Distribution Agreement

Signature:

Tomoko Namura April 18, 2012

Price Controls under Third-Degree Differential Pricing

by

Tomoko Namura

Dr. Shomu Banerjee
Adviser

Department of Economics

Dr. Shomu Banerjee

Adviser

Dr. Emily Hamilton

Committee Member

Dr. Diwas KC

Committee Member

2012

Price Controls under Third-Degree Differential Pricing

By

Tomoko Namura

Dr. Shomu Banerjee

Adviser

An abstract of
a thesis submitted to the Faculty of Emory College of Arts and Sciences
of Emory University in partial fulfillment
of the requirements of the degree of
Bachelor of Arts with Honors

Department of Economics

2012

Abstract

Price Controls under Third-Degree Differential Pricing
By Tomoko Namura

This paper examines the effects of a price control in a smaller of the two monopolistic but different sized markets. Studying such effects in third-degree differential pricing situation, where a monopolistic firm charges different prices according to the demands in different markets, I introduce two models. In Model 1, the firm has a constant marginal cost. In this model, a price restriction placed in the smaller market will only increase the demand in this market, and no changes will take place in the other market. Furthermore, in Model 1, the government will most likely set the price ceiling near the marginal cost to achieve the maximum level of consumer surplus without driving the firm out of the market. In Model 2, in which the firm has a linearly increasing marginal cost, as the government of the market with a smaller demand lowers the price, there comes a price where the firm no longer supplies that market on the demand. Additionally, I propose that the government considers deadweight loss when setting the price ceiling, so that the increase in consumer surplus never goes above the deadweight loss. Understanding the effects of price ceilings under third-degree differential pricing provides add to the theory of pricing behavior by monopolies in general and also the pharmaceutical market.

Price Controls under Third-Degree Differential Pricing

By

Tomoko Namura

Dr. Shomu Banerjee

Adviser

A thesis submitted to the Faculty of Emory College of Arts and Sciences
of Emory University in partial fulfillment
of the requirements of the degree of
Bachelor of Arts with Honors

Department of Economics

2012

Acknowledgements

First, I would like to thank my adviser, Dr. Shomu Banerjee, for his guidance throughout this process. His encouragement and passion have motivated me through my years of studying economics. Without his patience and kindness, this thesis would not have been possible. I would also like to thank my committee members, Dr. Emily Hamilton and Dr. Diwas KC, for serving on my committee. Lastly, I would like to thank my family for their support throughout my college career.

Table of Contents

Price Control under Third-Degree Differential Pricing

1. Introduction

Price controls on patented drugs are common phenomena in many countries across the world. For example, suppose that a pharmaceutical company sells a drug in the United States as well as in Canada or the European Union (EU), where the company is free to charge any price in the US but faces price regulation in the foreign market. These government regulations lower the prices of patented drugs in these foreign countries in order to make them more accessible to consumers. In this work, I aim to study the effect of such price controls in one market segment when drugs are sold under third-degree differential pricing. That is, when patent monopolies that produce these drugs segment their markets and charge different prices in each segment based on the different consumers' willingness-to-pay. Such market segmentation and pricing behavior is called third-degree differential pricing (or price discrimination) in economics literature. The research question that I will attempt to answer in this paper is the effects of price control on the quantities sold in both markets and its impact on the firm's profits.

Understanding the consequence of price controls provides further insight into the profit-maximizing production and supply behavior of monopolistic firms, as well as into the theory of social welfare. A report written by the US Department of Commerce estimates that in countries with price controls, drug prices "were 18 to 67 percent less than U.S. prices, depending on the country" (ITA, 2004). With this in mind, the question of interest in this paper is how these artificially low prices abroad affect the prices and quantities supplied in both domestic and foreign markets, a question which seems to be unanswered in the economics literature. In particular, will the firm produce a quantity on the demand curve (i.e., sell the maximum possible amount at the regulated price) or below such levels? Does the firm always follow one of these two production strategies, or does the firm move from one to another? And if the latter is true, is there a turning point in the level of the ceiling where the firm goes from producing on the demand curve to producing less? By attempting to answer all of the above questions, this study will add to the theory of pricing behavior of monopolies in general and shed some light on the prescription drugs market.

Following our example, often, large drug companies operate as monopolies because of the patents they hold on certain drugs. Patents incentivize pharmaceutical companies to continue to conduct research and development (R&D) by protecting a drug company's rights to the medicines that they invent. By doing so, a patent makes a particular company the only producer of its invented drug for the life of the patent, allowing the firm to produce and sell as a monopoly and possibly to engage in price discrimination. The company charges a higher price in the market segment that is willing to pay such a price, and the firm sells at a lower price in places where the consumers have a lower willingness to bear such price. Hence, in my example with the US and the EU, the pharmaceutical company charges a higher price in the United States (the larger market) and a lower price in the European Union (the smaller market of the two), even in the absence of any government regulation in the foreign market. Additionally, because of the larger demand in the US, the quantity sold is higher in the US compared to that of the EU.

However, the high unrestricted-equilibrium prices that the pharmaceutical companies prefer to charge, which are results of their expensive R&D costs, are often not what the average consumers are able to afford. This negative consequence of high-cost medical research on the consumers leads governments to place price controls in patented-drug markets. According to the US Department of Commerce, "these include direct and indirect price controls, profit controls, reference pricing, physical budget constraints and prescribing guidelines, marketing approvals, and limits on promotion, among many others" (ITA, 2004). Furthermore, the government is able to regulate the drug industry because of its monopsony power as a provider of socialized medical care (ITA, 2004). The scope of this work will relate purely to government regulation in the form of a price ceiling, as the effects of the other regulations listed above are more difficult to capture in a theoretical paper.

In our example of the European Union and the United States, price controls on medication are common in the EU because of the lower level of income compared to that of the United States. For example, in Germany, drug producers were "required to reduce the prices of their non-referenced drugs by 5% and their over-the-counter drugs during 1993 and 1994," and "the prices once lowered [were to] be frozen for two years" (Abel-Smith and Mossialos, 1994). In addition, in Spain, medication price controls are set so that the prices will not be greater than the costs, leading to its position to have the second-lowest drug prices in Europe. Portugal's ongoing government-regulated prices since 1984 are another example, giving Portugal its position to have the lowest drug prices in the European Union. Moreover, in Portugal, the drug costs cannot be greater than the lowest price of the three countries, Spain, Italy, and France (Abel-Smith and Mossialos, 1994). Since we see that price controls in the European Union (the smaller market) are more common than in the United States (the larger market), I begin my research by placing a price ceiling on the smaller market of the two, and assessing its effects on the larger market.

There is no previous literature that studies the effect of price controls on the profit-maximizing supply decisions of a manufacturer that engages in price discrimination. However, there is literature written on the effect of price controls on entry decisions of drugs by the pharmaceutical companies, which are determined by the firms' predicted profits with price ceilings. Lanjouw (2005) finds that among the high-income countries, the existence of price controls lowers the likelihood of some new drug entering those markets. To the contrary, this phenomenon does not apply to low-income states, where the drugs still eventually enter the market but price regulations by governments slow the speed of the drugs' market-entry (Lanjouw, 2005). In addition, the International Trade Administration (2004) report claims that the price controls decreases the revenues of pharmaceutical companies in the member countries of the Organisation for Economic Co-operation and Development (OECD), i.e., wealthy states, by approximately $18 billion to $ 27 billion per year.

In a theoretical work on the impact of government price regulations in the medications market, Danzon (1997) writes that one must account for the large fixed R&D costs. These massive R&D costs limit the pricing options for the companies because the government cannot "force its price down to marginal cost;" furthermore, if "this low price diffuses throughout the EU parallel trade, the welfare loss could be significant, since revenues would be inadequate to support innovative R&D" (Danzon, 1997). Regardless, there is not much literature on the theory of producer behavior when there are price controls.

This paper examines the effects of a price control in a smaller of the two monopolistic but different sized markets. I introduce two models. In Model 1, the firm has a constant marginal cost. Utilizing this model, I find that when a price restriction is placed on the smaller market, only the quantity demanded in this market is affected. In Model 2, the firm has a linearly increasing marginal cost. I find that in this model, at price ceilings below a certain price, the firm no longer sells the quantity demanded in that market with the price restriction. Furthermore, I study the effects of price ceilings on aggregate consumer and producer welfare. Utilizing welfare analysis, I also find that there possible exists an alternative minimum price ceiling for the government.

The remainder of the paper is structured as follows: Section 2 studies a model of a price control under third-degree differential pricing with a constant marginal cost; Section 3 has the same model but with a linearly increasing marginal cost; within Section 3, I first show that there exists a point where the firm no longer meets the demand in the smaller market; Sections 3.a. and b. contain the properties of what I call Regime 1, in which the firm produces at the demand in the market with a ceiling, and Regime 2, in which the firm does not meet the demand; in Section 3.c., I find the mathematical formula for the turning point price; and Section 3.d. examines the changes in aggregate consumer and producer surpluses as the price ceiling lowers and also the possible existence of an alternative minimum price ceiling; and lastly, Section 4 discusses the policy implications and suggests possible future research on my topic.

2. Model 1: Third-Degree Differential Pricing with Constant Marginal Cost

In this model, I assume a monopoly and two markets with different demands, Market 1 and Market 2. Market 1 can be identified with the US domestic market, while Market 2 can be regarded as the EU, where the price control is imposed. The two market demands are different in size, with Market 1 being the larger market with a higher level of wealth. Assuming nested linear demands for simplicity, i.e., the demand function for Market 2 lies inside the demand function for Market 1, the demand equations for Market 1 and Market 2 are

$$P_1 = a - Q_1 \text{ and } P_2 = b - cQ_2,$$

where P_1 and P_2 are the prices, and Q_1 and Q_2 are quantities demanded in Market 1 and Market 2, respectively; a, b, c are all positive constants, where $a > b$ ensures that Market 1 is larger and $c \geq b/a$ for nested demands. Note that the slope of the demand in Market 1 is normalized to one without a loss of generality (it is always possible to choose units for measuring the output so that this is the case).

Using the above demand functions, the total revenue for the firm in Market i = 1, 2 is

$$TR_i = P_i Q_i .$$

Then, the marginal revenue functions for each market are

$$MR_1 = a - 2Q_1 \text{ and } MR_2 = b - 2cQ_2 .$$

Since we assume constant marginal cost in this model, let our cost function, $C(Q)$, where $Q = Q_1 + Q_2$, holds a fixed positive slope, $\overline{K}$:

$$C(Q) = \overline{K}(Q_1 + Q_2),$$

and so

$$MC(Q) = \overline{K} .$$

Therefore, the total profit for the firm with constant marginal cost is

$$\Pi = TR_1 + TR_2 - C(Q),$$

which translates into

$$\Pi = P_1 Q_1 + P_2 Q_2 - \overline{K}(Q_1 + Q_2).$$

Under free market, the firm maximizes its profit by selling at the quantities that solve the following system of equations for $i = 1, 2$:

$$MR_i = MC = \overline{K},$$

as in Figure 1. The optimal quantities sold in each market found by solving the equations above are

$$Q_1* = \frac{a - \overline{K}}{2} \text{ and } Q_2* = \frac{b - \overline{K}}{2},$$

and by following these equations, the resulting profit-maximizing prices are

$$P_1* = \frac{a + \overline{K}}{2} \text{ and } P_2* = \frac{b + \overline{K}}{2}.$$

The two sets of optimal price and quantity show that the optimal quantity and price are both greater in Market 1 compared to those in Market 2; thus, $Q_1* > Q_2*$, and $P_1* > P_2*$.

Now, suppose that there is a price ceiling placed on the good in Market 2 at $\tilde{P}_2$. Looking at Figure 1, since this is a price ceiling, the price is fixed, and $\tilde{P}_2$ is less than the free-market price, P_2*, from the previous section. Additionally, $\tilde{P}_2$ does not go below the price where $MR_2 = \overline{K}$ because in that case, the firm decides to exit completely from Market 2 and focus solely on selling in Market 1. In short, the government sets $\tilde{P}_2$ between the two points, $MR_1(Q_1*) = MR_2(Q_2*) = \overline{K} < \tilde{P}_2 < P_2(Q_2*)$.

If there is a price control of $\tilde{P}_2$, which lies in the range above, placed in Market 2, then the quantity demanded in this market increases to $\tilde{Q}_2$ due to cheaper prices. Since by definition, $P_2(Q_2*) > \tilde{P}_2 = P_2(\tilde{Q}_2)$, $Q_2* < \tilde{Q}_2$ because marginal revenue is a downward-sloping function. However, as shown in Figure 1, the change in Q_2 does not lead to any changes in Q_1 and its resulting P_1 because marginal cost is constant at $\overline{K}$, and so $MR_1(\tilde{Q}_1) = \overline{K} = MR_1(Q_1*)$. Thus, $MR_1(\tilde{Q}_1) = MR_1(Q_1*)$, and so $Q_1** = Q_1*$.

In this model with a constant marginal cost, the consumer surplus remains constant in Market 1 because there are not changes in quantity or price in that market, as shown above. On the other hand, in Market 2, the consumer surplus continues to increase, due to the lower price and a higher demand. Thus, at the aggregate level, the consumer surplus increases. Additionally, to see the effect of lowering the price ceiling on the producer surplus or the firm profit, we still use the same set of demand equations and constant marginal cost equation. Setting $\tilde{P}_2$ to the demand equation in Market 2, we find that

$$\tilde{Q}_2 = \frac{b - \tilde{P}_2}{c}.$$

Then the optimal profit function in a situation with a constant marginal cost is

$$\tilde{\Pi} = P_1 * Q_1 * + \tilde{P}_2\left(\frac{b - \tilde{P}_2}{c}\right) - \overline{K}\left(Q_1 + \frac{b - \tilde{P}_2}{c}\right),$$

where Q_1* and P_1* are the equilibrium quantity and price in Market 1 under free market. Differentiating the above profit function with respect to $\tilde{P}_2$, the partial derivative is

$$\frac{\partial\tilde{\Pi}}{\partial\tilde{P}_2} = \frac{b + \bar{K} - 2\tilde{P}_2}{c} \ .$$

The above derivative is at 0 when $\tilde{P}_2 = \frac{b + \bar{K}}{2}$. Therefore, at $\tilde{P}_2 > \frac{b + \bar{K}}{2}$, then $\frac{\partial\tilde{\Pi}}{\partial\tilde{P}_2} < 0$, and the firm would profit from lower $\tilde{P}_2$. On the other hand, at prices $\tilde{P}_2 < \frac{b + \bar{K}}{2}$, $\frac{\partial\tilde{\Pi}}{\partial\tilde{P}_2} > 0$, which means that the firm's profits would decrease once $\tilde{P}_2$ becomes too low. However, because $P_2* = \frac{b + \bar{K}}{2}$ when $MR_2 = \bar{K}$, the firm's profits would always decrease if there is a price control. Therefore, the firms profits will be affected negatively with lower price ceilings.

With its constant marginal cost, Model 1 may be an appropriate model of our example of the pharmaceutical industry, since a constant marginal cost at the scale of production chosen by the firm may be more reflective of the characteristics of this market than increasing marginal cost. Nevertheless, compared to the case with increasing marginal cost, the constant marginal cost case is not very interesting in our analysis because the production decisions in each market are independent of each other. Extending our findings further in the next section, the next model we study (Model 2) now has linearly increasing marginal cost. This model is a further generalization of Model 1. Compared to Model 1, Model 2 has a wider variety of applications, such as the price discrimination that takes place in the air transportation industry between the business and tourist groups. Thus, for the rest of the paper, we study the case of third-degree differential pricing with linearly increasing marginal cost.

3. Model 2: Third-Degree Differential Pricing with Linearly Increasing Marginal Cost

Using the same set of demand functions from the previous model, now we assume that the cost function has a linearly increasing marginal cost curve. Then, the cost function is

$$C(Q) = \frac{k}{2}(Q_1 + Q_2)^2,$$

and so the marginal cost for the firm is

$$MC = k(Q_1 + Q_2),$$

for some constant[1]

$$0 \le k < \frac{2b}{a-b}.$$

Then, under free market conditions, as shown in Figure 2, the firm's equilibrium production levels are

$$Q_1{*} = \frac{ak + 2ac - bk}{2(ck + k + 2c)} \text{ and } Q_2{*} = -\frac{ak - bk - 2b}{2(ck + k + 2c)},$$

and the prices are[2]

$$P_1{*} = \frac{2ack + ak + 2ac + bk}{2(ck + k + 2c)} \text{ and } P_2{*} = \frac{2bk + bck + 2bc + ack}{2(ck + k + 2c)}.$$

As in Model 1, $Q_1{*} > Q_2{*}$, and $P_1{*} > P_2{*}$ because of the larger demand in Market 1.

[1] If $k \ge \frac{2b}{a-b}$, then the firm would never enter Market 2.

[2] Note that $Q_1{*}$, $Q_2{*}$, $P_1{*}$, and $P_2{*}$ in this model have different values from those in Model 1.

Likewise in Model 1, if there is a price restriction placed on the good in Market 2, $\overline{P}_2$, is cheaper than the free-market price, P_2*, and greater than the marginal revenue in Market 2 under free-market conditions. Therefore, $MR_1(Q_1*) = MR_2(Q_2*) = MC(Q_1*+Q_2*) < \overline{P}_2 < P_2(Q_2*)$, holds in this model as well, as illustrated in Figure 3.

Earlier in Introduction, I questioned whether the profit-maximizing firm would always sell on the demand or not meet the demanded quantity in Market 2 at some level of a price ceiling. To answer that puzzle that adds onto the theory of supply behavior of a monopoly, I find the following.

Proposition 1: Existence of a turning point price, *T*

There is a critical price ceiling in Market 2, T*, such that for some price ceiling* $\overline{P}_2^{\,A}$*,* $T < \overline{P}_2^{\,A} < P_2*$*, the firm would produce on the demand curve in Market 2. For some price restriction* $\overline{P}_2^{\,B}$*, such that* $MR_2(Q_2*) < \overline{P}_2^{\,B} < T$*, the firm will supply less than the demanded quantity at that price in Market 2.*

Proof: When there is a price ceiling placed in Market 2, this price ceiling becomes the marginal revenue in this market, $MR_2 = \overline{P}_2$, and as stated earlier, $MR_2(Q_2*) < \overline{P}_2 < P_2*$, by definition. As shown in Figure 4, at $\overline{P}_2^{\,A}$, the marginal cost at that demanded quantity in Market 2, $MC(Q_1*+Q_2^A)$, increases from $MC(Q_1*+Q_2*)$ because Q_2 is higher from the lowered price. By superimposing the marginal cost curve onto the Market 1 marginal space with the vertical intercept of $MC(Q_2^A)$, the residual marginal cost of $MC(Q_1+Q_2^A)$ becomes the marginal cost curve in Market 1. Then, the dollar-value of $MR_1(Q_1^A)$ at the point where $MC(Q_1+Q_2^A)$ intersects the MR_1 curve is less than $MR_2 = \overline{P_2}^A$. Therefore, the firm would choose to produce at the demand curve in Market 2 at that price control because $\overline{P_2}^A = MR_2 > MR_1 (Q_1^A)$.

In contrast, as in Figure 5, if P_2 is at $\overline{P_2}^B$, then the marginal revenue that results from that price control after following the process similar to the above is greater than $MR_2 = \overline{P_2}^B$: $MR_2 < MR_1(Q_1^B)$. Thus, at such low level of P_2, the producer reduces some of its supply from the quantity demanded in Market 2 and sells more in Market 1, where the firm can yield greater revenue. Therefore, since all curves involved in this paper are continuous, on the domain $[Q_2*, D_2 (MR_2(Q_2**))]$ lies a Q_2^T such that $f(Q_2^T) = T$, by the Intermediate Value Theorem, where the firm is indifferent between these two market strategies above. □

With the proposition above, I have established that there are two supply strategies for the producer, one meeting the demand in Market 2 and the other not. In the next two sub-sections, 2.a. and b., I derive the mathematical formulas for the quantities and prices in both markets using the same assumptions of linear demands and linearly increasing marginal cost.

3.a. Model 2: Regime 1 – Supplying at the Demand Curve in Market 2 with Price Control

In this regime, shown graphically in Figure 6, the firm supplies at the demand curve for the given level of price ceiling set by the government, meaning that for $\overline{P_2}$ that lies in the range of $T < \overline{P_2} < P_2*$, $\overline{P_2} > MC (Q_1**+D_2(\overline{P_2})) = MR (Q_1**)$, and $Q_2** = D_2(\overline{P_2})$. Here, I denote the original profit-maximizing quantities and prices with a single asterisk, and the new quantities and prices in Model 2a with two asterisks. Intuitively, with an increasing marginal cost function, a lower price in one market increases demand and supply in that market and decrease supply in the other market. This intuition is proven and stated explicitly in the following proposition.

Proposition 2: Increase in Market 2 quantity with a price control

A price ceiling in Market 2 would reduce the quantity sold in Market 1 and increase the supply in Market 2 compared to the optimal quantities in each market.

Proof : By definition the above, $MR_2(Q_2^*) \leq \overline{P_2} < P_2^*$. The firm maximizes its profits regardless of the existence of price controls when Q_1 and Q_2 are chosen so that $MR_1(Q_1) = MR_2(Q_2) = MC(Q_1+Q_2)$. In free market, $MR_1(Q_1^*) = MR_2(Q_2^*) = MC(Q_1^*+Q_2^*)$. Now, with the price control, $MR_2(Q_2^*) < \overline{P_2} = MR_2(Q_2^{**})$. Then, $[MR_1(Q_1^*) = MR_2(Q_2^*) = MC(Q_1^*+Q_2^*)]$ < new $[MR_1(Q_1^{**}) = MR_2(Q_2^{**}) = MC(Q_1^{**}+Q_2^{**})]$ because $MR_2(Q_2^*) < MR_2(Q_2^{**})$. Therefore, since $MR_1(Q_1^*) < MR_1(Q_1^{**})$ and price and demand are inversely related, $Q_1^* > Q_1^{**}$; directly resulting from this relationship, $P_1^* < P_1^{**}$. □

Proposition 2 shows that a price control in Market 2 reduces the quantity sold and increases its price in Market 1. Therefore, from the free-market equilibrium point, the consumer welfare in Market 1 is affected adversely. Conversely, in Market 2, consumer surplus increases after the government sets a price ceiling, which is consistent with its aim, as the consumers more demand a larger quantity at a lower price. Furthermore, the importance of this proposition lies in its universal application. Since the proof does not involve any explicit demand or marginal cost equations, Proposition 2 is true for all demand and cost functions.

Unlike Proposition 2, the result written in the next proposition relies on the assumption of the linear demand functions.

Proposition 3: Increase in total quantity supplied in the case of a price control

The total quantity supplied in two markets combined after the price regulation in Market 2 is greater than or equal to the total quantity supplied of two markets in free-market: $Q_1{*}+Q_2{*} \geq Q_1{**}+Q_2{**}$.

Proof : $\overline{P_2} = MR_2(Q_2{**}) \geq MC(Q_1{**}+Q_2{**})$ in a market with a price control, and $MR_2(Q_2{*}) = MC(Q_1{*}+Q_2{*})$ in free-market. With those equations in mind, now $MC(Q_1{*}+Q_2{*}) = MR_2(Q_2{*}) \leq \overline{P_2} = MC(Q_1{**}+Q_2{**})$. Simplifying this equation, we have $MC(Q_1{*}+Q_2{*}) \leq MC(Q_1{**}+Q_2{**})$. Because the marginal cost curve is an increasing function, $Q_1{*}+Q_2{*} \leq Q_1{**}+Q_2{**}$. □

Compared to the original free-market equilibrium, the quantity demanded is only increasing in Market 2 and decreasing in Market 1, as Proposition 2 states. Now, because Proposition 3 proves that there is an overall increase in the quantity demanded, the rise in the quantity demanded in Market 2 is larger than the fall in the demanded quantity by the consumers in Market 1.

With the above propositions established, at this time I will derive mathematical formulas for the profit-maximizing prices and quantities in the two markets with a given price ceiling in Market 2. First, assume that $\overline{P_2}$ is fixed as some constant in the range of $T < \overline{P_2} < P_2{*}$. As before, the demand equations for Market 1 and Market 2 are $P_1 = a - Q_1$ and $\overline{P_2} = P_2 = b - cQ_2$, and $TR_1 = aQ_1 - Q_1^2$ and $TR_2 = bQ_2 - cQ_2^2$. Additionally, I still assume the cost curve for this firm to be $C(Q) = \frac{k}{2}(Q_1 + Q_2)^2$, and $MC(Q) = k(Q_1 - Q_2)$. With the above information, the optimal quantity for the Firm to supply in Market 2 when it meets the market demand, $Q_2{**}$, is

$$Q_2{**} = \frac{(b - \overline{P_2})}{c},$$

as $\overline{P_2}$ is fixed. Then, by setting $MR_1 = MC$,

$$Q_1** = \frac{ac - bk + k\overline{P_2}}{c(k+2)},$$

and naturally,

$$P_1** = \frac{ack + ac + bk - k\overline{P_2}}{c(k+2)}.$$

With the above formulas, the profit function in Regime 1, a situation when the firm meets the demand fully in Market 2 for a given price control, is

$$\Pi** = \left(\frac{ack - kb + k\overline{P_2}}{c(k+2)}\right)\left(\frac{ack + ac + kb - k\overline{P_2}}{c(k+2)}\right) + \overline{P_2}\left(\frac{b - \overline{P_2}}{c}\right) - \frac{k}{c}\left(\frac{ack + ac + kb - k\overline{P_2}}{c(k+2)} + \frac{b - \overline{P_2}}{c}\right).$$

Hence, for the prices in the Regime 1 range, the producer simply supplies the consumers of Market 2 on the demand curve. The main result of this producer behavior is the increased supply in Market 2 and reduced supply in Market 1. However, in the next sub-section, as I have proved before, the producer opts not to meet the demand in Market 2, and instead sells more in Market 1, where the marginal revenue is greater.

3.b. Model 2: Regime 2 – Supplying Below the Demand Curve in Market 2 with Price Control

I will now look at a case where the firm does not produce at the Market 2 demand, and instead supplies less than that amount and shifts its supply to Market 1, in order to yield greater total profit. Similar to the previous section, I will derive the optimal quantities supplied and the price in Market 1 that yield maximum profit at a given price ceiling. Now this time, assume that the firm can control the amount of Q_2 to yield the most amount of profit, so Q_2 can be chosen to be smaller than $Q_2(P_2)$.

As P_2 lowers, if the firm tries to meet the consumer demand in Market 2, it realizes that now $P_2 < MC(Q_1^{**}+D_2(P_2)) = MR\ (Q_1^{**})$. After seeing that inequality, the firm will cut back on producing Q_2 to lessen its cost to meet that P_2, as Figure 7 shows. Now at such price ceilings, $\overline{\overline{P_2}}$, at which $\overline{P_2} > T > \overline{\overline{P_2}} \geq MR_2^*$, the firm makes its production decision of profit-maximizing $\hat{Q}_1$ and $\hat{Q}_2$ in respective market, where $\overline{\overline{P_2}} = MC(\hat{Q}_1 + \hat{Q}_2)$, such that $\hat{Q}_2 < D(\overline{\overline{P_2}})$, and $MR_1(\hat{Q}_1) = MC(\hat{Q}_1 + \hat{Q}_2)$.

For some profit-maximizing $\hat{Q}_2$, for which $\hat{Q}_2 < D(\overline{\overline{P_2}})$, $\hat{Q}_1$ and $\hat{Q}_2$ are related by some function $\hat{Q}_1 = \varphi\ (\hat{Q}_2)$. The function $\hat{Q}_1 = \varphi\ (\hat{Q}_2)$ can be obtained by setting $MR_1(\hat{Q}_1) = MC(\hat{Q}_1 + \hat{Q}_2)$. Substituting that function into $\overline{\overline{P_2}} = MC(\hat{Q}_1 + \hat{Q}_2)$ now transforms the function into $\overline{\overline{P_2}} = MC(\varphi(\hat{Q}_2) + \hat{Q}_2)$. We can find the inverse of this equation because this equation is a monotonic equation, as the marginal cost curve is an increasing function at all points. Inverting the above equation, we have $MC^{-1}(\overline{\overline{P_2}}) = \varphi(\hat{Q}_2) + \hat{Q}_2$. Now for easier reading, let $MC^{-1}(\overline{\overline{P_2}}) = \psi(\hat{Q}_2)$ for some function that expresses the optimal total quantity in terms of $\hat{Q}_2$, since we are interested in finding a function that calculates the profit maximizing $\hat{Q}_2$ for some $\overline{\overline{P_2}}$. So, $\psi(\hat{Q}_2) = \varphi(\hat{Q}_2) + \hat{Q}_2$. Differentiating this equation with respect to $\hat{Q}_2$, we get $\frac{d\psi(\hat{Q}_2)}{d\hat{Q}_2} = \varphi'(\hat{Q}_2) + 1$. Here, $\varphi'(\hat{Q}_2)$ is the equivalent of $\varphi'(\hat{Q}_2) = \frac{\partial Q_1}{\partial Q_2}$. The derived $\frac{\partial Q_1}{\partial Q_2}$ from $MR_1\ (Q_1) = MC\ (Q_1 + Q_2)$, which in our linear demands and marginal cost case is $a - 2Q_1 = k\ Q_1 + k\ Q_2$, is

$$\frac{\partial Q_1}{\partial Q_2} = -\frac{k}{k+2}.$$

Substituting that derivative into the previous equation of $\frac{d\psi(\hat{Q}_2)}{d\hat{Q}_2} = \varphi'(\hat{Q}_2) + 1$, now

$\frac{d\psi(\hat{Q}_2)}{d\hat{Q}_2} = -\frac{k}{k+2} + 1$, which always is positive. Because the function $\psi(\hat{Q}_2)$ is monotonically positive, we can invert this function and find the profit maximizing $\hat{Q}_2$ for the given $\overline{\overline{P_2}}$. After determining $\hat{Q}_2$, we can naturally find $\hat{Q}_1$, as well as $\hat{P}_1$.

We can apply the steps from the method above to find the formulas for $\hat{Q}_2$, $\hat{Q}_1$, and $\hat{P}_1$ in with linear demands and marginal cost. As written above, equating *MR1*($\hat{Q}_1$) = $MC(\hat{Q}_1 + \hat{Q}_2)$, we get $a - 2\hat{Q}_1 = k(\hat{Q}_1 + \hat{Q}_2)$, and thus $\hat{Q}_1 = -\frac{k\hat{Q}_2 - a}{k+2}$. Now using the formula for $\hat{Q}_1$ that we just found, we set equal $\overline{\overline{P_2}}$ = $MC(\hat{Q}_1 + \hat{Q}_2)$, which becomes $\overline{\overline{P_2}} = k\left(-\frac{k\hat{Q}_2 - a}{k+2} + \hat{Q}_2\right)$. Then,

$$\hat{Q}_2 = \frac{\overline{\overline{P_2}}(k+2) - ak}{2k}.$$

Following the above formula for optimal $\hat{Q}_2$, we can find the rest of the variables, $\hat{Q}_1$ and $\hat{P}_1$:

$$\hat{Q}_1 = \frac{a - \overline{\overline{P_2}}}{2} \text{ and } \hat{P}_1 = \frac{a + \overline{\overline{P_2}}}{2}.$$

The profit function for the firm in Regime 2 expressed in terms of $\overline{\overline{P_2}}$ with the previous three formulas substituted is

$$\hat{\Pi} = \overline{\overline{P_2}}^2\left(\frac{k+2}{4k}\right) - \overline{\overline{P_2}}\left(\frac{a}{2}\right) + \frac{a^2}{4}.$$

In this section, I have shown the mathematical equation for the optimal quantity the producer would supply in Market 2 when the price ceiling becomes too low that it is more profitable to shift some of its sales over to Market 1. In the next sub-section, I will study at which price the change between these two producer strategies (Regime 1 and Regime 2) occurs.

3.c. Turning Price between Regime 1 and Regime 2

Now that the existence of the two regimes, which determines whether the firm decides to supply Market 2 at the demand or at the reduced levels, is established, we are interested in the price where the change in production strategy occurs. Since at this turning price, which I use *T* to express in the paper and also in Figure 8, the firm is indifferent from following the production strategy of Regime 1 or Regime 2, I equate the two mathematical equations for the optimal Q_2 in each regime from our example and solve for *T*:

$$Q_2 ** = \frac{(b - \overline{P_2})}{c} = \frac{\overline{\overline{P_2}}(k+2) - ak}{2k} = \hat{Q}_2 .$$

After mathematical manipulation,

$$T = \frac{2bk + ack}{ck + 2c + 2k} .$$

The formula for *T* shows that as *a*, *b*, and *k* all increase, *T* rises as well. Furthermore, we can find the formulas for the other variables other than the price in Market 2 by substituting this price, *T*, such as

$$Q_2^T = \frac{b(k+2) - ak}{ck + 2c + 2k},\ Q_1^T = \frac{ac + ak - bk}{ck + 2c + 2k}\ \text{, and}\ P_1^T = \frac{ack + ac + ak + bk}{ck + 2c + 2k} .$$

At these levels of quantities and prices, the firm's marginal cost of $MC(Q_2^T + Q_1^T)$ is equal to $MR_2\ (Q_2^T)$, which also holds the same value as *T*; so $MR_2\ (Q_2^*) \leq \overline{\overline{P_2}} \leq T \leq \overline{P_2} < P_2(Q_2^*)$.

The blue line and dot on Figure 9 represent the optimal Q_2 for every price ceiling between MR_2* and P_2*, and it also summarizes our findings up to this point. Between P_2* and T, the firm produces Q_2 on the demand curve, illustrated by the blue line with a negative slope of $-c$. When the price ceiling is below T but higher than MR_2*, then the firm's optimal supply of Q_2 follows the blue line between those prices with a positive slope of $\frac{k}{k+2}$. Additionally, when the government sets the price ceiling at MR_2*, the firm has the option to either sell in Market 2 at Q_2* or to exit the market completely and focus its sales only in Market 1. Either way, the firm makes the same level of profit.

Thus, Figure 9 summarizes my findings that there exists a price in the range of price ceiling where the firm changes its supply strategy from meeting the consumer demand in Market 2 to undersupplying the market and increasing supply in Market 1.

3.d. Effects of a Lower Price Regulation on Consumer and Producer Surplus

In this section, I analyze the effects of a price ceiling on consumer surplus and producer surplus in each regime. First, we start by examining those changes in Regime 1, where I argue in the following proposition that the change in aggregate consumer surplus respect to the change in the price ceiling is indeterminate, depending on parameters, while I find that a lower price ceiling in Regime 1 will certainly decrease producer profit.

Proposition 4a: Effects of price regulation on consumer and producer surplus (Regime 1)

Assuming linear demands in the two markets and a linear marginal cost curve, the effect of a lower $\overline{P_2}$ *on consumer surplus is unclear, depending on c and k. On the other hand, a smaller* P_2

negatively affects producer surplus, which is the sum of total revenue and total variable cost. Therefore, at the aggregate level, the effect of $\overline{P_2}$ *on the total surplus is unknown.*

Proof : The consumer surplus in Regime 1, CS_{R1}, is a sum of consumer surplus in each market. So, by using the profit-maximizing quantities and prices under Regime 1,

$$CS_{R1} = \frac{1}{2}(b - \overline{P_2})(Q_2**) + \frac{1}{2}(a - P_1**)(Q_1**),$$

and with all ** variables substituted in except for $\overline{P_2}$,

$$CS_{R1} = \frac{1}{2}\left(b - \overline{P_2}\right)\left(\frac{b - \overline{P_2}}{c}\right) + \frac{1}{2}\left(a - \frac{ack + ac + kb - k\overline{P_2}}{c(k+2)}\right)\left(\frac{ab - kb + k\overline{P_2}}{c(k+2)}\right).$$

Now differentiating the above equation with respect to $\overline{P_2}$ and simplifying give

$$\frac{\partial CS_{R1}}{\partial \overline{P_2}} = -Q_2** + \frac{k}{c(k+2)}Q_1**.$$

The sign of the above partial derivative depends heavily on k and c. Because $Q_1** < Q_2**$, if $c > \frac{k}{k+2}$, then $\frac{k}{c(k+2)}Q_1** < Q_1** < Q_2**$, and $\frac{\partial CS_{R1}}{\partial \overline{P_2}} < 0$. Hence, consumer surplus and $\overline{P_2}$ are inversely related, and consumer surplus increases as the $\overline{P_2}$ falls towards the minimum level of $MR_2(Q_2*)$. However, if $c < \frac{k}{k+2}$, then $Q_1** < \frac{k}{c(k+2)}Q_1**$, and whether $\frac{k}{c(k+2)}Q_1**$ is greater than, less than, or equal to Q_2** is unknown. Thus, depending on the size of k and c, $\frac{\partial CS_{R1}}{\partial \overline{P_2}} < 0$ or $\frac{\partial CS_{R1}}{\partial \overline{P_2}} > 0$ are both possible, and total consumer surplus may increase or decrease as the price of the good in Market 2 becomes cheaper.

Now, to examine the effect of $\overline{P_2}$ on the maximum profit for that $\overline{P_2}$, we first need an equation for Π^{**}. From Section 3.a., we know that

$$\Pi^{**} = \left(\frac{ack - kb + k\overline{P_2}}{c(k+2)}\right)\left(\frac{ack + ac + kb - k\overline{P_2}}{c(k+2)}\right) + \overline{P_2}\left(\frac{b - \overline{P_2}}{c}\right) - \frac{k}{c}\left(\frac{ack + ac + kb - k\overline{P_2}}{c(k+2)} + \frac{b - \overline{P_2}}{c}\right).$$

Similar to the previous example with the consumer surplus, taking the partial derivative of Π^{**} with respect to $\overline{P_2}$ yields

$$\frac{\partial \Pi^{**}}{\partial \overline{P_2}} = \frac{ack + c(k+2)(b - 2\overline{P_2}) + 2k(b - \overline{P_2})}{c^2(k+2)} > 0,$$

and the firm continues to lose profit as the price ceiling lowers in Market 2. □

Because a lower P_2 always reduces producer surplus in Regime 1, depending on the relationship of a cheaper price ceiling on consumer surplus, the total surplus may increase or decrease.

Now, we look at the changes in aggregate consumer and producer surpluses in Regime 2, and the next proposition suggests that they both decrease in Regime 2, which only concerns prices below T.

Proposition 4b: Impact of price restriction on consumer and producer surplus (Regime 2)

Assuming linear demands in the two markets and a linear marginal cost curve, a lower $\overline{\overline{P_2}}$ *in Regime 2 decreases both consumer surplus and producer surplus, which is the sum of total revenue and total variable cost.*

Proof : First, we analyze the effect of lowering the price ceiling in Regime 2 on the sum of consumer surplus of two markets, which we will denote as CS_{R2}. Substituting the above formulas for the general consumer surplus equation,

$$CS_{R2} = \frac{1}{2}(b-\overline{\overline{P}}_2)\left(\frac{\overline{\overline{P}}_2(k+2)-ak}{2k}\right)+\frac{1}{2}\left(a-\frac{a+\overline{\overline{P}}_2}{2}\right)\left(\frac{a-\overline{\overline{P}}_2}{2}\right),$$

and differentiating this equation with respect to $\overline{\overline{P}}_2$ gives the change in CS_{R2} when there is a change in $\overline{\overline{P}}_2$ of

$$\frac{\partial CS_{R2}}{\partial \overline{\overline{P}}_2} = \frac{(b-\overline{\overline{P}}_2)(k+2)-2\overline{\overline{P}}_2}{4k},$$

which is always positive. Therefore, in Regime 2, the lower the price restriction in Market 2, the lower the total consumer surplus of Market 1 and Market 2.

On the producer side, the producer surplus, PS_{R2}, or in this case, total profit, changes in the same direction as $\overline{\overline{P}}_2$ as well. As I wrote earlier, the optimal profit function in Regime 2 is $PS_{R2} = \hat{\Pi} = \overline{\overline{P}}_2^{\,2}\left(\frac{k+2}{4k}\right)-\overline{\overline{P}}_2\left(\frac{a}{2}\right)+\frac{a^2}{4}$. Following the same method as in the case of consumer surplus gives the partial derivative of producer surplus with respect to $\overline{\overline{P}}_2$, which is

$$\frac{\partial PS_{R2}}{\partial \overline{\overline{P}}_2} = \frac{\partial \hat{\Pi}}{\partial \overline{\overline{P}}_2} = -\frac{k(a-\overline{\overline{P}}_2)-2\overline{\overline{P}}_2}{2k} > 0.$$

Hence, $\hat{\Pi}$ and $\overline{\overline{P}}_2$ move in the same direction: when the price ceiling in the Regime 2 range lowers, the firm's maximum profit given that price decreases. □

Since the total surplus, TS_{R2}, is the sum of consumer surplus and producer surplus,

$$\frac{\partial TS_{R2}}{\partial \overline{\overline{P}}_2} = \frac{\partial CS_{R2}}{\partial \overline{\overline{P}}_2} + \frac{\partial \hat{\Pi}}{\partial \overline{\overline{P}}_2} > 0.$$

This shows that the aggregate surplus in Regime 2 moves in the same direction as the maximum allowed price in Market 2, and therefore, the overall effect of $\overline{\overline{P}}_2$ on the total welfare is negative.

Throughout this paper, I have emphasized the importance of the consumer welfare in Market 2 in our analysis, since the government usually regulates price in order to increase consumer surplus. Even though any price ceiling increases consumer surplus above that of the original free-market level, there arises deadweight loss if the government sets the price ceiling below *T*. At this point, I propose the following that shows the role of deadweight loss in setting the minimum level of price ceiling the government should set.

Proposition 5: Existence of an alternate minimum price ceiling

Depending on the slope of the Market 2 demand curve, the minimum level of price ceiling may be higher than MR_2^*.

Proof : Because the government accrues deadweight loss from lowering the price in Market 2 past *T*, this point occurs where such deadweight loss and the gains in consumer surplus at that price are equal in Regime 2. In my model with linear demands and marginal cost, that point occurs at

$$\overline{P}_{2\,\min} = \frac{k(ac^2k^2 + 4ac^2k + 4ac^2 + 4ack^2 + 2bck^2 + 8bck + 8ack + 8cb + 8ak^2)}{8c^2 + c^2k^3 + 12c^2k + 6c^2k^2 + 6ck^3 + 24ck^2 + 24ck + 8k^3 + 16k^2}.$$

Depending on the values of each variable, if this price is greater than $MR_2(Q_2^*)$ of

$$MR_2(Q_2^*) = \frac{bk + ack}{ck + k + 2c},$$

then the government does not set the price below $\overline{P}_{2\,\min}$ because the gain in consumer surplus is less than the deadweight loss beyond that price. Such pricing restriction occurs when the slope of the demand in Market 2, in our case, *c*, is high enough, as a large *c* increases the area of the deadweight loss. On the other hand, if $MR_2(Q_2^*) > \overline{P}_{2\,\min}$, then the lowest the authorities can set the price in Market 2 is $MR_2(Q_2*)$, since if the regulators set the price lower than $MR_2(Q_2*)$, then the best choice for the firm is to exit the market. □

Hence, in this sub-section, I have shown the importance of producer and consumer surpluses in this model. Propositions 4 a and b show the changes in the two aggregate surpluses, and in Proposition 5, I use the change in consumer surplus and deadweight loss in order to determine the true value of the minimum price ceiling, which is either $MR_2(Q_2*)$ or the price where the increase in consumer surplus from lowing the price ceiling under T is equal to the deadweight loss, whichever is larger.

4. Discussion and Conclusion

With the assumption that there are two markets of different demands, Markets 1 and 2, this paper studies the effects of a price ceiling in the market with a smaller demand, Market 2, on a monopoly's supply behavior and on consumer and producer welfare in both markets. Furthermore, this paper also suggests a range for which a government to set a price restriction. In Model 1, I assumed a constant marginal cost for production by the firm. In this example, with $\tilde{P}_2$, the firm supplies at the demand in Market 2, with no changes taking place in Market 1. Additionally, in Model 1, consumer surplus always increases with a lower price ceiling, but the producer surplus constantly falls. Hence, the government in Market 2 most likely sets the price control somewhere near the marginal cost to maximize consumer surplus, even though the manufacturer is at a significant loss in this situation compared to the profit it makes in an unregulated market.

Unlike in Model 1, Model 2 has a linearly increasing marginal cost. In this situation, if the price ceiling in Market 2 is high enough, the firm produces at the Market 2 demand, increasing consumer surplus in that market and making the good available to a larger population at a lower price. However, if the government sets the price ceiling moderately low, then the manufacturer no longer produces the demanded amount in Market 2, and it undersupplies the market. Therefore, past a certain level of price control, there arises a deadweight loss in the market with a price regulation due to a shortage of the good in Market 2. As the price is lowered further, this deadweight loss increases along with the consumer surplus. Nonetheless, the increase in consumer surplus is larger than the deadweight loss up to where they are equal, and so the government will choose to lower P_2 until that point or the MR_2*, whichever is larger.

While the lower price in Market 2 positively affects the consumer surplus in that market, the price ceiling in Market 2 has a negative impact on the consumer welfare in Market 1. Since the degree of the change in each market depends on the slopes of the curves of marginal cost and the Market 2 demand, the overall impact of the price control on consumer surplus is indeterminate in the general case. However, the effect of the price ceiling on producer welfare is definitely negative, as I showed earlier. Since the drug manufacturers are now selling at a lower price abroad, they are not maximizing their profit. This reduces producer surplus and also incentives for these firms to invest in R&D in order to invent the most effective drugs (ITA, 2004). Over the years, as Internet sales have become more common, importation of cheap pharmaceuticals from abroad, such as Canada and Western Europe, has become a major issue that has sparked political debate in the United States (Calfee, 2003). Because many pharmaceutical companies' headquarters are located in the US, those firms prefer bans on re-importation of cheaper drugs from abroad into the US. Currently, siding with the drug manufacturers, the US law allows a small amount of imported drugs for personal use (Randall IV and Vogt, 2002). Due to a loss in the producer profit from the cheaper drugs abroad, even though consumer welfare may be increased in the short-term, it can be worsened in the long-run because of the lower amount of new pharmaceuticals entering the market.

Although this paper offers insight into the effects of a price regulation in a market with price discrimination, there should be further research done on this topic for a more comprehensive understanding. For theoretical extensions, this paper only examines the case with a price control in the smaller market. Understanding the impacts of a price ceiling in Market 1 is equally important, even though this may be a less realistic or common occurrence compared to a price ceiling in Market 2. Similar to my findings, I hypothesize that there is be a turning point price in Market 1, where the firm stops to meet the demand in Market 1. However, to obtain the specifics of this situation, one needs further examination.

Another possible future study is on the effects of price controls with a marginal cost curve of any shape. To obtain a more complete and general understanding of the mechanisms of price controls in third-degree differential pricing situation, a research with a high degree marginal cost function is necessary. Furthermore, the exact effect of price restrictions on welfare remains unclear, as it was beyond the scope this paper because the results were highly dependent on the slopes of the marginal cost and the demand curves in Market 2. Additionally, in order to simplify the model, I worked with a monopoly firm without considering the competition from other producers. In a more realistic model, however, the availability of cheaper third-party generic drugs to consumers should be taken into account to provide a more comprehensive and realistic understanding of the topic.

Most importantly, an empirical study with data, such as those obtained from a drug manufacturer, is essential to test the validity of my findings if possible. The most testable and interesting study is on the extent to which a price control abroad raises domestic prices and curtails domestic sales. A research of how closely my models reflect the production decisions by the firm is extremely beneficial, although my models are very simple and disregard other factors that may influence supply and pricing. Hence, my paper offers a numerous potential future researches that need further investigation to attain a full idea on the topic of price controls in third-degree differential pricing.

5. Appendix: Figures

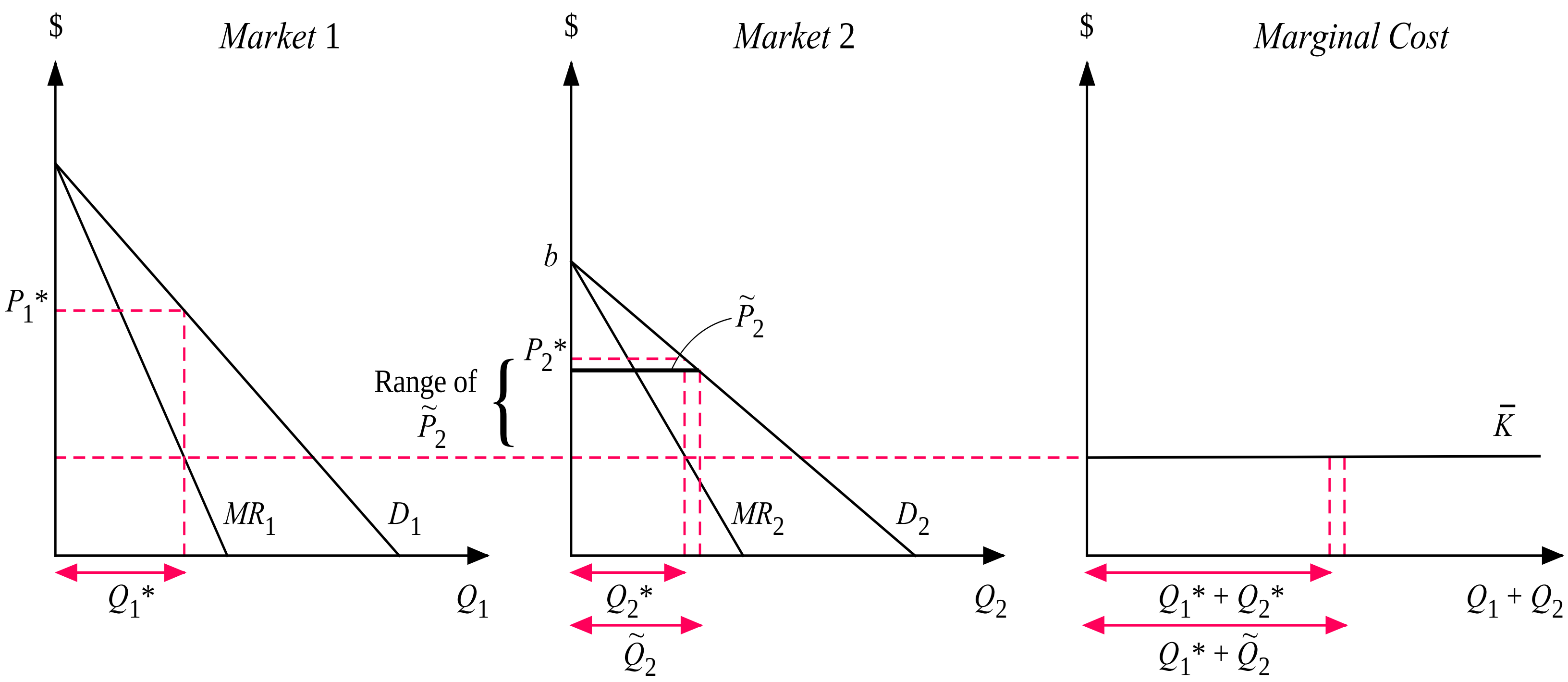

Figure 1: Price Control in Market 2 with Constant Marginal Cost

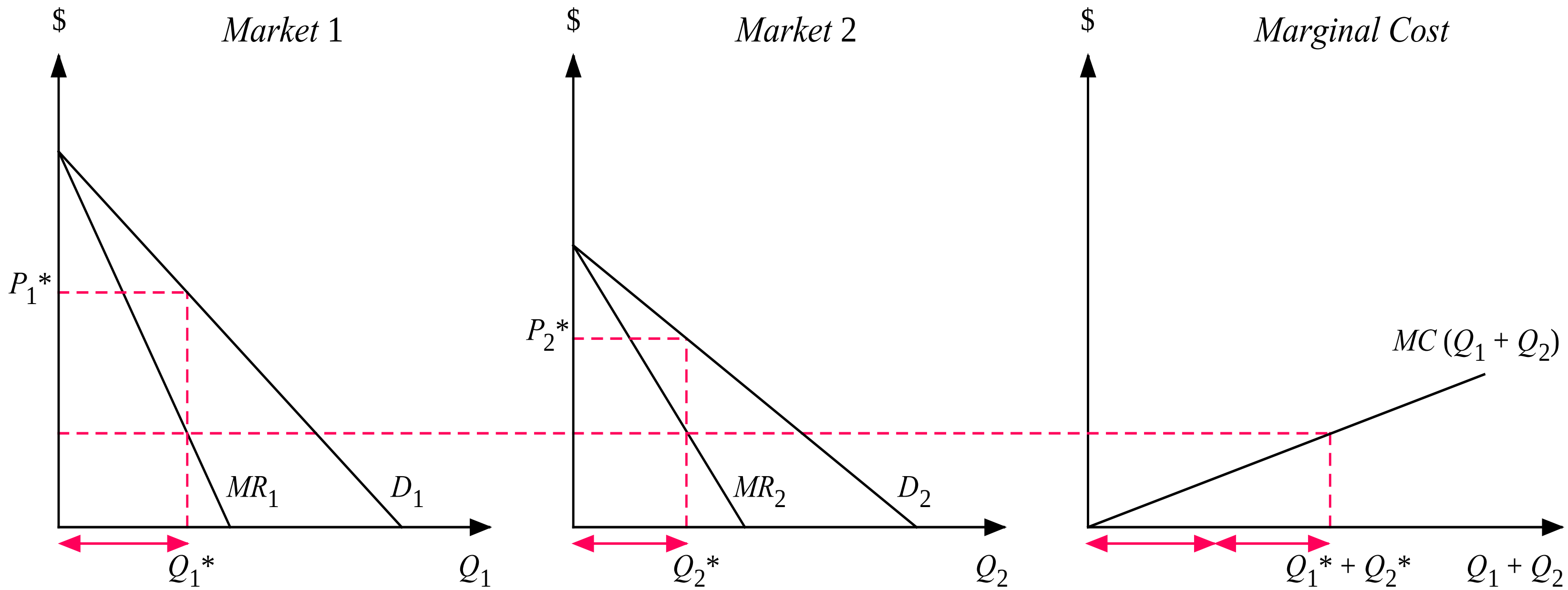

Figure 2: Equilibrium Quantities and Prices in Free Market Third-Degree Differential Pricing

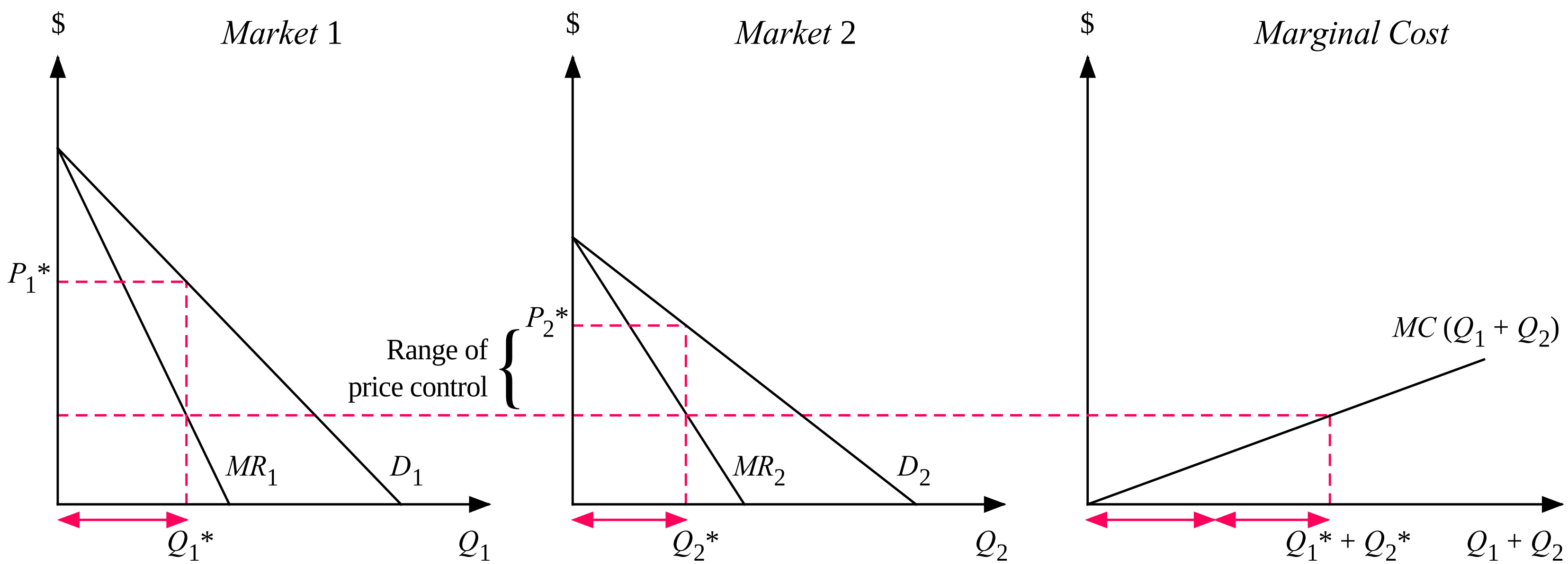

Figure 3: The Range of Price Control

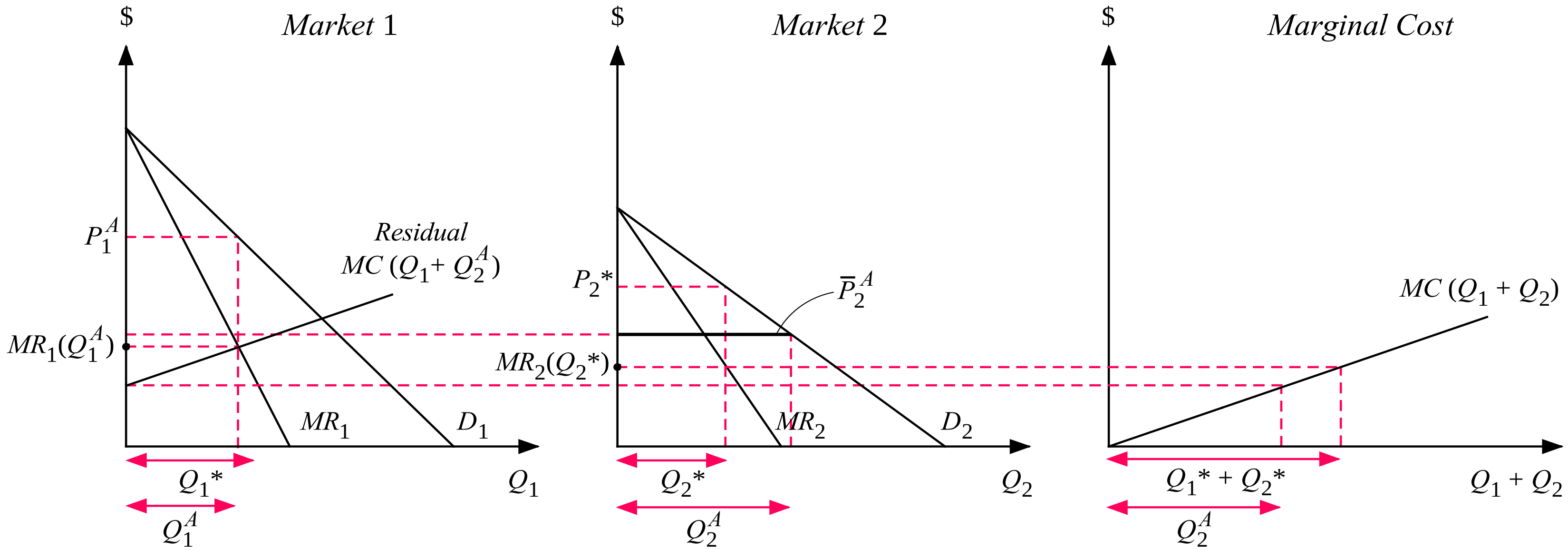

Figure 4: Case of Producing at the Demand in Market 2

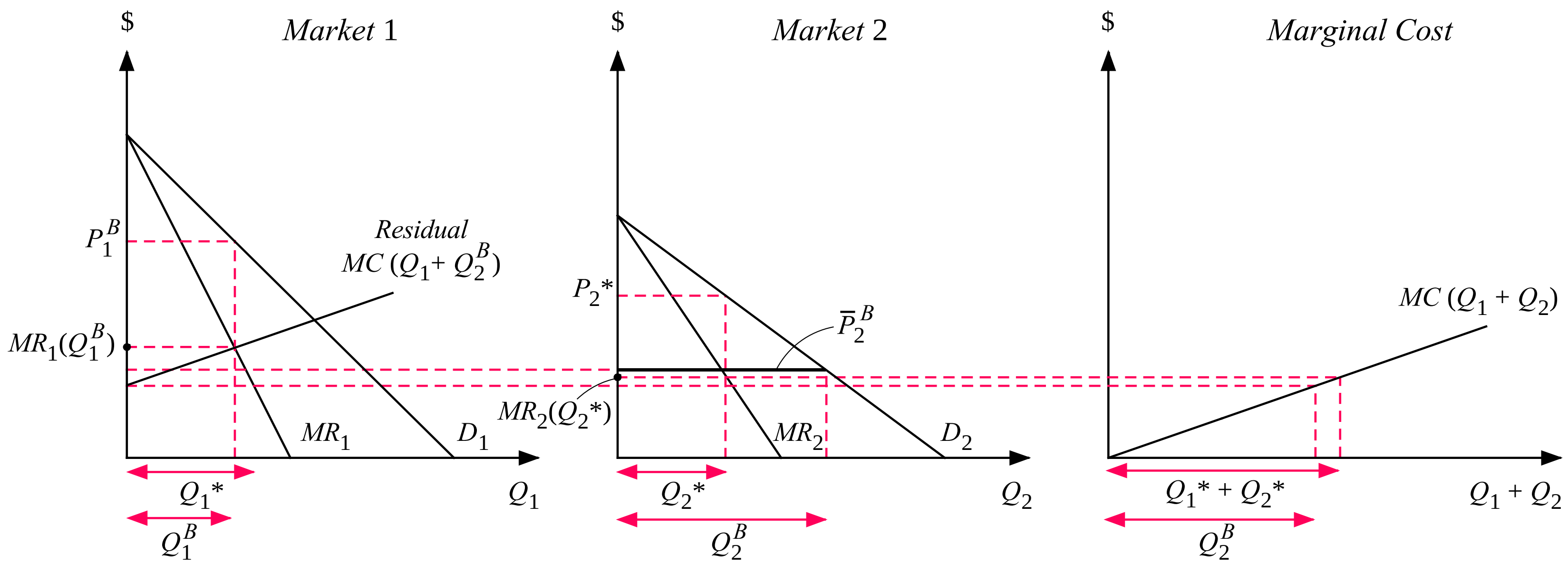

Figure 5: Case of Not Meeting the Demand in Market

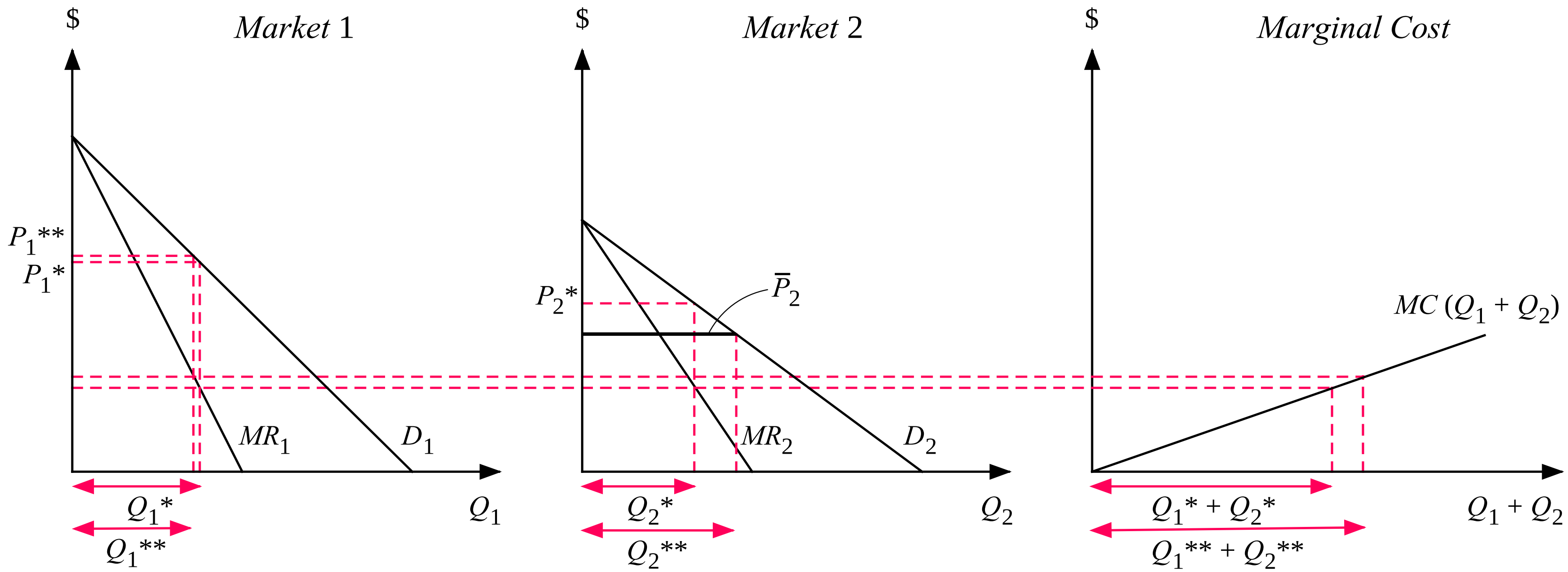

Figure 6: Profit Maximization in Regime 1

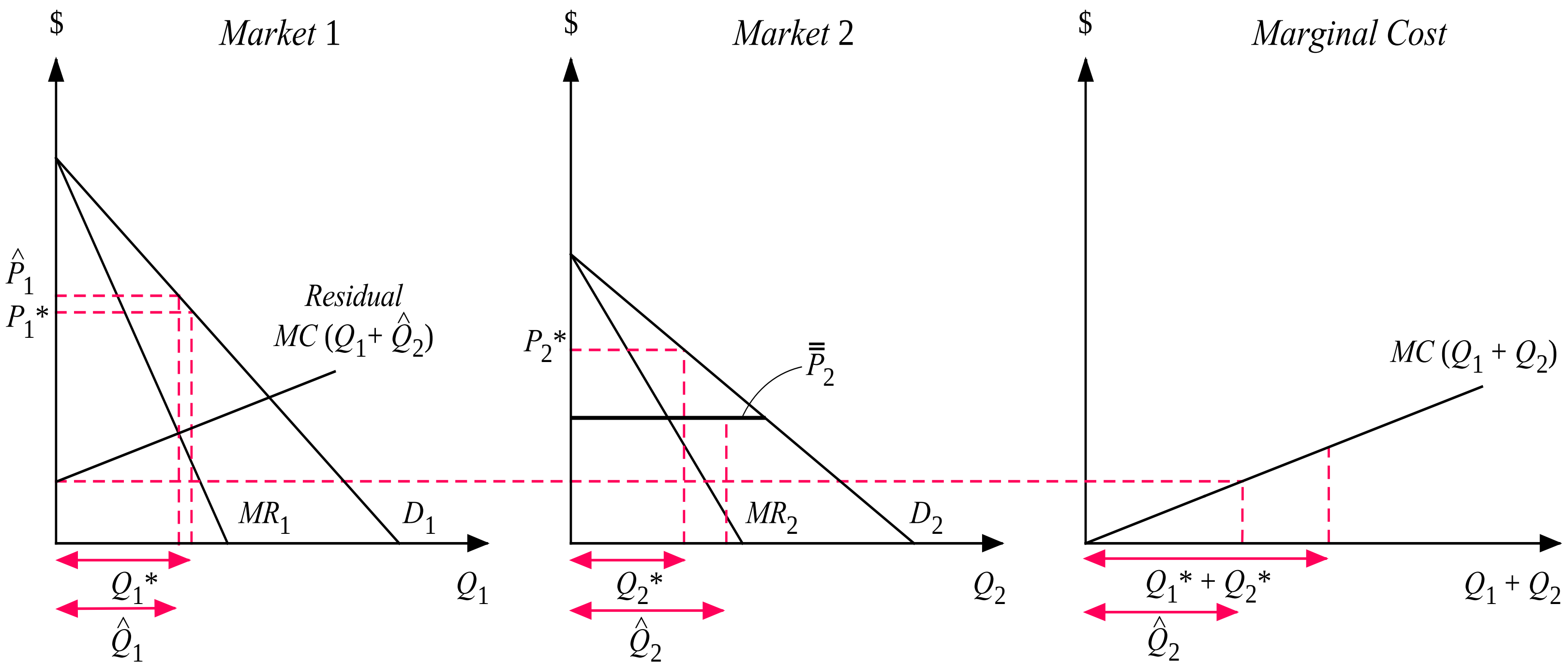

Figure 7: Profit Maximization in Regime 2

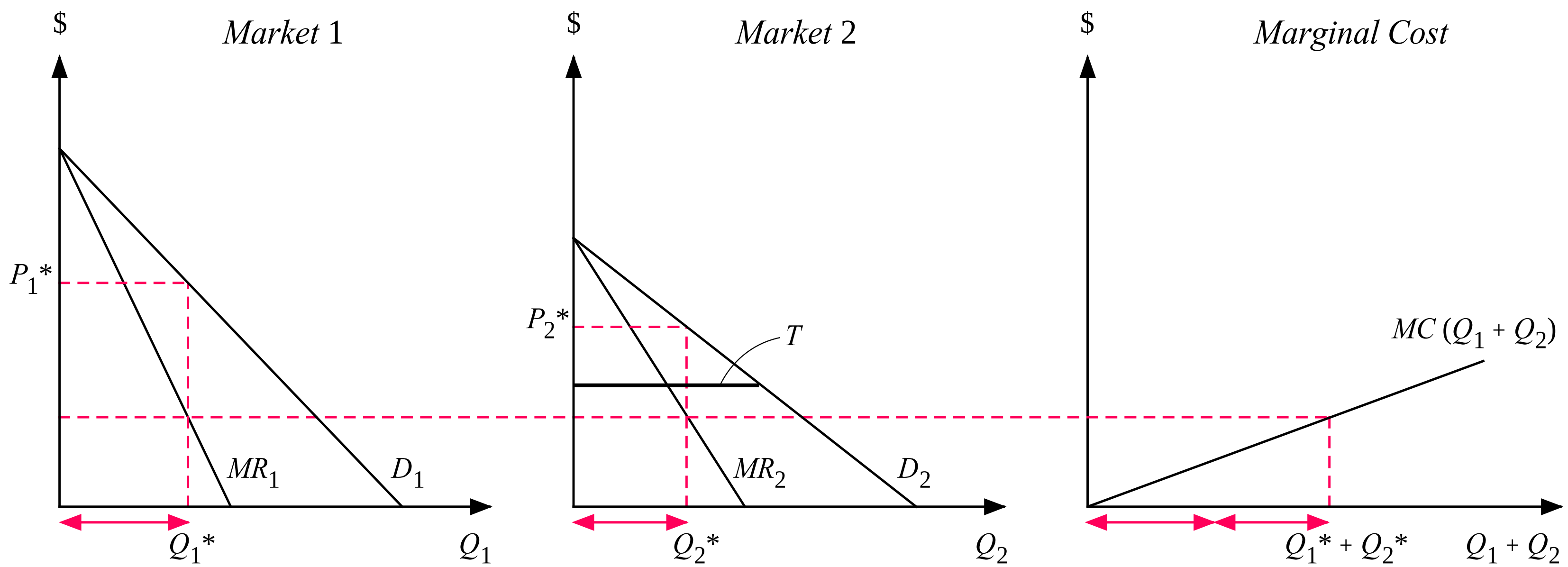

Figure 8: Supply at Turning Point Price Ceiling (*T*)

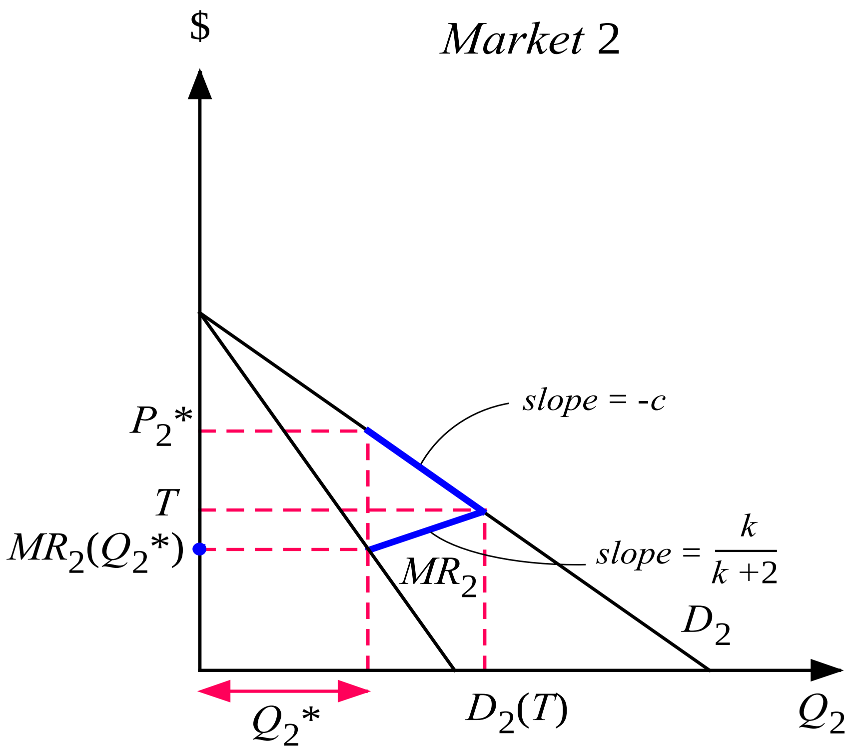

Figure 9: Optimal Q_2 with Price Ceiling

6. References

Abel-Smith, Brian, and Elias Mossialos. "Cost Containment and Health Care Reform: a Study of the European Union." *Health Policy* 28.2 (1994): 89-132.

Blanchard Randall and Donna U. Vogt. *Importing Prescription Drugs*. United States Congress. Congressional Report. [Washington, D.C.]: Congressional Research Service, Library of Congress, 2002.

Calfee, John E.. "The Grim Economics of Pharmaceutical Importation." *AEI Online*. American Enterprise Institute, 1 November, 2003. Web. 9 April, 2012. <http://www.aei.org/article/health/the-grim-economics-of-pharmaceutical-importation/>.

Danzon, Patricia M. "Price Discrimination for Pharmaceuticals: Welfare Effects in the US and the EU." *International Journal of the Economics of Business* 4.3 (1997): 301-22.

International Trade Administration. *Pharmaceutical Price Controls in OECD Countries: Implications for U.S. Consumers, Pricing, Research and Development, and Innovation.*Washington, DC: U.S. Dept. of Commerce, International Trade Administration, 2004.

Lanjouw, Jean O.. "Patents, Price Controls and Access to New Drugs: How Policy Affects Global Market Entry." Agricultural and Resource Economics Department: UC Berkley. 2005.