25	15	13577.91	-13375	202.91	0.87	24	13577.91	-14775	-1197.09	0.87	15
1200	800	400	100	15	25	15	13577.91	-6988.33	6589.57	0.87	40	13577.91	-10875	2702.91	0.87	25
1400	800	400	100	15	25	15	13577.91	2641	16218.91	0.87	56	13577.91	-4975	8602.91	0.87	35
1000	900	400	100	15	25	15	13577.91	-15352.33	-1774.43	0.87	16	13577.91	-15975	-2397.09	0.87	10
1200	900	400	100	15	25	15	13577.91	-10587	2990.91	0.87	32	13577.91	-13075	502.91	0.87	20

Table A.56: Scenarios where optimal introduction timing T^* does not change as h_n increases from 185(medium) to 300(high) (cont'd)

Parameters							$h_2 = 185$					$h_2 = 300$				
p_2	c_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1400	900	400	100	15	25	15	13577.91	-2579	10998.91	0.87	48	13577.91	-8175	5402.91	0.87	30
1000	700	600	100	15	25	15	13577.91	-10587	2990.91	0.87	32	13577.91	-13075	502.91	0.87	20
1200	700	600	100	15	25	15	13577.91	-2579	10998.91	0.87	48	13577.91	-8175	5402.91	0.87	30
1400	700	600	100	15	25	15	13577.91	8671.67	22249.57	0.87	64	13577.91	-1275	12302.91	0.87	40
1000	800	600	100	15	25	15	13577.91	-13375	202.91	0.87	24	13577.91	-14775	-1197.09	0.87	15
1200	800	600	100	15	25	15	13577.91	-6988.33	6589.57	0.87	40	13577.91	-10875	2702.91	0.87	25
1400	800	600	100	15	25	15	13577.91	2641	16218.91	0.87	56	13577.91	-4975	8602.91	0.87	35
1000	900	600	100	15	25	15	13577.91	-15352.33	-1774.43	0.87	16	13577.91	-15975	-2397.09	0.87	10
1200	900	600	100	15	25	15	13577.91	-10587	2990.91	0.87	32	13577.91	-13075	502.91	0.87	20
1400	900	600	100	15	25	15	13577.91	-2579	10998.91	0.87	48	13577.91	-8175	5402.91	0.87	30
1000	700	280	100	20	25	15	17976.1	-10237	7739.1	1.1	32	17976.1	-12725	5251.1	1.1	20
1200	700	280	100	20	25	15	17976.1	-2229	15747.1	1.1	48	17976.1	-7825	10151.1	1.1	30
1400	700	280	100	20	25	15	17976.1	9021.67	26997.77	1.1	64	17976.1	-925	17051.1	1.1	40
1000	800	280	100	20	25	15	17976.1	-13025	4951.1	1.1	24	17976.1	-14425	3551.1	1.1	15
1200	800	280	100	20	25	15	17976.1	-6638.33	11337.77	1.1	40	17976.1	-10525	7451.1	1.1	25
1400	800	280	100	20	25	15	17976.1	2991	20967.1	1.1	56	17976.1	-4625	13351.1	1.1	35
1000	900	280	100	20	25	15	17976.1	-15002.33	2973.77	1.1	16	17976.1	-15625	2351.1	1.1	10
1200	900	280	100	20	25	15	17976.1	-10237	7739.1	1.1	32	17976.1	-12725	5251.1	1.1	20
1400	900	280	100	20	25	15	17976.1	-2229	15747.1	1.1	48	17976.1	-7825	10151.1	1.1	30
1000	700	400	100	20	25	15	17976.1	-10237	7739.1	1.1	32	17976.1	-12725	5251.1	1.1	20
1200	700	400	100	20	25	15	17976.1	-2229	15747.1	1.1	48	17976.1	-7825	10151.1	1.1	30
1400	700	400	100	20	25	15	17976.1	9021.67	26997.77	1.1	64	17976.1	-925	17051.1	1.1	40
1000	800	400	100	20	25	15	17976.1	-13025	4951.1	1.1	24	17976.1	-14425	3551.1	1.1	15
1200	800	400	100	20	25	15	17976.1	-6638.33	11337.77	1.1	40	17976.1	-10525	7451.1	1.1	25
1400	800	400	100	20	25	15	17976.1	2991	20967.1	1.1	56	17976.1	-4625	13351.1	1.1	35
1000	900	400	100	20	25	15	17976.1	-15002.33	2973.77	1.1	16	17976.1	-15625	2351.1	1.1	10
1200	900	400	100	20	25	15	17976.1	-10237	7739.1	1.1	32	17976.1	-12725	5251.1	1.1	20
1400	900	400	100	20	25	15	17976.1	-2229	15747.1	1.1	48	17976.1	-7825	10151.1	1.1	30
1000	700	600	100	20	25	15	17976.1	-10237	7739.1	1.1	32	17976.1	-12725	5251.1	1.1	20

Table A.57: Scenarios where optimal introduction timing T^* does not change as h_n increases from 185(medium) to 300(high) (cont'd)

Parameters							$h_2 = 185$					$h_2 = 300$				
p_2	c_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1200	700	600	100	20	25	15	17976.1	-2229	15747.1	1.1	48	17976.1	-7825	10151.1	1.1	30
1400	700	600	100	20	25	15	17976.1	9021.67	26997.77	1.1	64	17976.1	-925	17051.1	1.1	40
1000	800	600	100	20	25	15	17976.1	-13025	4951.1	1.1	24	17976.1	-14425	3551.1	1.1	15
1200	800	600	100	20	25	15	17976.1	-6638.33	11337.77	1.1	40	17976.1	-10525	7451.1	1.1	25
1400	800	600	100	20	25	15	17976.1	2991	20967.1	1.1	56	17976.1	-4625	13351.1	1.1	35
1000	900	600	100	20	25	15	17976.1	-15002.33	2973.77	1.1	16	17976.1	-15625	2351.1	1.1	10
1200	900	600	100	20	25	15	17976.1	-10237	7739.1	1.1	32	17976.1	-12725	5251.1	1.1	20
1400	900	600	100	20	25	15	17976.1	-2229	15747.1	1.1	48	17976.1	-7825	10151.1	1.1	30
1000	800	280	100	10	20	20	3881.67	-12725.67	-8844	3.37	32	3881.67	-14591.67	-10710	3.37	20
1000	900	280	100	10	20	20	3881.67	-15378.42	-11496.75	3.37	21	3881.67	-16206.67	-12325	3.37	13
1000	800	400	100	10	20	20	3881.67	-12725.67	-8844	3.37	32	3881.67	-14591.67	-10710	3.37	20
1000	900	400	100	10	20	20	3881.67	-15378.42	-11496.75	3.37	21	3881.67	-16206.67	-12325	3.37	13
1000	800	600	100	10	20	20	3881.67	-12725.67	-8844	3.37	32	3881.67	-14591.67	-10710	3.37	20
1000	900	600	100	10	20	20	3881.67	-15378.42	-11496.75	3.37	21	3881.67	-16206.67	-12325	3.37	13
1000	800	280	100	15	20	20	8793.33	-12592.33	-3799	3.43	32	8793.33	-14458.33	-5665	3.43	20
1000	900	280	100	15	20	20	8793.33	-15245.08	-6451.75	3.43	21	8793.33	-16073.33	-7280	3.43	13
1000	800	400	100	15	20	20	8793.33	-12592.33	-3799	3.43	32	8793.33	-14458.33	-5665	3.43	20
1000	900	400	100	15	20	20	8793.33	-15245.08	-6451.75	3.43	21	8793.33	-16073.33	-7280	3.43	13
1000	800	600	100	15	20	20	8793.33	-12592.33	-3799	3.43	32	8793.33	-14458.33	-5665	3.43	20
1000	900	600	100	15	20	20	8793.33	-15245.08	-6451.75	3.43	21	8793.33	-16073.33	-7280	3.43	13
1000	800	280	100	20	20	20	12663.33	-11592.33	1071	3.93	32	12663.33	-13458.33	-795	3.93	20
1000	900	280	100	20	20	20	12663.33	-14245.08	-1581.75	3.93	21	12663.33	-15073.33	-2410	3.93	13
1000	800	400	100	20	20	20	12663.33	-11592.33	1071	3.93	32	12663.33	-13458.33	-795	3.93	20
1000	900	400	100	20	20	20	12663.33	-14245.08	-1581.75	3.93	21	12663.33	-15073.33	-2410	3.93	13
1000	800	600	100	20	20	20	12663.33	-11592.33	1071	3.93	32	12663.33	-13458.33	-795	3.93	20
1000	900	600	100	20	20	20	12663.33	-14245.08	-1581.75	3.93	21	12663.33	-15073.33	-2410	3.93	13
1000	700	280	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43	8986.25	-17706.67	-8720.42	0.67	26
1200	700	280	100	10	25	20	8986.25	-3681.67	5304.58	0.67	64	8986.25	-11141.67	-2155.42	0.67	40
1400	700	280	100	10	25	20	8986.25	11354.08	20340.33	0.67	86	8986.25	-1906.67	7079.58	0.67	53

Table A.58: Scenarios where optimal introduction timing T^* does not change as h_n increases from 185(medium) to 300(high) (cont'd)

Parameters							$h_2 = 185$					$h_2 = 300$				
p_2	c_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1000	800	280	100	10	25	20	8986.25	-18125.67	-9139.42	0.67	32	8986.25	-19991.67	-11005.42	0.67	20
1200	800	280	100	10	25	20	8986.25	-9577.92	-591.67	0.67	54	8986.25	-14756.67	-5770.42	0.67	33
1400	800	280	100	10	25	20	8986.25	3295.83	12282.08	0.67	75	8986.25	-6856.67	2129.58	0.67	46
1000	900	280	100	10	25	20	8986.25	-20778.42	-11792.17	0.67	21	8986.25	-21606.67	-12620.42	0.67	13
1200	900	280	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43	8986.25	-17706.67	-8720.42	0.67	26
1400	900	280	100	10	25	20	8986.25	-3681.67	5304.58	0.67	64	8986.25	-11141.67	-2155.42	0.67	40
1000	700	400	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43	8986.25	-17706.67	-8720.42	0.67	26
1200	700	400	100	10	25	20	8986.25	-3681.67	5304.58	0.67	64	8986.25	-11141.67	-2155.42	0.67	40
1400	700	400	100	10	25	20	8986.25	11354.08	20340.33	0.67	86	8986.25	-1906.67	7079.58	0.67	53
1000	800	400	100	10	25	20	8986.25	-18125.67	-9139.42	0.67	32	8986.25	-19991.67	-11005.42	0.67	20
1200	800	400	100	10	25	20	8986.25	-9577.92	-591.67	0.67	54	8986.25	-14756.67	-5770.42	0.67	33
1400	800	400	100	10	25	20	8986.25	3295.83	12282.08	0.67	75	8986.25	-6856.67	2129.58	0.67	46
1000	900	400	100	10	25	20	8986.25	-20778.42	-11792.17	0.67	21	8986.25	-21606.67	-12620.42	0.67	13
1200	900	400	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43	8986.25	-17706.67	-8720.42	0.67	26
1400	900	400	100	10	25	20	8986.25	-3681.67	5304.58	0.67	64	8986.25	-11141.67	-2155.42	0.67	40
1000	700	600	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43	8986.25	-17706.67	-8720.42	0.67	26
1200	700	600	100	10	25	20	8986.25	-3681.67	5304.58	0.67	64	8986.25	-11141.67	-2155.42	0.67	40
1400	700	600	100	10	25	20	8986.25	11354.08	20340.33	0.67	86	8986.25	-1906.67	7079.58	0.67	53
1000	800	600	100	10	25	20	8986.25	-18125.67	-9139.42	0.67	32	8986.25	-19991.67	-11005.42	0.67	20
1200	800	600	100	10	25	20	8986.25	-9577.92	-591.67	0.67	54	8986.25	-14756.67	-5770.42	0.67	33
1400	800	600	100	10	25	20	8986.25	3295.83	12282.08	0.67	75	8986.25	-6856.67	2129.58	0.67	46
1000	900	600	100	10	25	20	8986.25	-20778.42	-11792.17	0.67	21	8986.25	-21606.67	-12620.42	0.67	13
1200	900	600	100	10	25	20	8986.25	-14392.17	-5405.92	0.67	43	8986.25	-17706.67	-8720.42	0.67	26
1400	900	600	100	10	25	20	8986.25	-3681.67	5304.58	0.67	64	8986.25	-11141.67	-2155.42	0.67	40
1000	700	280	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43	13456.33	-17173.33	-3717	0.93	26
1200	700	280	100	15	25	20	13456.33	-3148.33	10308	0.93	64	13456.33	-10608.33	2848	0.93	40
1400	700	280	100	15	25	20	13456.33	11887.42	25343.75	0.93	86	13456.33	-1373.33	12083	0.93	53
1000	800	280	100	15	25	20	13456.33	-17592.33	-4136	0.93	32	13456.33	-19458.33	-6002	0.93	20
1200	800	280	100	15	25	20	13456.33	-9044.58	4411.75	0.93	54	13456.33	-14223.33	-767	0.93	33

Table A.59: Scenarios where optimal introduction timing T^* does not change as h_n increases from 185(medium) to 300(high) (cont'd)

Parameters							$h_2 = 185$					$h_2 = 300$				
p_2	c_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1400	800	280	100	15	25	20	13456.33	3829.17	17285.5	0.93	75	13456.33	-6323.33	7133	0.93	46
1000	900	280	100	15	25	20	13456.33	-20245.08	-6788.75	0.93	21	13456.33	-21073.33	-7617	0.93	13
1200	900	280	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43	13456.33	-17173.33	-3717	0.93	26
1400	900	280	100	15	25	20	13456.33	-3148.33	10308	0.93	64	13456.33	-10608.33	2848	0.93	40
1000	700	400	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43	13456.33	-17173.33	-3717	0.93	26
1200	700	400	100	15	25	20	13456.33	-3148.33	10308	0.93	64	13456.33	-10608.33	2848	0.93	40
1400	700	400	100	15	25	20	13456.33	11887.42	25343.75	0.93	86	13456.33	-1373.33	12083	0.93	53
1000	800	400	100	15	25	20	13456.33	-17592.33	-4136	0.93	32	13456.33	-19458.33	-6002	0.93	20
1200	800	400	100	15	25	20	13456.33	-9044.58	4411.75	0.93	54	13456.33	-14223.33	-767	0.93	33
1400	800	400	100	15	25	20	13456.33	3829.17	17285.5	0.93	75	13456.33	-6323.33	7133	0.93	46
1000	900	400	100	15	25	20	13456.33	-20245.08	-6788.75	0.93	21	13456.33	-21073.33	-7617	0.93	13
1200	900	400	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43	13456.33	-17173.33	-3717	0.93	26
1400	900	400	100	15	25	20	13456.33	-3148.33	10308	0.93	64	13456.33	-10608.33	2848	0.93	40
1000	700	600	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43	13456.33	-17173.33	-3717	0.93	26
1200	700	600	100	15	25	20	13456.33	-3148.33	10308	0.93	64	13456.33	-10608.33	2848	0.93	40
1400	700	600	100	15	25	20	13456.33	11887.42	25343.75	0.93	86	13456.33	-1373.33	12083	0.93	53
1000	800	600	100	15	25	20	13456.33	-17592.33	-4136	0.93	32	13456.33	-19458.33	-6002	0.93	20
1200	800	600	100	15	25	20	13456.33	-9044.58	4411.75	0.93	54	13456.33	-14223.33	-767	0.93	33
1400	800	600	100	15	25	20	13456.33	3829.17	17285.5	0.93	75	13456.33	-6323.33	7133	0.93	46
1000	900	600	100	15	25	20	13456.33	-20245.08	-6788.75	0.93	21	13456.33	-21073.33	-7617	0.93	13
1200	900	600	100	15	25	20	13456.33	-13858.83	-402.5	0.93	43	13456.33	-17173.33	-3717	0.93	26
1400	900	600	100	15	25	20	13456.33	-3148.33	10308	0.93	64	13456.33	-10608.33	2848	0.93	40
1000	700	280	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43	17858.39	-16706.67	1151.73	1.17	26
1200	700	280	100	20	25	20	17858.39	-2681.67	15176.73	1.17	64	17858.39	-10141.67	7716.73	1.17	40
1400	700	280	100	20	25	20	17858.39	12354.08	30212.48	1.17	86	17858.39	-906.67	16951.73	1.17	53
1000	800	280	100	20	25	20	17858.39	-17125.67	732.73	1.17	32	17858.39	-18991.67	-1133.27	1.17	20
1200	800	280	100	20	25	20	17858.39	-8577.92	9280.48	1.17	54	17858.39	-13756.67	4101.73	1.17	33
1400	800	280	100	20	25	20	17858.39	4295.83	22154.23	1.17	75	17858.39	-5856.67	12001.73	1.17	46
1000	900	280	100	20	25	20	17858.39	-19778.42	-1920.02	1.17	21	17858.39	-20606.67	-2748.27	1.17	13

Table A.60: Scenarios where optimal introduction timing T^* does not change as h_n increases from 185(medium) to 300(high) (cont'd)

Parameters							$h_2 = 185$					$h_2 = 300$				
p_2	c_2	v_2	b_2	Q_1	λ_1	λ_2	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*	$\Pi_o(Q_2^*, T^*)$	$\Pi_n(Q_2^*, T^*)$	$\Pi(Q_2^*, T^*)$	T^*	Q^*
1200	900	280	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43	17858.39	-16706.67	1151.73	1.17	26
1400	900	280	100	20	25	20	17858.39	-2681.67	15176.73	1.17	64	17858.39	-10141.67	7716.73	1.17	40
1000	700	400	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43	17858.39	-16706.67	1151.73	1.17	26
1200	700	400	100	20	25	20	17858.39	-2681.67	15176.73	1.17	64	17858.39	-10141.67	7716.73	1.17	40
1400	700	400	100	20	25	20	17858.39	12354.08	30212.48	1.17	86	17858.39	-906.67	16951.73	1.17	53
1000	800	400	100	20	25	20	17858.39	-17125.67	732.73	1.17	32	17858.39	-18991.67	-1133.27	1.17	20
1200	800	400	100	20	25	20	17858.39	-8577.92	9280.48	1.17	54	17858.39	-13756.67	4101.73	1.17	33
1400	800	400	100	20	25	20	17858.39	4295.83	22154.23	1.17	75	17858.39	-5856.67	12001.73	1.17	46
1000	900	400	100	20	25	20	17858.39	-19778.42	-1920.02	1.17	21	17858.39	-20606.67	-2748.27	1.17	13
1200	900	400	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43	17858.39	-16706.67	1151.73	1.17	26
1400	900	400	100	20	25	20	17858.39	-2681.67	15176.73	1.17	64	17858.39	-10141.67	7716.73	1.17	40
1000	700	600	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43	17858.39	-16706.67	1151.73	1.17	26
1200	700	600	100	20	25	20	17858.39	-2681.67	15176.73	1.17	64	17858.39	-10141.67	7716.73	1.17	40
1400	700	600	100	20	25	20	17858.39	12354.08	30212.48	1.17	86	17858.39	-906.67	16951.73	1.17	53
1000	800	600	100	20	25	20	17858.39	-17125.67	732.73	1.17	32	17858.39	-18991.67	-1133.27	1.17	20
1200	800	600	100	20	25	20	17858.39	-8577.92	9280.48	1.17	54	17858.39	-13756.67	4101.73	1.17	33
1400	800	600	100	20	25	20	17858.39	4295.83	22154.23	1.17	75	17858.39	-5856.67	12001.73	1.17	46
1000	900	600	100	20	25	20	17858.39	-19778.42	-1920.02	1.17	21	17858.39	-20606.67	-2748.27	1.17	13
1200	900	600	100	20	25	20	17858.39	-13392.17	4466.23	1.17	43	17858.39	-16706.67	1151.73	1.17	26
1400	900	600	100	20	25	20	17858.39	-2681.67	15176.73	1.17	64	17858.39	-10141.67	7716.73	1.17	40

Table A.61: T_n^* decreases whereas T_o^* remains unchanged as γ_o increases from 0.25(low) to 0.50(medium)

Parameters									$\gamma_o = 0.25$				$\gamma_o = 0.50$			
p_2	c_2	h_2	v_2	b_2	Q_1	$\lambda_o^{(1)}$	$\lambda_n^{(3)}$	γ_n	$\Pi(\cdot,\cdot,\cdot,\cdot)$	T_n^*	T_o^*	Q_2^*	$\Pi(\cdot,\cdot,\cdot,\cdot)$	T_n^*	T_o^*	Q_2^*
1000	800	180	280	100	75	10	15	0.5	36624.44	7.13	12	12	40249.97	6.53	12	12
1000	800	180	400	100	75	10	15	0.5	36624.44	7.13	12	12	40249.97	6.53	12	12
1000	800	180	280	100	80	10	15	0.5	36230.18	7.67	12	12	40666.66	7	12	12
1000	700	90	400	100	80	10	15	0.5	42827.94	7.73	10.8	32	48159.26	7.13	10.8	36
1000	800	180	400	100	80	10	15	0.5	36230.18	7.67	12	12	40666.66	7	12	12
1000	700	90	280	175	80	10	15	0.5	45240.88	7.6	10.8	34	51001.83	7	10.8	38
1000	800	90	280	175	80	10	15	0.5	41929.05	7.67	10.8	32	47275.52	7.13	10.8	36
1000	700	90	400	175	80	10	15	0.5	45276.5	7.6	10.8	34	51038.57	7	10.8	38
1000	800	90	400	175	80	10	15	0.5	41948.79	7.67	10.8	32	47300.18	7.13	10.8	36
1000	700	90	280	175	80	10	10	0.9	45443.67	7.6	10.4	34	51267.4	7.07	10.4	38
1000	800	90	280	175	80	10	10	0.9	42075.59	7.73	10.4	32	47467.4	7.07	10.4	38
1000	800	90	400	175	80	10	10	0.9	42107.85	7.73	10.4	32	47509.9	7.07	10.4	38

Table A.62: T_n^* decreases whereas T_o^* remains unchanged as γ_o increases from 0.50(medium) to 0.75(high)

Parameters									$\gamma_o = 0.50$				$\gamma_o = 0.75$			
p_2	c_2	h_2	v_2	b_2	Q_1	$\lambda_o^{(1)}$	$\lambda_n^{(3)}$	γ_n	$\Pi(\cdot,\cdot,\cdot,\cdot)$	T_n^*	T_o^*	Q_2^*	$\Pi(\cdot,\cdot,\cdot,\cdot)$	T_n^*	T_o^*	Q_2^*
1000	800	180	280	100	75	10	15	0.5	40249.97	6.53	12	12	40185.79	6.33	12	12
1000	800	180	400	100	75	10	15	0.5	40249.97	6.53	12	12	40185.79	6.33	12	12
1000	800	180	280	100	80	10	15	0.5	40666.66	7	12	12	41223.84	6.8	12	12
1000	700	90	400	100	80	10	15	0.5	48159.26	7.13	10.8	36	50491.34	6.8	10.8	38
1000	800	180	400	100	80	10	15	0.5	40666.66	7	12	12	41223.84	6.8	12	12
1000	700	90	280	175	80	10	15	0.5	51001.83	7	10.8	38	53571.93	6.67	10.8	40
1000	800	90	280	175	80	10	15	0.5	47275.52	7.13	10.8	36	49593.28	6.8	10.8	38
1000	700	90	400	175	80	10	15	0.5	51038.57	7	10.8	38	53606.5	6.67	10.8	40
1000	800	90	400	175	80	10	15	0.5	47300.18	7.13	10.8	36	49616.63	6.8	10.8	38
1000	700	90	280	175	80	10	10	0.9	51267.4	7.07	10.4	38	54627.49	6.6	10.4	42
1000	800	90	280	175	80	10	10	0.9	47467.4	7.07	10.4	38	50481.61	6.8	10.4	40
1000	800	90	400	175	80	10	10	0.9	47509.9	7.07	10.4	38	50522.69	6.8	10.4	40

Table A.63: T_n^* decreases whereas T_o^* remains unchanged as γ_n increases from 0.50(low) to 0.75(medium)

Parameters									$\gamma_n = 0.50$				$\gamma_n = 0.75$			
p_2	c_2	h_2	v_2	b_2	Q_1	$\lambda_o^{(1)}$	$\lambda_n^{(3)}$	γ_n	$\Pi(\cdot,\cdot,\cdot,\cdot)$	T_n^*	T_o^*	Q_2^*	$\Pi(\cdot,\cdot,\cdot,\cdot)$	T_n^*	T_o^*	Q_2^*
1200	800	90	280	100	80	10	10	0.25	42273.49	7.67	10.8	22	44950.2	7.6	10.8	30
1200	700	90	280	175	80	10	10	0.25	45991.33	7.53	10.8	24	50162.66	7.47	10.8	32
1200	700	90	400	175	80	10	10	0.25	46060.84	7.53	10.8	24	50241.75	7.47	10.8	32
1200	700	90	280	175	75	10	10	0.5	53073.59	6.4	10.4	30	58325.42	6.33	10.4	40
1200	700	90	280	100	80	10	10	0.5	50286.3	7	10.8	26	54108.28	6.93	10.8	36
1200	700	90	400	100	80	10	10	0.5	50348.2	7	10.8	26	54198.61	6.93	10.8	36
1200	700	90	280	100	75	10	10	0.75	53372.28	6.2	10	30	57900.93	6.07	10	40
1200	700	90	400	100	75	10	10	0.75	53392.98	6.2	10	30	57930.78	6.07	10	40
1200	800	90	280	100	80	10	10	0.75	50420.33	6.73	10.4	26	53671.55	6.67	10.4	36
1200	700	90	400	100	80	10	10	0.75	53243.2	6.6	10.4	28	57464.36	6.53	10.4	38
1000	700	90	280	175	80	10	10	0.75	49580.25	6.73	10.4	26	52835.04	6.67	10.4	36
1000	700	90	400	175	80	10	10	0.75	49600.33	6.73	10.4	26	52874.08	6.67	10.4	36
1200	700	90	400	175	80	10	10	0.75	55127.35	6.53	10.4	28	60382.52	6.33	10.4	40

Table A.64: T_n^* decreases whereas T_o^* remains unchanged as γ_n increases from 0.75(medium) to 0.90(high)

Parameters									$\gamma_n = 0.75$				$\gamma_n = 0.90$			
p_2	c_2	h_2	v_2	b_2	Q_1	$\lambda_o^{(1)}$	$\lambda_n^{(3)}$	γ_n	$\Pi(\cdot,\cdot,\cdot,\cdot)$	T_n^*	T_o^*	Q_2^*	$\Pi(\cdot,\cdot,\cdot,\cdot)$	T_n^*	T_o^*	Q_2^*
1200	800	90	280	100	80	10	10	0.25	44950.2	7.6	10.8	30	46497.8	7.53	10.8	36
1200	700	90	280	175	80	10	10	0.25	50162.66	7.47	10.8	32	52570.48	7.4	10.8	38
1200	700	90	400	175	80	10	10	0.25	50241.75	7.47	10.8	32	52676.49	7.4	10.8	38
1200	700	90	280	175	75	10	10	0.5	58325.42	6.33	10.4	40	61340.81	6.27	10.4	46
1200	700	90	280	100	80	10	10	0.5	54108.28	6.93	10.8	36	56355.7	6.87	10.8	42
1200	700	90	400	100	80	10	10	0.5	54198.61	6.93	10.8	36	56452.63	6.87	10.8	42
1200	700	90	280	100	75	10	10	0.75	57900.93	6.07	10	40	60559.8	5.87	10	48
1200	700	90	400	100	75	10	10	0.75	57930.78	6.07	10	40	60608.91	5.93	10	48
1200	800	90	280	100	80	10	10	0.75	53671.55	6.67	10.4	36	55538.4	6.6	10.4	42
1200	700	90	400	100	80	10	10	0.75	57464.36	6.53	10.4	38	59936.48	6.47	10.4	44
1000	700	90	280	175	80	10	10	0.75	52835.04	6.67	10.4	36	54627.49	6.6	10.4	42
1000	700	90	400	175	80	10	10	0.75	52874.08	6.67	10.4	36	54674.38	6.6	10.4	42
1200	700	90	400	175	80	10	10	0.75	60382.52	6.33	10.4	40	63415.85	6.27	10.4	46

Table A.65: None of T_n^*, T_o^* changes as γ_n increases from 0.50(low) to 0.75(medium)

Parameters									$\gamma_n = 0.50$				$\gamma_n = 0.75$			
p_2	c_2	h_2	v_2	b_2	Q_1	$\lambda_o^{(1)}$	$\lambda_n^{(3)}$	γ_n	$\Pi(\cdot,\cdot,\cdot,\cdot)$	T_n^*	T_o^*	Q_2^*	$\Pi(\cdot,\cdot,\cdot,\cdot)$	T_n^*	T_o^*	Q_2^*
1000	800	180	280	100	75	10	10	0.25	37217.07	7.13	12	8	36624.44	7.13	12	12
1000	800	180	400	100	75	10	10	0.25	37217.08	7.13	12	8	36624.44	7.13	12	12
1000	700	90	280	100	80	10	10	0.25	40139.92	7.67	10.8	22	42050.79	7.67	10.8	30
1200	700	180	280	100	80	10	10	0.25	40450.13	7.8	10.8	20	42766.48	7.8	10.8	28
1000	700	90	400	100	80	10	10	0.25	40179.78	7.67	10.8	22	42114.19	7.67	10.8	30
1200	700	180	400	100	80	10	10	0.25	40471.01	7.8	10.8	20	42808.89	7.8	10.8	28
1000	700	180	280	100	80	15	10	0.25	55091.57	4.73	12	10	54390.9	4.73	12	16
1000	800	180	280	100	80	15	10	0.25	54175.57	4.73	12	8	52982.9	4.73	12	12
1000	700	180	400	100	80	15	10	0.25	55091.57	4.73	12	10	54390.9	4.73	12	16
1000	800	180	400	100	80	15	10	0.25	54175.57	4.73	12	8	52982.9	4.73	12	12
1200	700	180	280	100	80	10	15	0.25	43289.97	7.8	10.8	30	47192.69	7.8	10.8	42
1200	800	180	400	100	80	10	15	0.25	40375.07	7.93	10.8	28	43171.67	7.93	10.8	40
1200	800	90	280	175	75	10	10	0.5	50262.89	6.47	10.4	28	54477.6	6.47	10.4	38
1200	800	180	280	100	80	15	10	0.5	57645.25	4.67	8	22	59597.43	4.67	8	32
1200	800	180	400	100	80	15	10	0.5	57645.25	4.67	8	22	59597.43	4.67	8	32
1200	700	180	280	175	80	15	10	0.5	60582.91	4.6	8.8	28	64771.96	4.6	8.8	42
1200	700	180	400	175	80	15	10	0.5	60582.92	4.6	8.8	28	64772.48	4.6	8.8	42
1200	800	90	280	100	75	10	10	0.75	50372.28	6.2	10	30	53911.73	6.2	10	38
1200	800	180	280	175	75	10	10	0.75	45799.74	6.47	10	24	48719.51	6.47	10	34
1200	800	180	400	175	75	10	10	0.75	45801.63	6.47	10	24	48727.45	6.47	10	34
1000	800	90	280	100	75	15	10	0.75	55871.03	4.13	7.2	24	57674.14	4.13	7.2	34
1200	800	180	280	100	75	15	10	0.75	56098.55	4.2	6.8	20	58184.58	4.2	6.8	28
1000	800	90	400	100	75	15	10	0.75	55871.03	4.13	7.2	24	57674.14	4.13	7.2	34
1200	800	180	400	100	75	15	10	0.75	56098.55	4.2	6.8	20	58184.58	4.2	6.8	28
1000	700	180	280	175	75	15	10	0.75	52736.21	4.2	7.2	22	55017.5	4.2	7.2	30
1200	700	180	280	175	75	15	10	0.75	57533.68	4.13	7.6	26	61765.4	4.13	7.6	36
1200	800	180	280	175	75	15	10	0.75	54982.97	4.2	7.6	24	58195.8	4.2	7.6	34
1000	700	180	400	175	75	15	10	0.75	52736.21	4.2	7.2	22	55017.5	4.2	7.2	30

Table A.66: None of T_n^*, T_o^* changes as γ_n increases from 0.50(low) to 0.75(medium) (cont'd)

Parameters									$\gamma_n = 0.50$				$\gamma_n = 0.75$			
p_2	c_2	h_2	v_2	b_2	Q_1	$\lambda_o^{(1)}$	$\lambda_n^{(3)}$	γ_n	$\Pi(\cdot,\cdot,\cdot,\cdot)$	T_n^*	T_o^*	Q_2^*	$\Pi(\cdot,\cdot,\cdot,\cdot)$	T_n^*	T_o^*	Q_2^*
1200	700	180	400	175	75	15	10	0.75	57533.68	4.13	7.6	26	61765.4	4.13	7.6	36
1200	800	180	400	175	75	15	10	0.75	54982.97	4.2	7.6	24	58195.8	4.2	7.6	34
1000	700	90	280	100	80	15	10	0.75	60974.08	4.4	8	30	63876.34	4.4	8	40
1000	700	180	280	100	80	15	10	0.75	56608.32	4.53	7.2	18	57915.67	4.53	7.2	26
1000	700	90	400	100	80	15	10	0.75	60974.09	4.4	8	30	63876.38	4.4	8	40
1000	700	180	400	100	80	15	10	0.75	56608.32	4.53	7.2	18	57915.67	4.53	7.2	26
1000	800	180	280	175	80	15	10	0.75	53243.14	4.53	7.2	20	54768.92	4.53	7.2	28
1200	800	180	280	175	80	15	10	0.75	57723.8	4.47	7.6	24	60918.55	4.47	7.6	34
1000	800	180	400	175	80	15	10	0.75	53243.14	4.53	7.2	20	54768.92	4.53	7.2	28
1200	800	180	400	175	80	15	10	0.75	57723.8	4.47	7.6	24	60918.55	4.47	7.6	34
1000	700	180	280	100	75	15	15	0.75	53147.36	4.27	6.8	26	55272.12	4.27	6.8	38
1000	700	180	400	100	75	15	15	0.75	53147.36	4.27	6.8	26	55272.12	4.27	6.8	38

Table A.67: None of T_n^*, T_o^* changes as γ_n increases from 0.75(medium) to 0.90(high)

Parameters									$\gamma_n = 0.75$				$\gamma_n = 0.90$			
p_2	c_2	h_2	v_2	b_2	Q_1	$\lambda_o^{(1)}$	$\lambda_n^{(3)}$	γ_n	$\Pi(\cdot,\cdot,\cdot,\cdot)$	T_n^*	T_o^*	Q_2^*	$\Pi(\cdot,\cdot,\cdot,\cdot)$	T_n^*	T_o^*	Q_2^*
1000	800	180	280	100	75	10	10	0.25	36624.44	7.13	12	12	36266.44	7.13	12	14
1000	800	180	400	100	75	10	10	0.25	36624.44	7.13	12	12	36266.44	7.13	12	14
1000	700	90	280	100	80	10	10	0.25	42050.79	7.67	10.8	30	43167.01	7.67	10.8	34
1200	700	180	280	100	80	10	10	0.25	42766.48	7.8	10.8	28	44141.24	7.8	10.8	32
1000	700	90	400	100	80	10	10	0.25	42114.19	7.67	10.8	30	43227.73	7.67	10.8	34
1200	700	180	400	100	80	10	10	0.25	42808.89	7.8	10.8	28	44185.31	7.8	10.8	32
1000	700	180	280	100	80	15	10	0.25	54390.9	4.73	12	16	53964.9	4.73	12	20
1000	800	180	280	100	80	15	10	0.25	52982.9	4.73	12	12	52264.9	4.73	12	14
1000	700	180	400	100	80	15	10	0.25	54390.9	4.73	12	16	53964.9	4.73	12	20
1000	800	180	400	100	80	15	10	0.25	52982.9	4.73	12	12	52264.9	4.73	12	14
1200	700	180	280	100	80	10	15	0.25	47192.69	7.8	10.8	42	49439.86	7.8	10.8	48
1200	800	180	400	100	80	10	15	0.25	43171.67	7.93	10.8	40	44786.47	7.93	10.8	46
1200	800	90	280	175	75	10	10	0.5	54477.6	6.47	10.4	38	56848.78	6.47	10.4	44
1200	800	180	280	100	80	15	10	0.5	59597.43	4.67	8	32	60775.58	4.67	8	38
1200	800	180	400	100	80	15	10	0.5	59597.43	4.67	8	32	60775.58	4.67	8	38
1200	700	180	280	175	80	15	10	0.5	64771.96	4.6	8.8	42	67321.02	4.6	8.8	48
1200	700	180	400	175	80	15	10	0.5	64772.48	4.6	8.8	42	67321.81	4.6	8.8	48
1200	800	90	280	100	75	10	10	0.75	53911.73	6.2	10	38	55953.41	6.2	10	44
1200	800	180	280	175	75	10	10	0.75	48719.51	6.47	10	34	50359.84	6.47	10	40
1200	800	180	400	175	75	10	10	0.75	48727.45	6.47	10	34	50374.54	6.47	10	40
1000	800	90	280	100	75	15	10	0.75	57674.14	4.13	7.2	34	58761.26	4.13	7.2	38
1200	800	180	280	100	75	15	10	0.75	58184.58	4.2	6.8	28	59451.57	4.2	6.8	32
1000	800	90	400	100	75	15	10	0.75	57674.14	4.13	7.2	34	58761.26	4.13	7.2	38
1200	800	180	400	100	75	15	10	0.75	58184.58	4.2	6.8	28	59451.57	4.2	6.8	32
1000	700	180	280	175	75	15	10	0.75	55017.5	4.2	7.2	30	56445.74	4.2	7.2	36
1200	700	180	280	175	75	15	10	0.75	61765.4	4.13	7.6	36	64306.23	4.13	7.6	42
1200	800	180	280	175	75	15	10	0.75	58195.8	4.2	7.6	34	60140.66	4.2	7.6	40
1000	700	180	400	175	75	15	10	0.75	55017.5	4.2	7.2	30	56445.74	4.2	7.2	36

Table A.68: None of T_n^*, T_o^* changes as γ_n increases from 0.75(medium) to 0.90(high) (cont'd)

Parameters									$\gamma_n = 0.75$				$\gamma_n = 0.90$			
p_2	c_2	h_2	v_2	b_2	Q_1	$\lambda_o^{(1)}$	$\lambda_n^{(3)}$	γ_n	$\Pi(\cdot,\cdot,\cdot,\cdot)$	T_n^*	T_o^*	Q_2^*	$\Pi(\cdot,\cdot,\cdot,\cdot)$	T_n^*	T_o^*	Q_2^*
1200	700	180	400	175	75	15	10	0.75	61765.4	4.13	7.6	36	64306.23	4.13	7.6	42
1200	800	180	400	175	75	15	10	0.75	58195.8	4.2	7.6	34	60140.66	4.2	7.6	40
1000	700	90	280	100	80	15	10	0.75	63876.34	4.4	8	40	65606.16	4.4	8	46
1000	700	180	280	100	80	15	10	0.75	57915.67	4.53	7.2	26	58695.95	4.53	7.2	30
1000	700	90	400	100	80	15	10	0.75	63876.38	4.4	8	40	65606.26	4.4	8	46
1000	700	180	400	100	80	15	10	0.75	57915.67	4.53	7.2	26	58695.95	4.53	7.2	30
1000	800	180	280	175	80	15	10	0.75	54768.92	4.53	7.2	28	55713.33	4.53	7.2	32
1200	800	180	280	175	80	15	10	0.75	60918.55	4.47	7.6	34	62878.27	4.47	7.6	38
1000	800	180	400	175	80	15	10	0.75	54768.92	4.53	7.2	28	55713.33	4.53	7.2	32
1200	800	180	400	175	80	15	10	0.75	60918.55	4.47	7.6	34	62878.27	4.47	7.6	38
1000	700	180	280	100	75	15	15	0.75	55272.12	4.27	6.8	38	56584.22	4.27	6.8	44
1000	700	180	400	100	75	15	15	0.75	55272.12	4.27	6.8	38	56584.22	4.27	6.8	44