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Price Variation in Markets with Homogeneous Goods: The Case of Medigap*

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Abstract

About one-third of elderly Americans age 65 and older supplements their Medicare health insurance in a private insurance market known as the "Medigap" market. Prices for Medigap policies vary widely, despite the fact that regulations enacted in 1992 standardized all Medigap policies, thereby creating a market with homogenous insurance products. Economic theory suggests that consumer search costs can lead to a non-degenerate price distribution within a market for otherwise homogenous goods. Using a structural model of equilibrium search costs first posed by Carlson and McAfee (1983), we find that nearly all consumers face search costs high enough to prevent them from searching until they find the lowest priced Medigap policy. We estimate average search costs to be $249, substantially higher than has been found in other markets, but plausible given the complex nature of the Medigap market and its elderly consumer population. The implied aggregate welfare loss is approximately $798 million or $484 per policyholder.

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1. Introduction

Nearly all Americans age 65 and older obtain basic health insurance coverage through the Medicare program. Although the introduction of Medicare led to a substantial reduction in out-of-pocket expenditure risk (Finkelstein and McKnight, 2005), the elderly still face significant risk on account of Medicare's large co-insurance rates, copayments, and caps (Goldman and Maestas, 2005). To help individuals insure against these "gaps" in Medicare coverage, a private individual insurance market for supplemental coverage evolved, known as the Medigap market. Currently, about 30 percent of Medicare beneficiaries purchase supplemental insurance policies (MedPac, 2004). The Medigap market is likely to grow in the future due to recent declines in the availability and generosity of employer-provided supplemental coverage, the main alternative form of private supplemental insurance (MedPac, 2004).

Prior to July 1992, the Medigap market was only minimally regulated. Insurance companies were free to offer consumer-specific contracts, varying the extent of coverage from contract to contract and underwriting on the basis of health status as long as minimum benefit standards were met. In 1991, thirteen percent of Medicare beneficiaries held two or more supplemental insurance plans (US General Accounting Office, 1994), which in many cases provided redundant coverage (Short and Vistnes, 1992). Furthermore, consumers were reportedly confused about their coverage options and at times taken advantage of by insurance companies (US Department of Health and Human Services, 1995).

The Omnibus Budget Reconciliation Act (OBRA) of 1990 introduced regulations intended to strengthen consumer rights in the Medigap market: ten standardized plans labeled A through J were established, the purchase and sale of multiple plans was prohibited, and medical underwriting was greatly restricted. Despite these regulations, one characteristic of the market did not change: prices continue to vary substantially between companies offering the same Medigap plans, even though coverage packages are now identical (Weiss Ratings Inc., 1997-2005). For example, 35 insurance companies in Illinois offered an attained age, standardized Plan F to 65-year-old women in 1998. Annual premiums ranged from $774 to $1603, with an average of $1069, a standard deviation of $162, and an implied coefficient of variation of 0.15. Illinois is not unique in the extent of price variation present in the Medigap market, nor is Plan F. In 31 states, the coefficient of variation of premium offers for Plan F reaches or exceeds 0.15, and this general pattern is present for the other standardized plan letters.

In this paper we investigate why price variation is sustained in the Medigap market. Because of the standardization imposed by OBRA 1990, the Medigap market is in essence a market with homogeneous goods. The existence of price variation in a market with homogeneous goods is an indicator of imperfect information in the market (e.g., see Stiglitz, 1989), and suggests that when consumers buy high-priced Medigap policies instead of identical lower-priced ones, welfare losses occur. To guide our analysis, we apply a theoretical model by Carlson and McAfee (1983) that explains the existence of a discrete price distribution in a market for homogenous goods with differences in cost structures among firms and search costs to consumers. The Carlson-McAfee model has been used to study price variation in a variety of settings. For example, Dahlby and West (1986) found support for the model's main predictions in the market for auto insurance. In a study of local pharmacy markets in upstate New York, Sorensen (2000) found more variation in prices for acute-care medications than for medications used to treat long-term chronic conditions, where the expected gains from searching were larger. Horteçsu and Syverson (2004) applied the Carlson-McAfee model to the market for S&P 500 index funds, finding that increased market participation by novice investors moved the search cost distribution rightward, supporting the existence of more expensive funds.

Applying the Carlson-McAfee model to the Medigap market, we estimate a maximum search cost of $498, and an average search cost of $249. By way of comparison, average search costs ranged from $28 to $125 in the market for auto insurance (Dahlby and West, 1986), and between $5 and $30 for every $10,000 of assets invested in the mutual fund market (Horteçsu and Syverson, 2004). Our findings suggest that many elderly consumers do not know where to find the lowest price in the market, and face costs of search that are high enough to prevent most of them from searching until they find the lowest price. In 80 percent of all markets nationwide, no more than 15 percent find the lowest priced policy. Relative to the case of perfect information, we estimate a total welfare loss of about $798 million or $484 per policyholder.

We begin with a brief description of the Medigap market and the OBRA 1990 reforms. Next, we explain our market and product definitions, and show evidence of price variation in markets around the U.S. (section 3). In section 4, we discuss theories of price variation and present an augmented version of the Carlson-McAfee search cost model. We describe our data in section 5, and estimate the search cost model's main equations in section 6. We conclude with a brief discussion of welfare implications.

2. Institutional Background

Medicare, enacted in 1965, provides health insurance coverage for people 65 and older and for certain disabled individuals. However, coverage is far from complete – Medicare only covers basic needs and even then, substantial co-insurance and co-payments are required. Medicare coverage has two components: Part A "hospital insurance" for inpatient and limited nursing home care, and Part B "medical insurance" for physician services and outpatient procedures. For those who have worked for at least 10 years (or whose spouses have), Part A has no premium and coverage starts automatically at age 65. Part B coverage requires a monthly premium and active enrollment.

Since the introduction of Medicare, there has been demand for insurance against its out-of-pocket costs. About 30 percent of Medicare beneficiaries obtain supplemental insurance through the private Medigap market, another 30 percent obtain supplemental coverage through their former employer, about 15 percent eliminate the coverage gaps by enrolling in Medicare managed care, 15 percent are eligible for and receive supplemental coverage through the Medicaid program, and about 10 percent have no supplemental coverage (MedPac, 2003). As the Medicare managed care market has contracted since its peak 1998 and employers continue to reduce coverage for new retirees (Kaiser Family Foundation, 2005), the Medigap market may become an even more important source of supplemental insurance in the future.

Since its inception, the Medigap market has attracted the concern of policymakers. Allegations of insurer fraud and concerns that the elderly were both uniformed about their coverage needs and unable to navigate the complexities of supplemental coverage offers led states to adopt minimum benefits standards in the late

70s and early 80s (Finkelstein, 2004).[1] Nevertheless, concerns about insurer malpractice grew, as consumer protection agencies accused insurers of extracting large rents by intentionally misleading people into purchasing multiple plans with duplicate coverage (Select Committee on Aging, 1990). This led to drastic reforms of the Medigap market with the passage of the Omnibus Budget Reconciliation Act (OBRA) in 1990. The most important reform was the requirement that insurers conform their plan offerings to a set of ten standardized plans, labeled A-J. Table 1 shows the coverage offerings of each of the ten plans. The plans range from coverage of only coinsurance (Plan A) to coverage of coinsurance, deductibles, excess charges, foreign travel emergency, at-home recovery, prescription drugs,[2] and certain preventive care services (Plan J).[3] Standardization was intended to increase the comparability of plan offers across insurance companies, which would hopefully enhance competition, lead to price reductions, and generate welfare gains for consumers.

A second important reform was the establishment of an open enrollment period during which medical underwriting is prohibited. The open enrollment period runs for six months, beginning when consumers turn 65 *and* enroll in Medicare Part B.[4] During open enrollment, an insurance company must accept a consumer's application regardless of medical condition, and can vary premiums only on the basis of age, gender, and smoking status. After the open enrollment period ends, insurers are free to engage in medical underwriting. Other regulations included guaranteed renewability of insurance policies, higher loss ratio requirements[5], and the prohibition of selling plans with duplicate coverage. These federal regulations came into effect in 1992 in all states but

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[1] The regulations also limited exclusions for pre-existing conditions, required insurers to offer "free look" periods, and set loss ratio requirements (Finkelstein, 2004).

[2] Since January 1, 2006, new issuances of Medigap plans H, I, and J no longer include prescription drug coverage. Those who held a Medigap policy with prescription drug coverage have the option of maintaining drug coverage through their Medigap policy or switching to a new Medicare prescription drug plan by May 15, 2006. Those who switched during this window of time also had the right to switch to a different Medigap plan letter offered by their insurer. These changes affect a very small segment of the Medigap market; only 9 percent of Medigap plan enrollees were enrolled in plans H, I, and J in 2001(Kaiser Family Foundation, 2005).

[3] In 2005, two new lower-cost standardized plans were introduced (Plans K and L), which offer fewer benefits and higher out-of-pocket costs subject to annual limits. We do not include the new plans in our analyses because our data pre-date their introduction.

[4] For example, for a consumer who turned 65 on the 1st of January in 1998, but enrolled in Medicare part B on April 1st, the open enrollment period begins on April 1st and ends on September 30th.

[5] The loss ratio is defined as the ratio of claims over premiums, reflecting the share of premiums collected from policyholders that is used to cover incurred medical costs.

Massachusetts, Minnesota, and Wisconsin, where similar regulatory measures had previously been introduced.

With underwriting limited to age, gender, and smoking status, insurance companies were left with few ways of varying premiums to match their risk exposure. In addition to varying premiums by gender and smoking status, they adopted three different methods of varying premiums by age: attained age rating, community rating, and issued age rating. Each method represents a different kind of risk pooling within an insurance plan. Attained age plans vary premiums according to the consumer's current age, whereas community rated plans pool all risks and charge the same premium to all policyholders regardless of age (although some differentiate by gender). Issued age premiums are based on the consumer's buy-in age, not on her actual age, and therefore the same premium is charged to all individuals who bought at the same age, regardless of the year in which they first bought their policy. If an insurance company wishes to raise premiums, it must do so for all policyholders within the same rating class. For example, it is not possible for an insurer to increase the premium separately for the oldest people in a community rated or issued age plan – this would only be allowed in an attained age plan. Each rating method implies a different age profile in premiums. Attained age plans feature a relatively low premium at age 65 but a steeply rising premium profile with age, whereas issued age plans have higher age 65 premiums and less steeply rising premium profiles with age.[6] For community rated plans, the age profile is flat. (For a detailed discussion, see Schroeder, Maestas, Goldman, 2005.)

It is important to note that because medical underwriting is permitted after the open enrollment period, individuals who wish to switch Medigap plans could face potentially large premium increases. Hence, the regulations largely deter individuals from voluntarily changing plans, and generally limit market-destabilizing gaming strategies such as buying an attained age plan when young (and premiums are relatively low) and switching to a cheaper community rated plan when older (and attained age premiums are relatively high).[7]

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[6] For Plan A, the average annual increase in premiums is about 3 percent for attained age rating in the first ten years, compared to 2.2 percent for issued age plans.

[7] The federal regulations offer protection against medical underwriting after the open enrollment period in special situations such as when an individual loses coverage because their Medigap insurer goes bankrupt;

3. Price Variation

3.1. Product and Market Definitions

As we showed in Table 1, the ten standard Medigap plans provide different degrees of coverage. These coverage differences will lead to cost differences, which in turn will lead to premium differences; thus, we expect premiums to vary *across* plan letters. We also expect them to vary *within* plan letter on those dimensions permitted by law: gender, smoking status, and age. For example, a smoker will pay more for Plan F than a non-smoker, and men will sometimes pay a different premium than women.[8] Attained age premiums will generally be lower than issued age and community rated premiums at younger ages, but will be higher at older ages. Finally, the local market in which a plan is sold is an important factor distinguishing two otherwise identical policies – a policy sold in Washington DC will be priced differently than one sold in Los Angeles, on account of differences in population health, state regulations, and local market conditions. Although insurers are free to vary prices by zip code or county, data from Weiss Ratings, Inc. (described in section 5) show that most premium variation occurs *across* rather than within states. For example, of the 47 firms offering plan F to 65 year-old women in Illinois, 29 (62 percent) charge the same premium in every zip code.[9] The remaining 18 firms have a mean within-firm coefficient of variation of 0.061, leading to an average within-firm coefficient of variation of 0.023 in Illinois. In most other states we find similar patterns (see Appendix Table 4). It is not altogether surprising that firms do not vary premiums much within states. Insurance companies are subject to regulations and reporting requirements that vary by state (e.g., open enrollment or loss ratio

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an individual voluntarily leaves a Medicare HMO within one year of first enrolling; an individual's Medicare HMO withdraws from their service area or otherwise terminates their coverage; an individual moves out of their Medicare HMO's service area; or a former employer terminates retiree health benefits (Centers for Medicare and Medicaid Services, 2006). In addition, states have the option of going beyond the federal regulations. Currently, Connecticut and New York have "continuous" open enrollment (i.e. no medical underwriting ever permitted), while California, Maine, and Massachusetts have an annual open enrollment period of one month around a person's birthday (The Lewin Group, 2001).

[8] In practice, insurance companies do not charge very different premiums to men and women: state average premiums for men and women remain within 5 percent of one another for any given plan, age, and rating method, with men sometimes but not always being charged a higher premium.

[9] Note that we consider all rating types together here. Since we omit those firms that operate within more than one rating method in any market (<2 percent of the entire sample), the variation in premiums within a firm is not caused by the rating method.

requirements), not county or zip code. In addition, data on covered lives from the National Association of Insurance Commissioners (described in section 5) suggest that for most firms the number of policyholders per zip code or county is too small for risk pooling in small geographic areas to be advantageous. In sum, the Weiss data suggest that states are the relevant "local" markets in most cases. This is particularly useful since the NAIC data on covered lives and claims are reported by state, not zip code or county.

In the analyses that follow, we assume that policies of the same plan letter, gender, smoking status, rating method, and age, which are offered in the same state, are perfect substitutes for one another.[10] To reduce the dimensionality of our analysis, we mostly focus on policies offered to female nonsmokers at age 65 (the most common buy-in age, and when most people are in their open enrollment period), although our results hold for male nonsmokers at age 65 as well. We analyze within-state variation in the price of these homogeneous policies, generally treating each rating method separately.

3.2 Evidence of Price Variation

Table 2 presents the variation in premiums for Medigap policies sold to 65 year-old non-smokers. In panel a) we show premium statistics for Plan F policies offered throughout the U.S, by rating method and by sex. The variation in premiums for Plan F policies nationwide is substantial, with coefficients of variation (CV) for female premiums ranging from 0.17 to 0.19. The extent of variation is similar for all rating methods. The distribution of prices hardly varies by sex. For each rating method, the average prices charged to men and women are within a few dollars of one another, the CV in premiums for men and women is virtually the same, and firms always offer policies to both sexes. Attained age rating is the dominant rating method nationwide: 55 percent of Plan F offers are attained age rated, 35 percent are issued age rated, and just 10 percent are community rated. Prices vary as expected across the rating methods, with attained age plans being least expensive for 65-year-olds and community rated plans being most expensive.

[10] Some firms also offer "Select" versions of some plan letters, which restrict provider choice to specific networks, much like managed care organizations. We do not include these plans in our analyses.

While there is substantial variation nationwide, some of this variation is expected on account of differences in the costs of operating in different states. Panel b) shows how prices for Plan F vary *within* states, focusing on attained age plans in an arbitrary group of ten states. Almost all of the within-state CV's are above 0.10, with two out of the ten at or near 0.20 (California and Wyoming), suggesting considerable within-state variation in premiums.[11] In some states, the range of premiums is quite large. For example, premiums for identical Plan F policies in California range from a low of $929 to a high of $1911. This spread is not merely due to outliers, as the ratio of the 90th over 10th percentiles is 1.8. The average premium differs substantially across states, indicating the presence of state-specific cost differences. Although the coefficient of variation appears to be unrelated to the number of plan offers in a state, this is an artifact of the non-representative sample of states we present in the table. Similar to Carlson and MacAfee (1983), we find that price dispersion is positively related to the number of firms in a market.[12] Appendix Table 1 displays the complete listing of coefficients of variation and offers for all states and plan letters, confirming that significant price variation persists in all states and for all policies.

In panel c) we consider just the state of Illinois, where we note that the same magnitude of price variation is present for the other plan letters, and climbs as high as 0.39 for the plan with the most comprehensive coverage, Plan J. The most offers are for plans A, C, and F, which is true for all states in general (see Appendix Table 1). As expected, the average premium increases with the amount of coverage, especially so for the plan letters that covered prescription drugs (H, I, J) in 1998.

Although the Medigap plan letters refer to a standardized set of insurance benefits, the firm's cost of delivering that set of benefits will depend on several factors, including the local supply of medical services and the efficiency with which it administers the insurance benefit. Supply factors can explain, for example, why Plan F is

[11] The coefficients of variation reported here for the Medigap market are comparable to those noted in other studies of price dispersion in markets for homogeneous goods. For example, Sorensen (2000) reports an average CV of 0.22 in retail prescription drug markets (page 838), and Dahlby and West (1986) report examples of 0.0739 and 0.1796 (bottom of page 424) for the automobile insurance industry.

[12] We assess this by regressing the CV on number of offers by plan letter and state in a model that includes plan letter dummies and clustering of standard errors by plan letter. The data used in this regression are shown in Appendix Table 1.

more expensive in California than Tennessee, but it does not explain why there is variation within a health care market.

4. Theoretical Framework

4.1. An Overview of Theories of Price Variation

In general, there are three potential explanations for sustained price dispersion in a homogenous goods market. The first is cross subsidization within a firm. In this scenario, a firm sells products in more than one market, allows for losses in one (or more) of them, and subsidizes the losses with profits made in other markets. In the Medigap context, firms could offer Plan A very cheaply (i.e. below costs) in order to attract people to the company. Then the firm could present the other plans it offers, which (by definition) are better plans in terms of coverage and thus are more expensive. The premiums for these plans would be above costs, and thus the firm could offset losses on Plan A (and perhaps make profits) if enough consumers decide to buy the more expensive plan. If only some firms engaged in this kind of pricing, or if all did but to different extents, prices could vary. It is unlikely that firms engage in this kind of cross-subsidization, however, because federal Medigap regulations require insurers to maintain loss ratios (the ratio of claims to premiums) of at least 65 percent for individual plans, and 75 percent for group plans. If that ratio is not met, the insurer has to pay transfers to his policyholders. If, as is usually assumed, the administrative costs for Medigap policies are about 10-15 percent of total costs (CMS, 2006b), there remains a maximum profit margin of 25 percent for collected premiums.

Firms could also cross subsidize *across* insurance markets by operating in the Medigap market with losses, but subsidizing these losses with profits from an entirely different insurance market, say long term care or life insurance. In other words, Medigap policies could be thought of as "loss leaders." Only about 11 percent of Medigap plans in the NAIC data operate with losses, however, indicating that this type of cross subsidization, if it even exists, is relatively uncommon.

Price variation could also persist if ostensibly homogeneous products are in fact differentiated on some dimension that is observable to consumers, but not to the researcher. Examples of product differentiation might include special discounts for spouses, financial stability of the insurance firm, or a reputation for efficient claims processing. Furthermore, advertising is a form of product differentiation, which in general does not alter the product, but increases knowledge and name recognition. While it is likely that some unobserved product differentiation exists in the Medigap market, it cannot plausibly explain price ranges where the maximum price is more than double the minimum price in some states and for some plan letters (see Table 2b and 2c).

A third reason for equilibrium price dispersion is that firms differ in their costs of production, and these differences are sustained by the existence of consumer search costs. Several theoretical papers have investigated the implications of incompletely informed consumers who have to gather information before they buy a product. Even with a large number of consumers and sellers, and no heterogeneity in production costs, Diamond (1971) concludes that the monopoly price prevails if there are search costs. Stiglitz (1989) shows how price dispersion arises through cost differentials in the presence of search costs, assuming that consumers are either fully informed or not at all informed (i.e., no learning about the market through sequential search) and a continuous distribution of prices. Carlson and McAfee (1983) relax these particular assumptions. They allow consumers to learn about the market through sequential search, and they assume a discrete price distribution, the latter feature being particularly relevant in the Medigap setting where there are relatively few firms operating in a given market. Perhaps most importantly, their model yields testable predictions. We explain their model and our augmentations in detail in the next section.

4.2. A Model of Search Costs and Price Dispersion

Carlson and McAfee (1983) explain sustained price variation in a homogeneous goods market with consumer search costs and variation in production costs. The intuition behind their model is to assume incomplete information in the sense that consumers are not fully informed: while they know the price distribution they do not know which firm offers which price.[13] However, consumers can obtain information about firm-price pairs at a certain cost that is specific to the consumer. Heterogeneity in search costs leads to

[13] Virtually all papers in the search cost literature assume a commonly known price distribution. This is necessary to evaluate any consumer's expected (monetary) gain from searching. Otherwise it is not possible for a consumer to assess when to stop searching (in dynamic programming models).

differences in the amount of information obtained, which allows for a non-degenerate price distribution to exist in the market.

Suppose all consumers gain utility u_j if they buy a Medigap policy from firm j:

(1) $$u_j = \lambda X_j - p_j ,$$

where X_j is a vector of firm j's characteristics other than price, p_j. Utility is linear, and it is normalized in terms of prices (i.e. there is no coefficient on p_j). Although the consumer does not know which firms yield which level of utility, she can rank all possible utilities from highest to lowest, $u_1 \geq u_2 \geq \ldots \geq u_N$. If only prices mattered ($\lambda = 0$) this would correspond to an ordering from lowest to highest price as in Carlson and MacAfee (1983). Here we augment their model to allow factors other than price to affect a firm's ranking. Upon entering the market, the consumer searches once, drawing an offer from firm k, which she learns yields utility u_k. Because she knows the ranking of all u_j, the consumer can calculate the expected gain, w_k, from searching again. The expected gain also depends on the probability of a firm being found, where we assume here that all firms N in a market are found with equal probability $1/N$. Then, for any utility u_k, the expected gain is:

(2) $$w_k = \sum_{i=1}^{k-1} \frac{1}{N}\left(u_i - u_k\right) = \frac{1}{N}\sum_{i=1}^{k-1} u_i - \frac{k-1}{N} u_k$$

The consumer then compares the expected gain to her search cost to determine whether to buy this policy or to search for another one.[14] Each consumer has a search cost draw s from a cumulative distribution function $G(s)$, where $g(s) = G'(s)$. The problem of search then becomes an optimal stopping problem: as long as s is lower than (or equal to) the expected gain, w_k, the individual will continue to search and stop if and only if $w_k \leq s \leq w_{k+1}$. Since the distribution of expected gains is the same for all consumers, the search cost distribution, $G(s)$, maps the searching individuals into groups of people that are associated with each firm's utility rank.

[14] Search in Carlson and McAfee's model occurs with replacement, i.e. the utility distribution does not change with the number of searches conducted. While this may seem unrealistic, note that consumers are not limited in the number of times they search, but only by their cost of searching again as it compares to their expected gain. They can discard any draw from the utility distribution with lower utility than a previous draw at no cost.

Figure 1 (slightly altered from Carlson-McAfee) depicts how the expected gains are distributed in an arbitrary example with five firms and gains from searching $w_1 < w_2 < w_3 < w_4 < w_5$, where $w_1 = 0$. Search costs are distributed uniformly on $[0,S]$, and in this example, the maximum search cost is larger than the maximum possible gain, w_5. W_5 (or $[S-w_5]/S$) then depicts the fraction of people in the market that buys the first plan they find. (This does not have to be the plan with the lowest utility, but recall that only people with a search cost draw of $s > w_5$ will end up buying this plan.) W_5 is also equivalent to the fraction of people that remains uninformed about all other firm-price combinations in the market, except for the one they acquire initially. Similar considerations apply to the other parts of the market, where W_1 depicts the fraction of people who will always buy at the lowest price, since their search costs are lower than the smallest gain, w_2.

To determine the relative demand for each firm's plan in the case of a general price distribution, we start by considering q_N, the number of individuals that buys at the firm giving the lowest utility, u_N. These are all people with search cost $s \geq w_N$, who are unlucky enough to draw this firm when entering the market:

$$(3_N) \qquad q_N = \frac{1}{N} G(s \geq w_N) = \frac{1}{N}\left[G(\infty) - G(w_N)\right],$$

where $G(\infty)$ represents the total number of individuals in the market, Q. Similarly, we can find the number of individuals that buys at the firm yielding the second lowest utility, firm $N-1$:

$$(3_{N-1}) \qquad \begin{aligned} q_{N-1} &= \frac{1}{N} G(s \geq w_N) + \frac{1}{N-1} G(w_N \geq s \geq w_{N-1}) \\ &= \frac{1}{N}\left[G(\infty) - G(w_N)\right] + \frac{1}{N-1}\left[G(w_N) - G(w_{N-1})\right] \end{aligned}$$

Intuitively, firm $N-1$ attracts $1/N$ of the consumers with the highest search costs and $1/(N-1)$ of those with the second highest search costs. In general, we can obtain each firm j's demand as:

$$(3) \qquad q_j = \sum_{k=j}^{N} \frac{1}{k}\left[G(w_{k+1}) - G(w_k)\right] = \frac{Q}{N} - \frac{G(w_j)}{j} + \sum_{k=j+1}^{N} \frac{G(w_k)}{k(k-1)} \ ,$$

with $G(w_{N+1}) = Q$. Equations (2) and (3) can then be used to calculate the number of all consumers in any firm j based on the expected utility gain w_j of further search associated with the firm, where we assume in line with Carlson-McAfee that the search cost distribution is uniform on an interval [*0,S*]. This leads to

$$(3') \qquad q_j = \frac{Q}{N} - \frac{Q}{j}\frac{w_j}{S} + \sum_{k=j+1}^{N}\left[\frac{Q}{k(k-1)}\frac{w_k}{S}\right].$$

Substituting equation (2) into (3') yields a demand equation in terms of the utilities associated with each firm *j* (see Appendix A.1.a. for derivation):

$$(4) \qquad q_j = \frac{Q}{N}\left[1 - \frac{1}{S}\left(\overline{u} - u_j\right)\right],$$

where, as before, q_j depicts the number of consumers in firm *j*. The demand thus depends on the difference in utility derived from firm *j*'s offer and the market average utility derived from this plan. When the utility gained from firm *j*'s plan offer increases, firm *j*'s market demand rises, as

$$(5) \qquad \frac{\partial q_j}{\partial u_j} = \frac{Q}{N}\frac{1}{S}.$$

Similarly, firm *j*'s demand also depends on the maximum search cost:

$$(6) \qquad \frac{\partial q_j}{\partial S} = \frac{Q}{N}\frac{1}{S^2}\left(\overline{u} - u_j\right).$$

Thus an increase in search cost leads to a loss in demand for firms with above average plan utility, and demand gains for firms with below average utility. Hence an upward shift in search costs will lead to a reduction in the variance in market demands, and as *S* approaches infinity each firm's market demand approaches the average demand, *Q/N*. (In a situation where the maximum search cost approaches zero, the search cost distribution is degenerate and every consumer will buy at the firm(s) providing the largest utility, leading to the full information market outcome.) Note also that a reduction in firm *j*'s demand can be brought about by an increase in the number of firms (*N*) as well as by an increase in the utility provided by any other firm, as this increases the average market utility.

We next turn to firm price setting decisions. Carlson and McAfee assume firms are heterogeneous in terms of their (quadratic) cost functions:

$$(7) \qquad c_j\left(q_j\right) = \alpha_j q_j + \beta q_j^2 = \alpha_j\left\{\frac{Q}{N}\left[1 - \frac{1}{S}\left(\overline{u} - u_j\right)\right]\right\} + \beta\left\{\frac{Q}{N}\left[1 - \frac{1}{S}\left(\overline{u} - u_j\right)\right]\right\}^2,$$

where $\alpha_j > 0$ and $\beta \geq 0$, both of which are testable hypotheses. Satisfaction of the condition on β guarantees profit maximization.[15] The profit function is

$$\text{(8)} \qquad \Pi_j = p_j q_j - c_j(q_j)$$

and maximizing it with respect to price yields a system of N equations in N unknowns, which can be solved for each price p_j (see Appendix A.1.b. for the derivation):

$$\text{(9)} \qquad p_j = \alpha_j + \frac{(1+\gamma)N}{N-1} S + \frac{(1+\gamma)N}{2N-1+\gamma N}(\overline{\alpha} - \alpha_j) - \frac{(1+\gamma)N}{2N-1+\gamma N}\lambda(\overline{X} - X_j) \ ,$$

where

$$\gamma = \frac{2\beta Q(N-1)}{SN^2} .$$

Since only α_j, and X_j vary across firms, variation in p_j is determined by firm-specific costs and other characteristics of the firm from which consumers derive utility.

5. Data

We draw on two sources of data in our empirical analyses. Our first dataset, from Weiss Ratings, Inc., is a snapshot of Medigap premiums in effect on January 1, 1998. The Weiss data capture about 91 percent of all firms operating nationwide, and are voluntarily provided by insurance companies. Firms report their premiums for the Medigap plan letters they offer by gender, age, smoking status, rating method, and zip code. The data also include the Weiss financial safety rating for each insurance firm, where "A" is "excellent", "B" is "good", "C" is "fair", "D" is "weak", and "E" and "F" are "very weak" and "failed", respectively.

Our second dataset, from the National Association of Insurance Commissioners (NAIC), has total premiums, claims, and covered lives for each plan letter offered by an insurance company in every state. In each year of NAIC data, the data are aggregated across policies issued during the previous three years. For example, the data for 1998 contain covered lives for policies issued by a particular firm in a given state in 1996, 1997 and 1998 combined. In order to match the NAIC data to the Weiss price data for 1998, we simply divide the three-year totals by three to obtain an estimate of the figures

[15] Note that the derivation in appendix A.1.c. shows that β is bounded from below by a values that could be less than zero. However, if β is estimated to be positive, firms will meet the profit maximization condition.

for 1998. This implicitly assumes that plans had the same influx of new policyholders in each of the three years.

We merge the NAIC and Weiss data with the goal of creating a dataset that contains price, quantity sold (covered lives), and production costs (claims) for each Medigap plan offered by a firm in every market. However, the two datasets are not strictly comparable and three issues arise when attempting to merge them. We give an overview of the major issues here, while Appendix 2 describes our merge procedures step by step. First, as the NAIC data are available at the state level, we must aggregate up the Weiss data. As discussed earlier, we do not lose much information since insurers predominantly vary premiums across states, rather than within states.

Second, while the Weiss data list premiums by age, the NAIC data report covered lives for all ages combined. Because health status varies with age, we wish to avoid attributing prices offered to a relatively healthy group to the quantity purchased by a less healthy group (or vice versa). This concern is mitigated by the fact that most people who buy Medigap policies buy them when they turn 65 years old. Since those who bought policies at age 65 dominate total covered lives, age 65 premiums should be well matched to the market share averaged over all ages. One way of testing this assertion is to assess whether a firm's market share is likely to vary substantially by the policyholder's age. In our model, a firm's market share is uniquely determined by the utility it offers relative to the average utility offered by other firms in the market. If the relative utility offered does not vary with age, then the firm's market share for each age will equal its average market share over all ages. We can readily test whether this is the case when $\lambda = 0$ by computing relative premiums by policyholder age for each firm (using the Weiss data) in every market, and then computing a measure of the age-related variation in relative premiums for each firm (in every market). We find that relative premiums do not vary much by age: the average within-firm standard deviation of relative premiums as a percent of the market average premium is just 3.3 percent; in 75 percent of state-firm-plan letter-rating method observations the standard deviation over age groups is 4.6 percent or less, and in 90 percent the standard deviation over age groups is 7.1 percent or less. We conclude that since relative premiums do not vary much by age within firms, market shares are unlikely to vary much by age, and thus age 65 premiums are well matched to market shares that are averaged over all ages.

Finally, the NAIC data are comprehensive whereas the Weiss data are not. In merging the Weiss and NAIC data, we retain 91 percent of total covered lives represented in the NAIC data, consistent with the market coverage rate reported by Weiss for that time period. Table 3 compares firms in our merged subsample with the NAIC "universe." We retain 133 out of 186 firms found in the NAIC file (72 percent). The excluded firms are disproportionately inactive participants in the market or sell very few policies (and hence do not appear in the Weiss data). For example, the median firm in our subsample issued 3,934 new policies between 1996 and 1998, compared to 1,435 new policies in the NAIC file. The median firm in our subsample earned more than twice the premiums of the median firm in the NAIC file between 1996 and 1998 ($3.7 versus $1.8 million), and incurred more than twice the claims ($2.6 versus $1.2 million).

The Medigap market is populated by a few large firms that operate in most every state, and a large number of small firms that operate in select states. For example, just three percent of firms operate in more than 44 states, but this three percent accounts for one third of all covered lives nationwide. Another one-third of covered lives are accounted for by the 24 percent of firms who operate in 19 to 44 states, and the last one-third of covered lives is accounted for by the 73 percent of firms that operate in fewer than 19 states. These distributions are similar in the NAIC file and our merged sample, although our merged sample does contain significantly fewer of the largest firms operating in more than 44 states (3 percent v. 8.6 percent). The data reveal substantial heterogeneity in the financial stability of firms selling Medigap policies. Only 12 percent of firms enjoy a Weiss financial safety rating of A- or better, about 44 percent receive a B+, B or B-, and 32 percent receive a C+ or lower. About 12 percent of firms in our sample are not rated by Weiss.

Turning to characteristics of the policies themselves, about 62 percent of all Medigap policies are agent solicited in our merged sample, which compares to about 61 percent in the NAIC file. About one-third are sold directly by the insurance company in both our merged sample and the NAIC file. The average policy has been on the market for about 67 months in both files. The distribution of policyholders over plan letters is similar in both our merged sample and the NAIC file, with the average firm enrolling approximately five percent of policyholders in Plan A, about 25 percent in Plan C, and 42 percent in Plan F. The remaining seven standardized plan letters enroll just 27 percent of policyholders. About 44 percent of policyholders are in attained age plans, 30 percent are in issued age plans, and 26 percent are in community rated plans.

Finally, our merged sample contains 1,216 markets nationwide, where markets are defined by state-plan letter-rating method combinations. The average number of firms per market is 5.5 and the largest market has 31 firms. In 38.5 percent of markets only one firm operates; these tend to be community rated markets for less popular plan letters.

6. Empirical Analyses

6.1 Analysis of Firm Costs

Before attempting to directly estimate search costs in the Medigap market, we begin by assessing whether our data support the main empirical predictions of the Carlson-MacAfee model. In this section, we estimate the cost equation presented in (7), and test whether the profit-maximizing conditions, $\alpha_j > 0$ and $\beta \geq 0$, hold. Our measure of firm costs is the dollar amount of claims incurred by the insurance firm. While claims are just one component of costs, they are the major variable cost that firms face, and they vary across markets. We exclude from our estimation sample firms with fewer than 30 policyholders in any market because these firms are subject to extreme values in their claims that average out as the number of covered lives increases. We use covered lives as our measure of quantity.

Ideally, we would like to estimate the cost equation separately for each market, but this is not possible given the relatively small number of firms operating in each of our markets. Instead, we estimate the cost equation using 2,357 firm-state-plan-rating observations, where we control for market characteristics by including state-plan letter-rating method effects:

(7') $$c_{jspr} = \alpha_j q_{jspr} + \beta q_{jspr}^2 + \sigma_{spr} + \nu_{jspr} \quad ,$$

where the *jspr* subscript refers to firm *j* in state *s* selling plan letter *p* under rating method *r*. Identification of the firm-specific first order effects (α_j) comes from variation within a firm over the different *spr* markets it operates in. We allow the stochastic error term, υ_{jspr}, to be clustered by firm.

Table 4 shows our estimation results for two specifications, the first without market fixed effects (column 1) and the second with market fixed effects (column 2). The first row of Table 4 gives the average of the 114 estimated firm-specific first order effects (α_j,), which is \$712 in the model without market fixed effects, and \$663 in the model with market effects. There is substantial variation in the estimated firm effects; for example, the implied coefficient of variation in column 2 is 0.63. Consistent with our theoretical model, virtually all of the α_j's are positive, and for each with a point estimate less than zero, the hypothesis that $\alpha_j > 0$ cannot be rejected. In both specifications, the second order effect β is not statistically different from zero, which implies constant returns to scale. Under constant returns to scale, our estimates of α_j can be interpreted as marginal costs (and average costs); thus each new policyholder costs the average firm an additional \$663 per year in claims. Not surprisingly, the model explains almost all the variation in claims within markets. Consistent with the Carlson-McAfee model, the firms in our data appear to be profit maximizers.

6.2 Analysis of Firm Price-Setting Behavior

Having established that that there is significant variation in marginal costs across firms, we next turn to the second key prediction of the Carlson-McAfee model: that variation in firm marginal costs, α_j, leads to variation in prices, p_j, as described in equation (9). We implement equation (9) as follows:

$$(9') \qquad p_{jspr} = b + \kappa\left(\frac{c}{q}\right)_{jspr} + \phi\left(\overline{\frac{c}{q}}\right)_{spr} + \varphi\left(X_{jspr} - \overline{X}_{spr}\right) + \mu_{jspr}\,.$$

The first difference between our implementation and the original equation (9) is that we use firm *j*'s average claims $\left(\frac{c}{q}\right)_{jspr}$ as a proxy for α_j. In the previous section, we obtained estimates of α_j , but because these parameters were identified using within-firm variation over markets, they do not themselves vary across markets. Since firms price differently in different markets, the best measure of firm *j*'s marginal costs should also vary across markets. Moreover, we found in the previous section that average costs are approximately equal to marginal costs since $\beta \approx 0$. In equation (9), firm marginal costs enter twice; once in levels and again in deviations from the market mean. In (9'), we combine the two terms in levels, which from equation (9) implies that $\kappa = 1 - \phi$, where $\kappa > 0$ and $\phi > 0$. We do not impose this restriction, but test whether it holds.

Equation (9) also lets other firm characteristics $\left(X_{jspr} - \overline{X}_{spr} \right)$ affect prices in mean-deviated form—characteristics that may in fact differentiate seemingly homogeneous products. In (9'), we let X_{jspr} be a vector containing the following variables: a set of indicator variables measuring firm *j*'s Weiss financial safety rating, (a measure of financial stability); indicators for whether firm *j* sells Medigap policies in fewer than 19 or more than 44 states, respectively (to capture name recognition and national presence); the total number of plan letters firm *j* offers in the market (a measure of both market presence and the availability of close substitutes); an indicator for whether the firm has a loss ratio greater than one for plan letter *p* (to control for loss leader pricing); indicators for whether plan letter *p* is sold by insurance agents or directly by the insurance company (a measure of firm advertising methods); and the number of months the policy has been on the market (a measure of market exposure).

Finally, equation (9') includes a constant term, *b*, such that $b = \frac{(1+\gamma)N}{N-1}S$ in equation (9), where $\gamma = \frac{2\beta Q(N-1)}{SN^2}$. From our estimation of the cost equation, we found $\beta \approx 0$, which implies $\gamma \approx 0$, and thus that $b \approx \frac{N}{N-1}S$; in other words, our estimate of *b* should be $\left(\frac{N}{N-1}\right)$ times greater than the maximum search cost estimated over all markets nationwide. Based on the average number of firms per market reported in Table 3, $\left(\frac{N}{N-1}\right) = 1.22$. The last term, μ_{jspr}, is a stochastic error term, which is clustered by firm.

Table 5 presents estimation results for equation (9'). In the first column, we show results for our base specification, which includes just the cost terms and omits the product differentiation terms $\left(X_{jspr} - \overline{X}_{spr}\right)$. We estimate κ = 0.139 and ϕ = 0.484, both of which are statistically significant. Our estimate of ϕ implies that prices are higher in markets with higher average costs—for each dollar increase in market average costs, premiums rise by 48 cents. Holding constant market average costs, our estimate of κ suggests that firm premiums rise by about 14 cents for every one-dollar increase in firm costs that is above the market average. Although these results are generally consistent with the Carlson-McAfee model, our data reject the specific hypothesis that $\kappa = 1 - \phi$. The constant in our model gives an estimate of *b*=\$588, which is 1.18 times greater than our estimate of *S*=\$498*,* the maximum search cost, shown in Table 6 and discussed in the next section. This is remarkably close to our expected ratio of 1.22 based on the average number of firms per market.

Column 2 adds the mean-deviated product differentiation terms to our base specification. Our estimates of κ, ϕ, and *b* are largely unchanged. None of the product differentiation terms are estimated precisely enough as to be statistically significant, and judging by the very small increase in the R-squared, they contribute little additional explanatory power.

In column 3, we estimate a slightly different version of (9') where we fully mean the dependent variable as well as the independent variables. Although it can be shown that this equation is theoretically equivalent to (9'), it confers an econometric advantage of controlling for market fixed effects. A disadvantage is that we cannot recover estimates of ϕ and *b.* Our estimate of κ is unchanged in this fully mean-deviated specification. The point estimates on the product differentiation terms do not change much, but they are now much more precisely estimated. Firms with A, B, or C financial safety ratings charge \$20-30 more than firms rated D or F, and unrated firms charge about \$58 less than these firms. Prices are also higher at firms with greater national presence and name recognition. For example, firms operating in more than 44 states charge \$79 more than firms operating in 19 to 44 states and about \$110 more than firms operating in fewer than 19 states. The number of plan letters sold by a given firm does not affect prices. Firms operating in a given market with losses charge about \$61 less. Although this does not confirm the existence of loss leader pricing, it is consistent with its use by some firms. Solicitation method, whether by agents or direct from the firm, is largely unrelated to price, and policies that have been on the market longer are more expensive. Overall, the product differentiation terms contribute as much explanatory power in the fully mean deviated model as do marginal costs themselves, underscoring the importance of controlling for product differentiation when estimating search costs based on observed price variation.

In sum, our analyses of the cost and price-setting equations establish that the firms in the Medigap market largely behave as predicted by our augmented Carlson-McAfee model. Insurance firms are profit maximizers with varying marginal costs, which contribute to variation in prices. We next turn to the question of why price variation is sustained in the market.

6.3. Analysis of Demand

The starting point for our demand analysis is equation (4). Dividing both sides of (4) by Q_{spr}/N_{spr} and adding a stochastic error term μ_{jspr}, yields our empirical specification of the demand equation:

$$(4') \qquad \frac{q_{jspr}}{Q_{spr}/N_{spr}} = 1 - \frac{1}{S}\left(p_{jspr} - \overline{p}_{spr}\right) + \frac{\lambda}{S}\left(X_{jspr} - \overline{X}_{spr}\right) + \mu_{jspr}$$

Once again, X_{jspr} is a vector containing our measures of product differentiation. We estimate (4') using a tobit model, since approximately 23 percent of firms in our data report zero covered lives. We exclude markets in which only one firm operates (since there is no price variation). Note that because the mean of our dependent variable is 1, this specification is equivalent to a fully mean-deviated model.

Our theoretical model suggests that price is an endogenous variable, itself both determined by and a determinant of demand. Since all variables are expressed as deviations from the market mean, unobserved market factors are not a concern; however, our analysis of firm costs in section *6.1* suggests that unobserved firm factors could matter. Although we control for a number of important firm characteristics (e.g., financial stability, market presence, market tenure, loss-leader pricing), we have no data measuring firm-specific factors like advertising expenditures. All else equal, a firm that spends more on advertising could have higher demand, as well as higher costs. In section *6.2,* we showed that higher costs are correlated with higher prices in this market. In this example, our estimated price coefficient would be biased upward. Since the maximum search cost is just the inverse of the price coefficient, our search cost estimate would be biased downward. Therefore, in order to account for unobserved firm heterogeneity within markets, we also estimate a random effects tobit model.

Table 6 presents our estimation results. Column 1 gives the estimated coefficients from our base tobit specification, column 2 presents coefficients from our random effects tobit specification, and column 3 shows the implied structural estimates of the maximum search cost S (row 1) and the λ vector (all other rows). A likelihood ratio test comparing the two models indicates that the random effects model is superior, with a relatively high proportion of the residual variance being due to unobserved firm heterogeneity (ρ=0.60). The price coefficient declines slightly once we add the random firm effects, but the difference is not statistically significant. This pattern is consistent with the presence of unobservable factors that are positively correlated with both price and demand, but their effect is quite small. The point estimate in column 2 of –0.002 implies that for every $100 increase in price above the average price, a firm's demand decreases by 20 percent of average demand.

Unlike the price coefficients, the coefficients on many of the product differentiation terms change once we add the random firm effects. Focusing on column 2, firms with a financial safety rating of A experience notably higher demand, but, surprisingly, so do unrated firms. Demand is highest at firms with the most national presence, (those operating in more than 44 states), and at firms offering a larger menu of plan letters. Firms selling plans with a loss ratio>1 (i.e., claims in excess of premiums) experience notably higher demand, even controlling for relative price. Demand is higher under both agent and direct solicitation, and for policies with longer market tenure.

Column 3 shows the implied structural estimates of the parameters S and λ. The first row depicts the estimated maximum search cost, S, which is the inverse of the coefficient in column 1 multiplied by (-1). The implied maximum search cost in the Medigap market is substantial, estimated to be $498. Under the assumption that search costs are uniformly distributed, dividing by 2 yields an average search cost of $249. The remaining quantities in column 2 represent the λ-coefficients from the original utility specification in equation (1). They may be interpreted as the marginal utility (in monetary terms) of other firm and policy characteristics. For example, the estimates imply that an "A" financial safety rating is worth $1080 to consumers relative to a D or F rating, that consumers value agent and direct solicitation policies equally (and more so than policies sold through membership organizations), and that consumers value each additional plan letter offered by a firm at $30. Consumers also value plans with loss ratios exceeding one; since relative price and financial stability are held constant, this must proxy for some other plan characteristic, perhaps some kind of special discount on other products or services.

Using the specification in Table 6, we next estimate equation (4') separately by plan letter and by rating method to investigate how search costs might vary across different segments of the market. Shown in Table 7 are the estimated price coefficients (column 1) and the implied maximum search costs (column 2) from separate random effects tobit models estimated for each indicated plan letter and rating scheme. There are significant differences in search costs across the plan letters. Search costs tend to be higher for the most popular plans (C, F), and for the plans that offer prescription drug coverage (H, I, J). The estimated maximum search cost for the most popular plan, F, is $714, which is substantially higher than the maximum search cost of $498 estimated over all markets. The maximum search cost also varies across the three rating methods with the highest estimated maximum search costs ($1124) arising in the market for community rated policies. In sum, search costs are substantial in virtually all parts of the market.

6.4. Welfare Implications

To further judge the plausibility of our estimates, we use our model to quantify the fraction of consumers in the market who do not search and the fraction who search until they find the lowest price. Using the estimated parameters of equation (4'), we can estimate the set of expected utility gains from searching in each market (the w_j's in equation (2)), and then quantify the fractions of insured individuals that are associated with each expected utility gain. In other words, we can calculate the W_j's represented in

Figure 1 for each market in our sample and consider their distribution over all markets (taking into account covariates).

Figure 2 graphs the cumulative density for W_I, the fraction in each market buying the policy yielding the highest utility, and Figure 3 graphs the cumulative density for W_N, the fraction who do not search (and thus buy the first policy they find). In each figure, the x-axis gives the fraction buying the best policy (Fig 2) or the fraction not searching (Fig 3), and the y-axis gives the cumulative density of these fractions over all markets we observe, weighted by the number of covered lives in each market. The cumulative distribution function for W_N indicates that there are very few markets in which no one searches: in about 85 percent of all markets, the fraction who do not search at all (W_N) is equal to zero. However, as the distribution for W_I shows, this does not lead to a majority of individuals searching until they find the best plan: in 80 percent of all markets, the fraction of individuals that buys the plan with the highest utility is just 15 percent or less.

In Table 8, we examine how the fractions buying the best and worst plans vary by rating method and plan letter. In the first column, each cell entry shows the fraction buying the highest-utility plan averaged over all markets for the indicated rating method and plan letter. The second column shows the average fractions not searching. In markets for attained age plans, most people fall somewhere in the middle—relatively few search until they find the best plan, and equally few buy the first plan they find. Exceptions are plan letters H, I, and J, which all offer prescription drug coverage. In these markets, a much larger fraction of individuals finds the plans at the extremes of the plan-utility distribution. One explanation for this pattern is market size. In markets with a small number of firms (as is the case for the prescription drug plans), market shares will tend to be bigger than in markets with a large number of firms.[16] In the markets for issued age and community rated plans, larger fractions tend to find the best plans, but larger fractions also buy the first plan they find. Overall, the data generally reinforce the conclusion drawn from Figures 2 and 3: while most individuals search a bit, very few search until they find the lowest price in the market; in other words, large parts of the

[16] Carlson and McAfee (1983) point out that with an infinite number of firms in a market, the market share of the lowest-price firm approaches zero.

Medigap population face search costs that are high enough to prevent them from searching until they find the plan yielding the highest utility.

Because most consumers pay more for their Medigap policies than need be, consumer welfare is lower than it would be if information were complete. We compute a “back-of-the-envelope” estimate of the implied welfare loss by using our model to simulate aggregate utility under the status quo and under an alternative scenario of complete information. In the complete information scenario, we assume all insurers reduce their premium offers to the lowest price in the status quo market, and that none exit. Under these assumptions, we find an aggregate welfare loss of $798 million or $484 per policyholder.

Compared to studies of other markets, our estimated search costs are high. For example, using a similarly specified model, Dahlby and West (1986) found average search costs to be between $28 and $125 in different segments of the market for auto insurance. Using a somewhat different approach, Hortaçsu and Syverson (2004) found that search costs ranged between $5 and $30 for every $10,000 of assets invested in the mutual fund market. One important difference between their work and ours is that they relax the assumption that firms are found by consumers with equal probabilities; however, this is perhaps of greater necessity in their application than in ours since they do not have firm characteristics in their data. Our variables measuring market presence and financial stability, as well as our random firm effects, will capture differences in the probabilities of finding a given firm, to the extent they exist.

That search costs would be higher in the Medigap market than in other markets is not implausible, especially given the relatively advanced age of the consumer population buying Medigap plans, and the potential for age-related cognitive decline among many of them. Even in the absence of cognitive decline, the Medigap market is quite complicated, and its relationship with the equally complicated Medicare program could be challenging for some to understand. It could also be difficult to understand one’s specific needs for supplemental insurance coverage without having had much practical experience with Medicare’s coinsurance requirements. A complicating factor is that no individual has any familiarity with the Medigap market prior to turning age 65, and neither do one’s adult children, should their assistance be sought. Individuals have a relatively short window of time during which to search for and select a Medigap policy, and the one-shot nature of the market means that learning does not occur with successive purchases. An unfortunate consequences of the very regulations designed to protect consumers is that mistakes are not easily reversible. In this context, our results seem plausible given the complex nature of the market and its elderly consumer population.

7. Conclusion

In this paper we investigate why price variation is sustained in the Medigap market for supplemental health insurance, despite the fact that federal regulations passed in 1992 created standardized insurance products and prohibited insurers from underwriting on the basis of individual health status. Using price data from Weiss Ratings and demand data from the National Association of Insurance Commissioners, we analyze the Medigap market in 1998. We show that price variation is substantial, and exists in virtually all segments of the market nationwide. To guide our analysis, we use a theoretical model posed by Carlson and McAfee (1983), which we augment to account for firm and product differentiation. We conclude that firms in this market behave according to the assumptions of the Carlson-McAfee model: they are profit maximizers who have heterogeneous cost structures, which in turn contribute to price differences that are sustained by the presence of large consumer search costs. We estimate the average search cost to be about $249. Our estimates imply that while relatively few individuals buy the highest priced policy, equally few find the policy with the lowest price. The welfare loss imposed by the market's information deficit is substantial—approximately $798 million in aggregate or $484 per policyholder. Our results suggest that consumer welfare could be substantially improved if individuals had complete knowledge of the price distribution in the market.

Although the degree of variation in Medigap prices has both risen and fallen since 1998 (Schroeder, 2006), price variation of the approximate magnitude documented here persists in the Medigap market as recently as 2005 (Weiss Ratings, 2005). Certainly more information is available on the Internet now than in 1998; but even now insurers do not typically post their rates online. While some state insurance department websites list the names and phone numbers of Medigap insurers, they do not typically also list prices.

Even if prices were posted online, it is not clear that this would solve the information problem, since just 34 percent of households age 65 and older had Internet access in 2003 (U.S. Census Bureau, 2005). In fact, for the last 10 years, Weiss Ratings has sold a customized report listing all Medigap policies offered in a consumer's zip code (given age and gender) by rating method and Weiss' financial safety rating. The report, known as the "Weiss Ratings Shopper's Guide to Medicare Supplemental Insurance," is marketed via the Internet and can be purchased for $49. Compared to the average cost of search in the market, the Weiss report is a bargain. Nevertheless, our results suggest that relatively few consumers are aware of this resource.

Increasing consumer knowledge of the Weiss Guide or developing a similar free resource would increase consumer information and improve welfare. As policymakers continue to grant the elderly expanded insurer choice in other areas of the Medicare program, such as the new Medicare prescription drug program or the Medicare Advantage program, consumer information issues, cognition and the cost of search are especially salient in assessing consumer welfare under the new policies.

References

Arrow, Kenneth J. 1963. "Uncertainty and the Welfare Economics of Medical Care." *The American Economic Review*, Vol. 53, No 5, pp 941-973.

Burdett, Kenneth, and Kenneth L. Judd. 1983. "Equilibrium Price Dispersion." *Econometrica*, Vol. 51, No 4, pp 955-970.

Card, David, Carlos Dobkin and Nicole Maestas. 2004. "The Impact of Nearly Universal Insurance Coverage on Health Care Utilization and Health: Evidence from Medicare." NBER Working Paper 10365.

Centers for Medicare and Medicaid Services (CMS). 2006a. "2006 Choosing a Medigap Policy: A Guide to Health Insurance for People with Medicare."

Centers for Medicare and Medicaid Services (CMS). 2006b. "National Health Expenditure Web Tables, Table 12." Downloaded May 2006 at http://www.cms.hhs.gov/NationalHealthExpendData/downloads/tables.pdf.

Carlson, John A., and R. Preston McAfee. 1983. "Discrete Equilibrium Price Dispersion." *The Journal of Political Economy*, Vol. 91, No 3, pp 480-493.

Dahlby, Bev, and Douglas S. West. 1986. "Price Dispersion in an Automobile Insurance Market." *The Journal of Political Economy*, Vol. 94, No 2, pp 418-438.

Diamond, Peter A. 1971. "A Model of Price Adjustment." *Journal of Economic Theory*, Vol. 3, No 2, pp 156-168.

Finkelstein, Amy. 2004. "Minimum Standards, Insurance Regulation and Adverse Selection: Evidence from the Medigap Market." *Journal of Public Economics* v88, n12: 2515-47.

Finkelstein, Amy and Robin McKnight. 2005. "What Did Medicare Do (And Was It Worth It)?" NBER Working Paper No. 11609, September 2005.

Goldman, Dana and Nicole Maestas. 2005. "Medical Expenditure Risk and Household Portfolio Choice." NBER Working Paper No. W11818. Available at SSRN: http://ssrn.com/abstract=875694

Hortaçsu, Ali, and Chad Syverson. 2004. "Product Differentiation, Search Costs, and Competition in the Mutual Fund Industry: A Case Study of S&P 500 Index Funds." *The Quarterly Journal of Economics*, Vol. 119, No 2, pp 403-456.

Kaiser Family Foundation. 2005. "Medicare Chart Book." Section 3, pp. 19-30.

Medicare Payment Advisory Commission (MedPac). 2003. "Report to Congress: Variation and Innovation in Medicare." Chapter 2, pp 19-38.

Medicare Payment Advisory Commission (MedPac). 2004. "Report to Congress: Market variation and Medicare Supplementation: Looking Ahead."

Schroeder, Mathis, Nicole Maestas and Dana Goldman. 2005. "Sources of Price Variation in the Medigap Market." Working paper.

Schroeder, Mathis. 2006. "Premium Variation in the Medigap Market." Cornell University.

Sorensen, Alan T. 2000. "Equilibrium Price Dispersion in Retail Markets for Prescription Drugs." *The Journal of Political Economy*, Vol. 108, No 4, pp 833-850.

Short, Pamela Farley, and Jessica Primoff Vistnes. 1992. "Multiple Sources of Medicare Supplementary Insurance." *Inquiry*, Vol. 29, pp 33-43.

Stiglitz, Joseph E. 1989. "Imperfect Information in the Product Market." In *Handbook of Industrial Organization*, Vol. 1, Schmalensee, R. and R.D. Willig, editors.

The Lewin Group. 2001. "Restricting Underwriting and Premium Rating Practices in the Medigap Market: The Experience of Three States." The Public Policy Institute, report No 2001-01. AARP, Washington, DC.

Poi, Brian P. 2004. "From the Help Desk: Some Bootstrapping Techniques." *The Stata Journal*, Vol. 4, No 3, pp. 312-328.

US Census Bureau, 2005. "Table 2B. Presence of a Computer and the Internet at Home for People 18 Years and Over, by Selected Characteristics: October 2003" Accessed June 2006 at http://www.census.gov/population/socdemo/computer/2003/tab02B.xls.

US Congress, Select Committee on Aging, Subcommittee on Human Services. 1990. "Medigap Fraud and Abuse: How Can Communities Stop These Problems?" Briefing by the Subcommittee on Human Services. Washington, DC, US Government Printing Office.

US General Accounting Office. 1994. "Health Insurance for the Elderly. Owning Duplicate Policies is Costly and Unnecessary". GAO/HEHS-94-185.

US Department of Health and Human Services. 1995. "The Impact of OBRA 1990 on State Regulation of Medigap Insurance." OEI-09-93-00230.

Weiss Ratings Inc. 1997-2005. "Medigap Insurance News Releases." Accessed December 2005 at http://www.weissratings.com/News/Ins_Medigap/ .

Table 1: Standardized Medigap Plan Benefits

	Plan Letter									
	A	B	C	D	E	F	G	H	I	J
Basic Benefits										
Medicare Part A Coinsurance and Hospital Benefits										
Medicare Part B Coinsurance or Copayment	*(all plans must cover)*									
Blood (three pints per year)										
Extra Benefits										
Skilled Nursing Facility Coinsurance			X	X	X	X	X	X	X	X
Medicare Part A Deductible		X	X	X	X	X	X	X	X	X
Medicare Part B Deductible			X			X				X
Medicare Part B Excess Charges						X	X [1)]		X	X
Foreign Travel Emergency			X	X	X	X	X	X	X	X
At-Home Recovery				X			X		X	X
Prescription Drugs [2)]								X	X	X
Medicare-Covered Preventive Services					X					X

Notes:
We do not include two new plans introduced in 2005 (Plans K and L) since our analysis focuses on 1998.
1) With plan G, 20 percent of Excess Charges must be paid by the policyholder.
2) In 2006, Prescription Drug coverage was moved to the new Medicare prescription drug plans.
Source: Centers for Medicare and Medicaid Services, 2006a.

Table 2: Premiums for Policies Offered to 65 Year-Old Nonsmokers

a) Plan F in All States by Sex and Rating Method

	Females			Males		
Rating Method	Mean Premium	CV	Offers	Mean Premium	CV	Offers
Attained Age	1073	0.18	680	1077	0.18	680
Issued Age	1271	0.19	436	1291	0.20	436
Community Rating	1310	0.17	126	1312	0.17	126

b) Plan F in Select States (Females, Attained Age Plans Only)

State	Mean Premium	CV	Minimum	Maximum	$90^{th}/10^{th}$	Offers
AZ	1229	0.14	917	1630	1.4	22
CA	1317	0.19	929	1911	1.8	16
IL	1048	0.13	774	1408	1.3	27
KS	1068	0.14	789	1466	1.3	23
NH	994	0.13	828	1323	1.4	10
NJ	1035	0.11	845	1134	1.3	5
PA	1005	0.04	977	1033	1.1	2
TN	1058	0.16	784	1536	1.3	23
TX	1119	0.10	874	1318	1.4	27
WY	1055	0.20	876	1826	1.4	17

c) All Plan Letters in Illinois (Females, Attained Age Plans Only)

Plan	Mean Premium	CV	Minimum	Maximum	$90^{th}/10^{th}$	Offers
A	549	0.18	399	764	1.5	26
B	811	0.12	642	982	1.3	18
C	953	0.15	701	1189	1.5	24
D	819	0.12	632	934	1.4	12
E	847	0.20	650	1164	1.8	8
F	1048	0.13	774	1408	1.3	27
G	951	0.11	791	1140	1.3	10
H	1332	0.09	1212	1464	1.2	3
I	1541	0.13	1200	1744	1.5	6
J	2173	0.39	1365	3555	2.6	5

Notes:
Columns labeled "$90^{th}/10^{th}$" give the ratio of the 90^{th} to the 10^{th} percentiles. Premiums in 1998 Dollars.
Source: Authors' calculations using 1998 Weiss data.

Table 3: Summary Statistics for Merged Sample and NAIC Universe

	Merged Weiss-NAIC Sample	NAIC Universe
Firms		
Number of Firms	133	186
Median Total Covered Lives	3,934	1,435
Median Total Premiums	$3,733,795	$1,752,751
Median Total Claims	$2,605,330	$1,236,181
Operates in < 19 States	0.729	0.715
Operates in 19 to 44 States	0.240	0.199
Operates in >44 States	0.030	0.086
Loss Ratio > 1	0.038	0.108
Weiss Rating A	0.120	--
Weiss Rating B	0.436	--
Weiss Rating C	0.165	--
Weiss Rating D	0.157	--
No Weiss Rating	0.120	--
Policies		
Agent Solicited Policy	0.662	0.608
Direct Solicited Policy	0.346	0.328
Average Months Policy on Market	66.6	66.7
Fraction Covered Lives in Plan A	0.048	0.049
Fraction Covered Lives in Plan C	0.255	0.255
Fraction Covered Lives in Plan F	0.423	0.422
Fraction Covered Lives in All Other Plans	0.274	0.274
Fraction Covered Lives in Attained Age Plan	0.440	--
Fraction Covered Lives in Issue Age Plan	0.303	--
Fraction Covered Lives in Comm. Rated Plan	0.257	--
Markets		
Number of Markets	1216	--
Number of Firms per Market: Mean (Max)	5.5 (31.0)	--
Fraction of Markets with One Firm	0.385	--
Mean Number Plan Letters Offered by Firms in Market	6.6	--

Notes:
See Appendix 2 for merge details. Covered lives, premiums and claims are shown here as three-year totals over the period 1996-1998, as reported by NAIC.
Source: Authors' calculations using Weiss data, 1998, and NAIC data, 1998.

Table 4: Estimation of Cost Equation (7')

	(1)	(2)
Mean(α_j)	\$712	\$663
St. Dev(α_j)	\$245	\$420
percent of $\alpha_j > 0$	100	98.8
β	0.005	0.006
	(0.007)	(0.005)
Market FE (σ_m)	no	yes
Observations	2357	2357
R-squared	0.963	0.987

Notes:
Dependent variable is claims incurred by firm *j* operating in market *m*. Estimation sample excludes firm-market pairs with fewer than 30 covered lives. Robust standard errors (clustered by firm) in parentheses. The α_j are the coefficients on covered lives and β is the coefficient on the square of covered lives.
Source: Authors' calculations using Weiss Ratings data, 1998, and NAIC data, 1998.

Table 5: OLS Estimation of Price Equation (9')

	Price in Levels		Price Mean Deviated	
	(1)	**(2)**	**(3)**	**(4)**
Firm Claims ***(κ)***	0.139	0.138	0.139	0.137
	(0.053)	(0.056)	(0.008)	(0.008)
Market Average Claims ***(ϕ)***	0.484	0.488		
	(0.075)	(0.074)		
Weiss Rating A		28.3		26.2
		(73.2)		(13.1)
Weiss Rating B		31.9		30.4
		(64.2)		(10.3)
Weiss Rating C		20.6		20.0
		(64.1)		(12.1)
No Weiss Rating		-56.2		-58.2
		(71.7)		(12.7)
Operates in < 19 States		-110.4		-108.2
		(51.6)		(11.7)
Operates in 19 to 44 States		-78.5		-78.5
		(56.7)		(9.9)
Number Plan Letters Offered		1.9		1.7
		(7.9)		(1.7)
Loss Ratio >1		-61.5		-61.9
		(54.4)		(16.1)
Agent Solicited Policy		21.2		16.3
		(40.4)		(10.4)
Direct Solicited Policy		-13.5		-17.4
		(49.9)		(12.7)
Months Policy on Market		0.738		0.745
		(0.424)		(0.141)
Constant ***(b)***	588	586		
	(45)	(41)		
Observations	2357	2327	2357	2327
R-squared	0.392	0.414	0.106	0.207

Notes:
Specifications based on equation (9') in the text. Dependent variable is the premium charged to 65-year-old female nonsmokers, entered in levels in columns (1) and (2), and in deviations from the market mean premium in columns (3) and (4). All regressors entered as deviations from market mean, except in columns (1) and (2) where Firm Claims and Market Average Claims are entered separately. Sample includes firms that insure at least 30 individuals in any given market. Reference group for financial safety rating is "Weiss Rating D", and for states of operation, "Operates in > 44 States." Robust standard errors (clustered by firm) are in parentheses.
Source: Authors' calculations using Weiss Ratings data, 1998, and NAIC data, 1998.

Table 6: Tobit Estimation of Demand Equation (4')

	(1)	(2)	(3)[1]
Price	-0.0022***	-0.0020***	498***
	(0.0001)	(0.0001)	(32)
Weiss Rating A	2.2510***	2.1702***	1080***
	(0.1241)	(0.1131)	(91)
Weiss Rating B	0.5123***	1.0287***	512***
	(0.0883)	(0.0891)	(54)
Weiss Rating C	0.7442***	1.2896***	642***
	(0.1054)	(0.1004)	(67)
No Weiss Rating	1.3613***	2.7781***	1382***
	(0.1166)	(0.1231)	(108)
Operates in <19 States	-1.5261***	-1.5006***	-747***
	(0.1232)	(0.1735)	(87)
Operates in 19 to 44 States	-2.6510***	-2.5486***	-1268***
	(0.0989)	(0.0837)	(90)
Number Plan Letters Offered	-0.0731***	0.0611***	30***
	(0.0144)	(0.0150)	(8)
Loss Ratio >1	2.4097***	1.3082***	651***
	(0.2114)	(0.1807)	(100)
Agent Solicited Policy	0.9239***	1.6690***	831***
	(0.1084)	(0.1314)	(78)
Direct Solicited Policy	0.5025***	1.6814***	837***
	(0.1217)	(0.1503)	(91)
Months Policy on Market	0.0057***	0.0086***	4***
	(0.0015)	(0.0014)	(1)
Random Firm Effects	no	yes	
Observations	6011	6011	6011
Log Likelihood	-10755	-9778	
ρ		0.600	
LL Ratio to Constant-Only Model	0.933	0.848	

Notes:
Tobit specification in column (1) and random effects Tobit specification in column (2). All regressors entered in deviations from market-level mean. Model also includes a constant. Reference group for financial rating is "Weiss Rating D", and for states of operation is "Operates in > 44 States."
1) Column (3) shows the implied estimates of S (row 1) and λ (all other rows) from equation (4'). The entry in row 1 is obtained by inverting the coefficient in column (2) and multiplying by –1. In all other rows, the entry is obtained by dividing the corresponding coefficient in column (2) by the coefficient on price in column (2) (i.e., $-1/S$). The standard errors in column 2 are obtained using the delta method.

Standard errors in parentheses.

*, *, ***: significant on a 10, 5, and 1 percent level, respectively.

Source: Authors' calculations using Weiss Ratings data, 1998, and NAIC data, 1998.

Table 7: Implied Maximum Search Cost *S* by Plan and Rating Method

	Estimated Coefficient on Price	Implied Maximum Search Costs	N	LL Ratio to Constant-Only Model
Plan A	-0.0018***	556***	1167	0.837
	(0.0005)	(160)		
Plan B	-0.0005	1852	789	0.808
	(0.0005)	(1543)		
Plan C	-0.0021***	478***	1096	0.873
	(0.0003)	(69)		
Plan D	-0.0042	240	447	0.818
	(0.0028)	(160)		
Plan E	-0.0038***	267***	223	0.817
	(0.0010)	(74)		
Plan F	-0.0014***	714***	1174	0.824
	(0.0003)	(133)		
Plan G	-0.0034***	298***	521	0.796
	(0.0007)	(64)		
Plan H	-0.0014***	694***	113	0.812
	(0.0004)	(193)		
Plan I	-0.0012***	840***	305	0.813
	(0.0003)	(212)		
Plan J	-0.0007*	1408*	176	0.818
	(0.0004)	(774)		
Attained Age	-0.0021***	488***	3512	0.850
	(0.0002)	(40)		
Issued Age	-0.0013***	763***	1980	0.794
	(0.0002)	(128)		
Community Rating	-0.0009***	1124***	519	0.879
	(0.0003)	(404)		
All	-0.0020***	498***	6011	0.848
	(0.0001)	(32)		

Notes:
Each row gives the price coefficient from a tobit model estimated on the indicated subsample, using the same specification as in Table 6. The implied maximum search cost figures are obtained by multiplying the inverse price coefficient by (-1), following equation (4'). The standard errors follow by the delta method. "LL Ratio" is the ratio of the log-likelihood of this tobit model and a model without any independent variables. Robust standard errors (on a firm level) are in parentheses.
*, **, ***: significant on a 10, 5, and 1 percent level, respectively.
Source: Authors' calculations using Weiss Ratings data, 1998, and NAIC data, 1998.

Table 8. Fractions Buying Best Plan and Not Searching by Plan Letter and Rating Method

	Avg Frac Buying Best Plan	Avg Frac Not Searching	Avg # of Firms	# of Markets
A. Attained Age Plans				
A	0.057	0.021	17	35
B	0.070	0.022	12	34
C	0.029	0.020	16	33
D	0.095	0.099	8	39
E	0.207	0.163	5	33
F	0.055	0.040	18	31
G	0.070	0.055	9	35
H	0.294	0.432	3	22
I	0.252	0.119	5	34
J	0.266	0.080	4	29
B. Issued Age Plans				
A	0.121	0.089	11	31
B	0.259	0.108	7	27
C	0.148	0.000	10	25
D	0.578	0.219	3	31
E	0.557	0.314	3	15
F	0.146	0.069	11	26
G	0.387	0.038	5	31
H	0.626	0.204	3	9
I	0.321	0.115	3	29
J	0.870	0.029	3	12
C. Community Rated Plans				
A	0.256	0.132	8	11
B	0.140	0.214	8	8
C	0.136	0.167	10	8
D	0.117	0.352	6	8
E	0.282	0.155	5	6
F	0.189	0.197	11	6
G	0.116	0.324	6	6
H	0.232	0.088	4	7
I	0.421	0.040	5	6
J	0.487	0.317	3	8

Notes:
Cell entries in column 1 show the fraction buying the best plan averaged over all markets for the indicated plan letter and rating method. Column 2 shows the fraction not searching at all in the market. Column 3 refers to the average number of firms in the market, whereas column 4 shows how many of these markets with at least two firms exist. All results are derived from utility calculations based on the main specification in column 2 (3) of table 6.
Source: Authors' calculations using Weiss Ratings data, 1998, and NAIC data, 1998.

Figure 1: Example of Search Cost and Information Distribution

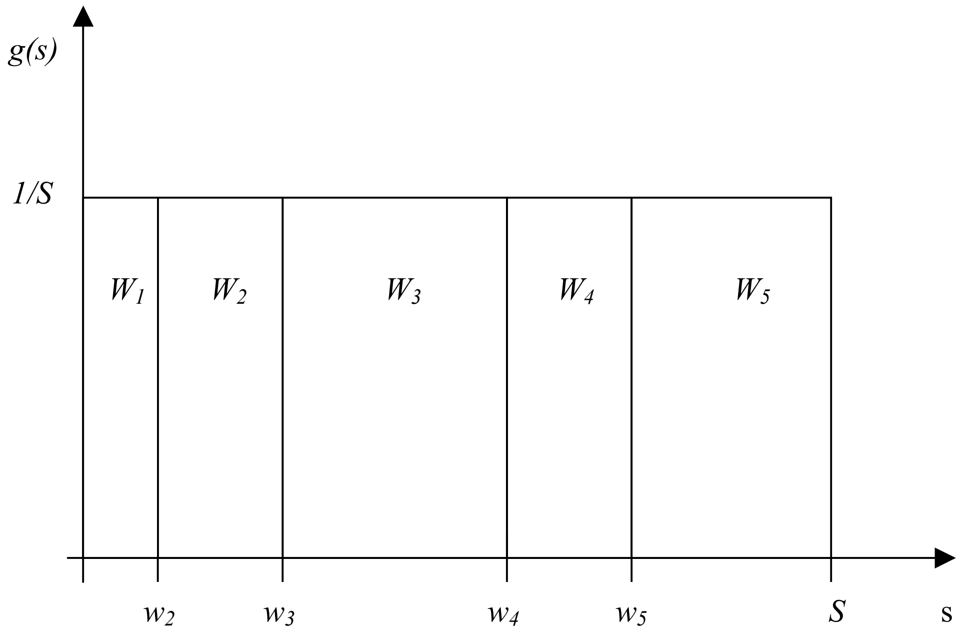


Figure 2: Cumulative Distribution of W_1 (Fraction Who Buy Best Plan) over all Markets

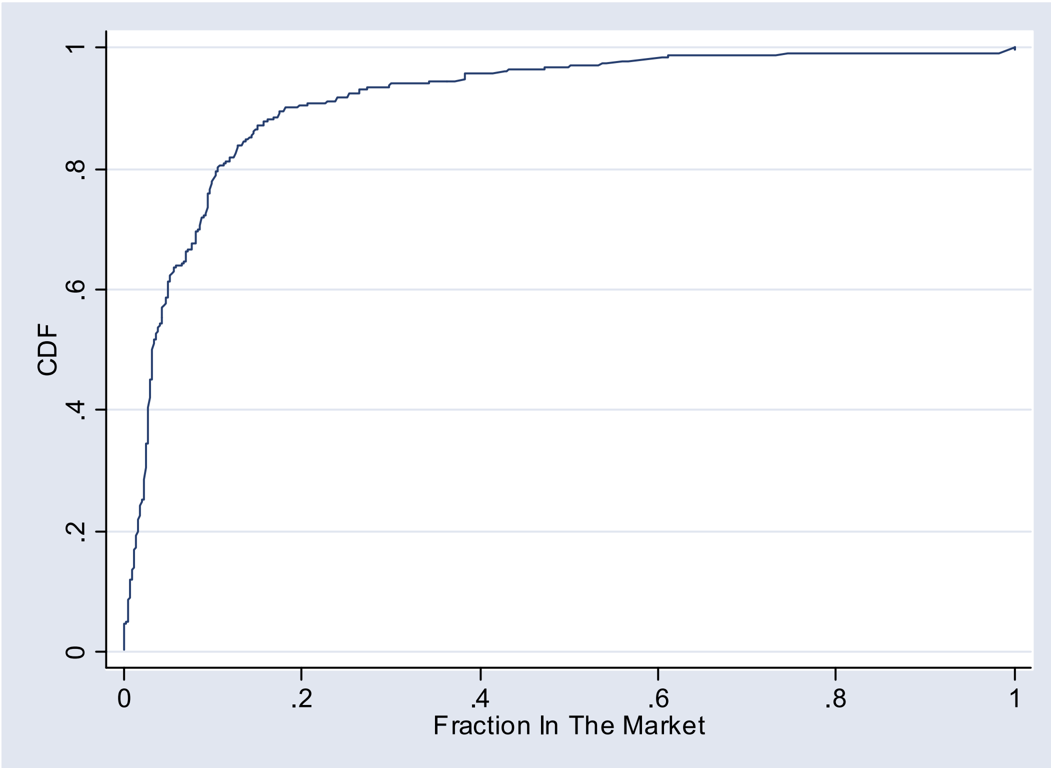
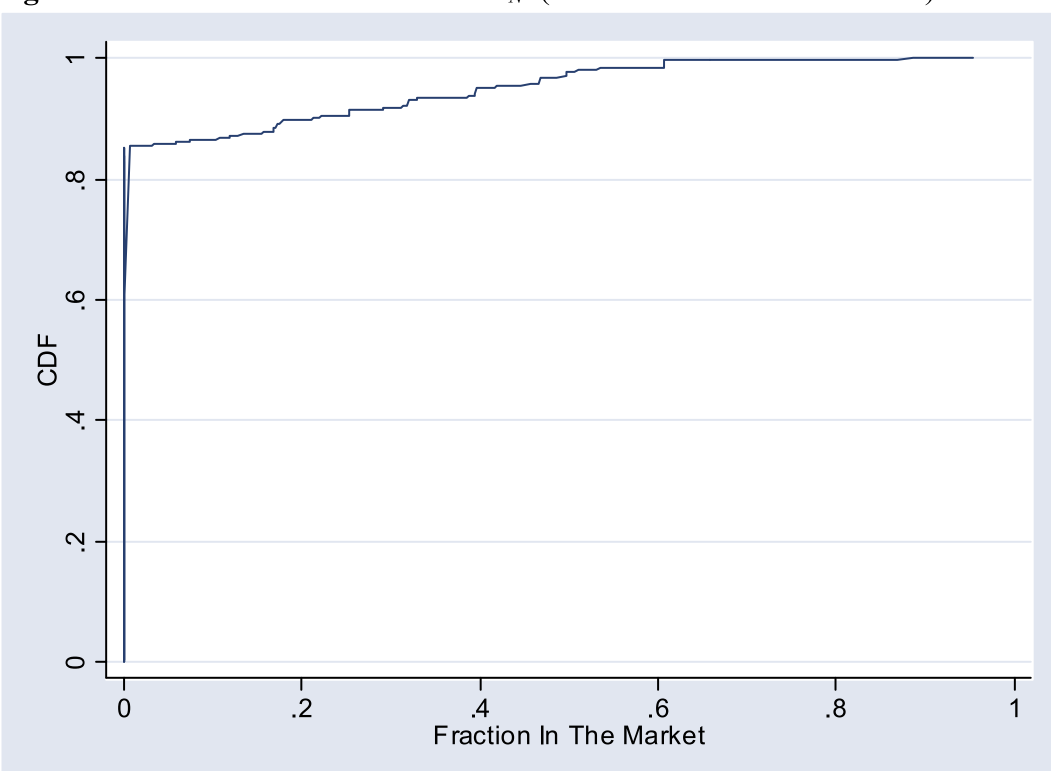


Figure 3: Cumulative Distribution of W_N (Fraction Who Do Not Search) over all Markets



Appendix 1: Formulas

A.1.a. Demand Equation

$$(4) \qquad q_j = \frac{Q}{N}\left[1-\frac{1}{S}\left(\overline{u}-u_j\right)\right]$$

First, we use equation (2),

$$(2) \qquad w_k = \sum_{i=1}^{k-1}\frac{1}{N}\left(u_i - u_k\right) = \frac{1}{N}\sum_{i=1}^{k-1}u_i - \frac{k-1}{N}u_k$$

and substitute the w_k's in equation (3'):

$$(3') \qquad q_j = \frac{Q}{N} - \frac{Q}{j}\frac{w_j}{S} + \sum_{k=j+1}^{N}\left[\frac{Q}{k(k-1)}\frac{w_k}{S}\right]$$

Then the following terms within this equation are obtained:

$$(10) \qquad \begin{aligned} \frac{Q}{j}\frac{w_j}{S} &= \frac{Q}{jS}\left[\frac{1}{N}\sum_{i=1}^{j-1}u_i - \frac{j-1}{N}u_j\right] \\ &= \frac{1}{S}\frac{Q}{N}\left[\frac{1}{j}\sum_{i=1}^{j-1}u_i - \frac{j-1}{j}u_j\right] \end{aligned}$$

and

$$(11) \qquad \begin{aligned} \sum_{k=j+1}^{N}\left[\frac{Q}{k(k-1)}\frac{w_k}{S}\right] &= \frac{1}{S}\sum_{k=j+1}^{N}\left[\frac{Q}{k(k-1)}\left(\frac{1}{N}\sum_{i=1}^{k-1}u_i - \frac{k-1}{N}u_k\right)\right] \\ &= \frac{1}{S}\frac{Q}{N}\sum_{k=j+1}^{N}\left[\frac{1}{k(k-1)}\left(\sum_{i=1}^{k-1}u_i - (k-1)u_k\right)\right] \end{aligned}$$

To obtain equation (4), we use (10) and (11) and evaluate for each q_j, starting with q_N:

$$(12) \qquad \begin{aligned} q_N &= \frac{Q}{N}\frac{1}{S}\left[S - \left(\frac{1}{N}\left(u_1 + u_2 + \ldots + u_{N-1}\right) - \frac{(N-1)}{N}u_N\right) + 0\right] \\ &= \frac{Q}{N}\frac{1}{S}\left[S - \left(\frac{1}{N}\left(\sum_{i=1}^{N}u_i - u_N\right) - \frac{(N-1)}{N}u_N\right)\right] \\ &= \frac{Q}{N}\frac{1}{S}\left[S - \left(\overline{u}_N - u_N\right)\right] = \frac{Q}{N}\left[1 - \frac{1}{S}\left(\overline{u} - u_N\right)\right] \end{aligned}$$

For q_{N-1} we get:

$$q_{N-1} = \frac{Q}{N}\frac{1}{S}\left[S - \left(\frac{1}{N-1}(u_1 + \ldots + u_{N-2}) - \frac{N-2}{N-1}u_{N-1} \right) \right.$$

$$\left. + \left(\frac{1}{N(N-1)} \right) [(u_1 + \ldots + u_{N-1}) - (N-1)u_N] \right]$$

$$= \frac{Q}{N}\frac{1}{S}\left[S - \left(\frac{1}{N-1}\left(\sum_{i=1}^{N} u_i - u_{N-1} - u_N \right) - \frac{N-2}{N-1}u_{N-1} \right) \right.$$

$$\left. + \left(\frac{1}{N(N-1)} \right) \left[\sum_{i=1}^{N} u_i - u_N - (N-1)u_N \right] \right]$$

$$= \frac{Q}{N}\frac{1}{S}\left[S - \frac{1}{N-1}\left(\sum_{i=1}^{N} u_i - u_{N-1} - u_N - (N-2)u_{N-1} - \frac{1}{N}\sum_{i=1}^{N} u_i + \frac{1}{N}u_N + \frac{N-1}{N}u_N \right) \right]$$

$$= \frac{Q}{N}\frac{1}{S}\left[S - \frac{1}{N-1}\left(N\bar{u} - \bar{u} - (N-1)u_{N-1} - u_N + u_N \right) \right]$$

$$= \frac{Q}{N}\frac{1}{S}[S - (\bar{u} - u_{N-1})] = \frac{Q}{N}\left[1 - \frac{1}{S}(\bar{u} - u_{N-1}) \right]$$

Repeating this process for each firm j leads to the demand equation (4).

A.1.b. Price Equation

The price equation (9) follows from maximizing equation (8)

(8) $\Pi_j = p_j q_j - c_j(q_j)$

with respect to price, after substituting in the cost equation, (7):

(7) $c_j(q_j) = \alpha_j q_j + \beta q_j^2 = \alpha_j \left\{ \frac{Q}{N}\left[1 - \frac{1}{S}(\bar{u} - u_j) \right] \right\} + \beta \left\{ \frac{Q}{N}\left[1 - \frac{1}{S}(\bar{u} - u_j) \right] \right\}^2$

Note that from equation (4) and equation (1),

(13) $\frac{\partial q_j}{\partial p_j} = -\frac{Q(N-1)}{SN^2}$

Then we obtain the following derivative with respect to (the firm's own) price:

(14)

$$
\begin{aligned}
\frac{\partial \Pi_j}{\partial p_j} &= q_j + p_j \frac{\partial q_j}{\partial p_j} - \alpha_j \frac{\partial q_j}{\partial p_j} - 2\beta q_j \frac{\partial q_j}{\partial p_j} \\
&= \frac{Q}{N} + \frac{2\beta Q}{N}\frac{Q(N-1)}{SN^2} + \alpha_j \frac{Q(N-1)}{SN^2} + \frac{Q}{SN^2}\sum_{i\neq j} p_i + \frac{2\beta Q}{SN^2}\frac{Q(N-1)}{SN^2}\sum_{i\neq j} p_i \\
&\quad - \frac{Q}{SN}\lambda\left(X_j - \bar{X}\right) - \frac{2\beta Q}{SN}\frac{Q(N-1)}{SN^2}\lambda\left(X_j - \bar{X}\right) \\
&\quad - \frac{Q}{SN}p_j + \frac{Q}{SN^2}p_j - \frac{Q(N-1)}{SN^2}p_j - \frac{2\beta Q}{SN}\frac{Q(N-1)}{SN^2}p_j + \frac{2\beta Q}{SN^2}\frac{Q(N-1)}{SN^2}p_j \equiv 0
\end{aligned}
$$

This can be simplified into the following expression:

(15) $$p_j\left[(2+\gamma)(N-1)\right] = (1+\gamma)N\left[S - \lambda\left(X_j - \bar{X}\right)\right] + \alpha_j(N-1) + (1+\gamma)\sum_{i\neq j} p_i$$ or

(16) $$p_j = \frac{1+\gamma}{2+\gamma}\frac{1}{N-1}\sum_{i\neq j} p_i + \frac{1}{2+\gamma}\alpha_j + \frac{1+\gamma}{2+\gamma}\frac{N}{N-1}S - \frac{1+\gamma}{2+\gamma}\frac{N}{N-1}\lambda\left(\bar{X} - X_j\right)$$, where

$$\gamma = \frac{2\beta Q(N-1)}{SN^2}$$

Since the solution is algebraically complicated, we now show with an example of three firms, that the solution presented in equation (9) is correct. For $N=3$, there are three equations (16) in three unknowns, which can be solved by substituting in.

(16_1) $$p_1 = \frac{1+\gamma}{2+\gamma}\frac{1}{N-1}(p_2 + p_3) + \frac{1}{2+\gamma}\alpha_1 + \frac{1+\gamma}{2+\gamma}\frac{N}{N-1}S - \frac{1+\gamma}{2+\gamma}\frac{N}{N-1}\lambda\left(\bar{X} - X_1\right)$$

(16_2) $$p_2 = \frac{1+\gamma}{2+\gamma}\frac{1}{N-1}(p_1 + p_3) + \frac{1}{2+\gamma}\alpha_2 + \frac{1+\gamma}{2+\gamma}\frac{N}{N-1}S - \frac{1+\gamma}{2+\gamma}\frac{N}{N-1}\lambda\left(\bar{X} - X_2\right)$$

(16_3) $$p_3 = \frac{1+\gamma}{2+\gamma}\frac{1}{N-1}(p_1 + p_2) + \frac{1}{2+\gamma}\alpha_3 + \frac{1+\gamma}{2+\gamma}\frac{N}{N-1}S - \frac{1+\gamma}{2+\gamma}\frac{N}{N-1}\lambda\left(\bar{X} - X_3\right)$$

Substituting (16_3) into (16_2) and solving for p_2 yields a function in terms of p_1:

(16_2')

$$
\begin{aligned}
p_2 &= \frac{(1+\gamma)}{(3+\gamma)}p_1 + \frac{(1+\gamma)}{(3+\gamma)}3S - \frac{(1+\gamma)(2+\gamma)}{(5+3\gamma)(3+\gamma)}6\left(\bar{X} - X_2\right) - \frac{(1+\gamma)^2}{(5+3\gamma)(3+\gamma)}3\left(\bar{X} - X_3\right) \\
&\quad + \frac{4\alpha_2(2+\gamma)}{(5+3\gamma)(3+\gamma)} + \frac{2\alpha_3(1+\gamma)}{(5+3\gamma)(3+\gamma)}
\end{aligned}
$$

Plugging (16_2') back into (16_3) yields a similar formula for p_3:

$$(16_3') \quad p_3 = \frac{(1+\gamma)}{(3+\gamma)} p_1 + \frac{(1+\gamma)}{(3+\gamma)} 3S - \frac{(1+\gamma)(2+\gamma)}{(5+3\gamma)(3+\gamma)} 6(\overline{X} - X_3) - \frac{(1+\gamma)^2}{(5+3\gamma)(3+\gamma)} 3(\overline{X} - X_2)$$
$$+ \frac{4\alpha_3(2+\gamma)}{(5+3\gamma)(3+\gamma)} + \frac{2\alpha_2(1+\gamma)}{(5+3\gamma)(3+\gamma)}$$

Then, using (16_2') and (16_3') in (16_1), we obtain the formula for p_1:

$$(16_1') \quad p_1 = \frac{3}{2} \frac{(1+\gamma)(5+3\gamma)}{(5+3\gamma)} S + \frac{1}{2} \frac{(2+2\gamma)}{(5+3\gamma)} (\alpha_1 + \alpha_2 + \alpha_3) + \frac{1}{2} \frac{2\alpha_1}{(5+3\gamma)}$$
$$- \frac{1}{2} \frac{3(1+\gamma)^2}{(5+3\gamma)} \left[\lambda (3\overline{X} - X_1 - X_2 - X_3) \right] - \frac{1}{2} \frac{6(1+\gamma)}{(5+3\gamma)} \lambda (\overline{X} - X_1)$$

Note that $(3\overline{X} - X_1 - X_2 - X_3) = 0$; then after some rearranging of the a_1 terms, (16_1') simplifies to:

$$(16_1'') \quad p_1 = \alpha_1 + \frac{3}{2}(1+\gamma)S + \frac{(1+\gamma)}{(5+3\gamma)} 3(\overline{\alpha} - \alpha_1) - \frac{(1+\gamma)}{(5+3\gamma)} 3\lambda (\overline{X} - X_1) ,$$

which is exactly what was proposed in equation (9) if $N=3$.

A.1.c. Profit Maximization

For firms to be profit maximizing, the second derivative has to be negative:

$$(17) \quad \frac{\partial^2 \Pi_j}{\partial p_j^2} = -\frac{Q}{SN} + \frac{Q}{SN^2} - \frac{Q(N-1)}{SN^2} - \frac{2\beta Q}{SN} \frac{Q(N-1)}{SN^2} + \frac{2\beta Q}{SN^2} \frac{Q(N-1)}{SN^2}$$
$$= -\frac{2Q(N-1)}{SN^2} \left[1 + \frac{\beta Q(N-1)}{SN^2} \right]$$

Note that (17) is only less than zero if

$$1 + \frac{\beta Q(N-1)}{SN^2} > 0 \Rightarrow \beta > -\frac{SN^2}{Q(N-1)}$$

Hence β is bounded from below, where $\beta \geq 0$ will lead to the profit maximizing condition in any case.

Appendix 2: Data

Our first dataset is a snapshot of Medigap premiums in effect on January 1, 1998 by zip code from Weiss Ratings, Inc. It contains the premium charged for any plan letter offered by a firm, by age, plan type (i.e. standard, select, or smoker), rating method, and gender. We use the following algorithm to aggregate the data to the state level.

Within any zip code, no firm offers more than one plan within an age-plan letter-plan type-rating method cell. We restrict the data to standard plans (of all letters) for 65 year-olds only, hence we reduce the dimensionality to plan letter-rating method cells within every zip code. For each firm in each cell, we then average premiums over zip codes in the state. Appendix Table 4 reports the average within-firm coefficient of variation by state and plan letter. The values are virtually zero in all states and plan letters, except for California and Florida, where the CVs reach 0.05 and 0.09, respectively, for some plan letters. As noted above, just two percent of all plans offered have a parallel offer by the same firm with a different rating, meaning that in the same state-plan-age cell, the firm is offering the same plan letter using two different rating methods. We drop these plans from the analysis.

Our second dataset, from NAIC, contains data for all Medigap policies issued by insurance companies in a given state during the years 1996-1998. We only keep observations on individual standard Medigap policies offered after OBRA-90 within the continental United States (except Massachusetts, Minnesota, and Wisconsin which have different standardization schemes). Some plan letters are offered more than once by the same firm in the same state. These are likely to be plans that differ across counties, as observed in the Weiss data. Since we have no means of identifying these local differences, we combine these plans (about 22 percent), summing up covered lives, premiums and claims, such that each firm only offers one policy in each state-plan letter cell. To the extent we are combining policies with different rating methods, these cases will not be present in our merged sample since we exclude the two percent of policies in the Weiss data where firms use more than one rating method in a given market.

Both the Weiss data and the NAIC data have the company name of the firms offering a Medigap policy. After some minor adjustments, we can merge the two datasets based on the company name, the US state of operation and the plan letter. (Note that the NAIC data do not have any information on the age of the people covered under the policy.) To analyze how well the two datasets merge, we focus on the number of covered lives represented by firms in the NAIC data that we successfully merge to firms in the Weiss data. For example, the NAIC data contain firms representing 1,814,515 covered lives between 1996 and 1998. Firms representing 151,053 of these covered lives are not found in the Weiss data; thus our merged sample captures 91.6 percent of the Medigap market nationwide. Column 1 of Appendix Table 2 shows the total number of covered lives accounted for by firms in the NAIC data, by plan letter, and Column 2 shows the number of covered lives not matched to the Weiss data. Appendix Table 3 shows the fraction of NAIC covered lives not matched by state and plan letter. In most state-plan letter combinations, the fraction not matched is very low; however in order to guarantee that we observe "most" of any given market, we drop those state-plan letter cells where the fraction not matched exceeds 50 percent. Overall, we drop cells representing just 5,618 covered lives, or 0.3 percent of total covered lives (App. Table 2, col. 3). Column 4 of Appendix Table 2 reports the fraction of total covered lives either not matched or omitted to be just 8.6 percent.

Appendix Table 1: Coefficient of Variation and Number of Offers by State and Plan

Plan	**A**		**B**		**C**		**D**		**E**	
	CV	**(Offers)**	**CV**	**(Offers)**	**CV**	**(Offers)**	**CV**	**(Offers)**	**CV**	**(Offers)**
AK	0.13	(22)	0.19	(13)	0.14	(17)	0.11	(10)	0.11	(6)
AL	0.20	(33)	0.17	(23)	0.19	(28)	0.18	(12)	0.20	(8)
AR	0.20	(42)	0.22	(28)	0.20	(37)	0.22	(18)	0.22	(11)
AZ	0.22	(48)	0.16	(29)	0.18	(42)	0.14	(18)	0.12	(12)
CA	0.26	(37)	0.22	(20)	0.28	(31)	0.14	(15)	0.14	(10)
CO	0.22	(45)	0.17	(31)	0.19	(41)	0.20	(20)	0.23	(13)
CT	0.27	(17)	0.07	(11)	0.16	(13)	0.12	(11)	0.08	(6)
DC	0.11	(15)	0.08	(11)	0.09	(12)	0.05	(7)	0.06	(6)
DE	0.16	(24)	0.15	(19)	0.09	(5)	0.15	(14)	0.16	(9)
FL	0.20	(34)	0.14	(22)	0.14	(28)	0.07	(16)	0.20	(11)
GA	0.16	(40)	0.15	(30)	0.16	(36)	0.16	(19)	0.16	(14)
HI	0.21	(20)	0.17	(13)	0.14	(17)	0.16	(8)	0.09	(6)
IA	0.23	(46)	0.23	(31)	0.20	(43)	0.15	(19)	0.18	(12)
ID	0.25	(45)	0.21	(29)	0.27	(41)	0.25	(18)	0.21	(13)
IL	0.20	(55)	0.17	(37)	0.19	(47)	0.17	(23)	0.22	(19)
IN	0.16	(48)	0.17	(32)	0.16	(41)	0.15	(21)	0.16	(13)
KS	0.20	(44)	0.16	(27)	0.18	(39)	0.15	(15)	0.14	(9)
KY	0.16	(39)	0.15	(28)	0.17	(35)	0.11	(16)	0.13	(10)
LA	0.18	(39)	0.15	(28)	0.15	(34)	0.14	(17)	0.10	(8)
MD	0.21	(29)	0.20	(21)	0.19	(22)	0.24	(12)	0.24	(11)
ME	0.19	(14)	0.20	(10)	0.19	(12)	0.17	(7)	0.15	(5)
MI	0.22	(38)	0.17	(24)	0.21	(37)	0.19	(16)	0.20	(11)
MO	0.16	(50)	0.13	(30)	0.15	(44)	0.12	(22)	0.17	(10)
MS	0.21	(43)	0.19	(34)	0.19	(39)	0.11	(20)	0.11	(11)
MT	0.16	(37)	0.13	(22)	0.14	(35)	0.15	(16)	0.11	(8)
NC	0.23	(42)	0.21	(31)	0.25	(36)	0.16	(16)	0.17	(10)
ND	0.16	(39)	0.12	(24)	0.13	(36)	0.15	(18)	0.12	(11)
NE	0.20	(53)	0.19	(35)	0.17	(46)	0.18	(24)	0.18	(14)
NH	0.14	(19)	0.11	(13)	0.13	(18)	0.11	(11)	0.08	(6)
NJ	0.18	(5)	0.14	(3)	0.13	(5)	0.08	(2)	0.00	(1)
NM	0.19	(41)	0.14	(31)	0.14	(35)	0.14	(19)	0.06	(10)
NV	0.22	(42)	0.18	(28)	0.18	(38)	0.15	(18)	0.16	(11)
NY	0.12	(14)	0.13	(14)	0.11	(11)	0.06	(4)	0.14	(4)
OH	0.21	(54)	0.17	(37)	0.17	(49)	0.14	(24)	0.16	(16)
OK	0.24	(51)	0.18	(36)	0.19	(46)	0.19	(24)	0.20	(16)
OR	0.25	(40)	0.17	(25)	0.19	(33)	0.17	(16)	0.18	(12)
PA	0.19	(35)	0.16	(35)	0.13	(32)	0.11	(14)	0.19	(10)
RI	0.23	(17)	0.21	(13)	0.21	(16)	0.08	(9)	0.09	(6)
SC	0.17	(42)	0.19	(33)	0.21	(36)	0.16	(20)	0.18	(11)
SD	0.20	(41)	0.14	(23)	0.17	(35)	0.17	(15)	0.21	(12)
TN	0.20	(52)	0.21	(37)	0.21	(48)	0.19	(23)	0.20	(15)
TX	0.20	(61)	0.18	(43)	0.17	(54)	0.17	(25)	0.17	(13)
UT	0.18	(39)	0.16	(28)	0.18	(35)	0.16	(18)	0.18	(10)
VA	0.16	(46)	0.16	(31)	0.16	(39)	0.13	(19)	0.16	(12)
VT	0.13	(14)	0.11	(10)	0.07	(13)	0.11	(9)	0.03	(4)
WA	0.19	(26)	0.20	(10)	0.15	(22)	0.09	(5)	0.19	(7)
WV	0.22	(35)	0.22	(22)	0.18	(31)	0.19	(14)	0.22	(8)
WY	0.25	(33)	0.23	(24)	0.20	(33)	0.21	(15)	0.23	(10)

(continued next page)

Appendix Table 1 (continued)

Plan	F		G		H		I		J	
	CV	(Offers)	CV	(Offers)	CV	(Offers)	CV	(Offers)	CV	(Offers)
AK	0.14	(20)	0.15	(14)	0.16	(4)	0.19	(10)	0.20	(4)
AL	0.15	(28)	0.16	(17)	0.29	(7)	0.18	(10)	0.28	(8)
AR	0.17	(37)	0.18	(18)	0.31	(8)	0.26	(12)	0.30	(8)
AZ	0.16	(44)	0.19	(19)	0.19	(9)	0.16	(14)	0.23	(11)
CA	0.19	(34)	0.17	(17)	0.10	(8)	0.14	(12)	0.28	(9)
CO	0.17	(44)	0.16	(21)	0.30	(10)	0.32	(15)	0.29	(10)
CT	0.13	(15)	0.09	(7)	0.51	(5)	0.55	(4)	0.22	(4)
DC	0.10	(14)	0.12	(8)	0.10	(4)	0.07	(5)	0.12	(5)
DE	0.10	(8)	0.00	(1)	0.00	(1)	0.13	(9)	0.12	(6)
FL	0.15	(32)	0.15	(17)	0.09	(6)	0.28	(10)	0.13	(7)
GA	0.15	(38)	0.14	(17)	0.31	(8)	0.23	(10)	0.31	(10)
HI	0.17	(18)	0.17	(11)	0.00	(3)	0.18	(7)	0.15	(4)
IA	0.20	(42)	0.22	(18)	0.11	(8)	0.19	(13)	0.26	(11)
ID	0.20	(41)	0.18	(21)	0.37	(10)	0.33	(14)	0.22	(13)
IL	0.16	(47)	0.14	(18)	0.29	(9)	0.19	(16)	0.32	(12)
IN	0.13	(43)	0.17	(21)	0.28	(9)	0.14	(10)	0.28	(8)
KS	0.15	(40)	0.14	(16)	0.20	(6)	0.15	(11)	0.20	(8)
KY	0.14	(36)	0.18	(17)	0.26	(7)	0.31	(8)	0.14	(7)
LA	0.11	(35)	0.13	(18)	0.15	(7)	0.13	(9)	0.18	(8)
MD	0.17	(25)	0.13	(14)	0.32	(9)	0.25	(13)	0.32	(8)
ME	0.19	(14)	0.18	(7)	0.86	(3)	0.69	(6)	0.19	(2)
MI	0.15	(30)	0.13	(15)	0.35	(9)	0.39	(12)	0.21	(8)
MO	0.12	(46)	0.14	(21)	0.25	(10)	0.13	(12)	0.19	(11)
MS	0.16	(42)	0.20	(19)	0.17	(9)	0.21	(12)	0.22	(10)
MT	0.14	(33)	0.14	(16)	0.11	(7)	0.15	(9)	0.27	(11)
NC	0.24	(37)	0.18	(18)	0.31	(6)	0.21	(12)	0.32	(6)
ND	0.15	(35)	0.16	(18)	0.13	(7)	0.17	(12)	0.21	(8)
NE	0.12	(45)	0.13	(18)	0.25	(9)	0.14	(12)	0.18	(10)
NH	0.13	(19)	0.11	(10)	0.08	(6)	0.18	(6)	0.24	(8)
NJ	0.10	(5)	0.09	(2)			0.04	(2)		
NM	0.11	(38)	0.16	(21)	0.12	(7)	0.14	(12)	0.19	(10)
NV	0.17	(38)	0.18	(19)	0.20	(7)	0.14	(13)	0.19	(10)
NY	0.14	(8)	0.12	(4)	0.21	(6)	0.02	(3)	0.18	(2)
OH	0.17	(51)	0.16	(24)	0.17	(10)	0.20	(13)	0.22	(11)
OK	0.20	(47)	0.18	(24)	0.25	(11)	0.16	(16)	0.29	(12)
OR	0.18	(36)	0.20	(18)	0.24	(9)	0.25	(15)	0.23	(11)
PA	0.08	(4)	0.00	(3)	0.14	(11)	0.00	(1)	0.29	(5)
RI	0.21	(16)	0.24	(11)	0.13	(5)	0.18	(9)	0.17	(5)
SC	0.15	(38)	0.15	(18)	0.22	(9)	0.17	(13)	0.22	(9)
SD	0.15	(38)	0.13	(20)	0.25	(7)	0.19	(12)	0.17	(8)
TN	0.17	(48)	0.16	(22)	0.33	(10)	0.23	(14)	0.27	(11)
TX	0.14	(55)	0.14	(23)	0.23	(11)	0.18	(16)	0.24	(12)
UT	0.15	(35)	0.17	(20)	0.19	(10)	0.15	(13)	0.23	(11)
VA	0.21	(42)	0.13	(20)	0.17	(7)	0.23	(13)	0.21	(10)
VT	0.00	(1)			0.03	(3)			0.04	(2)
WA	0.21	(22)	0.20	(6)	0.27	(5)	0.49	(9)	0.16	(6)
WV	0.18	(33)	0.16	(16)	0.32	(4)	0.20	(11)	0.21	(5)
WY	0.20	(33)	0.24	(17)	0.23	(9)	0.23	(14)	0.25	(10)

Notes: All numbers are based on premiums for 65 year-old female nonsmokers in 1998. We account for the different rating methods by first computing the CV within each rating method, then we average the CVs across the three rating methods. Cells without values have no offers. Source: Authors' calculations using Weiss Ratings data, 1998.

Appendix Table 2: Statistics from Merging Weiss and NAIC Data

Plan Letter	(1) Total NAIC Covered Lives	(2) Covered Lives Not Matched to Weiss Data	(3) Covered Lives Dropped[1)]	(4) Fraction Dropped or Not Matched[2)]
A	88151	7780	467	0.09
B	129499	6786	0	0.05
C	468767	40683	82	0.09
D	143838	10208	826	0.08
E	29298	104	0	0.00
F	762457	64531	0	0.08
G	54672	3437	46	0.06
H	31044	15664	3851	0.63
I	44274	1258	323	0.04
J	62515	602	23	0.01
Total	1814515	151053	5618	0.09

Notes:

A "matched" record refers to a successful merge of a firm-state-plan letter combination in the Weiss and NAIC data.

1) Number of covered lives in state-plan letter cells that were dropped because fewer than 50 percent of covered lives were matched. See Appendix Table 3 for match rates by state and plan letter.

2) (4) = [(2) + (3)] / (1)

Source: Authors' calculations using Weiss Ratings data, 1998, and NAIC data, 1998.

Appendix Table 3: Fraction of NAIC Covered Lives Not Matched in Weiss Data by State and Plan

	PLAN									
STATE	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
AK	0.02	0.03	0.01	0.08	0.00	0.05	0.01	0.00	0.00	
AL	0.33	0.27	0.34	0.13	0.00	0.35	0.43	0.00	0.00	
AR	0.03	0.07	0.04	0.02	0.00	0.08	0.01	0.02	0.00	0.00
AZ	0.19	0.06	0.14	0.00	0.11	0.10	0.05	0.00	0.05	0.00
CA	0.02	0.03	0.02	0.00	0.06	0.02	0.00	0.00	0.14	
CO	0.05	0.26	0.01	0.00	0.25	0.01	0.20	0.08	0.02	0.06
CT	0.01	0.04	0.02	0.08	0.00	0.01	0.08	0.01	0.94	0.00
DC	0.04	0.00	0.02	0.08	0.00	0.05	0.01	0.00	0.00	
DE	0.01	0.00	0.57	0.18	0.00	0.03			0.00	
FL	0.04	0.02	0.01	0.09	0.00	0.09	0.06	0.15	0.01	0.00
GA	0.07	0.04	0.02	0.04	0.00	0.05	0.06	0.00	0.00	
HI	0.06	0.00	0.00	0.00		0.00	1.00			
IA	0.18	0.13	0.01	0.00	0.00	0.02	0.00	0.00	0.01	0.00
ID	0.00	0.00	0.00	0.00	0.40	0.00	0.00		0.00	
IL	0.07	0.04	0.02	0.02	0.00	0.04	0.10	0.00	0.01	0.00
IN	0.04	0.01	0.05	0.00	0.00	0.04	0.08	0.05	0.19	0.56
KS	0.03	0.03	0.01	0.02	0.00	0.01	0.04	0.05	0.14	0.00
KY	0.15	0.18	0.15	0.01	0.01	0.08	0.01	0.90	0.00	0.00
LA	0.04	0.03	0.04	0.07	0.00	0.13	0.05	0.00	0.00	
MD	0.02	0.00	0.01	0.08	0.00	0.03	0.04		0.00	0.00
ME	0.03	0.00	0.00	0.01	0.00	0.03	0.02	0.02	0.00	0.00
MI	0.11	0.18	0.20	0.05	0.00	0.32	0.00		0.01	
MO	0.00	0.01	0.02	0.02	0.05	0.03	0.08	0.48	0.57	0.00
MS	0.14	0.31	0.21	0.83	0.01	0.44	0.14	0.00	0.22	0.01
MT	0.08	0.01	0.00	0.00	0.00	0.02	0.00	0.00	0.12	0.00
NC	0.09	0.03	0.15	0.08	0.01	0.06	0.02	0.02	0.01	0.00
ND	0.03	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.04	0.13
NE	0.12	0.07	0.05	0.04	0.00	0.09	0.10	0.01	0.01	0.07
NH	0.05	0.00	0.01	0.00	0.00	0.05	0.00	0.50	0.00	
NJ	0.10	0.47	0.12	0.29	0.33	0.05	0.78	1.00	0.04	1.00
NM	0.19	0.11	0.07	0.00		0.08	0.04		0.00	0.00
NV	0.08	0.02	0.05	0.05	0.00	0.08	0.03	0.00	0.00	0.01
NY	0.00	0.00	0.00	0.03		0.01	0.00	0.07	0.65	
OH	0.09	0.08	0.14	0.00	0.00	0.18	0.00	0.02	0.43	0.40
OK	0.19	0.09	0.05	0.03	0.00	0.18	0.00	0.00	0.00	
OR	0.06	0.00	0.00	0.01	0.04	0.06	0.02	0.01	0.00	
PA	0.00	0.00	0.29	0.01	0.02	0.02	0.00	0.78	1.00	0.00
RI	0.06	0.03	0.01	0.16		0.07	0.05	0.05	0.00	
SC	0.05	0.03	0.04	0.02	0.00	0.02	0.00	0.00	0.01	
SD	0.08	0.02	0.02	0.00	0.00	0.08	0.01	0.00	0.00	0.00
TN	0.39	0.10	0.10	0.00	0.00	0.16	0.17	0.00	0.02	
TX	0.47	0.28	0.25	0.38	0.00	0.28	0.11	0.00	0.02	0.18
UT	0.78	0.00	0.02	0.00		0.03	0.01	0.00	0.01	
VA	0.01	0.02	0.02	0.06	0.00	0.01	0.00	0.00	0.00	0.00
VT	0.03	0.00	0.00	0.00	0.00	1.00		0.63	1.00	0.00
WA	0.03	0.15	0.12	0.15	0.01	0.06	0.16	0.00	0.01	0.01
WV	0.02	0.03	0.02	0.01	0.00	0.01	0.01	0.02	0.00	0.00
WY	0.07	0.00	0.01	0.05	0.00	0.05	0.06	0.00	0.00	0.00

Notes: Cell entries give the fraction of total NAIC covered lives not matched to the Weiss data. State-plan letter cells with a fraction larger than 0.50 are dropped from the analysis.
Source: Authors' calculations using Weiss Ratings data, 1998, and NAIC data, 1998.

Appendix Table 4: Mean Within-Firm Coefficient of Variation in Premiums by State and Plan

	PLAN									
STATE	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
AK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AL	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
AR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AZ	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.00	0.01
CA	0.04	0.05	0.05	0.05	0.04	0.05	0.05	0.04	0.04	0.03
CO	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01
CT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FL	0.08	0.09	0.08	0.08	0.07	0.09	0.06	0.08	0.09	0.08
GA	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.01
HI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ID	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IL	0.02	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.01
IN	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
KS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
KY	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
LA	0.03	0.03	0.03	0.03	0.02	0.03	0.02	0.02	0.02	0.02
MD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ME	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MI	0.02	0.02	0.02	0.02	0.00	0.02	0.01	0.01	0.00	0.01
MO	0.01	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0.02	0.01
MS	0.01	0.02	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01
MT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NE	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
NH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	
NM	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
NV	0.01	0.02	0.02	0.03	0.03	0.02	0.02	0.04	0.03	0.03
NY	0.05	0.04	0.03	0.04	0.04	0.05	0.04	0.04	0.03	0.02
OH	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
OK	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
OR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PA	0.02	0.02	0.02	0.02	0.03	0.01	0.01	0.01	0.04	0.01
RI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SC	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.01
SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TN	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
TX	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.02
UT	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.01
VA	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01
VT	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00
WA	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
WV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: For each firm, we compute the state-plan letter coefficient of variation in premiums for plans offered to 65 year-old female non-smokers, then we average the within-firm coefficients of variation over firms in the cell. Firms operating in more than one rating scheme within a cell (2 percent of all firms) were dropped from the analysis.
Source: Authors' calculations using Weiss Ratings data, 1998.