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

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**Abstract**

About one-third of Americans age 65 and older supplement their Medicare health insurance through a private insurance market known as the "Medigap" market. We show that prices for Medigap policies vary widely, despite the fact that all plans are standardized, and even after controlling for firm heterogeneity. 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 estimate average search costs to be $66, on par with estimates of search costs from other markets.

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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. 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, 27 insurance companies in Durham, NC 27708 offered an attained-age rated, standardized Plan F to 65-year-old women in 2004. Annual premiums ranged from \$1145 to \$2311, with an average of \$1560, a standard deviation of \$301, and an implied coefficient of variation of 0.19.

Durham is not unique in the extent of price variation present in the Medigap market, nor is Plan F.  We document substantial price variation in all segments of the market.

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 $125, and an average search cost of $66. 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 many of them from searching until they find the lowest price.

## 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

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

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 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

[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.

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]

Because of standardization and the limitations on underwriting, the Medigap market is an ideal setting in which to study price variation. It is important to underscore

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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; 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).

the fact that Medigap policies are nothing more than secondary insurance policies; they *do not* limit nor confer access to particular networks of physicians and hospitals. Any provider that accepts and bills Medicare will also accept and bill a Medigap issurer. The standardization of policies insures that there is no variation in coverage for services from one insurer to another.

## 3. Price Variation

### *3.1. 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 in 2004. 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.[8] To reduce the dimensionality of our analysis, we 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). 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), is an administrative regulatory database containing total premiums, claims, and covered lives for each plan letter offered by an insurance company in every state. Insurance companies are required by law to file with NAIC, thus the NAIC data represent the universe of Medigap policies. In each year of NAIC data, the data are aggregated across policies newly issued during the previous three years. For example, the data for 2004 contain covered lives for policies issued by a particular firm in a given state in 2002, 2003 and 2004 combined. In order to match the NAIC data to the Weiss price data for 2004, we simply divide the three-year totals by three to obtain an estimate of the figures for 2004. This implicitly assumes that plans had the same influx of new policyholders in each of the three years.

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[8] 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.

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 provide an overview of the major issues here, and additional details in Appendix 2. First, as the NAIC data are available at the state level, we must aggregate up the Weiss data. As we document in the following section, we do not lose much information in doing so 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 new policies issued to individuals for all ages combined. However, this is not problematic because most people who buy new Medigap policies buy them when they enroll in Medicare at age 65 under the one-time open enrollment rules. Since those who buy policies at age 65 dominate new purchases of Medigap policies at any point in time, age 65 premiums are well matched to covered lives for all new policies issued.

Finally, the NAIC data are comprehensive whereas the Weiss data are not. In merging the Weiss and NAIC data, we retain observations for 72 out of 108 firms in the NAIC "universe," accounting for 91 percent of total covered lives represented in the NAIC data. This coverage rate is consistent with the market coverage rate reported by Weiss for that time period. As Table 2 shows, the excluded firms are disproportionately inactive participants in the market or sell very few policies (and hence do not bother reporting to Weiss). For example, the median firm in our merged sample issued 5,203 new policies between 2002 and 2004, compared to just 1,313 new policies issued by the median firm in the NAIC file. The median firm in our merged sample earned nearly four times the premiums of the median firm in the NAIC file between 2002 and 2004 ($6.9 versus $1.8 million), and incurred nearly three times the claims ($4.6 versus $1.6 million). Nearly half (46 percent) of firms in the NAIC file have loss ratios (claims/premiums) in excess of unity compared to 26 percent of firms in the merged sample. Nevertheless, the composition of our merged sample is similar to the NAIC file in terms of the number of firms per state (4.5 v. 4.4 respectively), the distribution of covered lives over plan letters, rating methods, solicitation method (agent v. direct), and the average number of months a policy has been on the market.

*3.2. The Distribution of Prices within Local Markets*

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.[9] 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.

To give an example of the variation in posted premiums within a local market, Table 3 highlights a single zip code, listing all price offers for a single policy, Plan F, Attained Age. In Durham, NC 27708, twenty-seven firms offer Plan F to 65-year-old female nonsmokers under attained-age rating. Annual premiums range from a low of $1,145 by United Teacher Associates Insurance Company to a high of $2,311 with Oxford Life Insurance Company; the maximum price in the market is twice the minimum price. The mean premium is $1,560 and the standard deviation is $301. These imply a substantial coefficient of variation of 0.19. Also listed is the financial safety rating of each firm given by Weiss. Although the 27 firms vary substantially in financial strength, there is no little apparent correlation between price and financial rating.

Although insurers are free to vary prices across zip codes or counties, the 2004 Weiss data show that most premium variation occurs *across* rather than within states. This is convenient since quantity data for the Medigap market, made available by the National Association of Insurance Commissioners (NAIC), is reported at the state level. Table 4 shows the extent to which firms vary the prices of their policies over zip codes within a state using the 2004 Weiss data. For each policy sold by a firm, we compute the

[9] 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.

coefficient of variation (CV) of its premiums over all zip codes within a state. Then for each state, we report the median within-firm CV, the 75th percentile CV, and the highest within-firm CV for all policies sold in the state. We also show the fraction of policies that have the same rank in the price distribution at both the zip code and state levels. For example, there are 82 unique firm-policy combinations in Alaska. The median within-firm price CV for those 82 policies is 0.00, as is the 75th percentile. The maximum within-firm price CV in the state is 0.03. In other words, virtually every firm in Alaska charges the same premium in every zip code. On the other hand, in California the median within-firm CV for 153 firm-policy combinations is 0.15, and the maximum is 0.27. In nearly all states, the median within-firm CV is close to zero, and there are many states in which the 75th percentile CV is also close to zero.

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 requirements), not county or zip code. In addition, the NAIC data 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. We set an arbitrary stringent threshold for the *maximum* within-firm CV in a state of 0.10, and consider those states with a maximum below 0.10 as having virtually no within-firm variation in prices; about 24 states meet this criteria. In the state-level analyses that follow, we present analyses for the entire sample and for this subset of "good" states.

We next aggregate the price data up to the state-level by averaging the price of every policy over all zip codes within a state to obtain the state average price for each policy. If all firms charged the same price in every zip code, the state-level data would be an exact replica of each and every zip code. However, as we saw in Table 4, a few firms do vary prices across zip codes in some states, and therefore we need to ensure that the aggregation process itself does not generate spurious price variation. To examine this, we compare the distribution of prices at the state and zip levels. Because we expect price to vary by policy type (i.e., plan letter and rating method) as well as across local markets, in the zip code data we regress price on zip code-policy fixed effects (i.e., a dummy for every unique policy-zip code combination) and plot a kernel density of the residuals. By construction, each residual is the deviation in a firm's price from the local market mean price for the policy. We follow a similar procedure for the state data, except we regress the state average price for a policy on state-policy fixed effects (a dummy for every unique policy-state combination). Figure 1 shows that the two densities overlap one another nearly perfectly, implying that the aggregated state-level price distribution is an excellent replica of the underlying zip-code level price distribution.

Overlap in the price distributions does not guarantee that every firm occupies the same rank in the state price distribution as in the zip-code distribution. In Table 2, we include a column tabulating the fraction of policies in a state whose price has the same rank at the state level as at the zip level. In about one-fifth of states, all policies occupy the same rank at both the zip and state levels. Among the rest, most policies occupy the same rank at both levels, but there is more evidence of rank differences. This is mostly due to the fact that in some states, a few firms do not operate in all zip codes and thus there are more firms represented at the state level than in some zip codes. For the most part, our designation of "good" states on the basis of the maximum within-firm CV also identifies those states in which nearly all policies occupy the same rank in both price distributions.

Figure 1 is striking in that it shows a substantial amount of price variation within local markets for the same policy; indeed, the distribution has a coefficient of variation of 0.26.[10] While the density of within-market residuals is a useful device for summarizing the price variation over many markets and products, we also show the coefficients of variation for the top 10 policies by state, which account for 71 percent of total covered lives. These data are presented in Table 5. The columns are rank ordered, with column 1 representing the largest policy, denoted "F AA" for Plan F, Attained Age. Empty cells indicate that a policy is not sold in a particular state. Five of the policies are sold in most states, while the other five are sold in just a few states. These tend to be state-mandated guaranteed-issue versions (e.g., denoted "F AA*") of the major policies that must be made available to everyone, not just those in their open enrollment period. The table

[10] 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.

documents substantial price variation throughout the market—within all plan letters, rating methods, and states.

The densities in Figure 1 and underlying Table 5 are plan-weighted, in the sense that each policy gets equal weight regardless of whether any consumers actually buy the policy. If some firms post prices but are not active in the market, then the variation in price could be due to "stale" prices for plans with no enrollees. To examine this, we merge our state-aggregated Weiss data with the regulatory data from NAIC listing covered lives for each policy offered by a firm in every state. Figure 2 shows the (state-level) distributions of plan-weighted versus quantity-weighted prices. The densities of residual prices are obtained in the same way as for the state-level density in Figure 1. Figure 2 shows that the distribution tightens and shifts rightward once we apply quantity-weights, but substantial within-market variation in price remains. The coefficient of variation for the quantity-weighted price distribution is 0.13.

Price variation could also persist if ostensibly homogeneous products are in fact differentiated on some quality dimension that is observable to consumers, but not to the researcher. Examples of product differentiation might include financial stability of the insurance firm, or firm name recognition. While quality is typically unobserved in many studies of equilibrium price variation, we are fortunate in that the Weiss data include the Weiss financial rating for the firm. The Weiss Safety Rating consists of a letter grade, ranging from A+ to E, and is similar to ratings of financial strength given by other firms such as Standard and Poor's. We also construct a proxy for name recognition by computing the number of states nationwide in which the firm operates. Other measures include the policy's market duration, the number of other Medigap policies offered by the firm (menu size), and whether the policy is sold through agents or directly from the company.

We also control for the within-firm coefficient of variation in the loss ratio (ratio of claims to premiums) computed over all policies the firm offers. Within-firm variation in the loss ratio is an important control if firms cross-subsidize policies by allowing for losses on one (or more) of them, and subsidizing the losses with profits made on other policies. For example, a firm could offer Plan A very cheaply (i.e. below cost) 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.[11] 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.

Figure 3 shows the quantity-weighted distribution before and after we control for firm quality. The distributions are quite similar, suggesting that little of the price variation is due to product differentiation on quality dimensions or loss leader pricing within the Medigap policies.

An important reason for equilibrium price dispersion that has received much attention in the literature is the possibility that firms differ in their costs of production, and these differences are sustained by the existence of consumer search costs. We turn to a discussion of consumer search costs next.

## 4. Theoretical Framework

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

[11] There are limits to the extent to which firms can engage in such behavior. 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 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.

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.

*4.1. 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.[12] 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 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) $$w_k = \sum_{i=1}^{k-1} \frac{1}{N}\left(u_i - u_k\right) = \frac{1}{N}\sum_{i=1}^{k-1} u_i - \frac{k-1}{N} u_k$$

[12] 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).

The consumer then compares the expected gain to her search cost to determine whether to buy this policy or to search for another one.[13] 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.

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 $N-1$:

[13] 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.

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

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:

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

where $\alpha_j > 0$ and $\beta \geq 0$, both of which are testable hypotheses. Satisfaction of the condition on $\beta$ guarantees profit maximization.[14] The profit function is

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

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):

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

where

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

Since only $\alpha_j$, 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. Empirical Analyses

### *5.1 Analysis of Firm Costs*

We begin by examining an important determinant of price, namely marginal costs. A key empirical prediction of the Carlson-MacAfee model us that marginal costs vary across firms. 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

---

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

variable cost that firms face, and they vary across markets. Dividing total claims by covered lives gives the average cost associated with each policy in every market. Although the empirical prediction in Carlson-MacAfee is with respect to marginal costs, under constant returns to scale (a plausible assumption for this market), marginal costs will equal average costs. We regress claims per covered life on policy-state fixed effects (weighting by covered lives) and plot the density of residuals in Figure 5. Each residual represents the deviation in claims per person from the market-level mean of claims per person for a given policy in a given market. The density has substantial spread, indicating a large amount variation in average costs across firms for the *same* policy within the *same* markets. Indeed, the implied coefficient of variation for average costs is 0.33.

Although the Medigap plan letters refer to a standardized set of insurance benefits, a 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 more expensive in California than Tennessee, but it does not explain why there is substantial variation in costs within a health care market. Our analysis of average claims suggests that the average health of plan enrollees varies from firm to firm. These average health differences could result from differences in marketing strategies (e.g., cream-skimming) or it could random variation in health that does not “average out” in smaller plans.

A second important determinant of price is the load, or the expected present discounted value of insurance benefits divided by the expected present discounted value of payments. In our data we have neither expected benefit nor payment streams by age; however, we can construct the loss ratio, claims (expected benefits) divided premiums at age 65. Combining this fact with knowledge about the structure of risk pooling under the different rating methods makes the age-65 loss ratios for attained age plans, which risk pool within age groups, a useful indicator of loads in the Medigap market.[15] We regress

[15] This exercise would be more difficult with community-rated plans—because policyholders of all ages are part of the same risk pool, premiums typically exceed claims at younger ages but are lower than claims at older ages. Thus loss ratios for community-rated policies would tend to bias up the estimate of load. Under attained age rating, premiums are lowest at age 65 and rise with age to match the age profile in claims.

the loss ratio for each policy on policy-state fixed effects (quantity-weighted) and plot the kernel density of the residuals in Figure 6. As before, each residual measures the deviation from the market mean loss ratio for each policy. The figure shows substantial variation in the loss ratio across firms (CV=0.14). The mean loss ratio in the market is 0.74, which if interpreted as an approximate indicator of load suggests that the loads on many policies are quite high—on average 26 cents on the dollar. Although this estimate of load pertains to just age 65, given the very high cost of switching policies or insurers in the Medigap market it is unlikely that loads would be any lower at older ages.

In sum, our analyses of costs and loads suggest patterns consistent with the Carlson-McAfee model. Not only do average costs vary greatly across firms, so do loads, and both likely contribute to variation in prices. Our estimate of the average load at age 65 is 26 cents on the dollar, which is substantial. We next turn to the question of why price variation is sustained in the market.

*5.2. Analysis of Demand*

The starting point for our demand analysis is equation (4). Dividing both sides of (4) by $Q_{sp}/N_{sp}$ and adding a stochastic error term $\mu_{jsp}$, yields our empirical specification of the demand equation, where *j* indexes firms, *s* indexes states, and *p* indexes policies (policies are in turn identified by combinations of plan letter, rating method, and whether guaranteed issue):

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

The vector $X_{jsp}$ contains our measures of product differentiation. We estimate (4') using a tobit model, since 10 percent of firms in our data report zero covered lives. 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. To address this simultaneity, we instrument for 2004 prices lagged prices from 2001. We select the three-year lag because NAIC covered lives are reported for the interval 2002-2004.

Since all variables are expressed as deviations from the market mean, unobserved market factors are differenced out; however, unobserved firm factors could yet matter. Although we control for a number of important firm characteristics (e.g., financial stability, market presence, market tenure, loss-leader pricing, solicitation method), 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 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. Even still, to the extent advertising expenditures vary by market, they will be accounted for by the mean deviations. We have available a highly relevant and fairly complete set of product differentiation measures; indeed more than are typically available in studies of price variation. We saw earlier that accounting for observable product differentiation did not appreciably reduce the magnitude of the price variation in the market; therefore it is unlikely that the relationship between price and demand could be entirely explained by additional unobserved factors.

Table 6 presents our estimation results. Column 1 gives the estimated coefficients from a simple tobit specification of the demand equation, and columns 2 and 3 present coefficients for demand and price equations, respectively, from the IV tobit specification. In the tobit model, the price coefficient is -0.003, which implies that for every $100 increase in price above the average price, a firm's demand decreases by 30 percent of average demand. Once we instrument with lagged price, the coefficient rises significantly to -0.008, implying a decrease of 80 percent of average demand for $100 increase in price above average. The estimated maximum search cost, *S*, is the inverse of the price coefficient multiplied by (-1). In the tobit model, we obtain a maximum search cost of $333; once we address the simultaneity problem, the maximum search cost declines to about $125. Under the assumption that search costs are uniformly distributed, dividing by 2 yields an average search cost of $66.

The sample size declines between the two specifications because some firms in our sample do not have an available 2001 price (most likely they were not present in the market in 2001 or did not report to Weiss). To make sure our estimates are not driven by a change in sample composition, we re-estimate the single-equation tobit model on the subsample used for the IV tobit and obtain a similar point estimate for the price coefficient of -0.004. This estimate is shown in Table 7 (column 2), along with additional robustness checks.

In the IV tobit specification in Table 6, many of the product differentiation terms are statistically significant. For example, firms with a financial safety ratings of A experience notably higher demand than other firms, and demand is rising in national presence; firms operating in more states have above average demand as do those offering a larger menu of policies. Stale prices are associated with lower demand, as are newer policies (less than 48 months market tenure). Loss leader pricing (as measured by the extent of within-firm variation in the loss ratio over policies) is associated with lower demand. Both unprofitable firms (loss ratio>1) and those making excessive profits (loss<0.65) experience significantly lower demand. Demand is higher under agent solicitation.

In the price equation, the coefficient on lagged price is 0.891 and is highly statistically significant, indicating a very strong first stage. The other coefficients indicate positive and large price differentials associated with financial strength, and using agents as the solicitation method. Prices are lowest for new entrants, suggesting that new attempt to attract market share with below average prices. It is possible that the high costs associated with switching insurers may enable insurers to subsequently raise prices faster later on in order to make up for early losses. Also of interest is that varying premiums over zip codes within a state is positively associated with a higher state average premium; this suggests that some firms are able to accomplish and benefit from risk pooling on a smaller scale.

Finally, Table 7 presents alternative specifications of the demand equation. Of note are that the price coefficient is identical when we restrict our sample to the "good states." In addition, the price coefficient is similar when we remove all control variables from the IV tobit model; this suggests that accounting for product differentiation does not appreciably change our estimate of search costs in the Medigap market.

Our estimated average search cost us comparable to those estimated for other markets. 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, tenure, and financial stability, will capture differences in the probabilities of finding a given firm, to the extent they exist.

**6. 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 2004. 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 find evidence that firms in this market behave according to the assumptions of the Carlson-McAfee model: they are profit maximizers who have heterogeneous cost structures and high loads, which contribute to price differences that are sustained by the presence of consumer search costs. We estimate the average search cost to be $66. Our results suggest that consumer welfare could be improved if individuals had complete knowledge of the price distribution in the market. In many cases, price information is available on state insurance department websites, and for more than 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 (in 2006). In other words, information is available, but Medigap buyers are either not finding it or are not making efficient use of it. One barrier to finding it could be the documented low rates of internet access among older people: just 34 percent of households age 65 and older had internet access in 2003 (U.S. Census Bureau, 2005).

On the other hand, it might not be that it is difficult to find information about the price distribution, but rather that it is difficult to understand how to making efficient use of the information. With ten plans offered under three different rating methods, prospective buyers must choose among as many as 30 different options offered by as many insurers in some markets. Given the relatively advanced age of the consumer population buying Medigap plans, and the potential for age-related cognitive decline among many of them, selecting a Medigap policy is undoubtedly a challenging task for many. 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 consequence 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.

These factors might explain the dominance of agents in the Medigap market. Faced with too many options and no clear criteria for evaluating the options, agents may play an important role in guiding individuals to particular policies. Our results indicate that agent-solicited policies are about $150 more expensive on average than direct-sold policies; thus agents do not guide older individuals to the lowest prices in the market. The additional premiums paid over the life of the policy greatly exceed the cost of search.

As policymakers continue to grant the elderly expanded insurer choice in other areas of the Medicare program, such as the 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.

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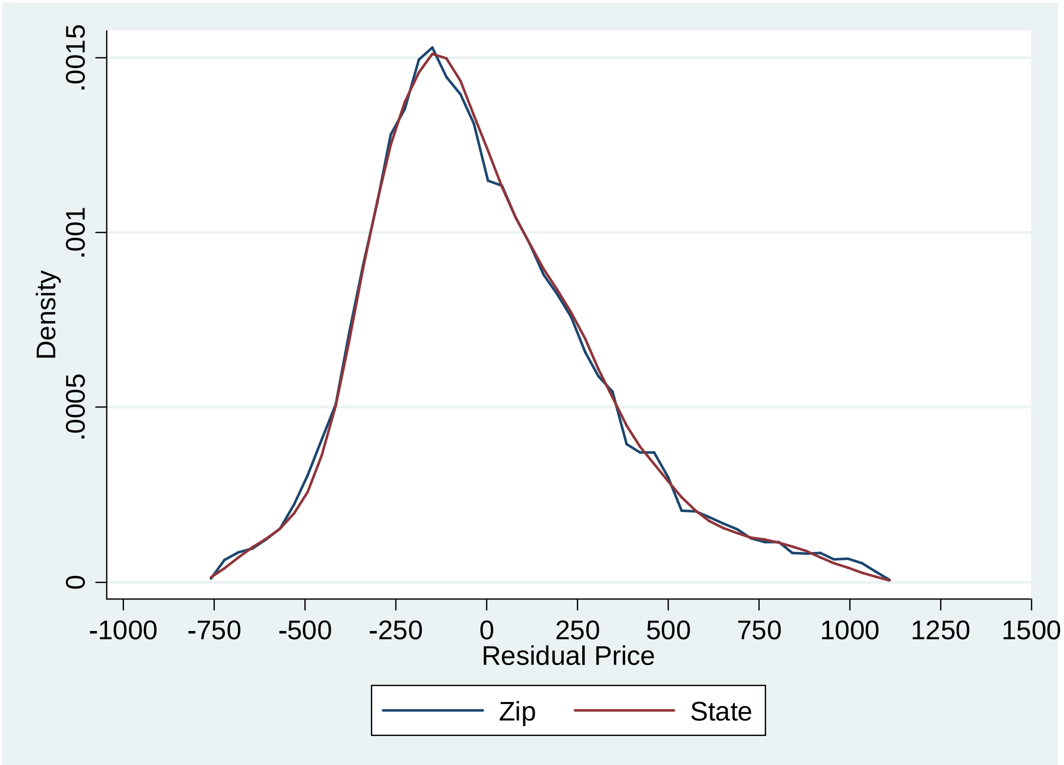
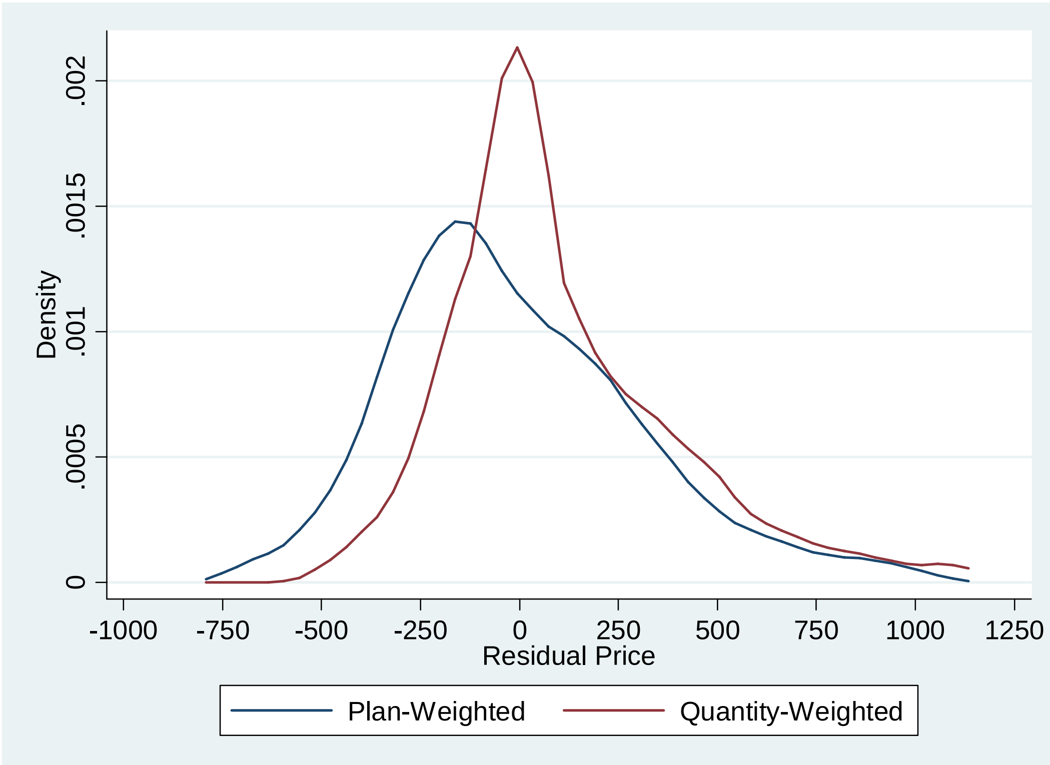
Figure 1. Comparison of Within-Market Price Distribution at State and Zip Levels




Notes: Price data from Weiss Ratings, Inc. The zip-code curve is the density of residuals from a regression of premium on policy-zip code fixed effects. The state curve is the density of residuals from a regression of premium on policy-state fixed effects. Shown are 1st-99th percentiles of each distribution.

Figure 2. Price Distribution, Plan-Weighted v. Quantity-Weighted




Notes: Price data are from Weiss Ratings, Inc and data on covered lives are from National Association of Insurance Commissioners. Plan-weighted curve is the density of residuals from a regression of premium on policy-state fixed effects. Quantity-weighted curve is density of residuals from covered-lives weighted regression of premium on policy-state fixed effects. Shown are 1st-99th percentiles of each distribution.

Figure 3. Quantity-Weighted Price Distribution, with and without Firm Quality Controls

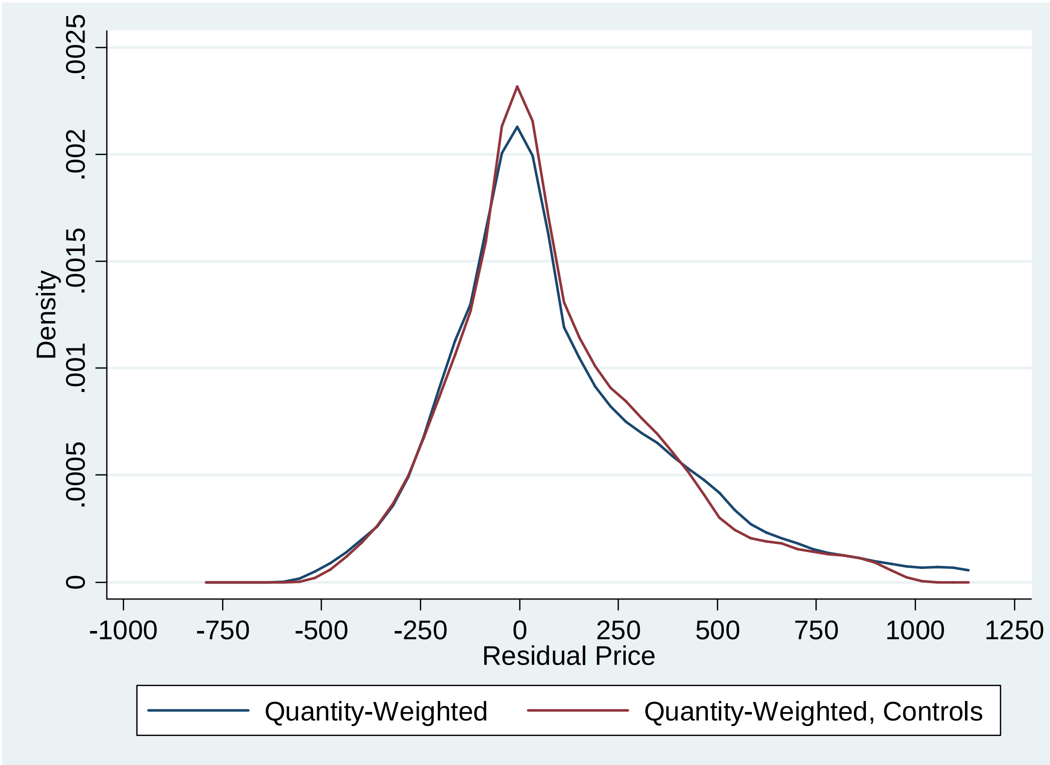


Figure 4: Example of Search Cost and Information Distribution

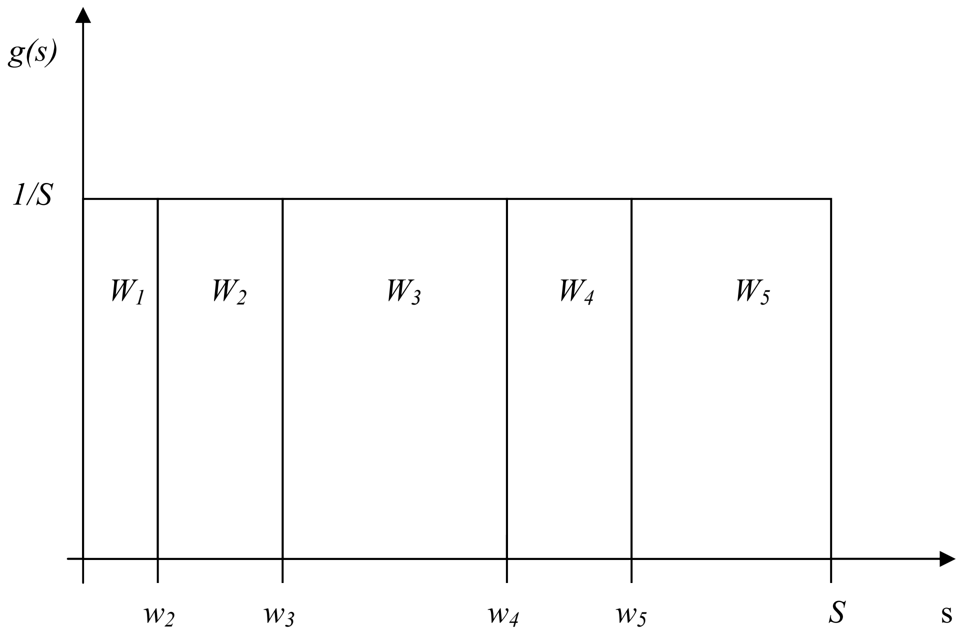
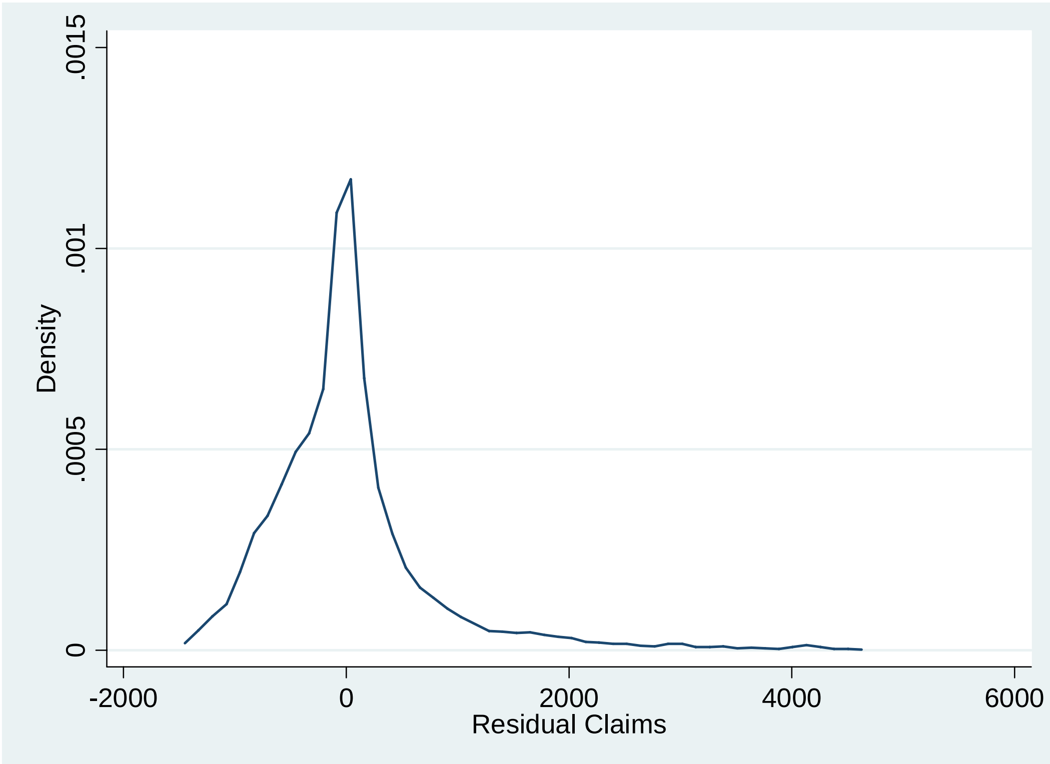
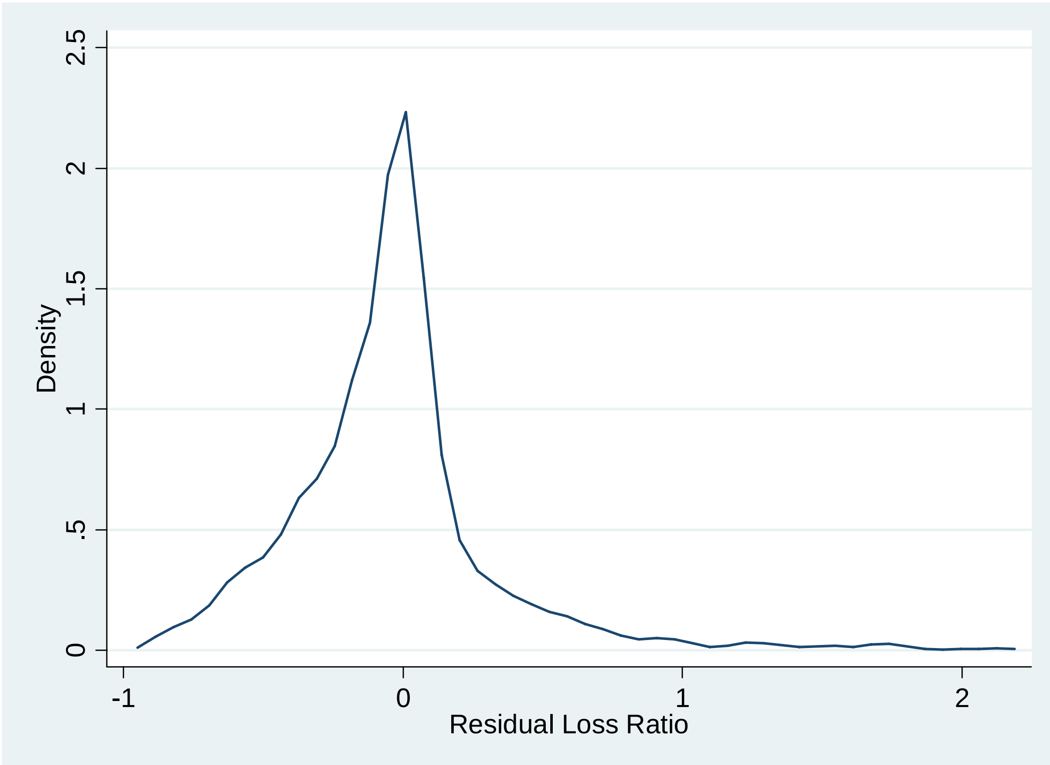


Figure 5. Within-Market Variation in Average Claims




Notes: Data are from National Association of Insurance Commissioners. Density is for residuals from covered-lives weighted regression of claims per person on policy-state fixed effects. Shown are the 1st-99th percentiles.

Figure 6. Loss Ratio Distribution for Attained Age Plans




Notes: Data are from National Association of Insurance Commissioners. Density is for residuals from covered-lives weighted regression of loss-ratio on policy-state fixed effects. Shown are the 1st-99th percentiles.

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 2004.
[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. Summary Statistics for Merged Sample and NAIC Universe

| | Merged Weiss-NAIC Sample | NAIC Universe |
|---|---|---|
| Total Covered Lives | 1,283,726 | 1,411,549 |
| *Firms* | | |
| Number of Firms | 72 | 108 |
| Number of Firms per State | 4.5 | 4.4 |
| Median Total Covered Lives | 5,203 | 1,313 |
| Median Total Premiums | $6,858,372 | $1,755,889 |
| Median Total Claims | $4,647,821 | $1,600,293 |
| Operates in < 23 States | 0.666 | 0.731 |
| Operates in 23 to 36 States | 0.181 | 0.167 |
| Operates in >36 States | 0.153 | 0.102 |
| Loss Ratio > 1 | 0.264 | 0.463 |
| Loss Ratio<0.65 | 0.417 | 0.296 |
| Weiss Safety Rating A | 0.208 | -- |
| Weiss Safety Rating B | 0.347 | -- |
| Weiss Safety Rating C | 0.250 | -- |
| Weiss Safety Rating D | 0.167 | -- |
| No Weiss Safety Rating | 0.028 | -- |
| *Policies* | | |
| Agent Solicited Policy | 0.722 | 0.658 |
| Direct Solicited Policy | 0.295 | 0.322 |
| Average Months Policy on Market | 91.8 | 100.3 |
| Plan A[1] | 0.034 | 0.032 |
| Plan C[1] | 0.145 | 0.134 |
| Plan F[1] | 0.477 | 0.456 |
| Attained Age[1] | 0.447 | -- |
| Issue Age[1] | 0.211 | -- |
| Community Rated[1] | 0.341 | -- |

Notes:
[1]Quantity-weighted by covered lives. See Appendix for merge details. Covered lives, premiums and claims are shown here as three-year totals over the period 2001-2004, as reported by NAIC.
Source: Authors' calculations using Weiss data, 2004, and NAIC data, 2004.

Table 3. Premiums for Plan F Attained Age in Durham, NC 27708

| Company | Annual Premium | Weiss Safety Rating |
|---|---|---|
| UNITED TEACHER ASSOCIATES INS CO | $1,145 | C+ |
| UNICARE LIFE & HEALTH INS CO | $1,164 | B |
| GLOBE LIFE & ACCIDENT INS CO | $1,165 | B+ |
| PENNSYLVANIA LIFE INS CO | $1,273 | C- |
| PHYSICIANS LIFE INS CO | $1,322 | A- |
| CENTRAL RESERVE LIFE INS CO | $1,324 | C- |
| PACIFICARE LIFE & HEALTH INS CO | $1,356 | C- |
| AMERICAN PIONEER LIFE INS CO | $1,356 | B- |
| MUTUAL OF OMAHA INSURANCE CO | $1,363 | A- |
| CONSECO HEALTH INS CO | $1,411 | D+ |
| PYRAMID LIFE INS CO | $1,419 | C |
| BANKERS LIFE & CASUALTY CO | $1,420 | D+ |
| LINCOLN HERITAGE LIFE INS CO | $1,422 | C+ |
| STATE FARM MUTUAL AUTOMOBILE INS CO | $1,510 | B+ |
| AMERICAN REPUBLIC INS CO | $1,510 | A- |
| CONTINENTAL GENERAL INS CO | $1,511 | C- |
| CONTINENTAL LIFE INS OF BRENTWOOD | $1,534 | B- |
| CONSTITUTION LIFE INS CO | $1,679 | D |
| CENTRAL STATES HEALTH & LIFE OF OMAHA | $1,689 | C |
| STERLING LIFE INS CO | $1,729 | C- |
| GE LIFE & ANNUITY ASR CO | $1,751 | B |
| USAA LIFE INSURANCE COMPANY | $1,812 | A |
| WORLD INS COMPANY | $1,875 | B |
| STANDARD LIFE & ACCIDENT INS CO | $1,981 | B+ |
| MEDICO LIFE INS CO | $2,033 | D+ |
| GUARANTEE TRUST LIFE INS CO | $2,055 | C |
| OXFORD LIFE INS CO | $2,311 | C- |
| Statistics | | |
| Number of Firms in Local Market | 27 | |
| Mean Premium | $1,560 | |
| Standard Deviation | $301 | |
| Coefficient of Variation | 0.19 | |

Notes: Data are from Weiss Ratings, Inc. for zip code 27708 in year 2004. Premiums are for 65-year-old female nonsmokers, Plan F, attained age-rated.

Table 4. Distribution of Within-Firm Price CVs over Zip Codes within a State

| State | Number Policies | Within-in Firm CV P50 | Within-in Firm CV P75 | Within-in Firm CV Max | Fraction Same Rank State and Zip | "Good" State |
|---|---|---|---|---|---|---|
| AK | 82 | 0.00 | 0.00 | 0.03 | 1.00 | 1 |
| AL | 148 | 0.04 | 0.05 | 0.10 | 0.68 | 0 |
| AR | 190 | 0.00 | 0.05 | 0.13 | 0.64 | 0 |
| AZ | 213 | 0.04 | 0.07 | 0.11 | 0.51 | 0 |
| CA | 153 | 0.11 | 0.15 | 0.27 | 0.49 | 0 |
| CO | 191 | 0.04 | 0.06 | 0.12 | 0.49 | 0 |
| CT | 73 | 0.00 | 0.00 | 0.00 | 1.00 | 1 |
| DC | 38 | 0.00 | 0.00 | 0.00 | 1.00 | 1 |
| DE | 116 | 0.00 | 0.00 | 0.05 | 0.90 | 1 |
| FL | 137 | 0.14 | 0.16 | 0.26 | 0.38 | 0 |
| GA | 178 | 0.05 | 0.06 | 0.18 | 0.40 | 0 |
| HI | 57 | 0.00 | 0.00 | 0.00 | 1.00 | 1 |
| IA | 226 | 0.00 | 0.04 | 0.09 | 0.55 | 1 |
| ID | 166 | 0.00 | 0.00 | 0.00 | 1.00 | 1 |
| IL | 253 | 0.07 | 0.10 | 0.18 | 0.44 | 0 |
| IN | 213 | 0.04 | 0.06 | 0.16 | 0.53 | 0 |
| KS | 190 | 0.00 | 0.04 | 0.13 | 0.56 | 0 |
| KY | 207 | 0.03 | 0.05 | 0.12 | 0.53 | 0 |
| LA | 211 | 0.07 | 0.10 | 0.19 | 0.39 | 0 |
| MD | 124 | 0.00 | 0.00 | 0.05 | 0.96 | 1 |
| ME | 86 | 0.00 | 0.00 | 0.06 | 0.81 | 1 |
| MI | 195 | 0.13 | 0.14 | 0.22 | 0.49 | 0 |
| MO | 209 | 0.04 | 0.07 | 0.16 | 0.43 | 0 |
| MS | 192 | 0.04 | 0.07 | 0.10 | 0.53 | 1 |
| MT | 168 | 0.00 | 0.00 | 0.05 | 0.98 | 1 |
| NC | 184 | 0.00 | 0.03 | 0.05 | 0.79 | 1 |
| ND | 176 | 0.00 | 0.00 | 0.07 | 0.88 | 1 |
| NE | 210 | 0.03 | 0.05 | 0.09 | 0.71 | 1 |
| NH | 72 | 0.00 | 0.00 | 0.06 | 0.99 | 1 |
| NJ | 48 | 0.00 | 0.00 | 0.00 | 1.00 | 1 |
| NM | 160 | 0.00 | 0.04 | 0.09 | 0.66 | 1 |
| NV | 153 | 0.06 | 0.10 | 0.16 | 0.45 | 0 |
| NY | 52 | 0.05 | 0.10 | 0.16 | 0.65 | 0 |
| OH | 248 | 0.05 | 0.07 | 0.19 | 0.45 | 0 |
| OK | 241 | 0.03 | 0.06 | 0.12 | 0.52 | 0 |
| OR | 159 | 0.00 | 0.00 | 0.12 | 0.74 | 0 |
| PA | 182 | 0.08 | 0.11 | 0.17 | 0.43 | 0 |
| RI | 76 | 0.00 | 0.00 | 0.00 | 1.00 | 1 |
| SC | 194 | 0.03 | 0.06 | 0.12 | 0.59 | 0 |
| SD | 188 | 0.00 | 0.00 | 0.04 | 0.94 | 1 |
| TN | 243 | 0.04 | 0.06 | 0.12 | 0.50 | 0 |
| TX | 260 | 0.08 | 0.10 | 0.21 | 0.39 | 0 |
| UT | 105 | 0.00 | 0.00 | 0.04 | 0.95 | 1 |
| VA | 191 | 0.04 | 0.11 | 0.19 | 0.40 | 0 |
| VT | 39 | 0.00 | 0.00 | 0.00 | 1.00 | 1 |
| WA | 107 | 0.00 | 0.00 | 0.00 | 0.79 | 1 |
| WV | 176 | 0.00 | 0.04 | 0.10 | 0.71 | 1 |
| WY | 151 | 0.00 | 0.00 | 0.04 | 0.84 | 1 |

Notes: Unit of observation is firm-policy-state, where CV is coefficient of variation of premiums for a given policy by a given firm over all zip codes within a state. "Good" states are states are firms where the maximum CV in a state is less than 0.10.

Table 5. Coefficients of Variation of Premiums by State, Top 10 Policies

| | F AA<br>1 | F CR<br>2 | F AA*<br>3 | F IA<br>4 | C CR*<br>5 | G AA<br>6 | J CR<br>7 | D AA<br>8 | C AA<br>9 | C IA*<br>10 |
|---|---|---|---|---|---|---|---|---|---|---|
| AK | 0.33 | | | 0.18 | | 0.09 | | 0.33 | 0.33 | |
| AL | 0.28 | | | 0.13 | | 0.23 | | 0.23 | 0.22 | |
| AR | | | | | | | 0.48 | | | |
| AZ | 0.20 | | | 0.38 | | 0.18 | | 0.22 | 0.21 | |
| CA | 0.35 | | | 0.08 | | 0.29 | | 0.13 | 0.37 | |
| CO | 0.20 | | | 0.21 | | 0.18 | | 0.26 | 0.18 | |
| CT | | 0.19 | | | 0.30 | | 0.09 | | | |
| DC | 0.25 | | | | | | | | 0.22 | |
| DE | 0.15 | | | 0.09 | | 0.08 | | 0.15 | 0.16 | |
| FL | | | | 0.23 | | | | | | 0.22 |
| GA | | | | 0.16 | | | | | | |
| HI | 0.16 | | | 0.13 | | 0.11 | | 0.25 | 0.31 | |
| IA | 0.24 | | | 0.19 | | 0.28 | | 0.26 | 0.20 | |
| ID | | | | 0.24 | | | | | | |
| IL | 0.25 | | 0.07 | 0.17 | | 0.19 | | 0.22 | 0.24 | |
| IN | 0.24 | | | 0.25 | | 0.20 | | 0.24 | 0.24 | |
| KS | 0.17 | | | 0.21 | | 0.19 | | 0.15 | 0.17 | |
| KY | 0.19 | | | 0.18 | | 0.17 | | 0.23 | 0.18 | |
| LA | 0.20 | | | 0.20 | | 0.15 | | 0.16 | 0.19 | |
| MD | 0.15 | | | 0.17 | | 0.09 | | 0.12 | 0.15 | |
| ME | | | | | | | | | | |
| MI | 0.25 | | | 0.22 | 0.13 | 0.20 | | 0.27 | 0.27 | |
| MO | | | | 0.23 | | | | | | 0.09 |
| MS | | | | | | 0.27 | | 0.20 | 0.23 | |
| MT | 0.21 | | | 0.13 | | 0.19 | | 0.21 | 0.22 | |
| NC | 0.18 | | | 0.18 | | 0.18 | | 0.21 | 0.18 | |
| ND | | | | | | 0.21 | | 0.21 | 0.20 | |
| NE | 0.24 | | | 0.16 | | 0.25 | | 0.24 | 0.21 | |
| NH | | | | | | 0.12 | | 0.00 | 0.21 | |
| NJ | 0.12 | | 0.04 | | | 0.20 | | 0.11 | 0.11 | |
| NM | 0.25 | | | 0.27 | | 0.16 | | 0.19 | 0.23 | |
| NV | 0.32 | | | 0.16 | | 0.25 | | 0.32 | 0.32 | |
| NY | | | | | | | | | | |
| OH | 0.48 | | | 0.27 | | 0.28 | | 0.21 | 0.44 | |
| OK | 0.24 | | | 0.34 | | 0.21 | | 0.23 | 0.20 | |
| OR | 0.22 | | | 0.22 | | 0.24 | | 0.27 | 0.23 | |
| PA | 0.21 | | | | | 0.16 | | 0.23 | 0.18 | |
| RI | 0.23 | | | 0.16 | | 0.20 | | 0.20 | 0.16 | |
| SC | 0.27 | | | 0.24 | | 0.22 | | 0.27 | 0.26 | |
| SD | 0.27 | | | 0.15 | | 0.31 | | 0.24 | 0.26 | |
| TN | 0.23 | | | 0.19 | | 0.24 | | 0.24 | 0.25 | |
| TX | 0.21 | | | 0.35 | | 0.23 | | 0.22 | 0.19 | |
| UT | 0.20 | | | 0.26 | | 0.18 | | 0.17 | 0.16 | |
| VA | 0.24 | | | 0.19 | | 0.16 | | 0.21 | 0.20 | |
| WA | | 0.07 | | | 0.01 | | | | | |
| WV | 0.27 | | | 0.06 | | 0.20 | | 0.22 | 0.23 | |
| WY | 0.23 | | | 0.27 | | 0.19 | | 0.27 | 0.21 | |

Notes: Cell entries are coefficients of variation for policy in state. Empty cells indicate policy not sold in state. Policies are rank ordered in terms of covered lives, with the largest policy shown in Column 1. Policies coded as Plan Letter (A-J), Rating Method (AA, IA, CR). *Indicates a guaranteed issue version of the policy sold to all consumers (not just during open enrollment) in select states.

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

| | Tobit | IV Tobit | |
|---|---|---|---|
| | Demand Eq. | Demand Eq. | Price Eq. |
| Premium in 2004 | -0.003** | -0.008** | -- |
| | (0.000) | (0.001) | |
| Premium in 2001 | -- | -- | 0.891** |
| | | | (0.031) |
| Firm Weiss Safety Rating A | 1.128** | 4.273** | 156.241** |
| | (0.278) | (0.419) | (25.717) |
| Firm Weiss Safety Rating B | 1.492** | 2.222** | 53.829** |
| | (0.202) | (0.265) | (16.161) |
| Firm Weiss Safety Rating C | 0.432* | 0.680* | 50.355** |
| | (0.205) | (0.280) | (17.119) |
| No Weiss Safety Rating for Firm | 0.642 | 0.070 | -100.959 |
| | (0.896) | (1.137) | (71.364) |
| Firm Operates in >36 States | 0.033 | 1.297** | 114.477** |
| | (0.216) | (0.284) | (17.061) |
| Firm Operates in 23 to 36 States | -1.083** | 0.980** | 276.785** |
| | (0.224) | (0.343) | (18.373) |
| Number of Policies Offered by Firm | 0.013 | 0.094* | -5.286 |
| | (0.038) | (0.047) | (2.923) |
| Agent Solicited Policy | 1.399** | 3.135** | 148.448** |
| | (0.260) | (0.334) | (19.408) |
| Stale Price | 0.088 | -0.917* | -237.014** |
| | (0.364) | (0.446) | (27.060) |
| Policy on Market < 48 Months | -0.313 | -0.766* | -113.785** |
| | (0.215) | (0.344) | (20.524) |
| Policy on Market 48 to 72 Months | -0.023 | -0.428 | -4.406 |
| | (0.222) | (0.272) | (16.919) |
| Policy Loss Ratio <0.65 | -1.101** | -1.270** | 9.370 |
| | (0.169) | (0.224) | (14.334) |
| Policy Loss Ratio >1 | -4.543** | -4.145** | 82.329** |
| | (0.218) | (0.289) | (16.447) |
| Firm Loss Ratio CV over Policies | -0.611** | -1.123** | -16.701 |
| | (0.109) | (0.159) | (9.861) |
| Firm Price CV over Zip Codes | -5.854** | -4.259* | 512.547** |
| | (1.524) | (2.069) | (126.778) |
| Constant | 2.231** | 2.237** | 20.481* |
| | (0.108) | (0.146) | (9.207) |
| Observations | 3187 | 2177 | |

Notes: *, **: significant at 5 and 1 percent levels, respectively. All regressors entered in deviations from market-level mean, where markets are policy-state combinations. Reference group for Weiss Safety Rating is Category D; for states of operation is fewer than 23 states; and for policy market duration greater than 72 months. Stale prices are prices with effective date preceeding 2003. Standard errors in parentheses. Data are from Weiss Ratings, 2004 and NAIC, 2004.

Table 7. Alternative Specifications of Demand Equation (4')

| | OLS (1) | Tobit (2) | IV (3) | IV Tobit, No Controls (4) | IV Tobit, "Good" States (5) |
|---|---|---|---|---|---|
| Premium in 2004 | -0.003** | -0.004** | -0.006** | -0.009** | -0.008** |
| | (0.000) | (0.000) | (0.000) | (0.001) | (0.001) |
| Observations | 2177 | 2177 | 2177 | 2331 | 801 |

Notes: *, **: significant at 5 and 1 percent levels, respectively. All columns except (4) based on same specification as in Table X. Standard errors in parentheses. Column (4) has no covariates other than price (instrumented). In column (5), "Good" states are states in which the maximum within-firm CV over all zip codes is <0.10. Data are from Weiss Ratings, 2004 and NAIC, 2004.

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

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 $p_1$:

($16_2$') $$p_2 = \frac{(1+\gamma)}{(3+\gamma)}p_1 + \frac{(1+\gamma)}{(3+\gamma)}3S - \frac{(1+\gamma)(2+\gamma)}{(5+3\gamma)(3+\gamma)}6\left(\bar{X} - X_2\right) - \frac{(1+\gamma)^2}{(5+3\gamma)(3+\gamma)}3\left(\bar{X} - X_3\right)$$
$$+\frac{4\alpha_2(2+\gamma)}{(5+3\gamma)(3+\gamma)} + \frac{2\alpha_3(1+\gamma)}{(5+3\gamma)(3+\gamma)}$$

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

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

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

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

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:

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

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

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 $\beta$ 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 2004 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.

Our second dataset, from NAIC, contains data for all Medigap policies issued by insurance companies in a given state during the years 2002-2004. 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.

Both the Weiss data and the NAIC data have the unique NAIC identification code and company name of the firms offering a Medigap policy. We merge the two datasets based on the NAIC identifier, 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.) Appendix Table 1 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. Overall, the percent of covered lives represented by firms in the NAIC data that we successfully merge to firms in the Weiss data is 91 percent.

**[UPDATE]**Appendix Table 1**:** 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.