SEARCH AND PRICES IN THE MEDIGAP INSURANCE MARKET*

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Abstract

This paper studies search and prices in the Medigap insurance market. Using data on market shares, insurer characteristics, and plan prices, we estimate to what extent prices can be explained by search and product differentiation. In our model, consumers search across Medigap insurers for prices as well as plan types. Our estimates indicate search costs are substantial: the estimated median cost of searching for an insurer is $22. Using the estimated parameters we find that eliminating search costs could result in price decreases of as much as 5 percent, along with increases in average consumer welfare of up to $321.

Keywords: Medigap, health insurance, search, product differentiation, price dispersion

JEL Classification: I13, D83, L15

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1 Introduction

Medigap is a form of private insurance designed to supplement Medicare by filling in the coverage gaps in Medicare payment. Medigap has a large share of the market for Medicare supplemental coverage; in 2009 Medigap provided coverage for about 20 percent of Medicare beneficiaries. One important feature of the Medigap market is plan standardization: as a result of the passage of the Omnibus Budget Reconciliation Act (OBRA) in 1990, all plans sold after July 1992 are required to conform to a set of standardized plans. This means that even though a plan type is usually offered by different insurers, it can be considered a homogenous good in terms of coverage. In addition to plan standardization, during a six-month open enrollment period that starts from the day an individual turns 65 and enrolls in Medicare Part B, insurers cannot decline a Medigap application because of pre-existing medical conditions. Due to this guaranteed issue, most beneficiaries enroll in a Medigap plan during open enrollment to avoid medical underwriting later on.

Even though Medigap plans are standardized and selection is limited due to guaranteed issue, there is substantial price variation across insurers within states. For instance, a 65-year-old woman living in Indiana could expect to pay anywhere between $1,223 and $3,670 for a Medigap Plan F policy in 2009, depending on her choice of insurer. Such a wide range of prices is not limited to this state only: the average coefficient of variation within states is 0.27 for Plan F, which is substantial.

Why are prices so dispersed for what is essentially a homogenous good? Since Stigler’s (1961) seminal article on the economics of information, economists have tried to answer this question by relating price dispersion to search frictions: if it is costly for individuals to obtain price information, because, for instance, finding out the price means visiting the seller or making phone calls, some individuals will not compare offers, which allows firms to raise prices. As a result firms might set high prices to maximize profits from individuals who do not compare offers, or set a relatively low price and maximize surplus from price comparers, resulting in price dispersion.
An additional explanation for the observed price variation is that even though conditional on plan type Medigap offerings are essentially homogeneous goods, insurers might still differ in terms of quality or service-related characteristics, such as branding and billing services, allowing higher-quality insurers to set higher premiums. Product differentiation and search can also go together: as shown by Anderson and Renault (1999) and Wolinsky (1986), if consumers are searching not only for low prices, but also for horizontal characteristics such as the best-fitting plan type, equilibrium price dispersion can be sustained as well.

We provide preliminary evidence that both firm-level product differentiation and search play important roles in the market for Medigap plans in Section 3. We then use this as a motivation for developing a search and product differentiation model in Section 4. More specifically, we model search for plans that are both horizontally and vertically differentiated. Consumers determine before they search which of the insurers to contact for information about plans and prices; they do so by making a trade-off between the expected utility of contacting a subset of insurers and corresponding search costs. We show how to estimate the model using aggregate data on prices, market shares, and plan characteristics. An attractive feature of the model is that search costs are non-parametrically identified, i.e., we do not have to make any specific assumptions about the distribution of search costs among individuals. Although this means that we have to assume individuals are homogeneous in how they value observed characteristics (i.e., we cannot allow for random coefficients), it does allow us to separately identify search cost and preference heterogeneity without using additional data on search behavior, which is usually not available to researchers.\footnote{We will show later in the paper that allowing for random coefficients does not seem critical in this market.}

Our estimates indicate that search costs are substantial; the estimated parameters of our main specification indicate that median search costs are $22 per search. In addition there is a lot of variation in search costs across individuals. We show how to use our estimates to study the competitive effects of lowering search costs. Assuming insurers set prices to maximize profits, we determine to what extent prices would change if quotes are obtained...
at no cost. According to our simulation results average prices decrease by between $48 and
$87, depending on the specification, which is up to 5 percent of the average yearly policy
premium. Consumer welfare, which also includes savings on search costs, increases by up to
$321 on average if search costs are zero.

Our paper is part of the literature that studies Medigap prices and price dispersion.²
Robst (2006) adopts a hedonic pricing model in order to examine the determinants of Medi-
gap premiums. Maestas, Schroeder, and Goldman (2009) use the search model of Carlson
and McAfee (1983) to model price dispersion for Medigap plans. They find that the av-
erage search cost is $72. Although we find the average search cost to be somewhat lower
than this number, unlike Maestas, Schroeder, and Goldman (2009) we model the joint de-
cision of which plan type to obtain and which insurer to choose. To allow for differences in
plan-type preferences across individuals our utility specification includes a stochastic utility
shock, which we model as ex-ante unobserved by the decision maker. This means that in
our model consumers search for prices as well as a good fit in terms of insurer and plan
type. A second difference between our model and that of Maestas, Schroeder, and Gold-
man (2009) is that search in their model is random, while search in our model is directed,
which means that individuals rank insurers according to expected utility, and, depending on
the decision-maker’s search costs, contact an optimal set of the highest-ranked insurers to
obtain information about prices and plan-type match.³ Finally, our model does not require
us to make any assumptions on the shape of the search cost distribution, which can be an
advantage if one does not know a priori how the search cost distribution looks like.⁴

²The earlier literature on Medigap has focused mostly on adverse selection (e.g., Wolfe and Goddeeris,
that adverse selection can actually lower markups and thus increase consumer welfare. Fang, Keane,
and Silverman (2008) instead find evidence of advantageous selection in Medigap and they identify various sources
of advantageous selection such as income and cognitive ability.

³In a random search model lower ranked firms are as likely to be part of a consumer’s choice set as higher
ranked firms, whereas in our directed search model a consumer needs to have low search costs to sample a
lower ranked firm. To explain demand at lower ranked firms search costs therefore have to be lower in our
search model than in the random search model, which means that search cost estimates will likely be higher
in a random search model.

⁴Maestas, Schroeder, and Goldman (2009) assume that search costs are uniformly distributed.
Our paper also adds to the consumer search literature. Brown and Goolsbee (2002) show that increased usage of Internet price comparison sites reduced search costs and thereby led to lower prices for term life policies. Hortaçsu and Syverson (2004) develop a model of product differentiation and search and find that both are important determinants of fee dispersion in the retail S&P 500 index funds sector. Cebul et al. (2011) find that search frictions in private health insurance markets lead to high prices and price dispersion, excessive marketing costs, and high insurance turnover. They also suggest that government-financed public insurance can reduce distortions created by search frictions. Wildenbeest (2011) provides a framework for studying price dispersion in markets with product differentiation and search frictions and shows how to estimate search costs using only price data. Our paper most closely relates to a study by Moraga-González, Sándor, and Wildenbeest (2012), who add search to the demand estimation framework of Berry, Levinsohn, and Pakes (1995). Moraga-González, Sándor, and Wildenbeest (2012) estimate the model using automobile data from the Netherlands. To be able to separately identify heterogeneity in search costs from heterogeneity in preference parameters, they link search costs to the distances between consumers and dealer locations. Our model builds on their findings; however, by working in a conditional logit rather than a mixed logit framework, search costs can be non-parametrically identified, which is useful if the data lack a suitable search cost shifter, as in our data.

The rest of the paper is organized as follows. In the next section we provide an overview of the industry. In Section 3 we discuss the data and present some preliminary findings on prices and price dispersion and how they relate to search frictions and product differentiation. Section 4 describes the model as well as the estimation method. We present our estimation results and counterfactuals in Section 5. Section 6 concludes.
2 Industry

Medigap, or Medicare supplemental health insurance, is a form of private insurance designed to supplement Medicare by filling in the coverage gaps in Medicare payment. Since its inception in 1965, Medicare, a federal health insurance program for the elderly, has been the primary form of health insurance for a majority of seniors in the United States. Basic Medicare has substantial cost-sharing and gaps in coverage, and does not include an upper limit on beneficiaries’ out-of-pocket spending. In 2009, for example, Medicare Part A (inpatient insurance) required an enrollee to pay a total deductible of $1,068 for the first 60 days of a hospital stay, $267 per day for days 61-90, $534 per day for days 91-150, and all costs for each day beyond 150 days. Under Medicare Part B (outpatient insurance), enrollees were responsible for a total deductible of $135 in 2009 as well as a 20 percent coinsurance payment of the Medicare-approved amount for covered services after the deductible had been reached. Since basic Medicare leaves the elderly at a substantial financial risk, in 2009 over 90 percent of beneficiaries had some kind of supplemental insurance to fill in the coverage gaps in basic Medicare. Of the different sources of supplemental insurance, Medigap provided coverage for about 20 percent of the Medicare beneficiaries in 2009 (Sheingold, Shartzer, and Ly, 2011). The Medigap market is highly concentrated. UnitedHealth Group has the largest na-

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5Medicare includes two basic parts: Part A, inpatient insurance, and Part B, outpatient insurance. Enrollment in Part A starts automatically for the eligible when they turn 65; no premium is involved. To be eligible for Medicare, an individual or his or her spouse must pay Medicare taxes for at least 10 years. If this criterion is not met, individuals can purchase Part A by paying a monthly premium, which was up to $443 per month in 2009. Part B enrollment requires a monthly premium (the base rate, which increases if an individual’s yearly income exceeds $85,000, was $94.60 in 2009); almost all elderly individuals choose to enroll.

6Another 30 percent had supplemental coverage through an employer-sponsored plan, and over 25 percent were enrolled in Medicare Advantage plans that provide additional benefits on top of traditional Medicare. In addition, about 15 percent of beneficiaries were covered by Medicaid due to dual eligibility, and about 1 percent were covered by other plans such as VA plans. The remaining 9 percent had no supplemental coverage.

7The distribution across different types of supplemental coverage was relatively stable between 2001 and 2005. Since 2006, however, there has been a decline in Medigap coverage. For example, the percentage of Medicare beneficiaries covered by Medigap dropped from slightly less than 25 percent in 2001 to about 20 percent in 2009 and 2010. The decline in Medigap enrollment has coincided with a steady increase in Medicare Advantage enrollment. As a result, the combination of these two types of coverage increased slightly from less than 40 percent in 2005 to almost 45 percent in 2009.

8The following statistics on market shares are based on our calculations using the 2009 National As-
tional market share of about 31 percent. The Mutual of Omaha Group has a market share of more than 8 percent. Another 5 firms have over 2 percent of the market: Wellpoint Inc Group (6.4 percent), Health Care Services Group (5.0 percent), CNO Financial Group (3.6 percent), BCBS of Michigan Group (2.2 percent), and Highmark Group (2.1 percent). The remaining 42 percent consists of firms that have less than 2 percent of the market each.

One important feature of the Medigap market is plan standardization. With the passage of the Omnibus Budget Reconciliation Act (OBRA) in 1990, all new policies sold after July 1992 are required to conform to a set of standardized plans (Massachusetts, Minnesota, and Wisconsin are not subject to the standardization). Each plan must offer the standard set of benefits regardless of which company sells it. Plan standardization was intended to promote competition among insurers and to avoid misunderstanding and confusion among seniors regarding coverage. Over time, the set of standardized plans has been modified. For example, Plans K and L were introduced in June 2006 following the Medicare Prescription Drug, Modernization, and Improvement Act of 2003. As of 2009, a total of twelve standardized plans, labeled by the letters A through L, were offered.\(^9\) Of these twelve plans, Plan A is considered the basic plan, covering Medicare Part A hospital stay coinsurance for days 61 to 150 and all Medicare Part B coinsurance payments. All other plans include additional coverage options.\(^10\) Not all plans are available in each state. Insurers that operate in a given state are required to offer at least the basic plan (Plan A). If they choose to offer other plans, Plan C or F has to be provided too. So far Plan F, which offers the second-most comprehensive coverage, has been the most popular plan type, enrolling more than 40 percent of Medigap policy holders.

Another important feature of the Medigap market is that during open enrollment insurers

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\(^9\)Plans M and N were first offered in June 2010 and will not be studied in this paper.

\(^10\)Some plans have altered their amount of coverage over time. For instance, before the introduction of the Medicare Part D program in 2006, Plans H to J also offered limited outpatient prescription drug coverage.
cannot deny coverage to an eligible applicant because of health status (guaranteed issue). The OBRA 1990 mandates a six-month open enrollment period for Medigap, starting from the day an individual turns 65 and enrolls in Medicare Part B. During the open enrollment period, insurers cannot decline an individual’s application or charge a higher premium because of an applicant’s pre-existing medical conditions. Medical underwriting is allowed after the open enrollment period, making it difficult to switch to a new plan. As a result, the majority of seniors subscribes to a Medigap plan during the open enrollment period in which medical underwriting is prohibited.

In addition to plan standardization and the absence of medical underwriting during the open-enrollment period, Medigap premiums are subject to regulation. Premiums are allowed to vary on the basis of age, gender, and smoking status. Regarding age, three different rating methods can be used: attained-age, issue-age, and community-rated. Attained-age means that premiums are allowed to increase with the age of the policy holder. Issue-age premiums are charged based on the age when the policy holder enrolls. Under issue-age rating, premiums are only allowed to increase to compensate for rising healthcare costs over time, and premium increases cannot be based on the age of the policy holder. Community-rating premiums are uniform across all subscribed individuals in the community. At the entry age of 65, premiums are higher for issue-age plans in comparison to attained-age plans in order to incorporate increases in utilization as individuals age (Robst, 2006). Premium differences based on gender are minimal, and premiums for smokers are on average higher than for non-smokers.

Regardless of plan standardization, we observe large price variation in Medigap plans.

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11When a beneficiary’s current source of coverage is no longer available, insurers operating in the market are required to offer a policy regardless of health status. For more details on this see the official Medigap guide published by CMS, “Choosing a Medigap Policy: A Guide to Health Insurance for People with Medicare.”

12State departments of insurance or other state agencies have the authority to approve insurance policy forms and premiums (Sheingold, Shartzer, and Ly, 2011). A state’s regulation is required to meet the National Association of Insurance Commissioners Model Standards. In addition, all insurers are subject to regulations on a minimum loss ratio of 65 percent for individual policies, which means that plans must spend at least 65 dollars on medical care for every 100 dollars in premium.

13Several states, including Connecticut, New York, and Vermont, mandate community rating.
within a market, even after controlling for factors such as plan type, age, gender, smoking status, and rating method. In the remainder of this paper we study how prices and price dispersion in otherwise homogenous Medigap plans are related to product differentiation and consumer search frictions.

3 Data and Basic Analysis

3.1 Data

Our data come from two sources. Data on premiums come from Weiss Ratings, which provide detailed pricing information for Medigap plans offered in 2009. The data include information on insurers, location, plan type, gender, age group, and some other characteristics such as rating method (attained-age, issue-age, and community-rated) and smoking status.

Data on market shares are derived from the National Association of Insurance Commissioners’ (NAIC) Medigap Experience Files. The NAIC dataset provides information on the number of active policies as of December 31, 2009, as well as other variables such as total premiums and claim volumes for 2009. This dataset allows us to differentiate between individual plans and group plans that are sold through employers. Since we are interested in how individual consumers make purchase decisions, our focus is on individual plans. The number of policies issued before 2007 and from 2007 to 2009 combined are reported separately.\textsuperscript{14} Policies issued before 2007 represent policy holders who subscribed before 2007 and chose to renew their policies up to 2009. For the calculations of the market shares used in our empirical analysis, we only use policies newly issued between 2007 and 2009.\textsuperscript{15} One

\textsuperscript{14}According to the data reporting instructions, the NAIC dataset provides a snapshot of the number of individuals covered under each policy on December 31 of each year reported. This means that we can only infer from the data the net gain in the number of covered lives. For example, suppose an insurer shows 10 covered lives for the most current three years (2007-2009). If a member bought a policy in April 2009 and passed away in November 2009, the person would not be reflected in the year-end covered lives number. The actual number of policies sold for the year is 11, but because of the way in which the data is captured, we do not observe the policy sold to the deceased policy holder.

\textsuperscript{15}Ideally, we would like to observe new policies sold only in 2009 to match our pricing data. However, only three years of combined data are available through NAIC, which, to the best of our knowledge, is the
obvious advantage of this measure is that we can focus our analysis on new policies sold to individuals who turned 65 and became eligible to purchase a Medigap plan. Market shares are constructed in a similar way in Starc (2012).

Several steps were taken before we merged the two datasets. We first dropped observations from the three states (Massachusetts, Minnesota, and Wisconsin) that are exempt from federal regulation and offer a different set of plans. Second, we dropped select plans (less than 1 percent of the market share) from both data sources and tobacco plans from the pricing data. In a third step we calculated insurer-specific aggregated state-level premiums by taking insurers’ average prices for a given plan over all zip codes within a state, which allows us to match the price data to the state-level market share data. Although this means loss of some price variation, most insurers offer the same plan type at only a limited number of prices across different areas within a state: more than 40 percent of plans are offered at a single price; for about 30 percent of plans the insurer has set two different prices within a state; and over 90 percent of plans are offered at fewer than three different prices. This lack of regional price variation has been documented in previous studies as well (see, for instance, Maestas, Schroeder, and Goldman, 2009) and might be explained by the fact that the premiums charged by an insurer need approval from state insurance offices.

The merged dataset contains information on prices and sales for each Medigap policy

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16Medigap select plans have lower premiums in comparison to standard plans but offer a limited provider network. We focus on non-select plans for several reasons. Firstly, select plans are not common. In our data, less than 5 percent of plans are select plans (this has also been noted in a study by Fox, Snyder, and Rice, 2003). Secondly, it would be difficult to control for plan characteristics for select plans, as each select plan might have a network that is unobserved by us.

17The NAIC data does not report covered lives separately for smokers and non-smokers. We use the non-smoking rate, as the vast majority of the elderly are non-smokers (according to data from the Centers for Disease Control and Prevention, about 90 percent of the elderly do not smoke).

18Premiums also vary by rating method, whereas our sales data does not differentiate according to rating method. Nevertheless, we find that more than 93 percent of firms use only one rating method for all plans in a given state. Moreover, around 98 percent of observations (at the state-insurer-plan level) are offered at one rating method only, which means that for these observations our premium data match our sales data quite well. For the remaining 2 percent of observations, we choose the rating method with the highest frequency in the data as the relevant rating method.

19The average coefficient of variation of premiums set by the same insurer for a given plan type across zip codes within a state is 0.03, with the 75th percentile equal to 0.07.
offered by each insurer at the state level. It corresponds to a total of 4,704 observations (at the state-insurer-plan level), accounting for more than 80 percent of the total policies sold between 2007 and 2009. A total of 109 companies are observed in the data, of which 14 operate in more than 30 states. The median number of states in which an insurer operates is 6. Note that the NAIC data only reports covered lives for all ages combined. Since most new policies were sold to individuals at the open enrollment period, and since most premiums do not differ across gender, the prices we use for estimating the model are the premiums for 65-year-old females (following Maestas, Schroeder, and Goldman, 2009).\footnote{For those observations that reveal a difference between male and female premiums, the mean difference is only around 7 percent of the average price (with a 99th percentile of approximately 19 percent).}

### 3.2 Price Dispersion and Cost Heterogeneity

**Price dispersion**

There exists large price variation for Medigap plans across insurers within a state. Take premiums for Medigap Plan F (the most popular plan) in Indiana as an example: a total of 40 companies offered Plan F in Indiana in 2009, and premiums for a 65-year-old woman using the attained-age rating method (the most popular rating method) range from $1,223 to $3,670, with a median of $1,818.

To get a better picture of the extent of premium variation, Table 1 summarizes the coefficient of variation by rating method, averaged over plan types and states.\footnote{Since insurers use different rating methods for a given plan type within a state, we combine plan type and rating method to identify a product. This means that Plan F attained-age and Plan F issue-age are treated as different products.} For all three rating methods the coefficient of variation is substantial. Attained-age and issue-age show slightly higher variation than a community-based rating. Moreover, there is substantial variation in the coefficient of variation across plan types and states; whereas in a few states some plan types show hardly any price variation, the coefficient of variation can be as high as 0.65 for the issue-age rating method. Note that Table 1 is calculated using prices for 65 year old females only; as reported above, prices for different age groups as well as for males...
follow similar patterns.

Table 1: Coefficient of Variation

<table>
<thead>
<tr>
<th>Rating</th>
<th>Mean</th>
<th>S.D.</th>
<th>Min</th>
<th>5%</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>95%</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attained-Age</td>
<td>0.217</td>
<td>0.082</td>
<td>0.000</td>
<td>0.071</td>
<td>0.173</td>
<td>0.216</td>
<td>0.267</td>
<td>0.344</td>
<td>0.486</td>
</tr>
<tr>
<td>Issue-Age</td>
<td>0.215</td>
<td>0.122</td>
<td>0.002</td>
<td>0.043</td>
<td>0.118</td>
<td>0.201</td>
<td>0.290</td>
<td>0.450</td>
<td>0.651</td>
</tr>
<tr>
<td>Community</td>
<td>0.208</td>
<td>0.114</td>
<td>0.009</td>
<td>0.018</td>
<td>0.154</td>
<td>0.197</td>
<td>0.263</td>
<td>0.381</td>
<td>0.559</td>
</tr>
</tbody>
</table>

*Notes: All reported values are averaged over plan types and states.*

Table 2 reports average prices and coefficient of variation by plan type for the attained-age rating plans, the most popular rating method in the data. The average price varies greatly across states. For example, the average premium for plan A is $1,143 across states, with a standard deviation of 152. Also the average difference between the minimum and maximum premium charged within a state is substantial. For instance, for Plan A the average difference is $902, which is close to 80 percent of Plan A’s mean price. Table 2 also shows that most plan types have an average coefficient of variation that exceeds 0.20. Plan F, the most popular and the second-most comprehensive plan, has the highest average price variation as measured by the coefficient of variation.

Table 2: Coefficient of Variation by plan type (attained-age)

<table>
<thead>
<tr>
<th>Plan Type</th>
<th>Price</th>
<th>Max-Min</th>
<th>Coefficient of Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
<td>Mean</td>
</tr>
<tr>
<td>A</td>
<td>1,143</td>
<td>152</td>
<td>902</td>
</tr>
<tr>
<td>B</td>
<td>1,567</td>
<td>255</td>
<td>971</td>
</tr>
<tr>
<td>C</td>
<td>1,814</td>
<td>192</td>
<td>1,493</td>
</tr>
<tr>
<td>D</td>
<td>1,449</td>
<td>191</td>
<td>939</td>
</tr>
<tr>
<td>E</td>
<td>1,520</td>
<td>274</td>
<td>559</td>
</tr>
<tr>
<td>F</td>
<td>1,852</td>
<td>199</td>
<td>1,938</td>
</tr>
<tr>
<td>G</td>
<td>1,463</td>
<td>211</td>
<td>1,122</td>
</tr>
<tr>
<td>H</td>
<td>1,468</td>
<td>217</td>
<td>278</td>
</tr>
<tr>
<td>I</td>
<td>1,631</td>
<td>250</td>
<td>621</td>
</tr>
<tr>
<td>J</td>
<td>1,746</td>
<td>181</td>
<td>721</td>
</tr>
<tr>
<td>K</td>
<td>1,030</td>
<td>161</td>
<td>215</td>
</tr>
<tr>
<td>L</td>
<td>1,401</td>
<td>251</td>
<td>408</td>
</tr>
</tbody>
</table>

Part of the variation in premiums across insurers might be attributed to plans that attract very few individuals due to high prices. To correct for differences in market share, we also
calculated the coefficient of variation weighted by market share for each plan. The weighted coefficient of variation for Plan F under attained age rating averages 0.20 for 65-year-old females, indicating that considerable price dispersion among Medigap plans still remains even after controlling for differences in market share.

**Cost heterogeneity**

One plausible explanation for price variation in Medigap plans involves what is known as “endogenous sorting.” That is, insurers might have a different pool of risk types, with high-priced insurers attracting consumers that are more costly to insure. Though a majority of beneficiaries purchase Medigap during the open enrollment period when insurers cannot decline an application, firms might still target different types of consumers through marketing or advertising. In this case, consumers with different risk types then sort themselves into different insurers, and the equilibrium might be such that high-risk consumers select an insurer that charges a high premium while low-risk ones select an insurer that offers a low premium.

To investigate whether and to what extent price variation across insurers can be explained by cost differentials, we use data on the total amount of claims filed for each observation (at the state-insurer-plan level).\(^22\) We use the average claim, defined as the ratio of total claims to the total number of covered lives, as a measure of the risk type for an average policyholder of a given plan, assuming a larger average claim indicates a higher risk type. We then run a regression of premiums on the average claim, after controlling for state-fixed effects, dummies for plan types, and dummies for rating methods, and we compare the results to a regression without controlling for the average claim.

The results are presented in columns 1 and 2 of Table 3. Column 1 is based on a regression

\(^{22}\)Note that according to federal regulation, the loss ratio (defined as total claims divided by total premiums) cannot be lower than 65 percent for individual Medigap plans. If this minimum ratio is violated, an insurer is required to provide transfers to its policyholders to be compliant with the regulation. We observe large differences in loss ratio across plans. The average loss ratio is 0.80, but almost 40 percent of the insurer-plan combinations have a loss ratio below 65 percent.
without controlling for the average claim. Column 2 adds the average claim. We find that a one-dollar increase in average claim is associated with a 5-cent increase in premium. The R-squared increases by about 3 percentage points, indicating that adding controls for the average claim does not contribute much to explaining the observed variation in premiums. Although not reported, we also run regressions separately for each plan type and find similar results. These results indicate that cost differentials are related to Medigap plan pricing but they do not play a major role in explaining the observed price variation across different insurers.

### 3.3 Product Differentiation and Search

As documented above, there is substantial price variation in Medigap plans, even though conditional on plan-type Medigap plans are homogeneous in terms of coverage. We also show that cost heterogeneity does not seem to help much to explain the observed price variation. In this subsection we provide evidence for two important determinants of this price variation, which we use to motivate the theoretical model we present in Section 4.

**Product differentiation**

One explanation for the observed price variation is product differentiation. Although Medigap plans are standardized, premiums might still differ across insurers due to differences in other dimensions than plan characteristics. For example, a consumer might favor an older
and more established firm or a firm with a better financial rating. Firms do differ in these attributes: age of the insurers ranges from 3 to 159 years and according to financial safety ratings provided by Weiss Ratings, 22 out of the 109 insurers in our dataset had a financial rating of A, 47 had a rating of B, and 12 were either unrated or rated below C.\footnote{Weiss Ratings rates each insurer as follows. “A” means the company offers excellent financial security; “B” means the company offers good financial security and has the resources to deal with a variety of adverse economic conditions; “C” means the company is currently stable, although during an economic downturn or other financial pressures it may encounter difficulties in maintaining its financial stability. A company is unrated for reasons such as total assets being less than $1 million or a lack of the information necessary to reliably issue a rating.}

Other attributes one might expect to play a similar role are billing services, reputation, and brand name. Unfortunately we do not observe firm attributes other than age and safety rating. Still, pricing patterns may provide indirect evidence of whether firm-level product differentiation plays an important role in explaining price variation for Medigap plans. If price variation is solely caused by firm-type product differentiation, one would expect insurers to charge consistently high or low prices for all offered plans in a given state: if a better financial rating or reputation allows the insurer to charge a higher premium this is likely to happen for all plan types the firm is selling. To see if this is indeed the case in our data, for each plan type we compare each insurer’s price to the overall price distribution in a state and determine in which quartile each price falls. We then calculate the fraction of plans that belong to each quartile for each insurer in a given state. If price variation primarily reflects product differentiation at the firm level, insurers are likely to consistently set premiums in the same quartile for all the plans that they offer in a state. We find that this happens to on average 30 percent of insurers in a state. The remaining insurers on average have an equal number of plans in each of the four quartiles.\footnote{To be more specific, we find the proportion of plans belonging to each quartile averages 22 percent for the first quartile, 28 percent for the second, 29 percent for the third, and 21 percent for the fourth.} If we compare each plan to the median of the price distribution, we find that on average 60 percent of insurers in a state charge prices for all offered plans consistently below or above the median. The remaining insurers tend to switch prices back and forth between below and above the median of the corresponding price distribution. Although these findings suggest that product differentiation is important,
it alone cannot explain all the variation in premiums observed in the data.

To further examine the role of firm heterogeneity in explaining observed price variation, we follow an approach suggested by Sorensen (2000). We compare the R-squared of a regression of premiums on plan dummies, rating methods, and state dummies (column 1 of Table 3) to the R-squared of a similar specification that also includes insurer-fixed effects (column 3 of Table 3). Adding the insurer-fixed effects increases the R-squared from 0.39 to 0.68, accounting for about 48 percent of the variation unexplained by the regression if we leave out the insurer-fixed effects.\textsuperscript{25} We find similar results if we add the average claim as an explanatory variable (compare column 4 of Table 3 to column 2). We also conducted a regression with additional controls for state-insurer fixed effects; this increases the R-squared from 0.68 to 0.83, accounting for about 45 percent of the variation unexplained by the regression using only insurer-fixed effects. These results confirm that although a significant amount of variation in premiums can be absorbed by firm heterogeneity, product differentiation alone does not fully explain price variation across insurers within a state.

\textbf{Search}

An additional explanation for the observed price differences relates to search frictions.\textsuperscript{26} Given the large number of insurers in each market, it will be costly for consumers to obtain information on the plans and corresponding rates offered by each insurer. Since Medigap is supplemental insurance sold and administered by private insurers, no free and universal pricing information is available to consumers. The most comprehensive guide to choosing a Medigap policy is published annually by the Center of Medicare and Medicaid Services.

\textsuperscript{25}Note that this comparison with and without controlling for firm fixed effects might lead us to overstate the importance of firm heterogeneity, because some price dispersion unrelated to firm differences will nevertheless be absorbed by the inclusion of fixed effects (Sorensen, 2000).

\textsuperscript{26}We study how search friction and product differentiation translate into price dispersion in identical Medigap plans. We do not specifically consider whether firms raise prices on existing enrollees after they are locked in (see, e.g., Ericson, forthcoming). Note that Ericson (forthcoming) finds that firms introduce new and cheaper plans to attract new enrollees in Medicare Part D, which is prohibited in Medigap due to plan standardization. However, consumer inertia might exist in the Medigap market and it is possible that firms set prices low to attract consumer when they make their initial purchase decisions (typically when they turn to age 65 and enroll in Medicare Part B). This is interesting to explore but beyond the scope of this paper.
The CMS suggests Medicare beneficiaries take the following three steps to acquire information about Medigap plans before subscribing to a plan: (1) decide which plan type to purchase; (2) find out which insurers are selling this plan type; and (3) call these insurers and compare costs. For step 2 the CMS advises beneficiaries to call the State Health Insurance Assistance Program or the State Insurance Department, or to visit medicare.gov. Note that these sources only provide a list of insurers that sell Medigap plans by state, which means that no pricing information is readily available. The CMS’s suggestion to call insurers to compare costs (step 3) can therefore be quite time consuming, especially given the large number of insurers in each state.

The presence of several websites that facilitate search further supports the notion that search frictions play an important role in this market. For instance, Weiss Ratings has a comprehensive nationwide Medigap pricing information database. Weiss Ratings sells this information to consumers; currently the cost of acquiring information about all Medigap plans sold in a specific zip code is $99.

As shown by a large theoretical literature on consumer search, search frictions may lead to price dispersion in homogenous product markets (Burdett and Judd, 1983; Stahl, 1989) as
well as markets for differentiated products (Anderson and Renault, 1999; Wolinsky, 1986). The results presented in the previous subsection suggest that firm differentiation is important in the Medigap market, so search frictions are unlikely to be only explanation for the price variation we observe in the data, ruling out a search model in which consumers search for homogenous products. Additional evidence that rules out search as the sole determinant of price dispersion derives from the relationship between market shares and prices. Were search to be the only explanation for price differences across insurers, one would expect to see a negative and monotonic relationship between price and market share (Hortaçsu and Syverson, 2004). In general, this is not the case in our data. For example, Figure 1 shows how market shares relate to prices for Medigap Plan G in Indiana—although there seems to be a weak negative relationship between the log price and log market share, this relationship is not monotonic. The insurer with the largest market share has the twelfth highest price out of 26 firms that offer plan G, and the insurer with the third largest market share has the fifth highest price. This lack of a monotonic relationship between price and market share also exists if we look at the market share of insurers, regardless of plan type. For example, in Indiana the insurer with the largest market share charges the fourth highest price; and the top five insurers in terms of market share all charge prices above the median of the overall price distribution.

Since both the institutional details of the market and the data suggest that both search and product differentiation play a role in explaining observed price variation across insurers, in the next section we take search and product differentiation as our main ingredients for our theoretical and empirical framework. As in Anderson and Renault (1999) and Wolin-

\footnote{In a typical homogenous good search model, the pricing equilibrium is in mixed strategies (see, for instance, Burdett and Judd, 1983; Stahl, 1989). We do not find evidence that supports mixed strategies in prices in the data. For instance, using three years of pricing data from 2007, 2008, and 2009, we find that more than 60 percent of insurers consistently set Medigap Plan F prices in the same quartile of the price distribution, and that more than 85 percent stuck to prices that were either below or above the median price. Moreover, around 10 percent of insurers charged the same prices between 2007 and 2009, and 30 percent had only one change in prices during the three-year period.}

\footnote{An insurer’s market share is calculated by summing up market share for all plans offered by an insurer in a given state, whereas price is the average price across the plan offered.}
sky (1986), our model also allows for horizontal product differentiation in order to capture uncertainty about which of the plans offered by an insurer most suits an individual. This means that in our model individuals are searching to find out price information as well as to figure out which of the Medigap plans offered by the insurers is the best match.

4 Model

4.1 Consumer Demand

Let the utility of consumer $i$ for plan $j \in \{1, 2, \ldots, J\}$ sold by insurer $f \in \{1, 2, \ldots, F\}$ be given by

$$u_{ijf} = x'_{jf} \beta - \alpha p_{jf} + \xi_{jf} + \epsilon_{ijf} = \delta_{jf} + \epsilon_{ijf},$$

where $x_{jf}$ are characteristics observed by both the researcher and the consumer, $\xi_{jf}$ is a vertical characteristic observed by the consumer only, and $\epsilon_{ijf}$ is a matching term unobserved by both the researcher and the consumer. The mean utility of product $j$ sold by insurer $f$ is given by $\delta_{jf}$. The utility of not buying any of the plans is

$$u_{i0} = \epsilon_{i0}.$$ 

We assume that consumers are searching nonsequentially for information about the plans. Consumers have information about $x_{jf}$ and $\xi_{jf}$, but not matching parameters $\epsilon_{ijf}$ and prices $p_{jf}$, so they search to discover these parameters. Search costs are randomly distributed in $[0, \infty)$ according to the cumulative distribution function (CDF) $G(c)$. We assume that $\epsilon$ follows a type I extreme value distribution with location parameter 0 and scale parameter 1, i.e., $F(\epsilon) = e^{-e^{-\epsilon}}$.

Let us start by examining consumers’ behavior. Since consumers do not know the realization of $\epsilon_{ijf}$ and $p_{jf}$ before they start searching, they rank insurance companies according to their mean utility $\phi_f$, where $\phi_f$ is the expected maximum utility of the set of plan types...
$G_f$ on offer be firm $f$, i.e., $\phi_f = \log \left( \sum_{j \in G_f} \exp[\delta_{jf}] \right)$.\textsuperscript{29,30}

Note that this ranking is the same for all consumers, so we can index insurers by their ex-ante attractiveness, i.e, insurer $f = 1$ is the most attractive insurer, insurer $f = 2$ the second-most attractive, and so on. We assume consumers can only evaluate the value of the outside good after having searched, i.e., consumers do not observe $\varepsilon_{ij0}$ before searching (so they will not condition their search behavior on this). Furthermore, we assume that the first observation is free, so that all consumers will search at least once.

An individual consumer with search cost $c$ chooses the number of insurance companies to sample, denoted $k^*(c)$, to maximize her expected utility. That is,

$$
    k^*(c) = \arg \max_k \left\{ E[\max\{u_{ij1}, u_{ij2}, \ldots, u_{ijk}\}] - (k - 1)c \right\}.
$$

As shown by Moraga-González, Sándor, and Wildenbeest (2012), assuming that $\varepsilon_{ijf}$ follows a type I extreme value distribution allows us to write the optimal number of quotes to obtain as

$$
    k^*(c) = \arg \max_k \left\{ \log \left( 1 + \sum_{f=1}^{k} \exp \phi_f \right) - (k - 1)c \right\}.
$$

We define $c_1$ as the consumer who is indifferent regarding whether to obtain quotes from $29$Since $\varepsilon_{ijf}$ follows a type I extreme value distribution with location parameter 0 and scale parameter 1, we get

$$
\delta_f = E \left[ \max_{j \in G_f} \{u_{ijf}\} \right] = \int_{-\infty}^{\infty} u \frac{d}{du} \left( \prod_{j \in G_f} F(u - \delta_{jf}) \right) du;
$$

$$
= \int u \frac{d}{du} \left( \prod_{j \in G_f} \exp \left[ -\exp \left[ -(u - \delta_{jf}) \right] \right] \right) du;
$$

$$
= \log \left( \sum_{j \in G_f} \exp[\delta_{jf}] \right).
$$

Note that we have left out the Euler constant from $\delta_f$, since it is common to all firms and therefore does not affect choices.

$30$We use the standard assumption in the theoretical literature on search for differentiated products that consumers form rational expectations about prices (as in Wolinsky, 1986; Anderson and Renault, 1999). This means that even though consumers do not observe realized prices before searching, they use expected (equilibrium) prices to rank the firms.
one insurer or from two insurers, i.e.,

\[ \ln(1 + e^{\phi_1}) = \ln(1 + e^{\phi_1} + e^{\phi_2}) - c_1. \]

Solving for \( c_1 \) gives

\[ c_1 = \ln \left( 1 + \frac{e^{\phi_2}}{1 + e^{\phi_1}} \right). \]

More generally, we define \( c_k \) as the consumer who is indifferent regarding whether to search \( k \) or \( k + 1 \) times, i.e.,

\[ \ln \left( 1 + \sum_{f=1}^{k} e^{\phi_f} \right) - (k - 1)c_k = \ln \left( 1 + \sum_{f=1}^{k+1} e^{\phi_f} \right) - kc_k. \]

Solving for \( c_k \) gives

\[ c_k = \ln \left( 1 + \frac{e^{\phi_{k+1}}}{1 + \sum_{f=1}^{k} e^{\phi_f}} \right). \]

Note that by definition \( \phi_k \) is decreasing in \( k \), which means that \( c_k \) is decreasing in \( k \) as well. Moreover, the above equation shows that critical search cost values cannot be negative.

Using the critical search cost values \( c_k \) and the search cost distribution \( G(c) \) we can calculate the fraction of individuals searching \( k \) times. The fraction of individuals searching once is

\[ \mu_1 = 1 - G(c_1). \]

The fraction of individuals searching \( k \geq 2 \) times is

\[ \mu_k = G(c_{k-1}) - G(c_k), \quad k = 2, \ldots, N - 1; \]

\[ \mu_N = G(c_{N-1}). \]

We now move to the question of insurance companies. First consider plan \( j \) sold by the insurer with the highest mean utility \( \phi_f \). Since all fractions of consumers will visit this
insurer, the market share of this plan is given by

\[ s_{j1} = \frac{e^{\delta_{j1}}}{1 + e^{\phi_1}} \cdot \mu_1 + \frac{e^{\delta_{j1}}}{1 + \sum_{\ell=1}^2 e^{\phi_{\ell}}} \cdot \mu_2 + \ldots + \frac{e^{\delta_{j1}}}{1 + \sum_{\ell=1}^N e^{\phi_{\ell}}} \cdot \mu_N = \sum_{k=1}^N \frac{e^{\delta_{j1}}}{1 + \sum_{\ell=1}^k e^{\phi_{\ell}}} \cdot \mu_k. \]

The second-highest-ranked insurance company will only attract the consumers who search at least twice, so the market share of a plan sold by this insurer is

\[ s_{j2} = \sum_{k=2}^N \frac{e^{\delta_{j2}}}{1 + \sum_{\ell=1}^k e^{\phi_{\ell}}} \cdot \mu_k. \]

More generally, the market share of a plan \( j \) sold by the \( f \)th-highest-ranked insurer is

\[ s_{jf} = \sum_{k=f}^N \frac{e^{\delta_{jf}}}{1 + \sum_{\ell=1}^k e^{\phi_{\ell}}} \cdot \mu_k, \]

while the overall market share of the \( f \)th-highest-ranked insurer is

\[ s_f = \sum_{k=f}^N \frac{e^{\phi_f}}{1 + \sum_{\ell=1}^k e^{\phi_{\ell}}} \cdot \mu_k. \]

Using the market share of the outside good, i.e.,

\[ s_0 = \sum_{k=1}^N \frac{1}{1 + \sum_{\ell=1}^k e^{\phi_{\ell}}} \cdot \mu_k, \]

we can rewrite \( s_{j1} \) as

\[ s_{j1} = s_0 \cdot e^{\delta_{j1}}, \quad (1) \]

or, by taking logs and rearranging,

\[ \ln s_{j1} - \ln s_0 = \delta_{j1}. \]
Similarly, again using the definition of $s_0$ we can write $s_{j2}$ as

$$s_{j2} = \left( s_0 - \frac{\mu_1}{1 + e^{\phi_1}} \right) \cdot e^{\delta_{j2}}. \tag{2}$$

Using $s_0$, the overall market share of the highest-ranked insurance company is

$$s_1 = s_0 \cdot e^{\phi_1},$$

which can be rewritten as

$$1 + e^{\phi_1} = \frac{s_0 + s_1}{s_0},$$

which can be plugged into equation (2) to get

$$s_{j2} = s_0 \left( 1 - \frac{\mu_1}{s_0 + s_1} \right) \cdot e^{\delta_{j2}}.$$

Taking logs and rearranging gives

$$\ln s_{j2} - \ln s_0 = \delta_{j2} + \ln \left( 1 - \frac{\mu_1}{s_0 + s_1} \right).$$

Similarly, the market share equation for a plan sold by the third-highest-ranked insurer is

$$\ln s_{j3} - \ln s_0 = \delta_{j3} + \ln \left( 1 - \frac{\mu_1}{s_0 + s_1} \right) \left( 1 - \frac{\mu_2}{s_0 + s_1 + s_2 - \mu_1} \right).$$

More generally, the difference between the log market share of plan $j$ sold by the $f$th-highest-ranked insurance company and the log market share of the outside good can be written as

$$\ln s_{jf} - \ln s_0 = \delta_{jf} + \sum_{k=1}^{f-1} \ln \left( 1 - \frac{\mu_k}{s_0 + \sum_{\ell=1}^{k} s_\ell - \sum_{\ell=2}^{k} \mu_{\ell-1}} \right). \tag{3}$$
4.2 Supply Side

To obtain marginal cost estimates we also model the supply side. The profits of an insurer $f$ supplying a subset $\mathcal{G}_f$ of $J$ plan types are given by

$$\Pi_f = \sum_{r \in \mathcal{G}_f} (p_r - mc_r) M s_r(p),$$

where $M$ is the number of consumers in the market. Assuming insurers set prices to maximize profits, the following first-order conditions should be satisfied:

$$s_j(p) + \sum_{r \in \mathcal{G}_f} (p_r - mc_r) \frac{\partial s_r(p)}{\partial p_j} = 0.$$

To obtain the marginal cost of each plan we solve for $mc$, i.e.,

$$mc = p - \Delta(p)^{-1} s(p),$$

(4)

where $\Delta$ is a $J$ by $J$ matrix with the element in row $j$ and column $r$ given by

$$\Delta_{jr} = \begin{cases} 
-\frac{\partial s_r}{\partial p_j}, & \text{if } r \text{ and } j \text{ are supplied by the same insurer;} \\
0, & \text{otherwise.}
\end{cases}$$

For the derivation of the derivatives of the market shares with respect to prices we assume that consumers choose the insurers from which they will obtain quotes before they observe prices (see the Appendix). This means we use the standard assumption that consumers form rational expectations about prices but do not observe price deviations before searching (as in Wolinsky, 1986; Anderson and Renault, 1999).
4.3 Estimation

We can use equation (3) to estimate the model in the following way:

\[
\ln s_{jf} - \ln s_0 = \beta X_{jf} - \alpha p_j + \gamma_1 R_{f1} + \gamma_2 R_{f2} + \ldots + \gamma_{N-1} R_{fN-1} + \xi_j, \tag{5}
\]

where \( R_{fk} \) is a firm ranking-related dummy that is given by

\[
R_{fk} = \begin{cases} 
1 & \text{if rank}_f > k; \\
0 & \text{if rank}_f \leq k. 
\end{cases}
\]

As \( \gamma_k = \ln \left(1 - \mu_k / \left(s_0 + \sum_{\ell=1}^{k} s_\ell - \sum_{\ell=2}^{k} \mu_{\ell-1}\right)\right) \), the estimated \( \gamma_k \)'s can be used to back out the \( \mu_k \)'s. Note that \( \phi_2 \) cannot be larger than \( \phi_1 \), so the minimum value of \( \ln(1 - \mu_1 / (s_0 + s_1)) \) is \( \ln s_2 - \ln s_1 \), while the maximum value is 0. Similarly, the minimum value of \( \ln(1 - \mu_2 / (s_0 + s_1 + s_2 - \mu_1)) \) is \( \ln s_3 - \ln s_2 \), while the maximum value is again 0. This means that we have to estimate equation (5) using the constraint that \( \gamma_k \in [\ln s_{k+1} - \ln s_k, 0] \).

To correct for the potential endogeneity of prices, we construct two instrument variables in the spirit of Hausman (1996) and Nevo (2000). The first instrument is the average price of the same plan offered by the insurer in other states. The second is the average price of all plans offered by the insurer in other states. Equation (5) is then estimated using constrained two-stage least squares. To restrict the number of ranking-related dummies we assume that consumers either have relatively high search costs, such that they search at most 5 insurance companies (i.e., the number of searches might be any number between 1 and 5), or that they have search costs low enough to obtain information from all insurers operating in a market.\(^{31}\)

\(^{31}\)To be more specific, we assume that people either search any number from 1 to 5 or they search more than 5 times, which allows them to get information on all the firms in a market. Our results are robust to using a different cutoff, such as 6 or 7 searches.
5 Results

5.1 Search Model

Table 4 reports the estimation results for the search model for various specifications, all of which include state-fixed effects. Our main specification, presented in column 1, includes both firm-fixed effects and plan-fixed effects. The price coefficient is negative and highly significant. The estimated rating method coefficients indicate that plans with an attained-age or issued-age rating method are less desirable than community-rated plans, although the issued-age coefficient is not significantly different from zero. All plan dummies are highly significant. Not surprisingly, Plan J, the most comprehensive plan, has the highest marginal utility; and Plan F, the second-most comprehensive plan, has the second-highest marginal utility. Compared to the omitted Plan L, two plans are less preferred: Plan K, due to a higher out-of-pocket limit, and Plan A, the basic plan, because it offers the least coverage.

The specification in column 2 replaces firm dummies by insurer-related characteristics such as financial rating and age of firm. We find some evidence that firms with rating A, the highest safety rating, are more preferable (although insignificant), while firms with no safety rating seem to be least preferable. Insurer age has a positive marginal utility as well, which is likely to reflect the reputation or stability of an insurer.

In column 3 of Table 4 we replace the plan dummies with controls for plan characteristics. With the exception of SNF coinsurance, all coefficients have a positive marginal utility. In particular, Medicare Part B deductibles (offered by Plan C, F, and J) and excess charges (offered by Plan F, G, I, and J) seem to be highly valued by consumers. The other coefficients seem quite consistent with the other specifications.

A comparison of these three specifications shows that the fit of the model as measured by the R-squared is the highest for our main specification. Moreover, our main specification reports the largest price coefficient in magnitude.

Figure 2 gives the estimated search cost cumulative distribution function, averaged across
Table 4: Estimation Results Search Model

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Price</td>
<td>-1.963</td>
<td>(0.101)***</td>
<td>-1.618</td>
<td>(0.077)***</td>
<td>-1.638</td>
<td>(0.077)***</td>
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<td>Insurer characteristics</td>
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<td></td>
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<tr>
<td>Firm Weiss Safety Rating A</td>
<td>—</td>
<td>0.151</td>
<td>(0.133)</td>
<td>0.177</td>
<td>(0.134)</td>
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<tr>
<td>Firm Weiss Safety Rating B</td>
<td>—</td>
<td>-0.085</td>
<td>(0.121)</td>
<td>-0.060</td>
<td>(0.121)</td>
<td></td>
</tr>
<tr>
<td>Firm Weiss Safety Rating C</td>
<td>—</td>
<td>-0.186</td>
<td>(0.121)</td>
<td>-0.148</td>
<td>(0.122)</td>
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</tr>
<tr>
<td>No Weiss Safety Rating</td>
<td>—</td>
<td>-0.368</td>
<td>(0.138)***</td>
<td>-0.386</td>
<td>(0.138)***</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>—</td>
<td>0.002</td>
<td>(0.001)*</td>
<td>0.002</td>
<td>(0.001)*</td>
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</tr>
<tr>
<td>Rating method</td>
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<tr>
<td>Attained-Age</td>
<td>-0.966</td>
<td>(0.406)**</td>
<td>-1.567</td>
<td>(0.304)***</td>
<td>-1.550</td>
<td>(0.306)***</td>
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<tr>
<td>Issued-Age</td>
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<td>(0.378)</td>
<td>-1.268</td>
<td>(0.292)***</td>
<td>-1.357</td>
<td>(0.295)***</td>
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<td>Plan dummies</td>
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</tr>
<tr>
<td>Plan A</td>
<td>-0.357</td>
<td>(0.177)**</td>
<td>-0.746</td>
<td>(0.178)***</td>
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<td>Plan B</td>
<td>0.516</td>
<td>(0.179)***</td>
<td>0.082</td>
<td>(0.183)</td>
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<td>Plan C</td>
<td>1.877</td>
<td>(0.185)***</td>
<td>1.303</td>
<td>(0.180)***</td>
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<td>Plan D</td>
<td>1.881</td>
<td>(0.177)***</td>
<td>1.059</td>
<td>(0.177)***</td>
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<td>Plan E</td>
<td>1.390</td>
<td>(0.198)***</td>
<td>0.657</td>
<td>(0.205)***</td>
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<tr>
<td>Plan F</td>
<td>4.110</td>
<td>(0.184)***</td>
<td>3.230</td>
<td>(0.175)***</td>
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<tr>
<td>Plan G</td>
<td>2.428</td>
<td>(0.179)***</td>
<td>1.690</td>
<td>(0.176)***</td>
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<tr>
<td>Plan H</td>
<td>2.301</td>
<td>(0.220)***</td>
<td>1.297</td>
<td>(0.228)***</td>
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<tr>
<td>Plan I</td>
<td>2.419</td>
<td>(0.217)***</td>
<td>1.648</td>
<td>(0.225)***</td>
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<tr>
<td>Plan J</td>
<td>4.646</td>
<td>(0.197)***</td>
<td>3.682</td>
<td>(0.194)***</td>
<td>—</td>
<td></td>
</tr>
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<td>Plan K</td>
<td>-0.951</td>
<td>(0.226)***</td>
<td>-0.228</td>
<td>(0.243)</td>
<td>—</td>
<td></td>
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<tr>
<td>Plan characteristics</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Inpatient deductible</td>
<td>—</td>
<td>—</td>
<td>0.839</td>
<td>(0.113)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part B deductible</td>
<td>—</td>
<td>—</td>
<td>1.164</td>
<td>(0.091)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home health</td>
<td>—</td>
<td>—</td>
<td>0.132</td>
<td>(0.085)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excess charge</td>
<td>—</td>
<td>—</td>
<td>1.341</td>
<td>(0.063)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extended drug coverage</td>
<td>—</td>
<td>—</td>
<td>0.325</td>
<td>(0.088)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SNF coinsurance</td>
<td>—</td>
<td>—</td>
<td>-0.206</td>
<td>(0.152)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foreign travel</td>
<td>—</td>
<td>—</td>
<td>0.682</td>
<td>(0.149)***</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Number of Observations    4,704    4,704    4,704
$R^2$                      0.600    0.500    0.486
$\bar{R}^2$                0.567    0.470    0.456
State Fixed Effects        yes      yes      yes
Firm Fixed Effects         yes      no       no

Average price decrease full info $48.12 $86.59 $82.81
as percentage 2.80% 4.98% 4.66%
Average change in consumer surplus $138.29 $320.54 $312.40

All specifications include a constant. Standard errors in parentheses. *** Significant at the 1 percent level.
** Significant at the 5 percent level. * Significant at the 10 percent level.
states, for specifications (1) and (3). Median search costs are approximately $22 based on our main specification and $49 based on specification (3), where we use insurer and plan characteristics instead of firm- and plan-fixed effects. This difference is intuitive: part of the variation in prices that is attributed to search frictions in specification (3) is picked up by the insurer-fixed effects as unobserved heterogeneity. There is large variation in search costs across individuals. According to the average search cost distribution based on specification (1), the 25th, 75th, and 90th percentiles are $11, $40 and $80, respectively.

Figure 2: Estimated search costs (averaged across states)

5.2 Comparison to Alternative Models

Most existing discrete choice models of demand assume that consumers have full information. To see to what extent our search model gives different estimates in comparison to a model that assumes full information, we estimate a standard conditional logit model of demand. Notice that the full information model is a special case of our search model; by setting all ranking-related dummies in equation (4) to zero, we get the standard conditional logit model of demand. Column 1 of Table 5 gives estimates for the full information model, which we

---

32 For each state we get non-parametric estimates of the search cost distribution. We the obtain the curves in Figure 2 by fitting a log-normal distribution through the estimated points on the search cost CDF of each state and then taking the average fitted CDF across states.
estimate by OLS. The estimated price coefficient is higher in absolute sense in comparison to the estimates for the search model, which indicates that assuming full information when individuals have limited information due to search frictions leads to an upward bias in the absolute value of the estimated price coefficient.

Although we allow consumers in our model to differ in terms of search costs, they are assumed to be similar in terms of their utility parameters. Whether this is an important limitation of the model is an empirical question. Unfortunately, our data lacks a suitable search cost shifter, which is a necessary requirement for estimating a richer search model (see Moraga-González, Sándor, and Wildenbeest, 2012). Instead we estimate a full information model that allows for heterogeneity in some of the preference parameters, to see if in such a setting this factor makes a substantial difference on the estimated parameters. Column 2 gives estimation results for a random coefficient logit model, controlling for endogeneity in a way that resembles the earlier model (following Berry, Levinsohn, and Pakes, 1995; Nevo, 2000). We assume that the price coefficient follows a normal distribution and estimate its mean and standard deviation. As shown in column 2 of Table 5, the mean price coefficient only changes slightly in comparison with the estimated price coefficient in column 1. More importantly, the standard deviation parameter is not significantly different from zero, which indicates that in the full information model allowing for heterogeneity in the price coefficient is not critical.

Column 3 of Table 5 gives estimation results for a specification in which we do not impose any constraints on the ranking-related dummies in equation (4). The constraints in our search model make the ranking of firms endogenous: consumers form rational expectations of the utility of each firm and will search highly valued firms first. The model without imposing constraints can be interpreted as a model with an exogenous ordering of firms according to decreasing market share. The estimation results are very close to the main specification. The fit of the model, as measured by the R-squared, increases.

Regarding the ordering of firm, it is possible that due to word-of-mouth effect, firms with
Table 5: Estimation Results Alternative Specifications

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full information</th>
<th>Exogenous ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>-2.536 (0.135)**</td>
<td>-2.723 (0.278)**</td>
</tr>
<tr>
<td>Price (st. dev.)</td>
<td>—</td>
<td>0.327 (0.254)</td>
</tr>
<tr>
<td>Rating method</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Attained-Age</td>
<td>-0.797 (0.423)*</td>
<td>-0.811 (0.021)**</td>
</tr>
<tr>
<td>Issued-Age</td>
<td>-0.189 (0.393)</td>
<td>-0.195 (0.010)**</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Observations</td>
<td>4,704</td>
<td>4,704</td>
<td>4,704</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.580</td>
<td>—</td>
<td>0.627</td>
</tr>
<tr>
<td>$\bar{R}^2$</td>
<td>0.564</td>
<td>—</td>
<td>0.595</td>
</tr>
<tr>
<td>State Fixed Effects</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Firm Fixed Effects</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Plan Fixed Effects</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

All specifications include a constant. Standard errors in parentheses. ** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

A larger market share in previous years will be more likely to be part of consumers’ choice sets. Column 4 gives estimation results for a specification that uses an exogenous ordering based on market shares in previous years. More specifically, we use the ranking of firms according to the number of current policies (active in 2009) that were sold before 2007 and use this as the order of search for our estimation. The estimated price coefficient is similar to that of our main specification. The coefficients for the two rating method variables are larger and now significant at the 1-percent level.

5.3 Price elasticities

Table 6 reports the estimated demand elasticities for Medigap Plan F for the five insurers in Indiana with the highest market shares, ranked by decreasing market share, for both the search model and the full information model. The diagonal entries indicate that estimated demand is more inelastic in the search model than in the full information model. In both panels Mutual of Omaha, the insurer with the highest market share in Indiana, has the most inelastic demand for Medigap Plan F. However, while the percentage change in market share
Table 6: Demand Elasticities Plan F (Indiana)

<table>
<thead>
<tr>
<th>Search</th>
<th>Omaha</th>
<th>Anthem</th>
<th>Royal Neighbors</th>
<th>Admiral Life</th>
<th>United Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mutual of Omaha</td>
<td>-2.289</td>
<td>0.072</td>
<td>0.010</td>
<td>0.011</td>
<td>0.006</td>
</tr>
<tr>
<td>Anthem Insurance</td>
<td>0.317</td>
<td>-3.199</td>
<td>0.025</td>
<td>0.027</td>
<td>0.016</td>
</tr>
<tr>
<td>Royal Neighbors Of America</td>
<td>0.251</td>
<td>0.146</td>
<td>-3.497</td>
<td>0.062</td>
<td>0.037</td>
</tr>
<tr>
<td>Admiral Life Insurance Company of America</td>
<td>0.231</td>
<td>0.135</td>
<td>0.052</td>
<td>-2.601</td>
<td>0.044</td>
</tr>
<tr>
<td>Order of United Commercial Travelers</td>
<td>0.215</td>
<td>0.125</td>
<td>0.048</td>
<td>0.070</td>
<td>-3.119</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Full information</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mutual of Omaha</td>
<td>-2.977</td>
<td>0.105</td>
<td>0.018</td>
<td>0.021</td>
<td>0.014</td>
</tr>
<tr>
<td>Anthem Insurance</td>
<td>0.461</td>
<td>-4.265</td>
<td>0.018</td>
<td>0.021</td>
<td>0.014</td>
</tr>
<tr>
<td>Royal Neighbors Of America</td>
<td>0.461</td>
<td>0.105</td>
<td>-4.572</td>
<td>0.021</td>
<td>0.014</td>
</tr>
<tr>
<td>Admiral Life Insurance Company of America</td>
<td>0.461</td>
<td>0.105</td>
<td>0.018</td>
<td>-3.436</td>
<td>0.014</td>
</tr>
<tr>
<td>Order of United Commercial Travelers</td>
<td>0.461</td>
<td>0.105</td>
<td>0.018</td>
<td>0.021</td>
<td>-4.082</td>
</tr>
</tbody>
</table>

Notes: Percentage change in market share of insurer i with a 1 percent change in the price of insurer j, where i indexes rows and j columns. Obtained using estimates in Column (1) of Table 4.

after a competitor’s price change is the same for all insurers in the full information model, in
the search model individuals are more likely to switch to insurers that are similarly ranked. This is intuitive: an individual subscribing to Order of United Commercial Travelers must have relatively low search costs, which means that she is likely to have the other insurers in her choice set, making it more likely that she will find a good deal at an insurer that is also relatively low ranked, for instance Admiral Life Insurance Company of America. Similarly, Mutual of Omaha gets a more than proportional share of the high-search-cost individuals, which makes it less likely that many individuals will switch to one of the lower-ranked insurers in case of a price increase with Mutual of Omaha.

Table 7 looks in more detail at substitution patterns among the plans provided by Anthem Insurance, the second-largest provider in Indiana. Note that although the cross-price elasticities are uniformly higher in the search model, as in the full information model a percentage increase in price leads to the same percentage increase in all plans’ market shares. The reason for this is that we assume a single search cost for getting information on all plans sold by an insurer, making searching less of an issue when substituting within an insurer.
Table 7: Demand Elasticities Anthem Insurance (Indiana)

<table>
<thead>
<tr>
<th></th>
<th>Plan A</th>
<th>Plan B</th>
<th>Plan C</th>
<th>Plan D</th>
<th>Plan E</th>
<th>Plan F</th>
<th>Plan G</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Search</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plan A</td>
<td>-2.363</td>
<td>0.001</td>
<td>0.003</td>
<td>0.001</td>
<td>0.000</td>
<td>0.185</td>
<td>0.044</td>
</tr>
<tr>
<td>Plan B</td>
<td>0.019</td>
<td>-3.177</td>
<td>0.003</td>
<td>0.001</td>
<td>0.000</td>
<td>0.185</td>
<td>0.044</td>
</tr>
<tr>
<td>Plan C</td>
<td>0.019</td>
<td>0.001</td>
<td>-3.235</td>
<td>0.001</td>
<td>0.000</td>
<td>0.185</td>
<td>0.044</td>
</tr>
<tr>
<td>Plan D</td>
<td>0.019</td>
<td>0.001</td>
<td>0.003</td>
<td>-3.499</td>
<td>0.000</td>
<td>0.185</td>
<td>0.044</td>
</tr>
<tr>
<td>Plan E</td>
<td>0.019</td>
<td>0.001</td>
<td>0.003</td>
<td>0.001</td>
<td>-3.370</td>
<td>0.185</td>
<td>0.044</td>
</tr>
<tr>
<td>Plan F</td>
<td>0.019</td>
<td>0.001</td>
<td>0.003</td>
<td>0.001</td>
<td>0.000</td>
<td>-3.199</td>
<td>0.044</td>
</tr>
<tr>
<td>Plan G</td>
<td>0.019</td>
<td>0.001</td>
<td>0.003</td>
<td>0.001</td>
<td>0.000</td>
<td>0.185</td>
<td>-2.908</td>
</tr>
<tr>
<td><strong>Full information</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plan A</td>
<td>-3.066</td>
<td>0.000</td>
<td>0.002</td>
<td>0.001</td>
<td>0.000</td>
<td>0.105</td>
<td>0.025</td>
</tr>
<tr>
<td>Plan B</td>
<td>0.011</td>
<td>-4.105</td>
<td>0.002</td>
<td>0.001</td>
<td>0.000</td>
<td>0.105</td>
<td>0.025</td>
</tr>
<tr>
<td>Plan C</td>
<td>0.011</td>
<td>0.000</td>
<td>-4.181</td>
<td>0.001</td>
<td>0.000</td>
<td>0.105</td>
<td>0.025</td>
</tr>
<tr>
<td>Plan D</td>
<td>0.011</td>
<td>0.000</td>
<td>0.002</td>
<td>-4.520</td>
<td>0.000</td>
<td>0.105</td>
<td>0.025</td>
</tr>
<tr>
<td>Plan E</td>
<td>0.011</td>
<td>0.000</td>
<td>0.002</td>
<td>0.001</td>
<td>-4.354</td>
<td>0.105</td>
<td>0.025</td>
</tr>
<tr>
<td>Plan F</td>
<td>0.011</td>
<td>0.000</td>
<td>0.002</td>
<td>0.001</td>
<td>0.000</td>
<td>-4.265</td>
<td>0.025</td>
</tr>
<tr>
<td>Plan G</td>
<td>0.011</td>
<td>0.000</td>
<td>0.002</td>
<td>0.001</td>
<td>0.000</td>
<td>0.105</td>
<td>-3.788</td>
</tr>
</tbody>
</table>

**Notes:** Percentage change in market share of plan i with a 1 percent change in the price of plan j, where i indexes rows and j columns. Obtained using estimates in Column (1) of Table 4.

5.4 Counterfactuals

Our model can be used to study what happens to prices and market shares as a result of changes in search costs.⁴³ To proceed, we first obtain marginal cost estimates using equation (4) as well as the demand estimates from Table 4. Once we have obtained marginal cost estimates we simulate to what extent prices would change as a result of a change to search costs. The bottom panel of Table 4 provides the average price decrease in case search costs are zero.⁴⁴ The percentage change is large: between 2.8 and 5 percent depending on which specification we take, which corresponds to an average savings of between $48 and $87.

Table 8 summarizes changes in prices and price dispersion by plan type. A comparison of observed prices, which are used to estimate the model, to simulated prices shows that average prices decrease for all plans when moving to a full information equilibrium. Price dispersion also decreases, as measured by either the difference between the maximum and

---

³³As in most of the existing literature on consumer demand, we do not allow firms to change the plans they offer.

³⁴The case of zero search costs can be interpreted as consumers being offered a price menu for all plans sold in a state at no cost. Currently no such information is made publicly available. Some aggregate data on premium ranges at the state-plan type level are accessible through medicare.gov for 2012 and 2013.
Table 8: Change in Coefficient of Variation

<table>
<thead>
<tr>
<th>Plan Type</th>
<th>Observed prices</th>
<th>Simulated prices (full information)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>average price</td>
<td>max-min of variation</td>
</tr>
<tr>
<td>A</td>
<td>1,143</td>
<td>902 0.171</td>
</tr>
<tr>
<td>B</td>
<td>1,567</td>
<td>971 0.182</td>
</tr>
<tr>
<td>C</td>
<td>1,814</td>
<td>1,493 0.173</td>
</tr>
<tr>
<td>D</td>
<td>1,450</td>
<td>939 0.133</td>
</tr>
<tr>
<td>E</td>
<td>1,521</td>
<td>559 0.114</td>
</tr>
<tr>
<td>F</td>
<td>1,853</td>
<td>1,938 0.207</td>
</tr>
<tr>
<td>G</td>
<td>1,463</td>
<td>1,122 0.171</td>
</tr>
<tr>
<td>H</td>
<td>1,468</td>
<td>278 0.049</td>
</tr>
<tr>
<td>I</td>
<td>1,631</td>
<td>621 0.098</td>
</tr>
<tr>
<td>J</td>
<td>1,746</td>
<td>721 0.102</td>
</tr>
<tr>
<td>K</td>
<td>1,030</td>
<td>215 0.079</td>
</tr>
<tr>
<td>L</td>
<td>1,401</td>
<td>408 0.111</td>
</tr>
</tbody>
</table>

Notes: Obtained using estimates in Column (1) of Table 4. Plans only include those rated according to attained-age. The coefficient of variation is weighted by sales. Prices are in US$. Minimum price or the coefficient variation (weighted by market share of each plan), although the differences are small. Note that price dispersion is not expected to disappear when search costs decrease to zero: due to product differentiation, firms with more favorable characteristics can set higher prices, which results in price dispersion even if there is full information.

To analyze changes in consumer welfare we use compensating variation (see also Small and Rosen, 1981; Nevo, 2000), which in our search model corresponds to

$$CV = \sum_{k=1}^{N} \mu_k^{\text{post}} \left[ \ln \left( 1 + \sum_{\ell=1}^{k} \exp \phi_\ell^{\text{post}} \right) - (k - 1)\bar{c}_k^{\text{post}} \right] - \sum_{k=1}^{N} \mu_k^{\text{pre}} \left[ \ln \left( 1 + \sum_{\ell=1}^{k} \exp \phi_\ell^{\text{pre}} \right) - (k - 1)\bar{c}_k^{\text{pre}} \right]$$

where $\bar{c}_k$ is the average search cost of consumers searching $k$ times. This amounts to the expected maximum utility when searching $k$ times (measured in dollars by normalizing by the price coefficient), averaged over all $k$ groups of consumers, taking average search costs for

---

35 Using an unweighted coefficient of variation gives similar results.
36 The results in Table 8 are obtained using the estimates from column 1 of Table 4. The results are qualitatively similar if we use the other two specifications from Table 4.
individuals in each group into account.\textsuperscript{37} The last panel of Table 4 gives the average change in consumer surplus when moving from the search model to the simulated zero search cost equilibrium. Such a change in consumer welfare is driven by several factors such as savings on search costs, reduction in premiums, and expansion of the market share. We find a large increase in consumer welfare for all the three specifications, with a magnitude of up to 4 times the average price decrease.

6 Conclusion and Discussion

In this paper we use market share and price data on Medigap plans to estimate the effect of search frictions on demand parameters. In our model consumers search among insurers for both the right plan type and prices. We have shown how to estimate the model using constrained two-stage least squares. Our estimates indicate that the search model provides a better fit than a model that assumes consumers have full information. Assuming full information when consumers in fact have limited choice sets leads to a higher estimated price coefficient in absolute sense. Moreover, search costs are found to be substantial: median search costs are estimated to be between $22 and $49, depending on the specification.

Using the estimated parameters, we simulate equilibrium prices when search costs completely disappear. Depending on the exact specification, prices are expected to decreases by between 3 and 5 percent, which corresponds to an average yearly savings of between $48 and $87. If we include savings on the actual cost of searching in our calculations, our findings are even more striking: average consumer welfare increases by $138 and $321 when moving to a zero-search-cost equilibrium.

One limitation of our paper is that we do not specifically model consumer selection into Medigap plans. Note that the existing literature has found mixed evidence of selection in Medigap plans (Fang, Keane, and Silverman, 2008).\textsuperscript{38} Moreover, allowing for both selection

\textsuperscript{37}If the policy change is such that the new search costs are zero, we set $\mu_N = 1$ while all other $\mu_k$’s are zero.

\textsuperscript{38}Due to regulations in Medigap (such as product standardization and guarantee issues), we suspect that
and search frictions is a huge challenge that is better addressed in future work. Nevertheless, we do offer some discussion on how our results would be affected if firms are able to take selection into account when setting prices. One obvious complication is that marginal costs may be related to prices, which leads to an additional channel through which prices affect profits. For example, an increase in price may scare away price-sensitive consumers, who may be more likely to have worse than average health conditions. In such a scenario marginal costs would be negatively related to prices, which means our current model is likely to overestimate marginal costs as well as the new equilibrium prices in the counterfactual of no search frictions. Moreover, if this would be the case, our counterfactual results should be considered as a lower bound with respect to price decreases.

39 In our model, marginal cost is kept constant but allowed to vary across firms and plans.
References


APPENDIX

The derivative of the market share of insurer $f$’s plan $j$ with respect to its own price is given by

$$
\frac{\partial s_{jf}}{\partial p_{jf}} = -\alpha \cdot \sum_{k=f}^{N} e^{\delta_{jf}} \left( 1 + \sum_{\ell=1}^{k} e^{\phi_{\ell}} - e^{\delta_{jf}} \right) \left( 1 + \sum_{\ell=1}^{k} e^{\phi_{\ell}} \right)^{-2} \cdot \mu_{k}.
$$

The derivative of the market share of insurer $f$’s plan $j$ with respect to the price of insurer $f$’s plan $g$ is

$$
\frac{\partial s_{jf}}{\partial p_{gf}} = \alpha \cdot \sum_{k=f}^{N} e^{\delta_{jf}} e^{\delta_{gf}} \left( 1 + \sum_{\ell=1}^{k} e^{\phi_{\ell}} \right)^{-2} \cdot \mu_{k}.
$$

The derivative of the market share of insurer $f$’s plan $j$ with respect to the price of insurer $h$’s plan $g$ is

$$
\frac{\partial s_{jf}}{\partial p_{gh}} = \alpha \cdot \sum_{k=\max\{f,h\}}^{N} e^{\delta_{jf}} e^{\delta_{gh}} \left( 1 + \sum_{\ell=1}^{k} e^{\phi_{\ell}} \right)^{-2} \cdot \mu_{k}.
$$