WHO SEARCHES FOR LOW PRICES? POPULATION CHARACTERISTICS AND PRICE DISPERSION IN THE MARKET FOR PRESCRIPTION DRUGS*

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Abstract:

We examine the relationship between population characteristics and price dispersion for 75 prescription drugs in five markets. Based on models of price dispersion, we consider that search costs are likely lower for the elderly, who are repeat purchasers. Expected benefits from search are likely higher for low income households, who lack insurance. Our results are consistent with the hypothesis that for communities with a large percentage of elderly and poor population, search effort is greater for pharmaceutical drugs, causing lower price dispersion. By understanding the characteristics of who searches for low drug prices, we begin to identify the motives of consumers that might also lead to search for the lowest cost healthcare provider or lowest cost insurance. The results suggest that the 2004 Medicare legislation that closed the pharmaceutical donut hole may have reduced search by the elderly, increased price dispersion, and potentially increased the average price of prescription drugs.

Keywords: search cost; price dispersion; prescription drugs

JEL: D12, D83, I1

I. INTRODUCTION

Prescription drugs are almost ideal examples of homogeneous commodities. A patient can fill her prescription at any pharmacy she chooses and expect to obtain exactly the same medicine. *A priori*, therefore, it would seem that if any commodity obeyed the law of one price then a prescription drug would be that commodity. That is not the case. Using data from two townships in up-state New York, Sorenson (2001) provided compelling evidence that the prices of individual drugs varied substantially among pharmacies within each of the two communities. The extent of price dispersion differed among individual drugs in ways that were consistent with the predictions of models that explain price dispersion on the basis of costly consumer search.

Price dispersion among homogeneous goods is not unique. Other studies have examined the determinants of price dispersion in the markets for gasoline (Adams 1997), water (Yoskowitz 2002), automobiles (Dahlby and West 1986; and Goldberg and Verboven 2001), and grocery products (Aalto-Setala 2003). They have also generally concluded that prices in those markets vary in ways that cannot be accounted for solely by heterogeneity in product attributes with respect to physical characteristics, space, time, or, in cross country studies, government regulation. In addition, apparent violations of the law of one price have been observed in commodity markets for agricultural products and raw materials that are relatively homogeneous with respect to their physical characteristics (see, for example, Goodwin et al). However, Sorenson's study of pharmaceutical drugs is of particular interest because he examines prices in two clearly defined markets for commodities that are physically identical. He finds that search costs, measured by the frequency of drug purchases, affect the amount of price dispersion. Models of price dispersion based on costly search for information by consumers seem to provide plausible alternative explanations, especially as many prescription drugs are not widely used and their prices are not commonly known by buyers.

As Sorenson observes, his empirical analysis of the effects of search costs is incomplete in at least one important respect. Sorenson's data were for only two geographically adjacent markets (less than 30 miles apart). Thus, he could not investigate the effects of characteristics of the communities being served by the pharmacies in those markets.

In this paper, we address the question, "who searches for the lowest drug prices?" Research by Talukdar (2008) and Morton et al (2003) show a link between consumer search characteristics and retail and internet pricing. Thus, search characteristics for consumer groups may be very different across drug markets as well. For example, the proportions of the elderly and the poor in a population served by a market may affect the amount of search in that market because of differences in opportunity costs of time and expected benefits from search. We expand upon previous research to examine market characteristics that affect price dispersion among prescription drugs. Our analysis of consumer search characteristics is particularly relevant to the current policy debate concerning healthcare reform, changes to Medicare, and insurance coverage through the workplace.

We examine price dispersion for pharmaceutical drugs in five geographically isolated markets in Montana using data obtained from a cross section survey, administered by the authors on the pricing of 75 different drugs by individual pharmacies. The five markets are a minimum of eighty miles apart from one another and have distinctly different demographic and other socio-economic characteristics. The new data set permits a more extensive evaluation of the effects of search and population characteristics on price dispersion.

The major contribution of this paper is to identify the characteristics in a community that affect the costs of search and search effort for the lowest priced drugs, by examining the impact on price dispersion. The proportion of the population who are elderly and the proportion of the population in poverty are two market indicators of search costs used in the model. The results for both of these variables are consistent with the hypothesis that price dispersion is lower in markets where costs of search are low and expected benefits high. As several models of price dispersion predict, this study provides evidence that in markets where consumers have low search costs and high expected benefits, pharmaceutical prices vary less than in markets with high search costs and low expected benefits. These findings suggest that the 2004 Medicare legislation, which closed the prescription drug donut hole for many elderly people, may have increased price dispersion and the average price of prescription drugs, with adverse consequences for the cost of that program.

This study also addresses a related but different issue. Several news articles from 2004 reported that imports of Canadian drugs were a major concern for pharmacy manufacturers, consumers, and policy makers (New York Times, 2004). In 2005, the Canadian health minister, Uijal Dosanjh, avowed that Canada intended to ban the bulk export of prescription drugs (Associated Press, 2005). Three of the cities included in the analysis are relatively close to Canadian cities (within about a two hour drive). Consumers in those communities, therefore, could possibly have acquired prescription drugs directly from Canadian pharmacies where prices for many of those drugs were apparently much lower and also available to U.S. citizens at the time of the survey (the summer of 2004). Thus, we also examine whether proximity to Canada affects the level and dispersion of drug prices within the five markets for which data are available.

II. THEORETICAL ISSUES OF PRICE DISPERSION

The theoretical literature indicates that price dispersion in a market is likely to be influenced by several factors: (a) seller heterogeneity, (b) product characteristics that affect the benefits from search, and (c) consumer characteristics that affect the cost of search by consumers. Price dispersion may be observed in a market because of heterogeneity among sellers with respect to production costs (Reinganum, 1979) or product attributes (Besancenot and Vranceanu, 2004). In addition, however, as Stigler (1961) showed, price dispersion may occur in a market because some or all consumers lack information about product prices and must incur search costs in order to obtain that information.

Several models have extended Stigler's insights on consumer search. Salop and Stiglitz (1977), for example, show that a two-price equilibrium can occur where increasing returns to scale exist at the firm level and consumers have identical search costs. Burdett and Judd (1983) present a model in which price dispersion occurs because consumers are heterogeneous and collect different amounts of price information. McMillan and Morgan (1988), in a dynamic context, find that price dispersion can arise when search costs differ among consumers and, in consequence, some consumers search more intensively and become better informed than others. Wilde and Schwartz (1979) obtain price dispersion from a model in which consumers differ with respect to tastes and propensities for search.

The amount of consumer search is a function of both expected search costs and benefits. The opportunity costs of search time are likely to be lower for members of low income households, and the elderly, defined as individuals over 65, who are likely to be retired. Thus, in communities with larger proportions of the elderly and households in poverty, search effort is likely to be greater in the market for pharmaceutical drugs.

On average, individuals over 65 take more medications than other consumers and often pay with cash (HHS Weekly Report). Thus, the benefits from any given level of search are also likely to be greater for that group because search is being carried out over multiple commodities and economies of scope may be achieved. Repeated visits to the pharmacy for the elderly imply a lower cost to search for information. Finally, during the time period we consider in 2004, the elderly were not covered for prescription drugs by Medicare (Part D) which started in January 1, 2006. The high expected benefit and low cost of search suggests that the elderly search for lower drug prices.

For individuals below the poverty line, the market price for drugs impacts their purchase decisions, because they are less likely to have insurance and/or pay a flat fee for prescriptions. Even Medicaid, which helps some low-income individuals with health insurance, does not cover all low income consumers, because eligibility depends on several criteria including age, pregnancy, disability, blindness, income and resources, and citizenship. Thus, for people below the poverty line, the expected benefit from searching is expected to be greater than for people above the poverty line. Having more low income consumers in a community may lead to more search, as these individuals face a tighter budget and therefore, are more likely to search for savings.

DATA

Measuring price dispersion requires price data from different sellers of the commodity in each market. Sorenson examined price dispersion in two towns in up-state New York where, at the time of his study, each pharmacy was required to post prices publicly in the store for the top 150 drugs in terms of state-wide prescriptions. Thus, he was able to obtain data on prices for at least 150 separate pharmaceutical products from each outlet. In contrast to pharmacies in New

York markets, pharmacies in Montana are not required to post prices for drugs in a public location within each place of business. In our study of Montana, data had to be obtained through a survey instrument that was filled out by each participating outlet.[i] The survey instrument was administered to 58 pharmacies in five geographically distinct markets over the period July 1, 2004 to August 15, 2004. A total of 33 completed surveys were completed and returned, yielding a response rate of 57 percent. The five cities - Billings, Bozeman/Belgrade, Great Falls, Kalispell, and Missoula - are a minimum of eighty miles apart from each other and no other town with a pharmacy is closer than 20 miles away from these markets.[ii] In each of these markets, price data were obtained from a minimum of five pharmacies for each of the 75 drugs included in the survey.[iii]

Price dispersion is likely to be affected by specific market characteristics that serve as indicators of the amount of consumer search in each market. Thus, demographic variables on the population proportions of the elderly (aged 65 and over) and the poor (individuals below the federal poverty line) were collected for each of the five markets from the 2001 U.S. Census. Data on the distance of each market from the closest competing market in Canada were collected from an internet mapping service.

The degree of price dispersion for each drug is likely to be affected by the characteristics of that drug that affect consumer benefits from search, as well as the availability of substitutes. These characteristics include a drug's frequency of use. For each drug, therefore, typical dosages and therapy durations were collected from Mosby's 2004 Drug Guide. In addition, Thomson Healthcare's 2003 Drug Topics Redbook was used to collect information on each drug's average wholesale price and the number of manufacturers and re-packagers of the drug. The United States National Library of Medicine and the National Institute of Health served as sources for information on brand name drugs that have generic substitutes, the number of those substitutes, brand name drugs that do not have substitutes, and the class of treatment for which each drug was used.

Differences among pharmacies with respect to services may also affect price dispersion. Respondents to the survey were asked to provide information on their operations, including whether they offered a delivery service and whether it was free, their proximity to hospitals, physicians, medical centers, and retirement communities, availability of discounts for senior citizens, whether the pharmacy was located in a grocery store or a department store, whether it was a member of a chain or United Buying Group, and its hours of operation. In addition, the authors obtained data on thirty eight commonly marketed non-prescription items sold by each pharmacy.[iv]

III. EMPIRICAL MEASURES OF PRICE DISPERSION

Price dispersion for a commodity within a given market can be measured in several different ways. Two direct measures are the range and standard deviation of the price of a drug obtained using the actual price data. These measures are regressed on a set of explanatory variables that account for heterogeneity among sellers (pharmacies) and drug and market characteristics that affect incentives for search. Alternatively, empirical models can be estimated that regress individual drug prices on pharmacy-specific characteristics (such as hours and days of service, wholesale supplier, etc.) and other variables unrelated to search costs. The residuals from those models, "purged" of such effects, are then used to construct price dispersion measures which are regressed on variables related to search costs. Both of these approaches are used here.

Price dispersion measures computed directly from price data indicate that prices for pharmaceutical drugs vary substantially both within and between individual markets. The degree of this variation is illustrated in table I in which average prices, price ranges, standard deviations and coefficients of variation are reported for six drugs in each of the five markets included in the study. Prescriptions for four of the six drugs were relatively inexpensive, with average prices in the five markets ranging from $7.91 to $13.58, while prescriptions for the other two were relatively expensive, with average prices in the five markets ranging from $87.41 to $122.20.

(insert table I here)

Within each market, prices for some of these drugs exhibited considerable variation. For example, among the low priced drugs in table I, the average price for alprazolam (0.5MG) in the Billings market was $12.80, but the range in prices was $21.34 and the coefficient of variation was 64%. However, in the same market, other drugs with similar average prices exhibit much less price variation. In the Billings market, the average price for acetamine codeine #3 was $9.80, the range in prices was only $1.74, and the coefficient of variation was 6%. In addition, the same drug may exhibit much more price variability in one market than in another. For example, the coefficient of variation for the price of acetamine codeine ranged from 6% in the Billings market to 26% in the Great Falls market.

Further, while the coefficients of variation presented in Table I suggest that high price drugs exhibit less variation than low priced drugs, price ranges for more expensive drugs can be substantial even when their coefficient of variations are relatively small. Coefficients of variation for the two high priced drugs range from 5% for Allegra-D in Billings to 15% for Augmentin (875 mg) in Great Falls. Coefficients of variations for the four lower priced drugs range from 6% for acetamine codeine #3 in Billings to 64% for alprazolam, also in the Billings market, in all but 3 of 16 cases exceed 20%, and in all but one case exceed 15%.

Measures of price dispersion obtained directly from the sample data reflect the effects of all sources of price variation among pharmacies. In addition to factors that affect incentives for search, these variation effects include pharmacy specific effects that arise from differences in costs associated with heterogeneous services, variations in wholesale costs, and variations in competition for specific drugs. Following Sorensen, we estimate price level models to control for price variation caused by differences in the services offered by individual pharmacies, drug specific wholesale costs, and other variables unrelated to search costs. The residuals from these models are therefore "purged" of pharmacy and other non-search related effects. We use the residuals to compute measures of price variability for each drug. These measures are then regressed on drug characteristics and market characteristics that affect incentives for search.

Five alternative price level models are estimated to control for the effects of drug specific, pharmacy and other potential sources of heterogeneity, for which parameter estimates are reported in Table II. Model 1 includes only drug characteristics, model 2 includes drug and pharmacy characteristics, model 3 includes drug and pharmacy variables and two interaction variables between drug and pharmacy characteristics, and model 4 includes two additional market characteristic variables. Model 5 is identical to model 4 in terms of explanatory variables, but standard errors are estimated using the cluster command in Stata to account for potential city-related clustering effects. Model parameters are estimated using the OLS procedures in Stata. Cook and Weisberg (1983) tests indicated the presence of heteroskedesticity in the error terms and so robust standard errors are therefore estimated.

(insert table II)

Each price level model includes the following drug characteristics variables. Indicator (zero-one) variables account for whether the drug is sold under a brand name (*Brand*) and whether the drug is a brand name that faces competition from generic drugs (*Brand Substitutes*). Other variables identify the number of drugs that provide alternative therapies for conditions treated by the drug of interest (*Substitutes*), the number of companies manufacturing the drug (*Manufacturers*), and the drug's estimated average wholesale cost to pharmacies (*Average Cost*).

Sixteen drug treatment class variables identify the types of ailments for which each drug is used. For example, prescriptions used to treat chronic conditions might create more benefits from search because of the repeat nature of their demand. These sixteen variables are included to control for the primary use of the drug, but their results are not reported for brevity.

Twenty three pharmacy-specific characteristic variables were utilized in models 2-5 in table II. They include the total number of hours a pharmacy is opened, two dummy variables indicating whether or not the pharmacy is open on Saturdays and Sundays, seven dummy variables that account for eight primary wholesalers of pharmaceuticals, six dummy variables that account for seven secondary wholesalers, two dummy variables that account for the availability of any delivery services and free delivery, and five variables that account for other differences among pharmacies in their business operations (whether or not the pharmacy is a member of a chain or buying group, located in a grocery or big box department store, near a hospital, or as a standalone operation, and provides a wide or limited range of non-pharmaceutical products). Individual parameter estimates are reported in Appendix A (table AI) for the ten pharmacy characteristics variables that describe service attributes, chain membership, and location.

Market characteristics are included in model 4 in Table II. One measure of competition among sellers within a market is the number of sellers per thousand people in that market (*Pharmacies per 1000 people*). Markets in Canada represent another potential source competition. Hence, the distance from each Montana market to its closest Canadian market (*Distance to Canada*) is included with both linear and quadratic terms. Finally, interaction variables between whether a pharmacy belongs to a chain of stores and two drug characteristics, brand and the number of substitutes are included (*Chain_Brand*, and *Chain_Brand_Substitutes*). These variables account for the possibility that chains may have different mark-up rates for patented brands, brands with generic competitors, and generic drugs.

The general pattern of results for the price level models is as follows. A drug's retail price is likely to increase as its average wholesale cost increases. As expected, parameter estimates reported in Table II for *Average Cost* are positive and statistically significant at the one percent level. The *Average Cost* variable was constructed as follows. In 2004, Montana's Medicaid reimbursements to pharmacies were the equivalent of 85 percent of a drug's average wholesale price (AWP), considered to be the cost of obtaining the drug, plus a fixed dispensing fee of $4.70 per prescription. Contracts between insurance companies and pharmacies often use formulas similar to those established by Medicaid. Thus the variable *Average Cost*, which serves as a proxy for the average cost to a pharmacy of acquiring a drug, is measured as the sum of the drug's AWP and the Medicaid prescription fee of $4.70.[v]

As competition increases from substitute drugs, a drug's price is expected to be lower. Parameter estimates for the variable *Number of Substitutes* are negative, generally significant at the one to ten percent level, and therefore consistent with this hypothesis. As the number of manufacturers providing the same drug increases and competition among them increases, the price of that drug might be expected to fall. However, an increase in the number of manufacturers may result in differences in production costs and, therefore, differences in wholesale prices that are passed through to the retail level. Parameter estimates for the variable

Number of Manufacturers are positive and significant at the one percent level, and therefore, indicate that the latter influence may be more important than competition effects.

The degree of competition in the market for a specific drug is likely to inversely affect the price at which the drug is sold. If the drug is a brand name drug (*Brand* equals one), then its price is expected to be higher. However, if that same drug faces competition from generic substitutes (*Brand Substitutes* equals one), its price is expected to be lower. Results presented in Table II support these hypotheses. In all eight models, the coefficient for *Brand* is positive while the coefficient for *Brand Substitutes* is negative, and both are statistically significant at the one percent level.

Drug prices appear to be lower in pharmacies located within a mile of a hospital, higher in pharmacies that open on Saturdays, and lower in pharmacies that open on Sundays (with coefficients that are statistically significant at the ten percent level). Other pharmacy characteristics do not appear to have any systematic effects on pharmaceutical drug pricing decisions. A pharmacy's choice of primary and secondary wholesaler may also affect price levels. Coefficients for the dummy variables for three primary wholesale sources and two secondary wholesale sources are statistically significant from zero in some models.

The price level models explain some of the within-sample differences in prices. Unadjusted coefficients of determination (R-squared) are about 0.91 for the models presented in Table II. However, a considerable amount of variation remains to be explained. Among the 75 drugs, the average estimated standard deviation of the price of a drug within a given market computed using the price data obtained in the survey is $5.85 and the average difference between the highest and lowest price for a drug is $15.84. Using the residuals obtained from the most comprehensive price level model (model 4), the average estimated standard deviation is $5.30

and the average range is $14.25. Thus price level model 4, which accounts for pharmacy, manufacturer, and other sources of heterogeneity, reduces the estimated average standard deviation and range of drug prices by about ten percent.

IV. MODELS OF PRICE DISPERSION

Price dispersion within a market for a specific drug is likely to be a function of physical drug characteristics that affect incentives for search, characteristics of the supply side of the market that affect competition, and characteristics of consumers in the market that affect incentives for search. Two market characteristics variables related to search costs, *Percent 65* and *Percent Poverty*, are also included in the price dispersion models. Again, elderly individuals are expected to have lower search costs, due to repeat purchasing of drugs, and low income individuals are expected to have greater search benefits, due to a more constrained budget and/or lack of health insurance. Price dispersion within each market is expected to be inversely related to both of these indicators of search intensity.

To control for other factors that cause price dispersion, we include drug characteristics that affect the expected benefits consumers obtain from search. Returns to search are likely to be larger for drugs whose prescriptions have to be filled more frequently to complete a therapy than for drugs whose prescriptions have to be filled only once or twice, and so price dispersion is assumed to depend on annual frequency of use as measured by the variable *Purchase Frequency*. Purchase frequency is measured as follows. Each drug's estimated typical dosage per day is multiplied by the typical length of treatment, which is then divided by the typical quantity provided in a prescription to estimate the number of times in a year the typical patient has to purchase the drug.[vi] Drugs with estimated annual purchase frequencies of less than one are allocated a purchase frequency of one because at least one prescription must be filled if it is to be used.

More expensive drugs are also likely to offer greater returns from consumer search. Given that the measures of price dispersion used in this study are ranges and standard deviations, including an indicator of average cost in the price dispersion model may normalize for differences in price levels. The estimated average cost to a pharmacy of obtaining a drug, *Average Cost*, is used as a proxy for the average price of the drug to a consumer.

The number of manufacturers of a single drug may increase price dispersion because of differences in production costs among the competing firms that lead to different wholesale prices. Pharmacies tend to purchase drugs from one or two wholesalers, and those wholesalers obtain the same drugs from multiple manufacturers and re-packagers. These cost differences, therefore, are one potential source of price dispersion. A patented branded drug produced by a single manufacturer is also likely to exhibit less price dispersion among pharmacies because wholesalers can only purchase the drug from one manufacturer and, absent price discrimination among wholesalers by the manufacturer, only one wholesale price. Thus price dispersion is likely to be directly related to *Manufacturer* and inversely related to *Brand*.

Competition from other drugs may also affect price dispersion. A branded drug that faces competition from generic substitutes may exhibit less price dispersion because competition from generics reduces the incidence of high prices by increasing the probability that a low price is observed for any given level of consumer search. Increases in the number of generic substitutes are likely to further increase the probability that a given amount of search will result in the observation of a low price and reduce price dispersion. Hence, price dispersion is likely to be inversely related to the variables *Brand Substitutes* and *Substitutes*.

Finally, potential competition from other markets in which all drug prices are believed to be lower may reduce prices at the high end of the price distribution. This hypothesis implies that markets closer to Canada may experience less price dispersion.

V. RESULTS

The effects of drug and market characteristics on price dispersion are examined using four different price dispersion measures for each drug within each market. These four measures are (a) the range and (b) the standard deviation for each of the 75 drugs computed directly using the prices obtained from the pharmacy survey, and (c) the range and (d) the standard deviation for each drug estimated using the residuals from the price level models presented in Table II.

5.1 Pooled OLS

Table III columns 3, 4, 7, and 8 present parameter estimates for models in which the measures of price dispersion based on residuals from a price level model (model 4 from table II). Price dispersion model parameters and robust standard errors were estimated using OLS and related procedures in Stata. Although three city specific variables were included in several of the price dispersion models, clustering of price differences by city could still be a concern (see, for example, Wooldridge). However, accounting for clustering effects in the estimation procedures has little impact on the estimated standard errors relative to those obtained using robust estimation procedures that account for potential heteroskedasticity. In particular, the standard errors and t-statistics associated with market specific variables such as percent in poverty and percent elderly were essentially unchanged.

(insert table III)

In table III, two regression models are estimated to explain variations in each of the four price dispersion measures. Model 1 includes only drug characteristic variables: *Purchase*

Frequency, Brand, Brand Substitutes, Substitutes, Manufacturers, and *Average Cost*. Model 2 also includes the three market characteristic variables: *Percent Poverty*, *Percent65,* and *Distance to Canada*.

The central concern of this study is the role of market characteristics of search costs in determining price dispersion. Search effort is related both to the benefits consumers expect to receive and the search costs they incur. The two market specific indicators of search costs are *Percent Poverty* and *Percent65*. The elderly and the poor are assumed to have relatively low search costs and high benefits. Many of the elderly are likely to obtain smaller costs from search because they have to obtain multiple prescriptions on a regular basis. Low income households are less likely to be insured and therefore more likely to pay the full price of a prescription drug. Thus, they may also obtain relatively large benefits from search.

Parameter estimates for both these variables are uniformly negative and in four of the eight models for which results are reported (the models that explain the standard deviation measures of price dispersion) statistically significant at either the ten percent or five percent confidence level. Thus, the results are consistent with the hypothesis that price dispersion is lower in markets where search costs are low and expected benefits relatively substantial for larger proportions of the population.

Also of some concern is the parameter estimates for the *Distance from Canada,* which are negative and statistically significant at the ten percent level in three of them. This result is not consistent with the hypothesis that pharmacies close to Canada face more competition and exhibit less price dispersion. Furthermore, in Table 2, there is no evidence that proximity to Canada had any effect on the level of drug prices or price in Montana markets in the summer of 2004. One explanation for this result is that transportation costs (including travel time) are generally relatively large. For example, the shortest distance between a Montana and Canadian market is over seventy miles and involves a two and half hour round trip journey. In addition, in the summer of 2004, some Canadian companies were marketing drugs to all U.S. customers via the internet.[vii]

5.2 Purchase Frequency and Population Characteristics

To further emphasize the impact of population characteristics on price dispersion, we sort the data by *Purchase Frequency*, which is presumed to capture repeated searches.[viii] Drugs that are purchased once have a much smaller benefit from search, and the impact of population characteristics is expected to be less for drugs that are purchased less frequently. Table IV presents the same price dispersion (model 2) results for high and low purchase frequency drugs. High purchase frequency implies that the drug is purchased more than 12 times in a year.

The results for the population characteristics are similar to earlier results with a negative coefficient for all measures of price dispersion and statistical significance for two measures: standard deviation and residual standard deviation.

For these population characteristics, the magnitude and statistical significance of the estimated coefficients is greater for drugs with a high purchase frequency. Although the coefficients for population characteristics is not statistically different for low and high purchase frequency drugs, the result provides some support that when search benefits are high and search costs low, the elderly and poor will search more, lowering the amount of price dispersion.

5.3 Average Cost and Population Characteristics

We also sort the data by *Average Cost*, which is presumed to capture benefits from search.[ix] Drugs with a high average cost are correlated with more price dispersion and therefore greater benefits from search than low cost drugs. Table V presents the price dispersion model 2 results for high and low cost drugs. High cost drugs are drugs that have an average cost greater than $50.

Again, for these population characteristics, the magnitude and statistical significance of the estimated coefficients is greater for drugs with a high average cost. This result emphasizes that when search benefits are high, the elderly and poor will search more, lowering the amount of price dispersion.

We further note that for low cost drugs, *Purchase Frequency* has a positive impact on price dispersion. For low cost drugs that are repeatedly purchased, price dispersion is large, perhaps due to the perceived view of small search benefits.

VI. CONCLUSION

The law of one price implies that commodities with the same physical attributes should be offered at the same price by different sellers in the same market under the same conditions of sale. This is often not true even when, as is the case with pharmaceutical drugs, the commodities offered for sale in a given market have identical physical characteristics. This paper has reexamined the law of one price and price dispersion for pharmaceutical drugs in five geographically isolated markets more than eighty miles apart from one another in Montana, the fourth largest of the lower 48 states, in which there are less than 1 million people. Price data for 75 drugs were obtained from a "point in time" survey of 33 pharmacies in the five communities and four measures of price dispersion for each drug in each market were constructed.

Prices for the same drug varied substantially among pharmacies in each of the five markets in ways that could not be explained simply by differences in pharmacy services. However, price dispersion is lower for a drug when the expected benefits from search are greater. Price dispersion is lower for drugs with higher prices and there is some evidence that relative price dispersion is lower for drugs that are purchased more frequently. These results confirm the findings reported by Sorenson in his study of pharmaceutical drug prices in two communities in up-state New York.

In addition, in the five Montana markets examined in this study, price dispersion is lower in markets where the proportion of elderly in the population or the proportion of individuals in poverty is relatively large. The elderly and the poor both have relatively low opportunity costs of time, relatively large expected benefits from search, and, therefore, relatively high levels of search effort. Additionally, when search benefits are high, as is the case for high average cost drugs, the impact of population characteristics is greater. We also find similar evidence when search costs are low as is the case for repeatedly purchased drugs. These new findings provide additional empirical support for the hypothesis that price dispersion is affected by consumer search effort, which in turn is influenced by economic incentives.

This relationship is particularly critical to healthcare reform policies that may affect a person's decision to search for the lowest priced medicine. The main findings reported above support the view that policies that lower search costs and raise expected benefits can increase informed decision-making and decrease price dispersion. Various proposals have incentivized consumers of healthcare services to search more, but typically, they encourage searching over healthcare providers rather than the service or good itself.

One such policy that has reduced the incentive to search is Medicare (Part D), whose coverage started in January 1, 2006 after the time period we considered. The results of our study suggest that increased prescription drug coverage reduces the incentive for search. Closing the 'donut hole' may have increased price dispersion due to the potential for increased rents for pharmacies.

One weakness with the data is the relatively small sample of cities used in the cross-sectional regression. Cross-country and cross-city comparisons with a few observations are common, but we note that the empirical findings can only suggest a link between search effort and price dispersion, and are not conclusive. More importantly, our study provides new findings observing a possible relationship between search effort and population characteristics. This relationship should be considered when developing healthcare reform policies, but further research on the relationship should be studied.

Finally, this study provides little or no evidence that access to pharmaceuticals from Canadian markets had any measurable effects on either prescription price levels or price dispersion in 2004. This is worth noting in light of the extensive media attention given to the issue of the availability of much lower priced drugs in Canada during 2004 and early 2005. One reason for the finding may have been that during that time many U.S. consumers could obtain prescription drugs from Canadian outlets through the internet and, therefore, geographic proximity to Canadian markets was unimportant. Another may be that for most consumers in the markets examined in this study, travel costs exceeded any potential savings from buying prescription drugs in Canadian markets, even though such gains appeared to be quite substantial for some drugs.

References

Aalto-Setala, V. (2003). Explaining price dispersion for homogeneous grocery products. *Journal of Agricultural and Food Industrial Organization* 1 (9).

Adams, A. (1997). Search costs and price dispersion in a localized, homogeneous product market: some empirical evidence. *Review of Industrial Organization* 12 (5), 801-8.

Besancenot, D. and R. Vranceanu (2004). Quality and price dispersion in an equilibrium search model. *Journal of Economics and Business* 56 (2), 99 – 116.

Burdett, K. and K. Judd (1983). Equilibrium price dispersion. *Econometrica* 51 (4), 955–69.

Cook, R. and S. Weisberg (1983). Diagnostics for heteroscedasticity in regression. *Biometrika* 70 (1), 1–10.

Dahlby, B. and D. West (1986). Price dispersion in an automobile insurance market. *The Journal of Political Economy* 94 (2), 418–38.

Duff-Brown, B. (2005, 29 June). Health minister: Canada to ban export of bulk prescription drugs. Associated Press.

Goldberg, P. and F. Verboven (2001). The evolution of price dispersion in the European car market. *The Review of Economic Studies* 68 (4), 811–48.

Goodwin, B., T. Grennes, and M. Wohlgenant (1990). Testing the law of one price when trade takes time. *Journal of International Money and Finance* 9 (1), 21–40.

HHS Weekly Report (2004, 5 December). Science in the news: Almost half of Americans use at least one prescription drug annual report on nation's health shows. Available at http://www.hhs.gov/news/newsletter/weekly/archive/5dec04.html (accessed Jan. 2005).

McMillan, J. and P. Morgan (1988). Price dispersion, price flexibility, and repeated purchasing. *The Canadian Journal of Economics/Revue canadienne d'Economique* 21 (4), 883–902.

Morton, Fiona Scott, Florian Zettelmeyer, and Jorge Silva-Risso. 2003. Consumer Information and Discrimination: Does the Internet Affect the Pricing of New Cars to Women and Minorities? *Quantitative Marketing and Economics*. v1 (n1):65-92.

Porter, E. (2004, 16 October). Importing less expensive drugs not seen as cure for U. S. woes. The New York Times: A1.

Reinganum, J. (1979). A simple model of equilibrium price dispersion. *The Journal of Political Economy* 87 (4), 851.

Salop, S. and J. Stiglitz (1977). Bargains and ripoffs: A model of monopolistically competitive price dispersion. *The Review of Economic Studies*, 493–510.

Sorensen, A. (2000). Equilibrium price dispersion in retail markets for prescription drugs. *Journal of Political Economy* 108 (4), 833–50.

Stigler, G. (1961). The economics of information. *The Journal of Political Economy* 69 (3), 213.

Talukdar, Debabrata. 2008. Cost of Being Poor: Retail Price and Consumer Price Search Differences across Inner-City and Suburban Neighborhoods. *Journal of Consumer Research*. v35 (n3):457-71.

United States Census Bureau, "American Fact Finder." Available at http://factfinder.census.gov/ (accessed August 2004).

United States National Library of Medicine and the National Institute of Health, "Medline Plus." Available at http://www.nlm.nih.gov/medlineplus/druginformation.html (accessed Oct. 2004).

Wilde, L. and A. Schwartz (1979). Equilibrium comparison shopping. *The Review of Economic Studies*, 543–53.

Wooldridge, Jeffrey, M. (2002). *Econometric Analysis of Cross Section Data.* Cambridge, Mass.: MIT Press.

Yahoo!® Maps. Available at http://maps.yahoo.com/dd (accessed August 2004).

Yoskowitz, D. (2002). Price dispersion and price discrimination: Empirical evidence from a spot market for water. *Review of Industrial Organization* 20 (3), 283–9.

2003 Drug Topics® Redbook. Thomson PDR. 2003.

2004 Drug Guide. Mosby, Inc. 2004.

Table I: Price Levels and Measures of Price Dispersion for Selected Drugs in Five Montana Markets

		Drug					
		Acetam.Cod.#3 Tabs (20 caps)	**Allegra –D (30 caps)**	**Alprazolam 0.5 Mg (30 doses)**	**Amoxil 250 Mg (30caps)**	**Atenolol 25 Mg (30 doses)**	**Augmentin 875 Mg (20 doses)**
Billings	Mean	$9.80	$93.90	$12.80	$13.51	$9.95	$121.13
	Range	1.74	14.02	21.34	9.95	8.32	43.88
	SD	0.58	4.97	8.14	4.4	3.19	15.92
	CV	6%	5%	64%	33%	32%	13%
Bozeman	Mean	$13.51	$89.65	$12.63	$11.70	$9.49	$122.20
	Range	7.89	13.77	7.99	9.15	5.53	16.98
	SD	2.93	5.42	3.26	4.08	2.07	6.23
	CV	22%	6%	26%	35%	22%	5%
Great Falls	Mean	$11.17	$87.41	$13.58	$10.28	$11.97	$103.24
	Range	7.72	11.99	13.21	3.42	20.99	30
	SD	2.89	5.62	5.33	1.64	8.96	11.32
	CV	26%	6%	39%	16%	75%	15%
Kalispell	Mean	$11.41	$89.65	$10.94	$10.25	$9.44	$116.89
	Range	5.71	13.1	7	8.07	4.5	34
	SD	1.83	4.82	2.34	2.47	1.48	11.42
	CV	16%	5%	21%	24%	16%	10%
Missoula	Mean	$10.48	$88.39	$12.21	$9.82	$7.91	$119.52
	Range	5.94	13.01	16.28	7.64	7.81	25.16
	SD	2.16	4.57	5.16	2.69	2.55	8.82
	CV	21%	5%	42%	27%	32%	7%

Table II. Price Level Models Including Treatment Class Variables [A]

Variable	**Drug Effects (1)**	**Drug and Pharmacy Effects (2)**	**Drug, Pharmacy, and Drug & Pharmacy Effects (3)**	**Drug, Pharmacy, Drug & Pharmacy, and City Effects (4)**	**Drug, Pharmacy, Drug & Pharmacy, and City Effects (Clustering) (5)**
Brand	24.585***	24.608***	23.070***	23.070***	23.070***
	(1.43)	(1.42)	(1.77)	(1.77)	(1.39)
Brand with Substitutes	-6.829***	-6.923***	-6.596***	-6.595***	-6.595***
	(0.91)	(0.88)	(1.31)	(1.31)	(0.94)
Number of Substitutes	-0.023*	-0.024*	-0.024*	-0.024*	-0.024***
	(0.01)	(0.013)	(0.013)	(0.01)	(0.004)
Average Cost	1.048***	1.048***	1.048***	1.048***	1.048***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
Number of Manufacturers	1.106***	1.107***	1.108***	1.107***	1.107***
	(0.10)	(0.10)	(0.10)	(0.10)	(0.05)
Distance to Canada	-	-	-	-0.051	-0.051
				(1.18)	(0.91)
Distance to Canada^2	-	-	-	0.001	0.001
				(0.02)	(0.02)
Pharmacies per 1000 People	-	-	-	-4.394	-4.394
				(7.21)	(6.06)
Chain_Brand[C]	-	-	2.316	2.315	2.315
			(1.54)	(1.54)	(1.82)
Chain_Brand with Substitutes	-	-	-0.504	-0.500	-0.500
			(1.49)	(1.49)	(1.24)
Constant	-170.454***	-189.634	-188.723***	-184.698***	-184.698***
	(5.06)	(9.65)	(9.65)	(16.20)	(12.87)
Observations	2334	2334	2334	2334	2334
R-squared	0.9117	0.9149	0.9149	0.9151	0.9151

[A] Robust standard errors are presented in parentheses below each parameter estimate in models 1, 2 3 and 4. The superscripts ***, **, * indicate statistical significance at the 1%, 5%, and 10% confidence levels, respectively. The standard errors reported for model 5 are obtained using the cluster command in State to account for potential clustering effects. The models presented in Table II also include dummy variables for sixteen different treatment categories of drugs. Parameter estimates for these treatment class variables are not reported.

[B] Models 2, 3, 4 and 5 include a set of 22 pharmacy characteristic variables for which parameter estimates are reported in table AI in the appendix.

[C] *Chain_Brand* equals one if the pharmacy is a member of a chain and the drug is a patented brand. *Chain_Brand_Substitutes* equals one if the pharmacy is a chain and the drug is a brand that faces competition from substitutes.

Table III. Price Dispersion Models[A]

	Price Dispersion Model (1)				Price Dispersion Model (2)			
Variable	**Range (1)**	**Standard Deviation (2)**	**Residual Range (3)**	**Residual Standard Deviation (4)**	**Range (5)**	**Standard Deviation (6)**	**Residual Range (7)**	**Residual Standard Deviation (8)**
Percent Poverty	-	-	-	-	-0.245	-0.59**	-1.014	-0.808***
					(0.71)	(0.27)	(0.75)	(0.28)
Percent 65	-	-	-	-	-0.582	-0.680**	-1.030	-0.810***
					(0.76)	(0.29)	(0.80)	(0.30)
Purchase Frequency	0.086	0.053	0.051	0.040	0.086	0.053	0.051	0.040
	(0.14)	(0.05)	(0.12)	(0.04)	(0.14)	(0.05)	(0.12)	(0.04)
Average Cost	0.186***	0.067***	0.158***	0.060***	0.186***	0.067***	0.158***	0.060***
	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)
Manufacturers	0.305*	0.107*	0.220	0.087	0.305*	0.107*	0.220	0.087
	(0.17)	(0.06)	(0.17)	(0.06)	(0.18)	(0.06)	(0.17)	(0.06)
Brand	-3.020*	-1.225**	-5.165***	-2.17***	-3.020*	-1.225**	-5.165***	-2.171***
	(1.60)	(0.57)	(1.72)	(0.58)	(1.59)	(0.57)	(1.69)	(0.57)
Brand Substitutes	4.563***	1.691***	5.784***	2.29***	4.563***	1.691***	5.784***	2.292***
	(1.68)	(0.56)	(1.72)	(0.60)	(1.71)	(0.57)	(1.71)	(0.58)
Substitutes	-0.044***	-0.014**	-0.032**	-0.010*	-0.044***	-0.014**	-0.032**	-0.010*
	(0.02)	(0.01)	(0.02)	(0.005)	(0.02)	(0.01)	(0.02)	(0.005)
Distance to Canada	-	-	-	-	-0.134	-0.176*	-0.423*	-0.258***
					(0.24)	(0.09)	(0.25)	(0.10)
Constant	-28.041***	-9.974***	-22.332***	-8.66***	-13.205	12.562	17.399	20.979**
	(6.22)	(2.21)	(5.78)	(2.13)	(27.06)	(10.27)	(28.50)	(10.57)
Observations	370	370	370	370	370	370	370	370
R-squared	0.4145	0.4302	0.3382	0.3626	0.4218	0.4438	0.3498	0.3802

[A] Robust standard errors are presented in parenthesis. The superscripts ***, **, * indicate statistical significance at the 1%, 5%, and 10% confidence levels, respectively. These models also include sixteen treatment class dummy variables for which parameter estimates are not reported.

Table IV. Price Dispersion Models for Low and High Purchase Frequency Drugs[A]

	Price Dispersion Model (2) – Low Purchase Frequency				Price Dispersion Model (2) – High Purchase Frequency			
Variable	**Range (1)**	**Standard Deviation (2)**	**Residual Range (3)**	**Residual Standard Deviation (4)**	**Range (5)**	**Standard Deviation (6)**	**Residual Range (7)**	**Residual Standard Deviation (8)**
Percent Poverty	-0.371	-0.637*	-0.876	-0.764*	-0.771	-0.718*	-1.168	-0.852**
	(0.97)	(0.38)	(1.05)	(0.40)	(1.07)	(0.41)	(1.10)	(0.41)
Percent 65	0.016	-0.524	-0.87	-0.764**	-0.479	-0.651*	-1.143	-0.848**
	(0.89)	(0.36)	(0.98)	(0.38)	(1.00)	(0.39)	(1.04)	(0.39)
Purchase Frequency	-1.103	-0.433*	-1.288*	-0.523**	-	-	-	-
	(0.73)	(0.23)	(0.74)	(0.23)	-	-	-	-
Average Cost	0.226***	0.082***	0.198***	0.075***	0.069	0.025*	0.054	0.024
	(0.03)	(0.01)	(0.03)	(0.01)	(0.04)	(0.01)	(0.04)	(0.01)
Manufacturers	0.396	0.142*	0.178	0.091	-0.109	-0.041	-0.017	-0.011
	(0.24)	(0.08)	(0.29)	(0.09)	(0.26)	(0.09)	(0.21)	(0.07)
Brand	-4.119	-1.71	-6.391*	-2.585**	2.802	1.028	0.63	-0.068
	(3.03)	(1.05)	(3.41)	(1.14)	(2.66)	(0.97)	(2.66)	(0.96)
Brand Substitutes	4.845*	1.889**	5.758**	2.375***	4.155	1.527	6.418	2.742*
	(2.51)	(0.82)	(2.60)	(0.89)	(4.77)	(1.58)	(4.57)	(1.50)
Substitutes	-0.067**	-0.023**	-0.04	-0.013	0.013	0.006	-0.015	-0.003
	(0.03)	(0.01)	(0.04)	(0.01)	(0.05)	(0.02)	(0.04)	(0.01)
Distance to Canada	-0.048	-0.152	-0.348	-0.234*	-0.212	-0.197	-0.491	-0.280**
	(0.31)	(0.12)	(0.34)	(0.13)	(0.34)	(0.13)	(0.35)	(0.13)
Constant	16.976	24.388*	48.36	32.736**	30.942	27.539*	51.592	34.267**
	(34.06)	(13.20)	(36.50)	(13.83)	(37.78)	(14.58)	(38.68)	(14.46)
Observations	175	175	175	175	195	195	195	195
R-squared	0.542	0.572	0.46	0.504	0.29	0.312	0.244	0.259

[A] Robust standard errors are presented in parenthesis. The superscripts ***, **, * indicate statistical significance at the 1%, 5%, and 10% confidence levels, respectively. These models also include sixteen treatment class dummy variables for which parameter estimates are not reported. High purchase frequency implies that the drug is purchased more than 12 times in a year.

Table V. Price Dispersion Models for Low and High Average Cost Drugs[A]

Variable	Price Dispersion Model (2) – Low Average Cost				Price Dispersion Model (2) – High Average Cost			
	Range (1)	Standard Deviation (2)	Residual Range (3)	Residual Standard Deviation (4)	Range (5)	Standard Deviation (6)	Residual Range (7)	Residual Standard Deviation (8)
Percent Poverty	0.129	-0.328	-0.126	-0.469*	-1.465	-1.116**	-2.153	-1.235**
	(0.83)	(0.30)	(0.77)	(0.27)	(1.30)	(0.50)	(1.45)	(0.55)
Percent 65	0.569	-0.169	-0.096	-0.422*	-1.255	-1.115**	-2.155	-1.287**
	(0.77)	(0.28)	(0.71)	(0.25)	(1.23)	(0.48)	(1.37)	(0.53)
Purchase Frequency	0.561**	0.224**	0.573**	0.231***	0.121	0.067	0.126	0.086
	(0.28)	(0.10)	(0.23)	(0.08)	(0.24)	(0.09)	(0.20)	(0.08)
Average Cost	0.537***	0.197***	0.415***	0.163***	0.123***	0.048***	0.113***	0.048***
	(0.12)	(0.04)	(0.10)	(0.04)	(0.04)	(0.01)	(0.04)	(0.01)
Manufacturers	0.122	0.041	-0.045	-0.011	1.504*	0.500**	1.618*	0.570**
	(0.16)	(0.06)	(0.13)	(0.05)	(0.82)	(0.25)	(0.87)	(0.28)
Brand	-7.407**	-2.707**	-6.765**	-2.879***	-3.335	-1.059	-8.942*	-3.132**
	(3.35)	(1.18)	(2.99)	(1.09)	(2.78)	(0.98)	(4.75)	(1.48)
Brand Substitutes	8.207**	2.790***	7.544***	2.969***	2.283	1.058	1.843	0.976
	(3.22)	(1.04)	(2.84)	(0.98)	(3.01)	(0.98)	(3.36)	(1.12)
Substitutes	-0.009	0.001	0.017	0.008	-0.026	-0.009	-0.019	-0.005
	(0.03)	(0.01)	(0.03)	(0.01)	(0.05)	(0.02)	(0.05)	(0.01)
Distance to Canada	0.139	-0.045	-0.098	-0.136	-0.475	-0.338**	-0.827*	-0.411**
	(0.26)	(0.09)	(0.24)	(0.09)	(0.42)	(0.16)	(0.47)	(0.18)
Constant	-21.134	5.126	2.38	13.479	55.188	41.509**	90.133*	48.113**
	(30.17)	(10.95)	(28.49)	(10.09)	(46.68)	(18.00)	(51.87)	(19.53)
Observations	205	205	205	205	165	165	165	165
R-squared	0.385	0.396	0.328	0.361	0.472	0.517	0.425	0.474

[A] Robust standard errors are presented in parenthesis. The superscripts ***, **, * indicate statistical significance at the 1%, 5%, and 10% confidence levels, respectively. These models also include sixteen treatment class dummy variables for which parameter estimates are not reported. High cost drugs are drugs that have an average cost greater than $50.

Appendix

Table AI: Parameter Estimates for the Pharmacy Characteristics in the Price Level Models.[A]

Variable	Price Level Model Drug and Pharmacy Effects (2)	Drug, Pharmacy, and Drug & Pharmacy Effects (3)	Drug, Pharmacy, Drug & Pharmacy, and City Effects (4)	Cluster (5)
Non-Prescription Items Missing	0.185	0.185	0.127	0.127
	(0.11)	(0.11)	(0.14)	(0.13)
Delivery	-3.338	-3.348	-4.385	-4.385
	(3.02)	(3.02)	(3.32)	(3.26)
Free Delivery	1.975	1.985	2.108	2.108
	(2.97)	(2.97)	(3.50)	(3.14)
Chain	4.185**	2.825	2.659	2.659
	(1.87)	(1.99)	(2.43)	(1.91)
Hospital[B]	-4.618***	-4.617***	-2.993	-2.993
	(1.69)	(1.69)	(2.40)	(2.57)
Grocery	2.683***	2.683***	1.680	1.680
	(1.03)	(1.03)	(1.46)	(1.13)
Department	-4.651***	-4.652***	-2.617	-2.617
	(1.67)	(1.67)	(2.42)	(2.07)
Hours Open	0.096	0.096	0.048	0.048
	(0.11)	(0.11)	(0.14)	(0.14)
Open Saturdays	4.416	4.390	4.728	4.728*
	(3.19)	(3.19)	(3.31)	(2.58)
Open Sundays	-5.796**	-5.792**	-5.646	-5.646
	(2.74)	(2.74)	(3.45)	(3.40)
Observations	2334	2334	2334	2334
R-squared	0.9149	0.9149	0.9151	0.9151

[A] Robust standard errors are presented in parentheses. Superscripts ***, **, * respectively indicate that a coefficient is statistically significant at the 1%, 5%, and 10% level respectively. Class models include dummy variables for 16 different categorized drugs. Parameter estimates for the 13 dummy variables accounting for primary and secondary wholesalers are omitted because little is known about these wholesalers and therefore their interpretation is of limited interest.

[B] Hospital has a value of 1 if the pharmacy is within a mile of a hospital. Pharmacies located in hospitals were excluded from the survey because many are owned and operated by the hospital and their pricing structures may be linked to pricing structures for other hospital services.

[i] Seven pharmacies located in markets not included in the study were asked to pretest a preliminary survey instrument which included the top 150 most frequently prescribed drugs in 2003. These pharmacies expressed concerns about response burden. To lower the response burden for each pharmacist and increase response rates, the final survey instrument asked pharmacists to provide data on prices for 75 of those drugs.

[ii] Pharmacies with the same corporate parent often have similar pricing menus. Due to the small size of towns in Montana, only Billings includes two pharmacies with the same corporate parent in the same city. Even with the theory of pricing menus, we still find price dispersion across cities, suggesting that consumer search costs have an even greater impact.

[iii]One concern with the data is whether drug prices were collected during a period in which those prices were systematically changing, resulting in a misleading impression of price differences among pharmacies. All of the data were collected over a six week period in late July and August of 2004 during which general inflation was negligible and fiscal or marketing year ends for most drug companies did not occur. Thus, it is unlikely that systematic adjustments to wholesale or retail prices were implemented during the data collection period.

[iv] Response bias is an important problem to consider in the sample, given that some chain pharmacies cited corporate policy as their rationale for non-response. To examine this problem, correlations between non-prescription item prices and drug prices were examined. If systematic correlations exist, non-responders could be identified as either high-price or low-price firms, based on the price data for the 38 non-prescription items collected independently by the authors

from each pharmacy. No statistically significant correlations were found between the prices of non-prescription items and prescription drugs among responders. Further, although some chain pharmacies cited corporate policy as their reason for not participating in the survey, several pharmacies from the same chains did provide responses. Thus, there is no evidence to suggest that response bias is a serious problem in the data set.

[v] Information on the links between drug cost reimbursements for pharmacies in Montana under the Medicaid and insurance contracts was provided to the authors through personal communications from two practicing pharmacists.

[vi] For example, Atenolol is a beta-blocker typically taken once a day for the rest of a person's life with a prescription quantity of 30 pills. Thus the estimated annual frequency of purchase for Atenolol is 12.17 (= 1* 365/ 30).

[vii] In table III, the estimated coefficients for *Brand* are negative and statistically significant at the ten percent level. These results are consistent with the hypothesis that branded drugs produced by only one manufacturer exhibit less price dispersion because production costs do not vary as they could if more than one manufacturer made a drug. All eight parameter estimates for *Manufacturers* are positive and six are statistically significant at the ten percent level or better. These results provide some additional support for the hypotheses that variations in costs among manufacturers are a source of price dispersion among retailers. All eight parameter estimates for *Substitutes* are negative and statistically significant, indicating that competition decreases price dispersion. Parameter estimates for *Brand Substitutes* are positive and statistically significant.

These findings are not consistent with the hypothesis that, when branded drugs face competition from generic substitutes, less price dispersion is observed. In contrast, the results reported in table III suggest that the advent of generic substitutes may increase price variability, perhaps because the markets for the branded drug and the generics becomes segmented between consumers who are concerned about the quality of generics and those who are not.

[viii] In the estimation models reported in Table III, parameter estimates for *Purchase Frequency* are positive but not statistically significant different from zero. These estimation models include indicator variables for sixteen treatment classes. In similar models that exclude those variables (not reported here to conserve space), *Purchase Frequency* coefficients are negative and generally statistically significant. These results indicate that frequency of purchase is highly correlated with class of treatment, a conclusion that accords with medical common sense. Drugs needed to treat similar illnesses (for example, beta blockers or pain killers) are likely to be prescribed in similar doses and with similar treatment protocols.

[ix] In all eight models presented in Table III, in which the dependent variable is an absolute measure of price dispersion, parameter estimates for *Average Cost* are consistently positive and statistically significant. These results indicate that, ceteris paribus, as the average price of a drug increases, the absolute amount of price dispersion increases. However, in each of these models, the results imply that the ratio of the price dispersion measure to average cost declines as average cost (and the price of a drug) increases. Thus, the results suggest that relative measures of price dispersion, such as the coefficient of variation, decrease as average prices increase. This finding

is consistent with the hypothesis that as benefits from search increase relative price dispersion decreases.