

Entry Pricing and Product Quality: The Case of Antidepressant Drugs

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ABSTRACT

The rising prices of pharmaceuticals have generated considerable, and often acrimonious, debate. Yet, there is little theoretical work or empirical evidence on pharmaceutical entry-pricing strategies or on the time paths of the prices of new entrants versus incumbents. This study explores the entry pricing strategies of pharmaceutical manufacturers.

Previous theoretical models have considered a “price skimming” strategy, with drugs entering the market at a premier relative to incumbents or a “market penetration” strategy, pricing the drug at a discount in the hope of gaining market share. The selection of appropriate strategy depends upon the degree of product differentiation and/or the nature of repeat purchase arrangements. However, these investigations have not examined the implications of product quality for entry pricing and pricing dynamics.

The present study provides a model that demonstrates the interplay between quality and product differentiation in determining the optimal pricing strategy. In particular, higher (lower) quality products will engage in price skimming (market penetration) strategies in markets where products are sufficiently differentiated, but will choose a market penetration (price skimming) strategy in markets that are less differentiated. The reason is that in less differentiated markets, price competition is more important than quality competition for gaining market share and higher-quality firms are better able to garner greater market share through price cuts.

We tested this model using a unique database that combines information on drug price and quality for antidepressant drugs during the years 1999-2002. Based on quality perceptions by physicians, the antidepressant market we examine is a relatively homogeneous drug class, which consisted largely of selective serotonin reuptake inhibitors (SSRIs).

The results indicate that higher quality antidepressants engage in a market penetration strategy, charging initially lower prices that rise over time. Five years post-entry, we find that prices of all antidepressant drugs examined tend to converge. These findings are consistent with a market in which product differentiation is modest and consumers learn which drug works best for them through experience.

JEL Classification: I110, L100, L110

I. INTRODUCTION

Pharmaceuticals account for a significant share of total health care expenditures in the United States. In 2003, Americans spent \$179.2 billion on prescription drugs, almost 4.5 times the \$40.3 billion spent in 1990. Importantly, the rate of spending growth for prescription medications outpaced other areas of medical care from 1995 to 2003. During the period from 1995 to 2002, pharmaceutical manufacturing was the most profitable industry in the United States (Kaiser 2005).

The rapid increase in pharmaceutical spending has generated both interest and controversy over drug pricing. Yet, there is little theoretical or empirical evidence on entry pricing strategies or the time paths of the prices of new entrants versus incumbents. This study explores the entry pricing strategies of pharmaceutical manufacturers. Previous work has suggested that market conditions determine whether entrants choose lower penetration prices or higher skimming prices. Specifically, in markets where products are relatively well-differentiated and repeat purchase arrangements are less common, entrants are thought to adopt a market-skimming entry pricing strategy, charging a relatively high initial price. However, in more homogeneous markets and in those where repeat purchases are more common, one might expect a market penetration pricing strategy by an entrant (Eaton and Lipsey 1989; Schmalensee 1982; Dolan and Jeuland 1981; Rao 1984). In such markets, there may be greater uncertainty as to whether the entrant's drug is a significant improvement. Thus, the manufacturer may adopt a low-price entry strategy to familiarize consumers with the product, reaping the benefits in the form of higher market shares and prices over time.

Product quality has also been thought to affect entry pricing. For instance, Dean (1969) argued that higher-quality entrants will engage in a skimming strategy, while entrants that offer only marginal improvements will adopt a market penetration strategy, charging lower initial prices. Previous

research seems to suggest that (1) the degree of product differentiation and nature of repeat purchase arrangements affect the decision to engage in skimming or penetration pricing strategies and (2) substantially higher-quality products tend to adopt skimming strategies while modestly better products will engage in market penetration strategies.

While earlier theoretical models considered the roles of product differentiation and repeat purchases on pricing strategies, existing models have not explicitly derived the role of quality in affecting entry pricing strategies and subsequent pricing decisions. Moreover, existing studies on the effects of product differentiation and repeat purchase arrangements on entry pricing are fundamentally *across-market* issues, i.e., they account for alternative entry pricing strategies across markets that are distinguished by their product differentiation and/or the nature of repeat purchases of their products. However, these studies do not tell us if and when firms within a product market might engage in skimming or market penetration pricing strategies. Implicitly, these models assume that all firms within a given market adopt the same entry pricing strategy.

Thus, no current theory suggests how firms *within a product market* choose to engage in skimming or market penetration pricing strategies based on differences in product quality. Such a model would need to derive not only the relationship between quality and the entry price, but also the evolution of price over time.¹ Moreover, no previous work has examined the potentially important interactions between quality and product differentiation on optimal entry pricing strategies. In particular, no study has considered whether the relationship between product quality and pricing might vary depending upon the degree of product differentiation within a given market.

¹ For example, to formally derive a skimming strategy, one needs to show conditions for which higher quality leads to a higher entry price and conditions under which that price declines over time.

To help bridge these gaps in the literature, we provide a model in which entry pricing and pricing dynamics are determined as a function of product quality. Here, we demonstrate that the decision by manufacturers of higher-quality products to engage in skimming versus market penetration price strategies itself depends upon the degree of product differentiation within the market. In relatively homogeneous markets, market share is quite sensitive to price and a market penetration strategy is beneficial to makers of the higher-quality products. This is consistent with Comanor's (1986) assertion that price competition is more important when the market is relatively homogeneous.² In such cases, our model shows that market share *of the higher-quality products* is particularly sensitive to price, so that, for example, higher-quality drugs will set low initial prices to help generate greater market share. In more differentiated markets, firms manufacturing higher-quality products will optimally choose a market skimming strategy.

Our model is tested empirically using a nationally representative data set on drug utilization and expenditures combined with a physician survey on the quality attributes of drugs to examine the effect of drug quality on pharmaceutical pricing strategies. Our quality measure consists of a comprehensive physician assessment of drug attributes and it provides an overall index of a drug's efficacy and side effects.

Specifically, we examine the brand name antidepressant drug class during the period 1999 to 2002.

Based on physician quality perceptions, the brand name antidepressant market is a rather

² Comanor 1986: "...where sellers of new products have not been able to achieve substantial quality advantages, they rely more on price competition to enter a therapeutic market. Products that embody higher quality, on the other hand, are more distant from the competitive pressures of established products and can be priced at higher levels."

homogeneous drug class, consisting largely of selective-serotonin reuptake inhibitors (SSRIs). Using the data described above, we find strong evidence that antidepressant drugs adopt a market penetration pricing strategy, that is, higher-quality antidepressants enter at lower prices, but their prices rise over time. Low-quality antidepressants enter at higher prices and their prices decrease over time. These results are consistent with our model, namely, that market share is particularly sensitive to price for antidepressants with relatively high quality. Thus, the optimal strategy for higher-quality antidepressants is to adopt a market penetration pricing strategy.

Interestingly, we find that five years post-entry, the prices of the antidepressant drugs converge. This is consistent with consumer-search behavior: consumers switch among the drugs to find the one that works best for them -- which is not necessarily the one with the highest physician valuation -- and prices are adjusted over time via the switching process. As the antidepressant market is relatively homogeneous, the switching process is relatively stable and symmetric and all of the prices converge after 5 years.

The remainder of this paper is divided into seven parts. Part II summarizes the literature on entry pricing and empirical work as it pertains to the pharmaceutical industry. The antidepressant drug market examined in this study is described in Part III and the conceptual framework is presented in section IV. Part V describes the data and empirical models to be estimated and the results are presented in Part VI. Part VII summarizes the findings and their implications.

II. PREVIOUS WORK

There are two distinct types of rivals in pharmaceutical markets. First, there is competition from the branded substitutes, which typically embody different chemical entities and enjoy patent protection,

and second, there is competition from generic versions of new and existing products (Rao 1984).³ Unlike different generic versions of the same drug, brand name competitors are differentiated in terms of quality. As we are particularly interested in the role of quality in entry-pricing strategies, our analysis focuses on brand name-drugs.

THEORETICAL STUDIES

Dean (1969) distinguishes between two strategies for pricing new products: “skimming” pricing and “penetration” pricing. Skimming is the strategy of setting a high introductory price and then lowering it over time, while penetration is the strategy of setting a low price for a new product to gain market share, raising the price thereafter. Dean suggests that skimming may be used to extract the highest willingness to pay among consumers. This strategy may also be adopted when a product has few “close rivals” in its early stages.⁴ On the other hand, Dean asserts that penetration is more common

³ In much of this literature, price competition is not considered until patents have expired and generic substitutes enter. For instance, Frank and Salkever (1997) find higher prices following generic entry, while Caves et al. (1991) find a slight decline in a branded drugs’ price after the appearance of generic rivals. Grabowski & Vernon (1992) find the price trends of the original brand name drugs following generic entry differ by drug category. Thus, evidence on the effect of generic competition on the prices charged for the original brand name drugs is mixed.

⁴ That is, price skimming will occur in more differentiated markets. Dean discusses these ideas but does not formalize them in terms of a model. Eaton and Lipsey (1989) make a similar argument in the context of a spatial model of product differentiation.

when market share is very sensitive to the price or when the products face drastic (potential) competition. This work gives an insightful qualitative analysis, but does not provide a formal model.

A number of theoretical studies of pricing strategies followed Dean's seminal work. Schmalensee (1982) considers the riskiness of new products, suggesting that pioneering products should charge low entry prices, because the manufacturer must persuade customers to try its "ex ante risky product" in order to build its reputation. In addition, late entrants face substantial disadvantages relative to pioneering brands, so they need to set even lower introductory prices. Therefore, the optimal strategy for the later entrants is to differentiate themselves from the predecessor and avoid being perceived as a "me-too" brand.

Shapiro (1983) explored the optimal pricing strategy of a firm with an experience product, in which consumers learn about quality through use of the product itself. He states that firms' pricing strategies may be categorized according to customers' initial evaluations of the product: overestimation and underestimation of the product (i.e. optimistic and pessimistic evaluations). If consumers overestimate the quality of the product, the firm will milk its reputation. In this case, the optimal strategy is to set a high introductory price and then decrease the price over time. In the underestimation case, the product's reputation must be established and the best strategy in this case is to set a low introductory price and raise it over time. Shapiro considered the role of consumers' information, but not product signaling from the supply side.

Bagwell and Riordan (1991) model entry prices as a signal of quality. At the beginning of the period, the firm sets a price and then consumers form their beliefs about product quality on the basis of this signal. This belief is updated each period. As consumers become more informed about the drug's

quality, the price distortion lessens. The investigators argue that the most efficient way for the firm to signal high quality of new products is to charge high introductory prices.

The studies by Schmalensee (1982), Shapiro (1983) and Bagwell and Riordan (1991) shed light on how entry pricing may be affected by perceptions of quality (Schmalensee; Shapiro) and by the impact of price as a quality signal (Bagwell and Riordan). However, these studies do not explore the means by which products with different quality levels adopt different entry pricing strategies.

Moreover, they do not consider the role of product differentiation on entry pricing.

Dolan and Jeuland (1982) devised the first study to explicitly model drug pricing strategy in an intertemporal framework. They set up a theoretical model and interpret the skimming and penetration strategies according to the nature of demand. They conclude that market penetration pricing is optimal if repeated purchases of products are important and the skimming strategy is optimal if the demand is stable and production costs decrease over time. However, Dolan and Jeuland do not relate skimming or penetration strategies to variations in product quality.

EMPIRICAL STUDIES

Reekie (1978) investigated Dean's entry pricing ideas in the pharmaceutical market by examining the launching prices for 171 new molecular entities (NMEs) introduced into the U.S market between 1958 and 1975. He finds that the prices of new drugs with important therapeutic gains are significantly higher than the existing counterparts and that the prices of these drugs decline over time. In contrast, the prices of imitators are much lower than the existing drugs and these low initial prices are followed by increases in price over time.

Lu and Comanor (1998) explore the demand-side determinants for New Chemical Entity (NCE) prices. They examine the pricing strategies of 144 newly patented pharmaceuticals in the United States

between 1978 and 1987, finding that the main explanatory elements are the “therapeutic value” of the product and the competition in the market. Their study shows that the introductory price of drugs representing “important therapeutic gains” can be two or three times those of existing products. However, the drugs that largely duplicated existing ones are typically priced at comparable levels. They also examine the time path of drug prices following entry and find that the prices of the important new drugs declined by about 13% on average four years after entry into the market, while the prices of drugs with little or no therapeutic improvement rose by 22% on average.

Following Lu and Comanor’s (1998) approach, Ekelund and Persson (2003) review the pricing strategies of 246 NCEs in the Swedish market and compare the results with those in the US market. The Swedish pharmaceutical market is highly regulated, with various forms of price-cap regulations and other regulatory initiatives to limit pharmaceutical costs. Using the methodology delineated in Lu and Comanor (1998), they also find that introductory prices are positively correlated with drug quality. In contrast to the results in the US market, however, they did not find evidence of market penetration pricing strategy. Instead, all prices decrease substantially over time.

Perhaps due to sample size considerations, empirical studies of entry pricing in the pharmaceutical industry only consider the effects of quality on pricing across drug product markets. In contrast, we explore the effects of quality on entry prices *within* a large drug product market – antidepressants. This approach allows us to examine whether and to what extent quality affects entry pricing within a specific drug product class and to examine whether drugs within the same product class adopt different entry pricing strategies. Before turning to our empirical tests, however, the following section describes the antidepressant drug product market.

III. THE MARKET FOR ANTIDEPRESSANT DRUGS

Depression is one of the most prevalent and debilitating disorders in the United States, having an estimated lifetime prevalence between 10 and 20 percent (Katon and Sullivan 1990; Kessler et al. 1993; 1994).⁵ Depression is a chronic illness and patients frequently suffer recurrences or relapse (Thase 1990). As a result of the high prevalence and chronicity of depression, the market for antidepressant drugs is quite large. Recent evidence (Drug Benefits Trends 2005) indicates that 10 percent of women and 4 percent of men aged 18 and older currently take antidepressants. The report also shows that antidepressants were associated with the top 5 highest costs per member per year (PMPY) in 2002, averaging \$50.46.

Antidepressant drug use is common and has increased substantially in recent years. According to results from the National Ambulatory Medical Care Survey comparing data from 1999 with similar data from 1985, antidepressant drugs accounted for 13% of the entire increase in pharmaceutical prescribing (Pomerantz 2003). Sales of antidepressants are quite substantial and are likely to remain so. Total revenues from sales of antidepressants in the U.S. are estimated to grow from \$3.72 billion in 1996 to \$14.34 billion by 2006 (Frost and Sullivan 2001 Figure 4-6). SSRIs have dominated these sales, accounting for nearly 90% of sales in 1996. (Frost and Sullivan 2001 Figure 4-7).

Antidepressant drugs are most commonly associated with the treatment of depression, including major depression, dysthymia, and depression co-existent with anxiety disorders (Market Measures 2001, p. III-9). The oldest classes of antidepressant drugs include tricyclics (TCAs) and monoamine oxidase inhibitors (MAOIs), each of which have been available in the U.S. for decades. While these drugs are

⁵ Given its high prevalence and chronic nature, the economic burden of depression is very large. Research indicates that the costs of depression totaled \$83.1 billion in 2000 (Greenberg et al. 2003).

effective in the treatment of depression, they may have serious side effects. For instance, TCAs may be lethal when taken in overdose. As a result, these drugs are much less commonly used today. SSRIs began to appear in the late 1980s and 1990s. They have similar effectiveness to TCAs and MAOIs, but with better-tolerated side effects. Most recently, additional antidepressants have become available, including non-selective serotonin reuptake inhibitors (NSRIs) and selective norepinephrine reuptake inhibitors.

Antidepressants thus include a number of brand name drugs which are only available by prescription. We studied nine drugs constituting the vast majority of brand-name antidepressant drug sales in the United States. These drugs are in three therapeutically interchangeable categories of medications: selective serotonin reuptake inhibitors (SSRIs), which include Prozac (fluoxetine), Zoloft (sertraline), Paxil (paroxetine), and Celexa (citalopram); selective norepinephrine reuptake inhibitors (SNRIs), which include Effexor (venlafaxine) and Effexor XR; and “other,” a category that includes Wellbutrin SR (bupropion), Serzone (nefazodone) and Remeron (mirtazapine).

The antidepressant drugs included in our study are listed in Table 1. The drug introduction dates are taken from the FDA Orange Book. We also list physician’s average perceived quality for each drug from the Market Measures (2001) surveys.

[INSERT TABLE 1]

IV. CONCEPTUAL MODEL

TWO-PERIOD MODEL

We present a two-period model of a profit-maximizing pharmaceutical manufacturer. The firm chooses its drug's initial entry price and the price in the subsequent period. As the marginal production cost of pills is very low, we may ignore these costs without loss of generality.⁶

The firm chooses prices for its drug in each time period in order to maximize profits:

(1)

$$\max_{P_0, P_1} P_0 \rho(P_0, P_0^m, Q, Q^m, \xi) Y_0 + \frac{P_1}{1+r} (\alpha \times m(P_1, P_1^m, Q, Q^m, \xi) \rho(P_0, P_0^m, Q, Q^m, \xi) Y_0 + m(P_1, P_1^m, Q, Q^m, \xi) Y_1)$$

where

P_0 = the drug's entry price

P_1 = the drug price in period 1

P_0^m = the average price of all other drugs in the market at time 0.

P_1^m = the average price of all the other drugs existing in the market at time 1

Q = the quality of the drug

Q^m = the average quality of all other drugs in the market⁷

Y_0 = the number of potential new consumers of the drug in period 0

Y_1 = the number of potential new consumers of the drug in period 1

$\rho(P_0, Q, P_0^m, Q^m, \xi)$ = the fraction of potential new customers in period 0 who purchase the drug

$$0 \leq \rho \leq 1$$

⁶ In the pharmaceutical industry, research and development costs are quite substantial (Dimasi et al. 2003). Such costs are incurred well in advance of product launch and may be regarded as sunk costs at the time that pricing decisions are made. One could include production costs of pills by simply regarding the prices as being net of these small unit production costs without any changes in the model or its conclusions.

⁷ According to the physician perceptions, the quality of drug does not change significantly over time. In this model, we assume the drug's own quality and the market quality remain the same in two periods.

$m(P_1, P_1^m, Q, Q^m, \xi)$ = the fraction of potential customers in period 1 who purchase the drug

$$0 \leq m \leq 1$$

ξ = parameter measuring the degree of market differentiation. $0 \leq \xi \leq 1$ ⁸.

r = positive rate of discount

α = parameter measuring the rate of repeat purchases $0 \leq \alpha \leq 1$ ⁹

In period 0, the drug is sold to ρY_0 customers and there are $m Y_1$ new customers who purchase the drug in period 1. In addition, some fraction of those customers who bought in period 0 continue to purchase the drug in period 1 and this fraction will be greater if the drug is used for long-term treatment (i.e., it requires more repeat purchases); the expression $\alpha m \rho Y_0$ gives the number of these customers. We assume that $\partial \rho / \partial P_0 < 0$; $\partial \rho / \partial Q > 0$; and $\partial^2 \rho / \partial P_0 \partial Q < 0$. That is, a higher price reduces the fraction of potential consumers who will purchase the drug while higher quality increases this fraction. The expression $\partial^2 \rho / \partial P_0 \partial Q < 0$ indicates that a lower entry price leads to greater market share and that this effect is greater in absolute value (more negative) with increasing product quality.¹⁰

⁸ A higher value for ξ indicates greater market differentiation.

⁹ A market with a high level of repeated purchases has a high level of α , i.e. α is close to one, meaning that more customers from pervious period will appear again in the second period because of the long-term treatment.

¹⁰ This may be illustrated with an explicit example:

$$\text{Let } \rho(P, Q) = Q^5 P^{-5}$$

$$\text{Then } d^2 \rho / dP dQ = -.25 Q^{-5} P^{-1.5} < 0.$$

We also observe that the fraction of potential new customers ρ not only depends on the drug's own price P_0 and quality Q , but also on the market price P_0^m , market quality Q^m , and degree of market differentiation ξ . Thus, the pharmaceutical market we envision is a form of monopolistic competition, in which the firm has to take into account market price and quality conditions when setting its own price. For purposes of analytic tractability, we take P_0^m , Q^m and ξ as given.

We assume that $\partial\rho/\partial P^m > 0$; $\partial\rho/\partial Q^m < 0$; $\partial^2\rho/\partial P_0\partial P_0^m < 0$; $\partial^2\rho/\partial P_0\partial Q^m > 0$. In other words, a higher market price will increase the share of consumers purchasing the firm's drug, but this effect is smaller at higher levels of that drug's price. A lower market quality will increase the drug's demand, with this negative effect being less at higher levels of that drug's price.

We further assume that $\partial^2\rho/\partial P_0\partial\xi > 0$ and $\partial^2\rho/\partial Q\partial\xi > 0$. Thus, if a market is more differentiated, demand increases less with decreased price and demand increases more with higher quality. We posit that there exists a critical value ξ^* , above which the market can be considered as relatively differentiated and below which the market is relatively homogeneous.¹¹

Maximizing (1) with respect to P_0 and P_1 gives:

$$(2) \quad \rho + P_0 \frac{\partial\rho}{\partial P_0} + \frac{\alpha m P_1}{1+r} \frac{\partial\rho}{\partial P_0} = 0$$

$$(3) \quad \frac{\partial m}{\partial P_1} = -\frac{m}{P_1}$$

Substituting (3) into (2), and total differentiating (2) we obtain the following comparative statics results:

¹¹ We similarly assume $\partial m/\partial P_1 < 0$; $\partial m/\partial P_1^m > 0$; $\partial m/\partial Q > 0$; $\partial m/\partial Q^m < 0$; $\partial^2 m/\partial P_1\partial Q < 0$; $\partial^2 m/\partial P_1\partial Q^m > 0$; $\partial^2 m/\partial P_1\partial P_1^m < 0$; $\partial^2 m/\partial P_1\partial\xi > 0$ and $\partial^2 m/\partial Q\partial\xi > 0$.

$$(4) \quad \frac{dP_0}{dQ} = - \frac{\frac{\partial \rho}{\partial Q} + P_0 \frac{\partial^2 \rho}{\partial P_0 \partial Q} - \frac{\alpha P_1^2}{1+r} \frac{\partial^2 m}{\partial P_1 \partial Q} \frac{\partial \rho}{\partial P_0} - \frac{\alpha P_1^2}{1+r} \frac{\partial m}{\partial P_1} \frac{\partial^2 \rho}{\partial P_0 \partial Q}}{2 \frac{\partial \rho}{\partial P_0} + P_0 \frac{\partial^2 \rho}{\partial P_0^2} + \frac{\alpha m P_1}{1+r} \frac{\partial^2 \rho}{\partial P_0^2}}$$

By the second-order conditions for a maximum, the denominator in (4) must be < 0 .¹² Thus, the denominator for expression (4) is negative and the sign of dP_0/dQ depends upon the sign of the numerator. We can see that only the first term of the numerator is positive. If the positive effect of $\partial \rho / \partial Q$ dominates, we will observe the skimming strategy, i.e. $dP_0/dQ > 0$. Note, however, that the three remaining negative terms in the numerator each involve the expression $\partial \rho / \partial P_0$. This expression will become more (less) important the less (more) differentiated is the market. Thus we can further interpret the sign of dP_0/dQ using market differentiation theory.

(i) Suppose the market is relatively homogeneous: $\xi < \xi^*$

Given this assumption, the negative effect of $\partial \rho / \partial P_0$ is more likely to dominate the positive effect of $\partial \rho / \partial Q$.¹³ Therefore, dP_0/dQ is more likely to be negative.¹⁴

¹² The denominator is unambiguously negative if, as seems reasonable, $\partial^2 \rho / \partial P_0^2 < 0$. This assumption implies that $\rho(P_0, Q)$ is a concave function of P_0 . In this case, when P_0 is low, a slight change in P_0 will not influence ρ significantly. At higher levels of P_0 , however, the fraction of new consumers will fall dramatically with further increases in P_0 .

¹³ $\partial \rho / \partial Q$ will be a relatively small positive number given the assumption $\partial^2 \rho / \partial Q \partial \xi > 0$.

$\partial \rho / \partial P_0$ will be a very low negative number given the assumption $\partial^2 \rho / \partial P_0 \partial \xi > 0$.

Therefore, dP_0/dQ is more likely to be negative.

In other words, in a homogeneous market, a high-quality drug is more likely to enter with a lower initial price *because the market share is more sensitive to price for high-quality drugs* (recall that $\partial^2 \rho / \partial P_0 \partial Q < 0$). Thus, higher-quality drugs will be particularly successful in achieving significant market share by choosing a lower entry price. In addition, if $dP_0/dQ < 0$, then lower-quality drugs in the market will enter at a higher price. For these drugs, market share will not increase as much when prices are decreased and thus the products may enter the market at a higher price.

(ii) Suppose the market is relatively differentiated, $\xi > \xi^*$

In this case, the positive effect of $\partial \rho / \partial Q$ is more likely to dominate the negative effect of $\partial \rho / \partial P_0$ and other terms.¹⁵ Thus, dP_0/dQ is more likely to be positive.

In other words, if the market is sufficiently differentiated, a high-quality drug is more likely to enter with a higher initial price. Here, the increased quality must generate a large enough increase in the customer base in period 0 to offset the negative impact of higher prices associated with this customer base.

In addition, if repeat purchases are uncommon, we would expect α to be low and the discount rate, r , to be high. Lower α and higher r would decrease the negative terms in the numerator of expression

¹⁴ We may observe that in a homogeneous market, $\partial m / \partial P_1$ is also a very low negative number, which confirms our conclusion. In addition, we assume that the third order across differentiations is small enough to be ignored. For example, $\partial^3 \rho / \partial P_0 \partial Q \partial \xi = 0$.

¹⁵ $\partial \rho / \partial Q$ will be a large positive number given the assumption $\partial^2 \rho / \partial Q \partial \xi > 0$.

$\partial \rho / \partial P_0$ will be a slightly low negative number given the assumption $\partial^2 \rho / \partial P_0 \partial \xi > 0$.

Therefore, dP_0/dQ is more likely to be positive.

(4), raising the likelihood that $dP_0/dQ > 0$. In contrast, higher α and lower r will raise the likelihood that $dP_0/dQ < 0$. These observations suggest that higher-quality drugs tend to charge lower entry prices in a homogeneous market and in a marketplace where repeat purchases are more common.

Thus, when markets are relatively homogenous, price competition is more important for gaining market share and higher-quality drugs enjoy a comparative advantage in gaining market share through lower entry prices.

How will these entry prices compare to P_0^m , the average price of drugs already on the market? For sufficiently high levels of quality, these lower entry prices will be below the prices of drugs already on the market. In this case, higher-quality drugs will enter at a discount relative to the market. Whether these entry prices are, in fact, lower than the prices of existing drugs is an empirical issue which we will examine below. When products are more differentiated, price competition assumes less importance and the higher quality drugs enter with higher prices. At sufficiently high levels of quality, the higher entry prices will exceed the existing prices of competitor drugs already in the market. Again, however, this is an empirical issue.

The effect of market quality on entry price is given by:

$$(5) \quad \frac{dP_0}{dQ^m} = - \frac{\frac{\partial \rho}{\partial Q^m} + P_0 \frac{\partial^2 \rho}{\partial P_0 \partial Q^m} - \frac{\alpha P_1^2}{1+r} \frac{\partial^2 m}{\partial P_1 \partial Q^m} \frac{\partial \rho}{\partial P_0} - \frac{\alpha P_1^2}{1+r} \frac{\partial m}{\partial P_1} \frac{\partial^2 \rho}{\partial P_0 \partial Q^m}}{2 \frac{\partial \rho}{\partial P_0} + P_0 \frac{\partial^2 \rho}{\partial P_0^2} + \frac{\alpha m P_1}{1+r} \frac{\partial^2 \rho}{\partial P_0^2}}$$

As in expression (4), the denominator for expression (5) is negative and the sign of dP_0/dQ^m depends upon the sign of the numerator. Only the first term of the numerator is negative. In other words, if the market quality has direct strong effect on the drug's own demand, we are more likely to observe $dP_0/dQ^m < 0$. Finally, the effect of market price on the firm's entry price is:

$$(6) \quad \frac{dP_0}{dP_0^m} = - \frac{\frac{\partial \rho}{\partial P_0^m} + P_0 \frac{\partial^2 \rho}{\partial P_0 \partial P_0^m} - \frac{\alpha P_1^2}{1+r} \frac{\partial m}{\partial P_1} \frac{\partial^2 \rho}{\partial P_0 \partial P_0^m}}{2 \frac{\partial \rho}{\partial P_0} + P_0 \frac{\partial^2 \rho}{\partial P_0^2} + \frac{\alpha m P_1}{1+r} \frac{\partial^2 \rho}{\partial P_0^2}}$$

The denominator for expression (6) is negative and the sign of dP_0 / dP_0^m depends upon the sign of the numerator. We can see that only the first term of the numerator is positive. As long as the price effect on demand $\partial m / \partial P_1$ dominates cross price effects $\partial \rho / \partial P_0^m$, we are more likely to observe $dP_0 / dP_0^m < 0$, and vice versa.

PRICING DYNAMICS

We may also use our model to study pricing dynamics by comparing the entry and subsequent period prices of drugs. Again, using the first-order conditions given in equations (2) and (3) and rearranging terms, we may write:

$$(7) \quad \frac{P_0}{P_1} = \frac{\frac{\alpha m}{1+r} \varepsilon_0}{\varepsilon_1 - \varepsilon_0}, \text{ where } \varepsilon_0 = \frac{d\rho}{dP_0} \frac{P_0}{\rho} \quad \text{and} \quad \varepsilon_1 = \frac{dm}{dP_1} \frac{P_1}{m} = -1 \text{ from (2)}$$

Since $P_0 / P_1 > 0$, $\varepsilon_0 \in [-1, 0]$.

Therefore, we have (8) $\frac{P_0}{P_1} > 1$, when $-1 < \varepsilon_0 < -\frac{1+r}{1+r+\alpha m}$

$$(9) \quad \frac{P_0}{P_1} < 1, \text{ when } \varepsilon_0 > -\frac{1+r}{1+r+\alpha m}$$

These conclusions are consistent with demand theory. Demand elasticity ε_0 is relatively inelastic (as in Equation (9)), at the lower part of the demand curve (consider for example the linear demand curve)

where price is low and the demand is large. Therefore, P_0 is more likely to be less than P_1 in this inelastic range. The opposite is true when ε_0 is relatively elastic, as in Equation (8).¹⁶

We can rewrite equation (8) in the form: $P_0/P_1 > 1$, when $-1 < \varepsilon_0 < -1/(1 + \alpha m/(1+r))$

If α is large, r is low, and m is large, then the possible range for ε_0 enlarges, which means that P_0 is more likely to be greater than P_1 . Conversely, if α is low, r is high, and m is low, then the possible range for ε_0 shrinks and P_0 is less likely to be greater than P_1 .

SUMMARY

As our comparative static analysis demonstrates, a higher quality product does not necessarily enter the market at a higher price because pricing also depends upon on market conditions and the nature of repeat-purchases. Specifically, in a relatively homogeneous market and/or with more repeated purchases, market share is more sensitive to price for the high-quality drug than it is for the lower-quality drug. Therefore, the best strategy to gain market share is to set a lower initial price for a high-quality drug to gain market share. In a more heterogeneous market, market share is not as sensitive to price. Therefore we may observe the opposite strategy for a high-quality drug, i.e. a skimming strategy. In other words, price competition is more important when the market is relatively homogeneous.

These observations suggest that skimming and market penetration strategies depend upon the market characteristics and the nature of repeat purchase arrangements. The classic price-skimming strategy

¹⁶ In the extreme case of $\alpha = 0$, ε_0 and ε_1 are both equal to -1 from the f.o.c, and P_0 and P_1 are indeterminate. In this case, if there are no repeat purchases, a firm will set prices independently in the two periods.

discussed in the literature occurs when a high-quality drug enters the market at a higher price that is subsequently lowered. Although this certainly may occur in our model, it is also possible that a high-quality entrant will charge a lower initial price. And, as discussed earlier, prices may rise or fall over time.

Earlier discussions have focused on two scenarios: classic skimming, in which the entrant charges a higher price that declines over time, and market penetration, in which a lower entry price is selected and price rises over time. Our analysis delineates conditions under which four scenarios may occur. These cases are summarized in Table 2.

[INSERT TABLE 2]

V. DATA AND ESTIMATION

DATA

Our analysis is based on data from the 1999-2002 Medical Expenditure Panel Survey (MEPS) conducted by the Agency for Healthcare Research and Quality (AHRQ). The MEPS database consists of a number of files, two of which were employed in our study. The Consolidated File is a person-year level database, which provides detailed consumer information on health care utilization and expenditures as well as patients' demographics, socioeconomic characteristics, health, and health insurance status. The Prescribed Medicines File is an event-level file that includes information on the utilization and payments for each drug used by survey respondents.¹⁷ We converted the Prescribed Medicines File to the person-year level and then merged it with the Consolidated File for this study.

¹⁷ Household respondents provided information on the names of all outpatient medications used by each household member and the names and locations of the pharmacies where medication was obtained. They were also asked for permission to request records from these pharmacies. Pharmacy providers were asked to provide

Measures of physician-perceived quality indicators of drugs are provided by Market Measures Inc. (2001), a private medical survey research company. Their survey was conducted among a physician panel recruited from a random sample of those who treat patients with specific drug product classes. For example, information on the perceived quality of antidepressant drugs was obtained from a panel of psychiatrists, internists, and family practitioners who regularly treat patients suffering from depression and who are thus familiar with alternative antidepressant drugs. The quality evaluation is the physicians' perceptions of the performance of the drugs in actual clinical practice, rather than reports from clinical trials by the manufacturers. Physicians provided rating scores of 1 to 5 for various attributes of a particular drug, with higher scores representing better quality.

Using this information, we constructed composite quality measures. Physicians were queried about 10 indicators of quality for antidepressants, including patient tolerability and the degree to which each drug had interactions with other drugs. Physicians rated each dimension of quality on a Likert scale from 5 (best) to 1 (worst) for all drugs in the class. Complete descriptions of these quality indicators are provided in Appendix 1. We computed the means of these valuations for each drug as the aggregate of the *QUALITY* measure. Therefore, our quality measure consists of the average score of physician perceptions of drug quality.¹⁸

the data necessary to assign a national drug code, which is specific for manufacturers, ingredients, strength, package size, quantity dispensed, total charge, and sources of payments. The AHRQ performed detailed matching, imputation, consistency checks, sensitivity checks, and reconciliation algorithms.

¹⁸ For the antidepressant data, some indicators are not requested every year. To get a large-enough sample size, we include the indicators that were generated from 1999 to 2002.

The subjects we include in this study are persons who are 18 years and older who had health insurance during the survey year.¹⁹ These criteria left a sample of 5,742 subjects for analysis.

ESTIMATION

We estimate price equations for antidepressant drugs of the form:

$$(10) \quad \ln(P) = \alpha_0 + \alpha_1 X + \alpha_2 Q + \alpha_3 MktYear + \alpha_4 Q \times MktYear + \varepsilon$$

where P is defined as the average transaction price, i.e., the summation of patient payment and the insurer payment per prescription of a particular drug for each patient. Previous work on pharmaceutical pricing has typically used either wholesale prices or invoice prices, neither of which takes into account the substantial rebates and price discounts often obtained by third-party payers. (Congressional Budget Office, 1998). Our measure of the transaction price, however, is the true price received by the manufacturers after such rebates and discounts. All prices are inflation-adjusted to 2000 dollars using the medical care component of the consumer price index.

The variable $MKTYEAR$ indicates how long the drug has been on the market. It is defined as the difference between the survey year and the drug's approval year. This variable is also a proxy for the aggregate level of marketing efforts, such as detailing and direct to consumer advertising, which correlate with the length of time that a drug has been on the market.²⁰

Our quality measure is the average of the physicians' perception of the quality of each drug, as

¹⁹ We elected to exclude uninsured subjects because some of them may receive free drug samples, in which case our price measures could be biased. In fact, however, including this group produced results (available from the authors on request) that were quite similar to those in the text.

²⁰ Such marketing efforts tend to be concentrated in the initial years following a drug's introduction and typically decline substantially thereafter (Grossman and Shapiro 1984).

discussed in the previous section.²¹ We also include an interaction term between *MKTYEAR* and *QUALITY* to examine whether the relationship between quality and price varies with the length of time that the drug has been on the market.

The vector *X* includes other characteristics that could affect the transaction price, such as the health status, sociodemographic characteristics and drug insurance coverage of the patients/subjects. The names, descriptions, and summary statistics for variables used in this study are provided in Table 3.

²¹ We consider the quality measure to be an exogenous variable in our model specification. One might argue that higher-priced drugs signal higher quality, so that the physician's perceived quality is to some extent a function of the drug's price. However, the evidence repeatedly demonstrates that physicians have very poor information about drug prices (Allan and Innes 2004; Conti et al. 1998; Glickman et al. 1994; Silcock et al. 1997; Walzak et al. 1994). If true, (1) actual prices should bear little relation to physician perceptions of prices and (2) physician's perceptions of price should bear little relationship to their perceptions of a drug's quality. Consistent with this evidence, our data indicate the physician's perception of a drug's cost is weakly correlated with the actual transaction price ($\rho = 0.08$). Moreover, the correlation between physicians' awareness of an antidepressant drug's cost and their perception of the drug's quality is very low ($\rho = -0.02$). In addition, our transaction price measure is at the individual patient level. Even if physicians did have some knowledge of the average wholesale price, they would have far less knowledge of individual transaction prices, as our data confirm. Finally, because physicians do not bear the cost of the drug, they have less incentive to factor cost into their quality assessments.

To examine the effects of market quality (*MKTQUALITY*) and market price (*MKTPRICE*) on the drug price, we also estimated the following price equations:

$$(11) \begin{aligned} \ln(P) &= \alpha_0 + \alpha_1 X + \alpha_2 Q + \alpha_3 MktYear + \alpha_4 Q \times MktYear + \alpha_5 MktQuality + \varepsilon \\ \ln(P) &= \alpha_0 + \alpha_1 X + \alpha_2 Q + \alpha_3 MktYear + \alpha_4 Q \times MktYear + \alpha_5 MktQuality + \alpha_6 Mkt Price + \varepsilon \end{aligned}$$

We controlled for heteroskedasticity in the above price regressions using the method proposed by Greene (1999) and Wooldridge (1999).²²

[INSERT TABLE 3]

ANTIDEPRESSANTS REVISITED

Our theoretical model concludes that higher-quality drugs will enter with lower prices in markets that are not well differentiated and where repeat purchase arrangements are common. These features characterize the antidepressant drug market well. Thus, while Celexa and Wellbutrin SR have the highest quality ratings among the antidepressant drugs, their quality advantages are not substantially superior to other drugs in the group. Hence, it may be more difficult for consumers to perceive real differences in quality among the antidepressant drugs. In terms of our model, this suggests that we may be more likely to observe lower entry prices among high-quality drugs in the antidepressant marketplace.

²² For example, we first obtain the predicted errors from (10), and then regress the square of the predicted error terms on all the independent variables in (10). The predicted fitted values are the weights we used to correct for heteroskedasticity. In a small percentage (1%) of cases the fitted values were negative and could not be used as weights. The results (reported in the text below) were quite similar whether or not we corrected for heteroskedasticity.

The patterns on scrip use lend further support to these predictions. In particular, Table 1 indicates the average number of scrips filled per patient for antidepressants (4.70). When repeat purchases are important, our model predicts that higher-quality drugs will charge a lower entry price. Thus, we might expect to observe lower entry prices among higher-quality antidepressant drugs. The actual effects of quality on entry prices, as well as the time path of prices are empirical issues, however, to which we now turn.

VI. RESULTS

QUALITY AND ENTRY PRICE

Table 4 provides the results of the multivariate price equations. Model 1 includes interactions between the drug's quality and market year but does not correct for heteroskedasticity. Models 2-4 correct for heteroskedasticity. Model 3 adds market quality as an explanatory variable and model 4 adds market quality and market price.

Table 4 reveals that higher-quality antidepressants enter with lower initial prices, as the coefficient for *QUALITY* is negative and highly significant for antidepressants. The positive interaction between *QUALITY* and *MKTYEAR* indicates that, for antidepressants of sufficiently high quality, we will observe a market penetration strategy, with prices rising over time.

These patterns are consistent with both our model and our understanding of the antidepressant drug market. In choosing among brand-name antidepressants, a relatively homogeneous market, consumers may have greater difficulty determining whether new products constitute meaningful improvements. This factor, plus the greater degree of repeat purchases for antidepressants, suggest that charging a lower initial price may be a better long-run strategy for high quality entrants into this market.

Model 3 shows that market quality has a negative effect on the drug price, but the effect is not significant. Model 4 shows that market price has a significantly negative effect on the drug price. As indicated by Equation (6), the effect of market price on a drug's entry price is ambiguous. Entry price may be higher when the price of existing drugs is higher—a kind of positive spillover effect. On the other hand, a higher entry price may cause the firm to forego opportunities to gain market share from incumbent products by charging a lower entry price. Empirically, we find the latter effect dominates, so that the firm charges a lower entry price when the market price is higher.

Regardless of whether we control for market price and/or market quality in the model specification, we find the effect of drug quality on its price is always significantly negative and the magnitude of this effect changes little across specifications. Thus, the relationship between quality and entry price is robust.

We also note that the variable *HASRXINS* is negative and highly significant in the antidepressant regressions, implying that transaction prices for drugs are lower for persons who have drug benefits. In the literature, it has been argued (Congressional Budget Office, 1998) that drug manufacturers are more likely to offer discounts to institutions that have more control over drug distribution channels via entities such as drug formularies, a common feature of drug benefit plans. Our findings are consistent with the concept that plans offering drug benefits are able to obtain discounts, leading to lower transaction prices for the drugs purchased through these plans.

PREDICTED PRICES

Using the results from Model 2, we predict the entry price for each drug.²³ Specifically, we set the variable *MKTYEAR* to zero and estimate the real price of each drug when it entered the market. We also calculate the prices of the other drugs available at that time. We list these predicted prices in Table 5.

[INSERT TABLE 5]

Table 5 shows that the entry prices of Celexa and Wellbutrin SR, the two drugs with relatively higher quality, charged lower prices when they entered the market. Moreover, their prices were lower than the prices charged for drugs that were on the market when they entered. Thus, Celexa and Wellbutrin SR appear to have used the “market penetration” pricing strategy. In contrast, antidepressants associated with lower quality charged higher entry prices when they came into the market, consistent with the “price skimming” strategy.

Upon market entry, Celexa and Wellbutrin SR had a higher quality than the other available drugs, but the quality differentials were small in comparison to their competitors. As we hypothesized, when product differentiation is modest, higher-quality drugs charge lower initial prices, such as occurred with Celexa and Wellbutrin SR.

²³ We use model 2 because we do not have market price and market quality for Prozac, which was the first drug in the SSRI class. We can obtain predicted values for the other drugs using models 3 or 4, which incorporate these market effects. These results are quite similar to those reported in the text and are available from the authors on request.

We can also use our model to compute the time paths for the prices of each drug. These are summarized in Figure 1.

[INSERT FIGURE 1]

Manufacturers of the higher-quality drugs -- Celexa and Wellbutrin SR -- charged lower initial prices and increased their prices over time, the so-called market penetration pricing strategy. According to our model, these higher-quality drugs entered the market at a lower price on the theory that they will be better able to gain market share. In contrast, Figure 1 reveals that lower-quality drugs such as Remeron and Serzone, entered the market with higher prices that then declined over time. Intuitively, when lower-quality drugs decrease their price, their gain in market share is less than occurs with higher-quality drugs. Thus, there is less incentive for the lower-quality drugs to be given a low initial price.

Figure 1 also reveals that at five years post-entry, the prices of the drugs tend to converge. This pattern is consistent with a consumer-search model. Recall that our quality measure is the physician's perception of the *average drug quality*. Consumers also observe average drug quality ex-ante, but ex-ante quality may differ from the consumer's experience ex-post. The reason is that the effects of a given drug on any individual are often highly idiosyncratic. In addition, a particular drug may not be selected because some consumers may have contraindications to that drug even though it offers relatively high average quality. Other consumers may prefer a drug of slightly less average quality because it is on the formulary of their drug benefit plan and thus costs them less. Nonetheless, one would expect that most (but not all) consumers would initially prefer the higher-quality drugs with lower entry prices. This situation means that most consumers (and their physician agents) initially purchase drugs according to their average quality ratings, but thereafter will switch among the drugs

to find the one that works best for them.²⁴ It is a process of experimentation for an individual consumer. The drug that works best for an individual is not necessarily the drug has the highest average quality rating. Nevertheless, one might expect that, over time, relatively fewer consumers from the higher quality drug group will switch to the lower quality group and relatively more consumers from the lower quality group will switch to the higher quality group. Therefore, the market share for the high-quality drug will rise over time, while that of the lower-quality drug will decline. And, through such a process, it would not be surprising to find that the prices of lower-quality drugs decline over time while those of the higher-quality drugs rise, precisely the pattern that we observe.

VII. CONCLUSION

In this study, we hypothesize that a drug's entry price should depend on the *interaction* between the therapeutic quality of the new agent and the degree of product differentiation in the market. Our theoretical model predicts that in markets where products are relatively well-differentiated, higher-quality entrants will tend to adopt a market-skimming pricing strategy, charging a relatively high initial price. In more homogenous markets, we expect a high-quality entrant to observe a market penetration pricing strategy. Markets in which repeat purchase arrangements are common would reinforce these patterns.

Empirically, we examined brand-name antidepressant drugs during the period 1999 to 2002. On the basis of physician quality perceptions, product differentiation appeared to be fairly modest. Moreover, the antidepressant market is associated with substantial repeat purchases of the drugs. Consistent with

²⁴ Although most people treated pharmacologically for major depression and related diseases receive treatments over an extended period of time, switching among antidepressants is a common phenomenon. See Woods and Rizzo (1997) for further details.

our model, we find that higher-quality entrants engaged in a “market penetration” entry pricing strategy.

Our results thus indicate that drugs *within a given product market* may adopt quite different entry pricing strategies. The optimal pricing strategy depends upon the quality of the drug and the degree of product differentiation across drugs within that product market. We also find that price differences across drugs tend to diminish over time. This finding is consistent with the idea that consumers experiment with the drugs over time and search for the drug that works best. Although our empirical application focuses on the pharmaceutical industry, our theory may be applied to the study of entry pricing and pricing dynamics in other product markets as well.

Table 1: Antidepressants Summary Statistics

Drug Name	Observation	Initiated Year	Quality	# Average Scrips
<u>SSRI</u>				
Celexa	730	1999, Dec. 22	3.73	4.89
Prozac	991	1987, Dec. 29	3.56	5.17
Zoloft	1327	1991, Dec 30	3.6	5.24
Paxil	1330	1992, Dec. 29	3.45	5.15
<u>SNRI</u>				
Effexor	92	1993, Dec 28.	3.47	3.80
Effexor XR	319	1997, Oct 20.	3.58	5.05
<u>OTHER</u>				
Remeron	200	1996, Jun 14	3.28	4.54
Serzone	175	1994, Dec 22	3.42	4.30
Wellbutrin SR	578	1996, Oct 4	3.69	4.13
			Average Quality: 3.53	Average Scrips: 4.70
			Weighted Average Quality: 3.56	Weighted Average Scrips: 4.96
N=5742	Mean Market Year: 8.10			

Table 2: Alternative Market Pricing Strategies

Classic Skimming	Modified Skimming	Classic Market Penetration	Modified Market Penetration
$dP_0/dQ > 0$	$dP_0/dQ > 0$	$dP_0/dQ < 0$	$dP_0/dQ < 0$
$P_0 > P_1$	$P_0 < P_1$	$P_0 < P_1$	$P_0 > P_1$
Quality competition dominates	Quality competition dominates	Price competition dominates	Price competition dominates
$-1 < \varepsilon_0 < -\frac{1+r}{1+r+\alpha m}$	$\varepsilon_0 > -\frac{1+r}{1+r+\alpha m}$	$\varepsilon_0 > -\frac{1+r}{1+r+\alpha m}$	$-1 < \varepsilon_0 < -\frac{1+r}{1+r+\alpha m}$

**Table 3: Antidepressants: Variable Names, Description, and Summary Statistics
(includes all subjects aged 18 years or older who have health insurance) N=5742**

Variable Names	Description	Mean	Std Dev
<u>DEPENDENT VARIABLES</u>			
AVGPAYTOT	Average total payment (summation of self and third party payment) for each drug during a calendar year	80.04	40.64
<u>AGE, GENDER AND MARITAL STATUS</u>			
AGE1834	DV=1 if subject's age is between 18 and 34 else = 0	0.17	0.38
AGE3549	DV=1 if subject's age is between 35 and 49 else = 0	0.37	0.48
AGE5064	DV=1 if subject's age is between 50 and 64 else = 0	0.27	0.44
AGE6574	DV=1 if subject's age is between 65 and 74 else = 0	0.10	0.30
AGE75UP	DV=1 if subject's age is 75 and up else = 0	0.08	0.28
FEMALE	DV=1 if subject is female else = 0	0.74	0.44
<u>RACE & ETHNIC</u>			
WHITE	DV=1 if subject is white else = 0	0.54	0.50
BLACK	DV=1 if subject is black else = 0	0.05	0.21
HISPANIC	DV=1 if subject is Hispanic else = 0	0.10	0.30
OTHER	DV=1 if subject's ethnic is other else = 0	0.31	0.46
<u>EDUCATION</u>			
NOHS	DV=1 if subject has less than high school else = 0	0.09	0.28
SOMEHS	DV=1 if subject attended HS but did not graduate else = 0	0.16	0.36
HSGRAD	DV=1 if subject is HS graduate else = 0	0.31	0.46
SOMECOLL	DV=1 if subject attended college but did not graduate else = 0	0.16	0.37
COLLGRAD	DV=1 if subject is college graduate else = 0	0.21	0.41
GRADSCHL	DV=1 if subject attended graduate school else = 0	0.07	0.25
<u>HEALTH STATUS</u>			
HEALTHPOOR	DV=1 if subject's health is poor else = 0	0.14	0.34
HEALTHFAIR	DV=1 if subject's health is fair else = 0	0.20	0.40
HEALTHGOOD	DV=1 if subject's health is good else = 0	0.31	0.46
HEALTHVGOOD	DV=1 if subject's health is very good else = 0	0.26	0.44
HEALTHEXC	DV=1 if subject's health is excellent else = 0	0.10	0.30
<u>LOCATION</u>			
NORTHEAST	DV=1 if subject lives in North East Census Region else = 0	0.17	0.38
MIDWEST	DV=1 if subject lives in Midwest Census Region else = 0	0.24	0.43
SOUTH	DV=1 if subject lives in South Census Region else = 0	0.39	0.49
WEST	DV=1 if subject lives in West Region else = 0	0.20	0.40
<u>YEAR</u>			
YR1999	DV=1 if year is 1999 else = 0	0.18	0.38
YR2000	DV=1 if year is 2000 else = 0	0.19	0.39
YR2001	DV=1 if year is 2001 else = 0	0.30	0.46
YR2002	DV=1 if year is 2002 else = 0	0.33	0.47

Variable Names	Description	Mean	Std Dev
<u><i>HEALTH INSURANCE</i></u>			
HASRXINS	DV=1 if subject has Rx insurance during all or some of the period year else = 0	0.66	0.47
<u><i>QUALITY INDEX</i></u>			
QUALITY	Average of all the quality indicators	3.56	0.12
<u><i>YEARS ON MARKET</i></u>			
MKTYEAR	The Years the drug has been on the market	8.10	3.74

Table 4: Brand Name Drug Quality and Real Drug Prices with Dependent Variable : ln(Drug Price)

	Model 1		Model 2		Model 3		Model 4	
	Coef	P-Value	Coef	P-Value	Coef	P-Value	Coef	P-Value
<i>QUALITY</i>	-0.92	0.00	-0.83	0.00	-0.84	0.00	-0.70	0.00
<i>MKTYEAR</i>	-0.47	0.00	-0.43	0.00	-0.42	0.00	-0.40	0.00
<i>QUALITY*MKTYEAR</i>	0.13	0.00	0.12	0.00	0.12	0.00	0.11	0.00
<i>MKTQUALITY</i>					-0.16	0.68	-0.36	0.34
<i>MKTPRICE</i>							-6.14	0.00
AGE3549	0.05	0.03	-0.05	0.02	-0.05	0.02	-0.06	0.00
AGE5064	0.01	0.78	-0.09	0.00	-0.09	0.00	-0.11	0.00
AGE6574	-0.07	0.03	-0.13	0.00	-0.13	0.00	-0.14	0.00
AGE75UP	-0.04	0.20	-0.03	0.17	-0.03	0.17	-0.04	0.08
FEMALE	0.04	0.02	0.05	0.00	0.05	0.00	0.05	0.00
BLACK	-0.02	0.59	-0.04	0.24	-0.04	0.24	-0.04	0.16
HISPANIC	0.00	0.94	-0.13	0.00	-0.13	0.00	-0.13	0.00
OTHER	-0.02	0.23	-0.03	0.03	-0.04	0.04	-0.05	0.01
SOMEHS	-0.06	0.08	-0.09	0.00	-0.09	0.00	-0.08	0.00
HSGRAD	-0.05	0.10	-0.16	0.00	-0.16	0.00	-0.16	0.00
SOMECOLL	-0.02	0.49	-0.18	0.00	-0.18	0.00	-0.17	0.00
COLLGRAD	-0.03	0.40	-0.12	0.00	-0.12	0.00	-0.12	0.00
GRADSCHL	0.05	0.23	-0.04	0.31	-0.04	0.30	-0.03	0.50
HEALTHPOOR	-0.02	0.62	-0.01	0.65	-0.01	0.65	-0.01	0.71
HEALTHFAIR	-0.03	0.40	0.02	0.45	0.02	0.46	0.04	0.09
HEALTHGOOD	-0.04	0.20	-0.08	0.00	-0.08	0.00	-0.08	0.00
HEALTHVGOOD	-0.05	0.11	-0.10	0.00	-0.10	0.00	-0.09	0.00
HASRXINS	-0.06	0.00	-0.04	0.01	-0.04	0.01	-0.04	0.01
MIDWEST	-0.01	0.62	-0.02	0.26	-0.02	0.25	-0.04	0.09
SOUTH	-0.01	0.59	-0.12	0.00	-0.12	0.00	-0.13	0.00
WEST	-0.01	0.68	-0.06	0.02	-0.06	0.02	-0.07	0.01
_CONS	7.68	0.00	7.56	0.00	8.13	0.00	34.31	0.00
N	5742		5671		5671		5671	
ADJ. R SQUARE	0.02		0.14		0.14		0.16	

Notes:

1. Drug price is adjusted by CPI Medical Care Component in 2000 dollars
2. All the people in the sample have some type of health insurances and are ≥ 18 years of age.
3. Model 1: OLS estimation
4. Model 2: OLS estimation adjusted the heteroskedasticity. (Some predicted negative value cause 71 observations fewer.)
5. Model 3: OLS estimation with market quality, adjusted heteroskedasticity.
6. Model 4: OLS estimation with market quality and market price, adjusted heteroskedasticity.

Table 5: Predicted Entry Real Price of Antidepressants Compared to the Existing Drugs

Drug Name	Entry Year	Entry Price (\$)	Quality	Existing Drugs	Weighted Average Price of Existing Drugs at Entry Year (\$)**	Weighted Average Quality of Existing Drugs at Entry Year (\$)**
<i>Skimming Strategy</i>						
Paxil	92.Dec	92.74	3.45		82.41	3.54
				Prozac	83.49*	
				Zoloft	81.59*	
Effexor	93. Dec	90.90	3.47		85.61	3.53
				Prozac	83.24*	
				Zoloft	81.76*	
				Paxil	91.26*	
Remeron	96. Jun	106.67	3.28		84.75	3.53
				Prozac	82.50*	
				Zoloft	82.25*	
				Paxil	86.99*	
				Effexor	87.16*	
				Serzone	90.90	
Serzone	94. Dec	94.61	3.42		85.10	3.53
				Prozac	82.99*	
				Zoloft	81.92*	
				Paxil	89.82*	
				Effexor	89.64*	
<i>Penetration Strategy</i>						
Celexa	99.Dec	72.95	3.73		83.08	3.54
				Prozac	82.00*	
				Zoloft	82.58*	
				Paxil	84.25*	
				Effexor	84.75*	
				Effexor XR	83.08*	
				Remeron	98.47*	
				Serzone	87.34*	
				Wellbutrin SR	77.93*	
Zoloft	91.Dec	81.43	3.60		83.74	3.56
				Prozac	83.74*	
Effexor XR	97. Oct	83.08	3.58		83.66	3.54
				Prozac	82.25*	
				Zoloft	82.41*	
				Paxil	85.61*	
				Effexor	85.95*	
				Remeron	102.49*	
				Serzone	89.10*	
				Wellbutrin SR	76.92*	

Wellbutrin SR	96. Oct	75.93	3.69		85.35	3.52
				Prozac	82.50*	
				Zoloft	82.25*	
				Paxil	86.99*	
				Effexor	87.16*	
				Remeron	106.67*	
				Serzone	90.90*	

** Weighted average drug prices are calculated using scrip shares as the weights.

* These are individual drug prices

Note:

1. The predicted estimates of antidepressants were obtained from the price equation adjusted for heteroskedasticity by number of scrips:

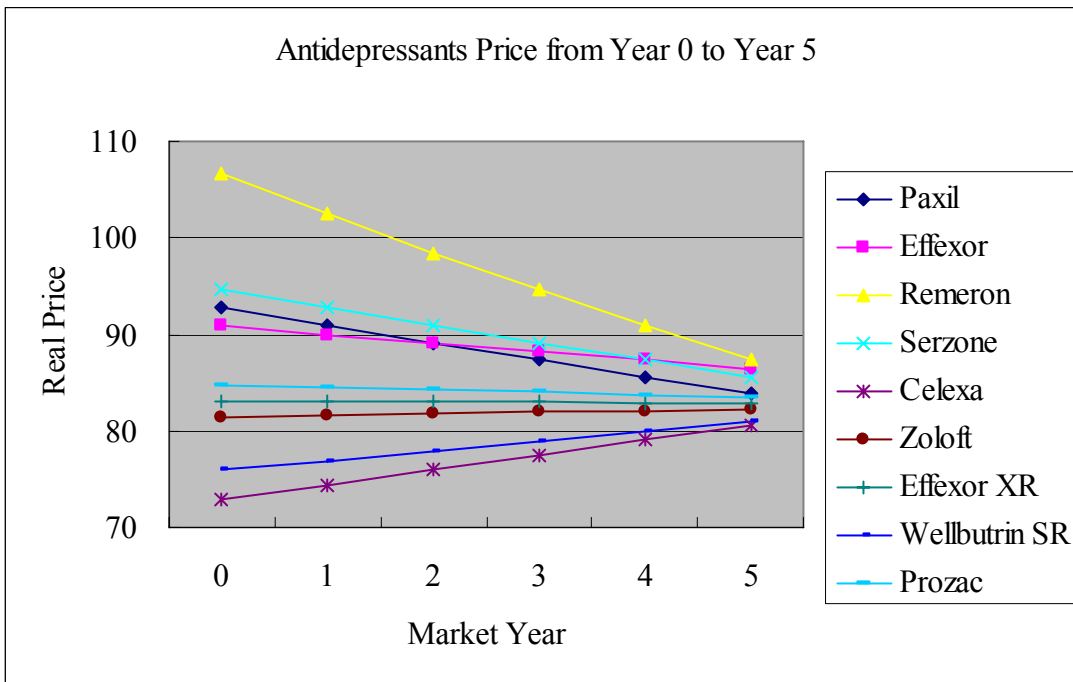
$$\ln \frac{P^i}{CPI^i} = \alpha_0 + \alpha_1 Q_i + \alpha_2 MktYear_i + \alpha_3 Q_i \times MktYear_i + \alpha_4 X + \varepsilon$$

We have:

$$\ln \hat{P} = -0.83Q_i - 0.43MktYear_i + 0.12Q_i \times MktYear_i + \bar{X} \hat{\beta}$$

2. To transform $\ln \hat{P}$ to \hat{P} , we use the smearing estimate. The smearing factor in our study is 1.15.

Figure 1: Predicted Prices of Antidepressants for Each Drug from 0 to 5 Market Years



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Appendix 1: Quality Indicators of Antidepressants

Variable	Description	Mean	Std. Dev.
QLTYLF	Improve Patient's Quality of Life	4.00	0.28
MLDMOD	Effective for Mild to Moderate Depression	4.08	0.25
ENERGY	Increased Energy Level/Activation	3.49	0.47
TOLERATE	Well-Tolerated by Patients	3.59	0.46
INTERAC	Few Interaction with Other Drugs	3.54	0.48
SEXUAL	Low Incidence of Sexual Dysfunction	2.86	0.49
CHGWEIGHT	No Weight Gain/Change	3.16	0.39
SEDATION	Low Incidence of Daytime Sedation	3.43	0.65
AGITATION	Minimal Agitation	3.50	0.25
RAPID	Rapid Onset of Action	2.95	0.17