Competition Among Insurers and Consumer Welfare

By

Matthew White
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Competition Among Insurers and Consumer Welfare

Matthew N. White†
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Abstract
This article presents a model to analyze consumer welfare, price, and competition in a three-way market among consumers, medical providers, and insurers. While insurers compete with each other for customers, they also act as collective bargaining agents on behalf of consumers in determining the equilibrium price of health care with providers. The entry of an additional insurer thus has contradictory effects on welfare, reducing premiums through competition but increasing price through reduced bargaining power of incumbent insurers. Moreover, the more favorable contracts allow consumers to purchase care more often, shifting out the demand curve for care and increasing price.

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† Univ of Delaware, Dept of Economics (416B Purnell Hall, Newark DE 19702); mnwecon@udel.edu
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1 Introduction

In a market for medical care with a relatively small number of providers, firms are able to set their price above marginal cost; because any given individual has no market power, he cannot negotiate for a lower price by threatening to choose a different provider. The presence of medical insurers thus improves consumer welfare both by smoothing utility in the face of uncertainty (from medical needs shocks) and by acting as a collective bargaining agent on behalf of individuals to set the price of care. While a single individual’s threats are infinitesimal, the purchasing power of a set of individuals aggregated by an insurer provides real negotiating power. If an insurer can credibly threaten to not cover a provider’s services (withholding a segment of customers) unless that provider lowers its price of care, the equilibrium price level reached by this sort of bargaining will be significantly lower.

Policies to rein in the cost of medical insurance by increasing competition rely on the notion that when there are a larger number of firms competing for customers, they will offer insurance contracts more favorable to consumers (the “competitive effect”). However, there are also two countervailing effects from the entry of an additional insurer. First, the cannibalization of market share and thus a decrease in the threat power of both the incumbent and entrant insurers when negotiating prices with medical providers (the “bargaining effect”). Second, an outward shift in the demand curve for care due to the more favorable contracts, which increases the price of care (the “demand effect”). A larger number of competing insurers will generate more favorable insurance contracts conditional on the price of care, but the equilibrium price will be higher. In this way, the effect on consumer welfare from the entry of an additional insurer is ambiguous.

To better understand the conflicting role of competition in determining the price of insurance and medical care, this paper specifies and solves a model of the market for health care among consumers, insurers, and medical providers. The model includes competition among insurers on the terms of contracts, a form of price negotiation between insurers and providers, and moral hazard on the part of consumers so that all three effects emerge.

1.1 Discussion

In the model, providers each choose a price at which to sell care; after observing these prices, each insurer chooses a contract to offer, modeled as a premium and a copay for each provider.

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1 For example, the Affordable Care Act includes the creation of insurance exchanges, marketplaces that allow consumers buying individual policies to consider comparable policies from different insurers, forcing the firms to compete directly on price. Counterproposed policies would allow the interstate sale of insurance policies, increasing the number of insurers operating in local or state markets to foster more competition.
Upon seeing the menu of offered contracts, individuals choose up to one contract, learn their medical need, and decide whether to buy care. Individuals’ medical needs are drawn from a known distribution and are private information to that individual; an individual’s need is experienced as a penalty to utility unless the individual purchases a unit of care. Providers in the model engage in Bertrand competition on price, but face increasing marginal costs of producing care; this prevents providers from fully competing to the point where price equals marginal cost. In equilibrium, insurers randomly withhold coverage of each provider’s services when all providers offer the same price, creating variance in the quantity of care demanded from each one. Because the marginal cost of care is increasing, provider profit is concave with respect to quantity of care produced. The variation in demand thus reduces expected profit and induces providers to compete to prices lower than they could in the absence of bargaining. Intuitively, the equilibrium price of care is increasing in the number of insurers and decreasing in the number of providers.

An analysis of consumer welfare under an example parameterization of the model demonstrates that the overall effect on welfare from additional insurers is not always monotonic, but instead can follow a U-shaped pattern. The loss of bargaining power caused by an additional insurer is large when the number of incumbents is small; likewise, the shift in total demand for care is also larger when the number of insurers is small. Thus the entry of the second or third insurer can have a net negative impact on individuals’ welfare if these effects overwhelm the benefit of a more favorable insurance contract due to increased competition among insurers. The amount of bargaining power lost decreases with each entering insurer, and the total demand function similarly converges as the number of insurers grows. This allows the benefits of more competition to dominate, increasing individuals’ welfare when the number of incumbent insurers is relatively large. In contrast to the entry of an additional insurer, reducing barriers to competition (represented in the model as the variance of preference shocks over insurance contracts) among incumbent insurers has an unambiguously positive effect on welfare so long as at least two insurers compete.

The U-shaped welfare pattern is not universal, but rather depends on the parameters of the model. When the magnitude of medical needs shocks is doubled, for example, individuals’ welfare monotonically increases with the number of insurers when there are a relatively large number of providers. On the other hand, when the variance of preference shocks over insurance contracts is large (so that individuals are “poor shoppers”, unable to accurately compare contracts), individuals’ welfare monotonically decreases in the number of insurers in many cases. The baseline parameters have not been selected to match real world data, so the patterns seen in the analysis are meant to demonstrate the complexity of the interactions in the three-way market rather than to predict the outcome of specific policies.
Each of the three effects of insurer entry is directly captured in the model by a specific component. The three effects can be isolated by solving for the equilibrium of similar games in which particular components are removed or held constant, allowing the total effect of insurer entry to be decomposed. For example, the pattern of welfare with respect to the number of insurers can be considered when the bargaining effect is “turned off” by eliminating insurers’ threat power entirely (or by allowing insurers to collude when bargaining, maintaining full threat power even with multiple insurers). This decomposition reveals that the possible net loss of consumer welfare from the entry of an additional insurer does not require both the demand effect and bargaining effect: even if either is turned off, the U-shaped welfare pattern persists. When both effects are turned off, however, individuals’ welfare is strictly increasing in the number of insurers as well as medical providers, as only the competitive effect is present. The decomposition shows how individually rational choices to purchase insurance can aggregate to be collectively harmful through changes to the price of care induced by moral hazard.

To emphasize how strong a role moral hazard plays in increasing the equilibrium price of care, an alternative specification considers a world in which medical needs are observable and contractible. In the baseline model, insurers know that reducing individuals’ out-of-pocket cost of care will cause them to purchase care more often and for less severe medical needs than when they pay full price. A complete insurance contract (one with no copay) is thus impossible, as individuals would obtain care all of the time, even for the smallest medical conditions.\footnote{In the stylized model, there is no time cost of medical care, only monetary cost. Realistically, free health care would not actually result in 100% utilization.} In the alternative model, insurance contracts are complete in equilibrium, but specify a minimum level of medical need for the care to be reimbursed. Repeating the welfare analysis reveals that containing moral hazard in this way severely limits the outward shift in demand from additional insurers, while the competitive effect is enough to overcome the loss of bargaining power. Additional insurers strictly improve welfare (except in one corner case), and prices are significantly lower than in the baseline model. More strongly, welfare is almost universally higher when medical needs are observable than when the demand and bargaining effects are turned off in the baseline model.

1.2 Contribution to the Literature

The notion that insurers can use their market power to negotiate with hospitals and physicians for lower service prices is not new, and goes back at least as far as the 1980s. Moreover, moral hazard in health insurance markets has been studied for decades. While there have been empirical studies of insurer market concentration on negotiated service prices and pre-
miums offered to customers, to date no paper has combined all of these aspects into a single theoretical model. In particular, previous work has been silent on the generosity of insurance contracts (through lower copayments) with respect to competition among insurers and providers, and its effect on consumer welfare.

This paper contributes to the existing literature in several ways. First, it employs a form of bargaining not previously modeled, an extreme form of the patient channeling strategies described in empirical studies of insurer concentration. More importantly, it is the first theoretical model that simultaneously captures several effects that have been modeled or discussed separately in previous work: competition among insurers potentially reducing premiums, insurer concentration bolstering bargaining power, and moral hazard from medical insurance. Empirical work concerned with insurer-provider bargaining tends to focus on negotiated prices while ignoring the premiums passed on to consumers, while studies of insurer competition make the opposite choice. Both strands of literature nearly universally ignore the role of moral hazard—well documented in studies of the elasticity of demand for medical care. To that end, the model is also somewhat unique in explicitly accounting for the generosity of insurance contracts (through the copay) and solving for the equilibrium terms of the insurance contract. While no individual component of the model is fully novel, this paper synthesizes several previously identified phenomena into a single tractable model that allows an analysis of their interaction and effects on consumer welfare itself—rather than indirect proxies like premiums or negotiated prices—through several channels. Moreover, the results are consistent with an array of applied studies of these issues.

To provide context for the model’s structure, results, and contribution, this section provides an overview of the empirical literature on insurer competition and bargaining with providers and a brief discussion of the closely related literature on competition among hospitals. It further describes previous theoretical work on insurance network formation games and upstream-downstream bargaining games.

A common theme in work on setting hospital service prices is that an insurer must be able to channel its customers to particular hospitals in order to have bargaining power and reduce price. Staten, Dunkelberg, and Umbeck (1987) examine whether Blue Cross can force hospitals to offer discounted prices via their large market share and find no relationship between the insurer’s market share and the discount extracted on a hospital-by-hospital basis; they argue that BC is unable to direct its patients to specific hospitals as a punishment/reward mechanism in negotiations. Melnick, Zwanziger, Bamezai, and Pattison (1992) present evidence to show that negotiated prices are increasing in the importance of a hospital to patient preferences and decreasing in hospital competition in a local area. With more complete national data, Bamezai, Zwanziger, Melnick, and Mann (1999) also find evidence supporting
the importance of patient channeling; Wu (2009) argues that managed care organizations engage in “partial channeling” by channeling patients within a broad network.

Overall, the empirical literature is fairly mixed on the issue of whether increases in competition among insurers leads to lower hospital service prices or premiums. Melnick, Shen, and Wu (2011) find a negative association between negotiated hospital prices and concentration in insurer markets, and a positive association with hospital concentration. Bates and Santerre (2008) consider whether insurers use their market power to bust the near monopolies in concentrated provider markets or instead act as monopsonist intermediaries, finding no evidence of the latter. In contrast, Dafny (2010) presents evidence that insurers do not act as benevolent agents for consumers by passing all service price reductions on to customers in the form of reduced premiums, but instead engage in direct price discrimination that is only possible in imperfect markets. Moreover, Dafny, Duggan, and Ramanarayanan (2012) examine the effects of the merger between two very large national insurers on premium growth rates in local markets, finding that exogenous increases in concentration are associated with an increase in premium growth. Trish and Herring (2015) find that when insurers do not negotiate prices with hospitals, concentration is positively associated with premiums, and that this relationship reverses in the presence of negotiation; similar results are shown in section 4.3 when the bargaining effect is “turned off” and equilibrium recomputed.

Very recent work in Ho and Lee (2015) represents a close empirical counterpart to the theoretical results presented here. They estimate a rich structural model of household demand for health insurance, premium setting, and price negotiation between insurers and providers (in a Bertrand-Nash bargaining game), then simulate the removal of an insurer from the choice set to demonstrate the ambiguous effects of insurer competition on both negotiated prices and (potentially) consumer welfare through premiums. In contrast to the model presented here, Ho and Lee treat total demand for care as exogenous and insurance contracts as complete and thus do not consider the utility-smoothing welfare effects of insurance nor the role of moral hazard on insurance contracts and the price of care.\(^3\)

The literature on competition among medical providers universally finds that greater concentration leads to higher prices, as is typically expected. Capps and Dranove (2004) find that mergers among hospitals significantly raise negotiated prices in most cases. Less strongly, Haas-Wilson and Garmon (2011) find anticompetitive effects from one of the two hospital mergers that they study in close detail. Gaynor and Vogt (2003) estimate a structural model of for-profit and non-profit hospitals’ pricing decisions and then simulate the

\(^3\)More generally, they assume that the terms of insurance contracts does not vary with premiums, provider networks, or insurer competition. The issues of existence and uniqueness of equilibria are ignored, as the paper focuses on identifying and quantifying the several effects of insurer competition.
effects of mergers between hospitals of the same type. Taking a more theoretical approach, Capps, Dranove, and Satterthwaite (2003) model consumer preferences for hospitals as a discrete choice conditional on diagnosis; an insurer thus aggregates hospitals into a coverage network that acts as an option contract. Ho (2009) presents related evidence that individuals strongly weigh an insurer’s provider network when selecting a plan.

This paper's model includes a form of bargaining between insurers and providers in which the number of firms is fixed and a complete network is formed by all insurers in equilibrium, but the theoretical literature presents some alternative possibilities. Inderst and Wey (2003) analyze a model with two upstream suppliers selling to two downstream retailers, deriving conditions under which each side of the market would prefer to merge into a single firm. Gal-Or (1997) presents a related two-on-two model of insurer-provider bargaining, focusing on when there will be an exclusionary equilibrium in which neither insurer contracts with a particular hospital.

The particular form of bargaining here, in which an insurer uses the threat of complete and random patient channeling to introduce variance in quantity demanded from each provider, is unique to the literature (though weaker forms of it are hinted at in descriptive studies). However, there is no standard bargaining model employed universally in empirical studies that motivate their estimations with theoretical models. Nash bargaining seems to be a default choice, as in Ho and Lee (2015) and other papers. While the existence of equilibria can be demonstrated in these models, uniqueness is a persistent issue. Moreover, equilibria can often be characterized, but fully solving for an exact solution is difficult in a simultaneous bilateral negotiation model, as would be the case with $N$ insurers and $M$ medical providers. Alternative bargaining models include the take-it-or-leave-it approach in Ho (2009), with hospitals as the side making the single offer, or a sort of “reduced form Nash” approach in Capps, Dranove, and Satterthwaite (2003) in which the gains from trade are split between the insurer and provider in a fixed proportion. The unique form of bargaining presented here was selected specifically for its tractability and clean, closed-form solution, while generating the key results common in empirical studies.

The structure of this paper is as follows: Section 2 presents the model, Section 3 solves for the subgame perfect Nash equilibrium of the market, Section 4 analyzes consumer welfare in the model, and Section 5 concludes.

2 Model

This section describes a one-shot game representing a market for medical care and insurance. The players consist of a unit mass of consumers (individuals, patients) indexed by $i$, a finite
number of insurers indexed by \( j = 1, 2, ..., N \) and a finite number of medical providers indexed by \( k = 1, 2, ..., M \). Consumers use consumption and medical care to maximize their expected utility, insurers sell insurance contracts to individuals to maximize their expected profit, and medical providers produce medical care to sell to consumers (potentially intermediated by insurers) to also maximize expected profit.

2.1 Timing

The order of events during the game is as follows:

1. Each of the \( M \) medical providers simultaneously chooses a price \( p_k \in \mathbb{R}_+ \) at which to sell medical care.

2. Each of the \( N \) insurers learns the vector of prices \( \vec{p} = (p_1, \cdots, p_M) \), then they each simultaneously choose an insurance contract \( \hat{\chi}_j \in \mathbb{R}_+^{M+1} \) to offer, representing the copays for each provider and the premium.

3. Consumers see the menu of offered insurance contracts \( \hat{X} = (\hat{\chi}_0, \hat{\chi}_1, \cdots, \hat{\chi}_N) \) and choose one to purchase (possibly a null contract), paying the premium for that contract.

4. Consumers learn their level of medical need, decide which provider to purchase care from (possibly none) and how much to consume.

5. Each medical provider produces care to meet consumers’ purchasing decisions, incurring production costs and gaining revenue from sales at their chosen price. Care is paid for by insurers and consumers at the contracted cost sharing.

2.2 Consumers

Consumers have a common utility function over consumption \( u(x) \), with \( u'(x) > 0 \) and \( u''(x) \leq 0 \) for all \( x > 0 \); as a technical condition, \( \lim_{x \to 0^-} u'(x) = \infty \), which is satisfied by constant relative risk aversion (CRRA) utility with coefficient of risk aversion \( \rho \). Each consumer \( i \) has a medical need or pain shock \( \eta_i \), which is continuously distributed on \( \mathbb{R}_+ \) according to CDF \( F(\eta) \) with associated PDF \( f(\eta) \). Pain is experienced as a penalty to utility unless the consumer obtains a unit of medical care \( m \in \{0, 1\} \), negating the pain. For each insurance contract (including the null contract described below) in a menu \( \hat{X} = (\hat{\chi}_0, \hat{\chi}_1, \cdots, \hat{\chi}_N) \), consumer \( i \) has an associated personal preference shock \( \epsilon_{ij} \) drawn from a T1EV distribution with standard deviation \( \sigma \); he receives this shock as a bonus to utility if
he purchases that contract. A consumer’s total utility is thus given by:

\[ U(x_i, \eta_i, m_i, \epsilon_{ij}) = u(x_i) - \eta_i(1 - m_i) + \epsilon_{ij}. \]  

(1)

An individual does not learn his \( \eta_i \) until after he chooses an insurance contract to purchase, whereupon it is private information unobservable to providers or insurers. The preference shocks for each insurer are known before the individual selects an insurance contract. Let \( D_{ik} = 1 \) when the individual purchases care from provider \( k \) and \( D_{ik} = 0 \) if he does not (\( D_{i0} = 1 \) when the individual does not buy care at all).

Each consumer has access to \( y > 0 \) in income or financial resources. Consumption can be purchased at a price of 1, while the out-of-pocket price of medical care depends on the consumer’s insurance contract. If the consumer has insurance contract \( \hat{\chi} = (z, \vec{c}) \), then the unit of medical care costs \( c_k \) if he buys care from medical provider \( k \). To have contract \( \hat{\chi} \), the consumer paid insurance premium \( z \), reducing his resources with which to purchase consumption whether or not he buys care. The null contract \( \hat{\chi}_0 = (0, \vec{p}) \) is always available, where \( \vec{p} \) is the vector of prices charged by the medical providers. Conditional on out-of-pocket cost, a consumer has no preferences among medical providers.

When choosing an insurance contract, the consumer’s problem is to:

\[ \max_{j \in \mathbb{N}} \mathbb{E}[U(x_i, \eta_i, m_i, \epsilon_{ij})]. \]  

(2)

The expectation is taken over the distribution of medical needs that the consumer could experience. After the contract \( \hat{\chi}_j \) is selected (and trivially defining \( c_{j0} = 0 \)), the level of need \( \eta_i \) becomes known and the individual’s problem is:

\[ \max_{x_i, k \in \mathbb{N}_M} U(x_i, \eta_i, m_i, \epsilon_{ij}) \text{ s.t. } x_i + c_{jk} + z_j \leq y, \ m_i = 1(k > 0). \]  

(3)

### 2.3 Insurers

Each insurer \( j \) simultaneously chooses a single insurance contract \( \hat{\chi}_j = (z_j, \vec{c}_j) \) to offer in order to maximize profit. When offering contract \( \hat{\chi}_j \), the expected profit from each consumer who buys the contract is:

\[ r(\hat{\chi}_j) = z_j - \sum_{k=1}^{M} \text{Prob}(D_{ik} = 1|\hat{\chi}_j)(p_k - c_{jk}). \]  

(4)

Defining \( q(\hat{\chi}_j|\hat{X}_{-j}) \) as the proportion of consumers who select \( \hat{\chi}_j \) when rival firms (in-
cluding the “null firm”) offer \( \hat{X}_{-j} \), then an insurer’s expected profit is:

\[
\pi(\hat{\chi}_j|\hat{X}_{-j}) = r(\hat{\chi}_j) \cdot q(\hat{\chi}_j, \hat{X}_{-j}).
\]

(5)

2.4 Medical Providers

Medical providers have a common production cost function \( \kappa(D_k) \) that is increasing and convex in the quantity demanded from that provider \( D_k \). To simplify analysis, assume there are no fixed costs, \( \kappa(0) = 0 \), and that the first units of care are very easy to produce, \( \kappa'(0) = 0 \). A provider must sell to all customers who wish to purchase care at the price chosen by that provider. When provider \( k \) sells care at price \( p_k \) and \( D_k \) individuals want to buy care, it receives expected profit of:

\[
\hat{\pi}_k = p_k D_k - \kappa(D_k).
\]

(6)

2.5 Equilibrium Defined

A strategy for a medical provider is a choice of \( p_k \in \mathbb{R}_+ \). A strategy for an insurer is a function \( \phi : \mathbb{R}_+^M \to \mathbb{R}_+^{M+1} \) that maps vectors of prices offered by providers into a choice of insurance contract to be offered. A strategy for an individual is a function \( \psi^c : \mathbb{R}_+^{N+M+NM} \times \mathbb{R}_+^{N+1} \to \{0, 1, \cdots, N\} \) that selects an insurance contract from a menu (taking account of his preference shocks) and a function \( \psi^a : \mathbb{R}_+^{M+2} \to \mathbb{R}_+ \times \{0, 1, \cdots, M\} \) that maps the insurance contract and medical needs into a choice of consumption and from which provider to purchase care.

Section 3 characterizes a subgame perfect Nash equilibrium for the insurance market game described above. As will be shown in Sections 3.2 and 3.3, the only SPNE are symmetric and have a complete network. In this case, symmetry means that all players of the same class (consumers, insurers, and providers) choose the same strategy. An equilibrium with a “complete network” is one where equilibrium behavior results in a consumer having strictly positive probability of purchasing care from any provider via any insurer, before medical needs or personal preferences are realized. In an equilibrium, individuals maximize their utility by selecting an insurance contract from the offered menu, and then optimally choose whether to purchase care once their medical need is known; each insurer offers a contract that maximizes its expected profit when individuals obey their equilibrium strategy, holding fixed the prices set by each provider and the contracts offered by rival insurers; and each provider chooses a price that maximizes their expected profit when insurers and individuals obey their equilibrium strategies, holding fixed the prices set by rival providers.
2.6 Discussion

Individuals’ preference shocks over insurance contracts have several possible real world analogues. First, the shocks could represent imperfect information or difficulty understanding contracts. While the model presents a relatively simple environment, it acts as a stand-in for the much more complex insurance contracts that real consumers face. Inability to precisely compare two or more insurance contracts would lead to “choice error”, allowing worse contracts to be purchased by some individuals. Alternatively, real individuals might face search costs to learn about insurance contracts, leading some of them to settle for “good enough” contracts. Both of these explanations are employed by Maestas, Shroeder, and Goldman (2009) in their analysis of price dispersion in heavily standardized Medigap insurance policies. Similarly, Frank and Lamiraud (2009) present evidence that consumers make less optimal decisions over health insurance contracts as the number of options becomes very large, and are likewise less willing to switch policies even when considerable savings are possible. Related, the fact that many individuals are offered medical insurance through their employer acts as a sort of preference shock, making certain insurers more accessible to an individual. Under any of these interpretations, we can consider how improving individuals’ information or access to competing plans (the variance of preference shocks) affects equilibrium outcomes in terms of welfare and price.

One could argue that, in reality, individuals have heterogeneous preferences over medical providers as well as insurers. Any given household might live significantly closer to one hospital or another, reducing travel costs, or a patient might have an existing relationship with a doctor at a particular provider. For example, the theoretical model in Gal-Or (1997) is effectively a two-dimensional Hotelling spatial differentiation setting, with the “length” of each dimension representing the degree of attachment to insurers or providers. These preferences undoubtedly exist, and might even have larger variance than the heterogeneity of preferences with respect to insurers. Their inclusion in a theoretical model, however, greatly complicates the analysis that characterizes equilibrium and how it changes with the number of insurers and medical providers—indeed, Gal-Or finds no pure strategy bargaining equilibrium in many circumstances. As this model is meant to provide a tractable framework with a particular focus on the several effects of insurer entry, this type of heterogeneity is omitted.

The most important property is that both insurers and providers compete with

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4 The magnitude of $\sigma$ can also be interpreted as the inverse of the coefficient on willingness-to-pay for insurance as estimated by Ho and Lee (2015), so that consumers are less sensitive to the “true value” of a contract and more dependent on unobserved, idiosyncratic preferences.

5 Further, preference shocks for providers must be unknown by consumers themselves until after contracts are purchased, a somewhat strange assumption that is not explicitly mentioned in the presentation of these models. Likewise, specifying the model to allow providers to set a separate price for each insurer (as well as
each other in an imperfect market that allows positive profits for all in equilibrium.

3 Model Equilibrium

The model will be solved backwards, starting from consumers’ choice of consumption and from which provider to purchase care (if any), and then consumers’ choice of insurance contract from a fixed menu. Taking consumers’ equilibrium strategy as fixed, I then find insurers’ equilibrium choice of “reduced form” insurance contract to offer conditional on providers’ prices (which does not depend on their strategy for their provider network). Finally, I solve for the equilibrium price that providers will offer under two strategies for insurers to include providers in their network.

3.1 Consumers’ Equilibrium Strategy

Equilibrium behavior for the consumer is straightforward to find. Because any given consumer has no strategic threat value, each consumer simply tries to maximize his own utility conditional on the menu of contracts offered.

Claim 1. After an insurance contract has been selected, a consumer purchases care if and only if it would result in higher utility given his realized pain, consuming all remaining resources. If care is purchased, it is from a provider with the lowest copay for that contract.

The individual will consume any resources not spent on the premium or copay because \( u'(x) > 0 \). Moreover, an optimizing consumer who purchases care will do so from the provider with the lowest out-of-pocket price, as doing otherwise would reduce his payoff from consumption. For any insurance contract, only the lowest copay value is relevant, so we can write the “reduced form contract” of \( \hat{\chi} \) as \( \chi = (z, \min(\bar{c})) = (z, c) \). A consumer can randomize among any providers with the lowest copay.

Claim 2. Consumers holding reduced form contract \( \chi \) purchase care with probability

\[
\text{Prob}(m_i = 1|\chi) = 1 - F(u(y - z) - u(y - z - c)).
\]

Conditional on having contract \( \chi = (z, c) \), he will choose the higher utility between purchasing and not purchasing care, receiving a payoff of:

\[
\max\{u(y - z) - \eta, u(y - z - c)\} = \max\{u_0 - \eta, u_1\}. \tag{7}
\]

an uninsured price) significantly complicates the proof of equilibrium.
Defining $\Delta u = u_0 - u_1$, a consumer buys care when $\Delta u > \eta$, which occurs a fraction $1 - F(\Delta u)$ of the time. That is, $\text{Prob}(m_i = 1|\hat{\chi}) = 1 - F(\Delta u)$, which will be relevant for an insurer’s decision problem. Temporarily omitting the personal preference shock $\epsilon_{ij}$, if a consumer purchases contract $\chi$, his expected utility is:

$$
\sigma\bar{u}(\chi) = F(\Delta u)u_0 + (1 - F(\Delta u))u_1 - \int_0^{\Delta u} \eta f(\eta)d\eta = u_1 + F(\Delta u)\Delta u - \int_0^{\Delta u} \eta f(\eta)d\eta. \quad (8)
$$

That is, he receives $u_1$ the portion of time that he purchases care, $u_0$ the portion of time that he does not purchase care, and experiences pain when he does not purchase care.\(^6\)

**Claim 3.** A consumer selects the contract that offers him the highest expected utility before his medical needs are known.

We can now formally define the two functions that compose individuals’ equilibrium strategy. To select an insurance contract, the individual maximizes his total utility among the menu of choices $\hat{X} = (\chi_0, \chi_1, \cdots, \chi_N)$, taking account of his preference shocks among these contracts:

$$
\psi^c(\hat{X}, \epsilon_i) = \arg \max_j \sigma\bar{u}(\chi_j) + \epsilon_{ij}. \quad (9)
$$

Defining the operator $\text{Rand}(\cdot)$ as a random selection from the given set, the individual’s optimal consumption and medical care decision rule is:

$$
\psi^a(\hat{\chi}, \eta_i) = \begin{cases} 
(y - z, 0) & \text{if } \eta_i < \Delta u \\
(y - z - c, \text{Rand}(K)) & \text{if } \eta_i \geq \Delta u
\end{cases}, \quad K = \{\arg \min_k c_k\}. \quad (10)
$$

### 3.2 Insurers’ Equilibrium Strategy

Turning now to the equilibrium behavior of insurers, this section first characterizes an insurer’s best response to his rivals’ choices, then demonstrates the existence of the (very likely unique) symmetric equilibrium contract for each price offered by insurers, and finally formalizes this equilibrium to match the definition provided in Section 2.5. Consumers are assumed to follow the strategy above (due to subgame perfection), and the vector of prices is treated as fixed at some $\vec{p}$ already chosen by providers.

#### 3.2.1 Insurers’ Profit and Best Response

**Claim 4.** Insurer profit as a function of its own contract $\chi_j$ is an analytic function of the premium $z_j$ and the smallest copay offered $\min(c_j)$, and only depends on rival insurers’

\(^6\)The factor of $\sigma$ is included here so that the insurance contract choice probabilities follow the typical formula. Inversely scaling the expected utilities is equivalent to scaling the magnitude of preference shocks.
contracts through the sum of exponentiated expected utilities of those contracts.

With consumers’ equilibrium behavior known, we can refine the functional definitions in section 3.2. It can never be optimal to offer the lowest copay rate for providers charging different prices; thus we need only consider contracts that offer the lowest copay to the provider(s) charging the lowest price. Now when insurer $j$ offers reduced form contract $\chi_j$, his expected profit per customer is:

$$r(\chi_j) = z_j - (1 - F(\Delta u_j))(p - c_j), \quad p = \min(\overline{p}).$$

(11)

The insurer’s share of consumers (the proportion of individuals who purchase the contract) can also now be defined. When an insurer offers reduced form contract $\chi_j$ and the full menu of reduced form contracts is $X$, that insurer’s share of customers is:

$$q(\chi_j|X_{-j}) = \frac{\exp(\overline{u}_j)}{\exp(\overline{u}_j) + \sum_{\ell \neq j} \exp(\overline{u}_\ell)}, \quad \overline{u}_\ell = u(\chi_\ell).$$

(12)

This is the well known result of a discrete choice problem with T1EV distributed errors. An insurer’s profit is simply the product of per customer expected profit and the share of consumers who purchase its contract, conditional on all other reduced form contracts offered:

$$\pi(\chi_j|X_{-j}) = r(\chi_j)q(\chi_j|X_{-j}).$$

(13)

While the expected profit from offering a particular contract depends on the contracts of all other insurers, all of the relevant information about these contracts can be summarized by the sum of their exponentiated expected utilities, $\hat{A} = \sum_{\ell \neq j} \exp(\overline{u}(\chi_\ell))$.

Claim 5. For any set of contracts offered by rival insurers, there exists a (non-negative profit) profit-maximizing contract to offer in response that is almost certainly unique. When it is unique, the best response contract is a continuous function of rivals’ contracts.

It can be shown that there exists a non-negative expected profit best response contract for any menu of rivals’ offered contracts $X_{-j}$ and at any price. Moreover, this best response is almost certainly unique, as the insurer’s profit function $\pi(\chi_j|X_{-j})$ is single peaked and quasi-concave among contracts that are not useless to individuals. Applying Berge’s maximum theorem, by the continuity of the underlying functions and the local quasi-concavity of the

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7Unfortunately, the typical methods for showing uniqueness of the local maximum are not fruitful in this case. The profit function is not strictly concave, nor is it even quasi-concave; proof of a single-crossing property of the isoquants of the function’s partial derivatives is also elusive. Figure 1 shows a typical contour plot of insurer profit by contract offered. The patterns shown are consistent across parameterizations.
proof function, the best response correspondence is a continuous function of $\hat{A}$, the summary statistic of rivals’ choices. Proof of the existence of the best response and discussion of its uniqueness are provided in Appendices A.1 and A.3.

### 3.2.2 Symmetric Equilibrium Among Insurers

**Claim 6.** There is a unique and symmetric equilibrium to the subgame among insurers, with all insurers offering the same contract. At any fixed $p$, the expected utility of the equilibrium contract is increasing in the number of insurers.

Note that when the best response to any menu of rivals’ contracts (summarized by $\hat{A}$) is a unique contract, the graph of all contracts that are best responses to some menu is a single locus. The monotonicity of the best response functions for the premium and copay are established in Appendix A.4; they are plotted in Figure 3. For mathematical convenience, define $A = \sum_{\ell \neq j} 0 \exp(u(\chi_\ell))$, the same as $\hat{A}$ but now excluding the null contract $(0, p)$. Labeling these functions as $\hat{z}(A)$ and $\hat{c}(A)$, we can define a new best response function $\nu_p(A) = \exp(\hat{z}(A), \hat{c}(A))$, the exponentiated expected utility of the best response contract when the sum of exponentiated expected utilities of rival insurers’ contracts is $A$ and the price is $p$. As both best response functions, the expected contract utility function, and the exponential function are all strictly monotone up, $\nu_p(\cdot)$ is also strictly increasing.

If there are $N$ insurers, then a symmetric equilibrium occurs at an exponentiated expected utility level $\tilde{u}$ where:

$$\tilde{u} = \nu_p((N - 1)\tilde{u}). \tag{14}$$

That is, if each of insurer $j$’s $N - 1$ rivals offers a contract with exponentiated expected utility $\tilde{u}$, then insurer $j$’s best response is to also offer a contract with the same exponentiated expected utility.\(^8\) This best response is unique, thus defining a symmetric equilibrium when all insurers obey the best response functions. Appendix B establishes that only symmetric equilibria can exist, that there is at least one symmetric equilibrium, and that the symmetric equilibrium is almost surely unique. At any price $p$, the equilibrium contract’s expected utility is strictly increasing in $N$. However, the arrival of the first insurer hardly improves expected utility, as a monopolist can offer a contract barely better than no insurance and still capture half of consumers with high per customer profit. The second (and subsequent) insurer forces significant competition for customers, resulting in a large cut to the premium and (to a lesser extent) copay.

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\(^8\)The fixed point equation in (14) is demonstrated graphically in Figure 2. The equilibrium levels of $A$ are likewise marked on Figure 3 to show the premium and copay that emerge for each number of insurers.
3.2.3 Equilibrium Formalized

The previous subsections established that there is a unique symmetric equilibrium of reduced form contracts for any vector of prices \( \vec{p} \) offered by providers, which only depends on the lowest price \( p \). Label this reduced form contract as \( \hat{\chi}^* = (z^*(p), c^*(p)) \). As described above, in equilibrium insurers will offer their lowest copay rate only for providers who offer the lowest price. Both individuals and insurers are indifferent between a contract that offers its lowest copay for just one provider and multiple providers, thus there are multiple equilibria in insurance contracts as originally specified when providers tie for the lowest price:

\[
\phi(\vec{p}) = (z^*(p), c^*(p) + 1(\vec{p} > p) + g(S)) \text{ for any } S \subset \{ k | p_k = \min \vec{p} \} \equiv S,
\]

\[
g : \varphi(N_M) \to \{0, 1\}^M, \quad g_k(S) = 1(k \in S).
\]

This can be interpreted as representing an insurer’s provider network: those who are “in network” are assigned the equilibrium copay, while providers “out of network” are given an arbitrarily higher copay that will never be chosen by individuals. The equilibrium strategy excludes any provider that does not offer the lowest price and a strict subset \( S \) of providers who do offer the lowest price \( S \). In the simplest case of \( S = \emptyset \), insurers include in their network all providers who offer the lowest price– a pure strategy with no bargaining.\(^9\)

**Claim 7.** There is a unique demand function that maps \( \vec{p} \) into the proportion of consumers who will buy medical care when there are \( N \) insurers. Total demand \( D_N(\vec{p}) \) is strictly decreasing in \( p \).

As only the low price matters for the equilibrium contract, demand can be expressed as:

\[
D_N(\vec{p}) = \sum_{j=0}^{N} q(\hat{\chi}_j^*|\hat{\chi}^*_j)(1 - F(\Delta u_j)), \quad \hat{\chi}^*_j = \phi(\vec{p}) \text{ for } j > 0, \quad \hat{\chi}^*_0 = (0, \vec{p}).
\]

Demand for care is the proportion of consumers selecting each contract who purchase care, weighted by the share of each contract. In equilibrium, \( N \) insurers will offer the same optimal contract, in addition to the always available null contract.\(^{10}\) Demand functions for different number of insurers (at the base parameters) are shown in Figure 5. These functions are strictly decreasing in price, but are neither concave nor convex for their entire spans. Moreover, demand for care is increasing in the number of insurers at higher prices, but is

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\(^9\)This simple choice of \( S \) is briefly examined in section 3.3.1, while a mixed “threatening” strategy introduced in section 3.3.2 is used for most of the analysis.

\(^{10}\)The dependence on \( N \) has been implicit throughout this analysis, but is made explicit here to aid in later discussion of how the equilibrium changes with \( N \) and \( M \).
weakly decreasing in $N$ at very low prices. These properties are formally established and discussed in Appendix C.

### 3.3 Medical Providers’ Equilibrium Strategy

If both individuals and insurers obey the equilibrium behavior described above, the game played among medical providers is relatively tractable to analyze. Two equilibria will be presented: first, a “simple” equilibrium in which the price of care is determined only by providers competing amongst themselves; and second, a “threatening” equilibrium in which insurers use their market power to effectively bargain for a lower equilibrium price than can be achieved in the simple equilibrium. The only difference between the two equilibria is insurers’ strategy for including providers in their network (by assigning them the lowest copay). The threatening equilibrium will be primarily used in the analyses in Section 4, with the simple version presented as a benchmark to demonstrate the effect of bargaining.

Starting with the case where there is only a single provider, we can now fill in (6) as:

$$\hat{\pi}(p) = pD_N(p) - \kappa(D_N(p)).$$

(17)

**Claim 8.** A monopolist medical provider prices above marginal cost, and the equilibrium price does not depend on whether the simple or threatening strategy is used by insurers.

To maximize profit, the monopolist provider must simply satisfy its first order condition:

$$D_N(p) = (\kappa'(D_N(p)) - p)D_N'(p).$$

(18)

The cost function $\kappa(\cdot)$ will be parameterized as a single quadratic term, so that $\kappa'(D_N(p))$ is linear in demand. The demand function is neither strictly concave nor convex, preventing a mathematical proof that there is a unique solution to the first order condition. In practice, however, the monopolist profit is concave with respect to price and thus has a unique maximizer. A monopolist cannot be credibly threatened with loss of business by exclusion from an insurer network. The monopolist prices above marginal cost, as the first factor of the RHS of (18) must be negative for the first order condition to be met (as $D_N(p)$ is positive while $D_N'(p)$ is negative).

#### 3.3.1 Simple Equilibrium

In the more interesting case where there are $M \geq 2$ medical providers, it is easy to show that the equilibrium must be symmetric and that all providers will earn non-negative profits; a
proof is provided in Appendix D. Suppose all insurers automatically include in their network all providers with the lowest price, so that $S = \emptyset$.

**Claim 9.** When insurers include in their network any provider offering the lowest price, the range of symmetric equilibrium prices is given by $\frac{1}{M} \gamma D_N(p^*) \leq p^* \leq \left(1 + \frac{1}{M}\right) \gamma D_N(p^*)$.

What prices can be supported as a symmetric equilibrium? Suppose all providers are offering $p_0$ and earning positive profits, and that the cost function is $\kappa(x) = \gamma x^2$ so that marginal cost is linearly increasing, $\kappa'(x) = 2\gamma x$. No provider could profitably deviate by raising his price, as this would result in zero profit. If a provider lowered his price very slightly, he would capture all of the demand but would need to pay much higher production costs. He can profitably reduce price by a tiny amount when:\[11\]

$$D_N(p) p - \kappa(D_N(p)) > \frac{D_N(p)}{M} p - \kappa \left(\frac{D_N(p)}{M}\right) \implies D_N(p) p - \gamma D_N(p)^2 > \frac{D_N(p)}{M} p - \gamma \frac{D_N(p)^2}{M^2} \implies$$

$$\implies p > \left(1 + \frac{1}{M}\right) \gamma D_N(p).$$

Because $D'_N(p) < 0$, this inequality has exactly one critical point in $p$. These prices are not an equilibrium because a provider can profitably deviate. At the opposite end, some prices are so low that even if all providers sold at them, demand (and thus costs) would be so high that all would earn negative profits. In that case, a provider can profitably deviate by raising his price to earn zero instead. Negative profits are earned with symmetric pricing when:

$$\frac{D_N(p)}{M} p - \kappa \left(\frac{D_N(p)}{M}\right) < 0 \implies p < \frac{1}{M} \gamma D_N(p).$$

As before, this inequality has a single critical point in $p$, so the prices ruled out as equilibria are a convex set.

Combining (19) and (20), the prices that constitute symmetric equilibria are given by:

$$\frac{1}{M} \gamma D_N(p^*) \leq p^* \leq \left(1 + \frac{1}{M}\right) \gamma D_N(p^*).$$

Thus the pure strategy\[12\] subgame perfect Nash equilibrium with a complete network is not unique, as an entire range of prices are admissible as equilibria. With pure strategies, insurers are unable to wield their market power to encourage providers to lower their prices. If a provider reduces his price from a symmetric equilibrium, insurers will reduce the copay for

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\[11\] The lower bar on $p$ is temporarily dropped to reduce notational clutter.

\[12\] When labeling this a “pure strategy” equilibrium, I ignore the randomization by individuals between providers offering the same price, which cannot be avoided.
that provider, pushing all customers to him and thus forcing large production costs relative to having demand split among all providers. In this way, if providers are already pricing at the ceiling of the equilibrium range, they will not compete to lower equilibrium prices.

### 3.3.2 Threatening Equilibrium

A key feature of the model is that individuals and insurers are indifferent among providers, conditional on price. If an insurer offers its lowest copay for one provider with the lowest price, the insurer has nothing to gain or lose from also offering the lowest copay for another provider at the low price. Insurers can use this to break the symmetric equilibrium in the upper range of prices given in (21), lowering the ceiling on equilibrium prices. Only a weak form of mixing is required to execute the strategy, and only in a very particular circumstance: when all providers offer the same price, each insurer will randomly choose exactly one provider to cover with the equilibrium copay rather than covering all of them.

**Claim 10.** If each insurer randomly selects one provider offering the lowest price to include in its coverage network, demand for each provider’s services will have the same mean as in the simple equilibrium, but with positive variance. This reduces expected provider profit while leaving insurer profit unchanged.

Rather than play a pure strategy of $S = \emptyset$, insurers instead play the mixed strategy:

$$S = \begin{cases} S \setminus \{ \text{Rand}(S) \} & \text{if } \min(p) = \max(p) \\ \emptyset & \text{otherwise} \end{cases}.$$  

Thus the new strategy calls for insurers to include in their network only a single, randomly chosen provider (independent across insurers) when providers all offer the same price. Subgame perfection is maintained as insurers always offer the equilibrium reduced form contract, but strategically withhold coverage from providers.

When insurers employ the strategy given in (22) and providers price equally, the variance of demand for a particular provider’s services takes a positive value, but the mean of demand is unchanged from the pure strategy equilibrium—the each provider will receive $\frac{1}{M}$ of the total demand $D_N(p)$ on average. With the price of care fixed at some $p$, each provider faces uncertain profit. When marginal cost is linear (as above), profit follows a quadratic form with an expected value of:

$$\mathbb{E}[\hat{\pi}_k | p = \bar{p}] = \frac{D_N(p)}{M} p - \gamma \left( \varsigma^2 + \left( \frac{D_N(p)}{M} \right)^2 \right), \quad \varsigma^2 \approx \frac{M - 1}{M^2 N} D_N(p)^2. \quad (23)$$
In this equation, $\varsigma^2$ is defined as the variance of demand for provider $k$’s services. When the mixed strategy is (22), demand is the sum of $N$ Bernoulli random variables, each returning $\frac{1}{N}$ with probability $\frac{1}{M}$ and zero otherwise, thus the form of $\varsigma^2$ above.\textsuperscript{13}

**Claim 11.** When each insurer randomly chooses one provider to include in their coverage network if all providers price equally, the ceiling on equilibrium prices is given by $p^{**} = (1 + \frac{1}{M} - \frac{1}{MN}) \gamma D_N(p^{**})$. This ceiling is lower than when insurers use the simple strategy.

If a provider can choose a price very slightly below the current symmetric pricing and achieve higher expected profit, then the current $p$ is not an equilibrium under mixed insurer strategies. Combining the two parts of (23), this occurs when:

$$D_N(p)p - \gamma D_N(p)^2 > \frac{D_N(p)}{M} p - \left( \frac{M - 1}{M^2 N} + \frac{1}{M^2} \right) \gamma D_N(p)^2 \implies p > \left( 1 + \frac{1}{M} - \frac{1}{MN} \right) D_N(p).$$  \hspace{1cm} (24)

The unique critical point of this inequality defines $p^{**}$, the ceiling of the equilibrium price range when insurers use mixed strategies. If providers are pricing symmetrically at or below $p^{**}$, the threat of facing random demand does not induce them to undercut their competitors, as absorbing all of the demand would generate such large costs. Thus the new range of equilibrium prices is characterized by:

$$\frac{1}{M} \gamma D_N(p^*) \leq p^* \leq \left( 1 + \frac{1}{M} - \frac{1}{MN} \right) \gamma D_N(p^*).$$  \hspace{1cm} (25)

Allowing mixed strategies among insurers lowers the ceiling of equilibrium prices, as the rightmost expression of (25) is smaller than that of (21). The floor is unchanged, as providers will never accept symmetric pricing that results in negative expected profits, preferring to price arbitrarily high and guarantee zero profit. As in the pure strategy equilibrium, the ceiling is decreasing in the number of medical providers due to competitive effects. Unlike the simple equilibrium, the upper bound of equilibrium prices now depends on the number of insurers. When an additional insurer enters the market, the variance of demand decreases, reducing the threat value of the random demand faced by providers. Thus the ceiling of equilibrium prices is increasing in the number of insurers due to reduced bargaining power.

**Claim 12.** The symmetric equilibrium price can be expressed as the market clearing price between demand for care $D_N(p)$, determined by the equilibrium of the subgame among insurers,

\textsuperscript{13}The definition of $\varsigma^2$ is an approximation. So long as a provider is priced at the lowest price among rivals, demand for its services can never fall to zero. Even if no insurer randomly selects provider $k$ for the lowest copay, $k$ will still have uninsured customers. The approximation is very accurate for several reasons: the share of uninsured customers tends to be small in equilibrium, the proportion of uninsured individuals who buy care is small, and the probability that no insurer covers a particular provider is small when $N > 2$. 

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and a “pseudo-supply” function $S_{M,N}(p)$, determined by the equilibrium among providers.

The right half of (25) can be rearranged to express the equilibrium price ceiling as a “pseudo supply curve”, yielding:

$$S_{M,N}(p) = \frac{p}{\gamma (1 + \frac{1}{M} - \frac{1}{MN})} \text{ for } N > 0 \& M > 1, \quad S_{M,N}(p) = \frac{p}{\gamma (1 + \frac{1}{M})} \text{ for } N = 0.$$  

When there are no insurers or only one medical provider, the threatening equilibrium cannot be used; the right half of (21) is used when there are no insurers, while this analysis does not apply at all when there is a monopolist provider. This linear function of the price of care represents the combinations of price and quantity of care that could be supply-side (ceiling) equilibria, rather than the quantity of care that firms are willing to supply at each price as in a traditional supply curve. The price that satisfies $S_{M,N}(p) = D_N(p)$ is thus the unique equilibrium price that will be offered by all medical providers. The determination of equilibrium price and quantity is shown in Figure 6 for $M = 2$ and variable $N$.

**Claim 13.** The ceiling of the equilibrium price range is never less than marginal cost at the equilibrium quantity. Price equals marginal cost iff there is one insurer and two providers.

If all medical providers price equally, the competitive price is characterized by $\frac{2}{M} \gamma D_N(p) = p$. When there is only a single insurer and exactly two medical providers, the monopolist insurer can force the price to the competitive level, but at any other combination of insurers and providers the top end of the equilibrium range will be higher. Just as in the subgame among insurers, the model is characterized by imperfect competition among providers in nearly all cases. As a final note, the mixed strategy employed by insurers is ideal from the perspective of consumers, as it maximizes the threat power of insurers (while maintaining subgame perfection) and thus results in the lowest equilibrium price ceiling possible.

## 4 Competition and Consumer Welfare

Having characterized equilibrium behavior for all players, we can now consider how competition among insurers and medical providers affects outcomes. The utility function is specified as CRRA, while the distribution of medical needs is exponential with mean $\lambda$; baseline parameters are provided in Table 1. The analysis begins with equilibrium outcomes from various numbers of insurers and medical providers for an example parameter set. The two objects of interest are the top end of the equilibrium price of care and the certainty equivalent level of consumption. Additional simulations are also presented to demonstrate
that some results of the main analysis are not universal, but depend on the parameters chosen. In Section 4.3, I decompose the effects of insurer entry, separating changes due to increased competition, shifts in demand, and loss of bargaining power by selectively turning off these channels. Finally, an alternative specification in which medical needs are observable (eliminating moral hazard) is presented and briefly discussed.

Somewhat unusually, the model yields a range of equilibrium prices of medical care rather than a unique value. The examples below assume that the ceiling of the equilibrium range is the price that will emerge, a choice validated by the structure of the game. From any configuration of prices offered by medical providers that are all greater than the equilibrium ceiling, a sequence of best responses to rivals’ current choices will converge to the equilibrium ceiling. In this way, the top of the equilibrium price range is a “stable sink” for a competitive game among providers, while lower prices cannot be reached from above. Moreover, the ceiling of the equilibrium price range yields the highest profit for medical providers— it is the optimal equilibrium for the players who get to move first and “lead the dance”. Most critically, the equilibrium ceiling varies with the number of both insurers and providers, allowing analysis with respect to competition.

The measure of consumer welfare used in the examples computes the certainty equivalent level of consumption compared to a baseline with no medical care available. Even with insurance, individuals face utility risk through both consumption (due to a copay) and untreated medical needs. If the expected utility across individuals, appropriately weighting by insured and uninsured, is run through the inverse of the utility function, it yields the certainty equivalent level of consumption. The ratio of this value to the certainty equivalent when individuals cannot purchase medical care (less one) is a normalized metric of the relative value of a competitive scenario: the percentage increase in certainty equivalent consumption that the insurers and medical providers give to individuals. Preference shocks are not included in the calculation of expected utility when computing the welfare metric, as these shocks are meant to represent imperfections in individuals’ understanding of or access to contracts and thus should not be considered boons to welfare. Moreover, the average preference shock of the selected insurance contract does not vary much once there are at least two insurers, so there is very little differential effect on welfare.15

14Technical caveat: The space of prices must be finitely discretized (e.g. to the penny) for the sequence to converge, otherwise successive best responses would move by infinitesimal amounts. The convergence can also occur for configurations where some (but not all) providers begin priced below the equilibrium ceiling, depending on the order of moves.
15The welfare values could be expressed as raw utilities, but these would be difficult to read. With $\rho = 5$, all expected utility values are very close to zero.
4.1 Number of Insurers

When an additional insurer enters the market, the welfare of consumers is affected in three ways. First, at any given price of care that providers offer, there will be more competition among insurers, resulting in a more favorable equilibrium contract and increasing expected utility (the “competition effect”). Second, the change in equilibrium contract at every price shifts the total demand for care function from \( D_N(p) \) to \( D_{N+1}(p) \), altering the equilibrium price range defined by (25) (the “demand effect”).\(^{16}\) Third, the additional insurer dampens the threat power of insurers against providers by reducing the variance of demand they can induce, increasing the equilibrium price and thus reducing expected utility (the “bargaining effect”). Graphically, the competition effect is seen in Figure 2 as an outward shift in the fixed point line, so that the equilibrium contract is more generous (Figure 3). The demand effect can be seen in Figure 6 as moving from one demand function to the next, while the bargaining effect is represented by the shift in the pseudo-supply line.

In summary, the competition effect benefits individuals directly, while the demand (usually) and bargaining effects harm them indirectly through a higher price of care. Note that each consumer would like to be offered the more favorable contract from increased competition, but would prefer if everyone else was not— the collective increase in demand harms all consumers, even though it arises from individually rational choices.

The examples below demonstrate that the latter two effects can sometimes dominate the competition effect, so that increasing the number of insurers reduces average individual welfare. In contrast, increasing the number of medical providers always strictly improves individuals' expected utility, as the only effect is to reduce the equilibrium price of care. For each combination of \( N \) and \( M \), the model is solved with the parameter values listed in Table 1. The equilibrium price of care and the certainty equivalent level of consumption at each combination are presented in Tables 2 and 3 respectively.

As expected, the equilibrium price of medical care increases with additional insurers (reading down any column of Table 2) due to both the greater total demand for care and the reduced threat power of insurers. The only exception to this pattern is when the first insurer enters the market when there are two, three, or four medical providers. When there is only one provider, the first insurer has no ability to threaten the monopolist provider, thus the equilibrium price increases due to greater demand for care. When there are many providers, the first insurer has threat power to reduce the price of care, but this effect is overwhelmed by the increase in demand. Only at “moderate” levels of providers can threat power dominate the countervailing effect. As noted above, the equilibrium price decreases

\(^{16}\)The direction of this effect is ambiguous, but reduces the expected utility of individuals in the typical case when total demand increases.
with the number of medical providers (reading across any row); the only exception is when there is exactly one insurer and at least two providers, when the price is constant (see (25) when \( N = 1 \)). Note in particular the relatively large drop in the equilibrium price when the second medical provider enters the market. Rather than freely choosing the price of care to maximize profit, the providers must compete with each other. Moreover, they are susceptible to the threatening strategy of insurers, unlike the monopolist, further reducing the equilibrium price.

Reading down any column of Table 3 reveals that the effect of entry on consumer welfare is not monotone. Instead, welfare seems to follow a U-shape as insurers enter the market. For example, when there are two medical providers, welfare is 7.56% above baseline with one insurer, falls to 4.28% after the second and third insurers enter the market, but then steadily increases to 4.37% when nine insurers have entered. All other columns follow the same pattern, with the “welfare trough” consistently occurring when there are three insurers. Both the shift in the demand function and the loss in threat power from an additional insurer becomes smaller as the number of incumbent insurers increases. Thus the demand and bargaining effects of entry are strongest when \( N \) is small, tapering off to be dominated by the competition effect as \( N \) grows, generating the U-shaped pattern seen in each column.

Most strikingly, the adverse effect of an additional insurer is strongest when moving from zero to one insurers: welfare drops when moving from the first to the second row of Table 3. The shift in the demand function (and thus in price) is so great that it more than offsets the consumption-smoothing benefits of insurance and the ability for the insurer to use its threat power to negotiate a lower equilibrium price.\(^{17}\) Moreover, a monopolist insurer need not offer a favorable contract due to lack of competition. The only counterexample occurs when there are exactly two medical providers. More strongly, this is the only case where the presence of any number of insurers is able to increase consumer welfare above the level it reaches in the absence of insurers. This surprising and counterintuitive result is not universal, however; see Section 4.3 for an alternative parameterization where the presence of insurers does raise individuals’ expected utility. Finally, note that increasing the number of medical providers strictly increases welfare through increased price competition among providers (except when there is exactly one insurer).

Table 4 shows the relative welfare gains\(^{18}\) for each combination of insurers and medical providers when medical needs shocks are twice as large as in the benchmark example (\( \lambda = 0.5 \)). In this case, the entry of an additional insurer (as long as there already at least one)

\(^{17}\)The demand effect would not be as large if the distribution of medical needs had a longer right tail but identical mean (greater skew), as with a Weibull distribution with shape parameter less than 1.

\(^{18}\)The values in Table 4 are not comparable to those in any other table, as the change in \( \lambda \) lowers the denominator of the certainty equivalent consumption through higher average medical needs.
is always strictly welfare-improving, with no U-shape in any column; as more insurers are added in each column, individuals’ welfare overtakes its original level with no insurers. The critical number of insurers at which this occurs is greater when there are more medical providers, as the welfare loss from the entry of the first insurer becomes greater and greater.

4.2 Variance of Preference Shocks

As mentioned in Section 2.6, the preference shocks over insurance contracts can be interpreted as informational barriers to perfect competition among insurers. They could represent difficulty in understanding and comparing contracts, search costs, or the effect of purchasing insurance through an employer. This section considers how the variance of the preference shocks affects individuals’ welfare. Intuitively, increasing the magnitude of the preference shocks relative to the utility function should usually harm consumers, inducing them to “make mistakes” more often and allowing insurers to offer less favorable contracts, knowing that many consumers will choose them due to a large preference shock. While this intuition usually holds, it is not a universal result.

In the extreme case where preference shocks are eliminated entirely, competition from two or more insurers pushes the equilibrium contract to the expected utility-maximizing point on the zero profit locus (the “perfect competition contract”). In this case, all consumers will choose the best contract among their choices, without preference error. Suppose an insurer offers the current best contract and it is not the perfect competition contract. Then another firm could choose a nearby contract that offered slightly more favorable terms to individuals while still yielding positive profit, capturing the entire market. The zero profit portion of the perfect competition result can also be seen as the limit of (44) as the scale of $\Delta u$ approaches infinity and both terms go to zero. The equilibrium contract will vary with the price of care, as the insurer must break even to remain in business, generating a “perfect competition demand curve”, plotted on Figure 8.20 Under the additional assumption that these insurers collude against providers during negotiations (or there is a benevolent monopolist insurer), the perfect competition equilibrium can be determined. With insurer profit eliminated, demand for care under perfect competition is significantly higher as consumers are offered more generous contracts. In equilibrium, both the price of care and total quantity of care are much higher than in the imperfectly competitive scenarios presented in Tables 2 and 3. However, welfare is also significantly higher—indeed, even higher than in the most favorable

19 As before, this contract must yield non-negative profit, else the insurer could improve its payoff by choosing a different contract. See Appendix F for derivations.

20 With no preference shocks, individuals make no errors when selecting a contract. Because an actuarially fair contract offering positive insurance is definitely better than being uninsured, all individuals buy insurance under perfect competition.
scenario considered in Section 4.3, when the demand effect is turned off.

In contrast, the absence of preference shocks can result less favorable contracts when there is only one insurer. In this case, the monopolist insurer can capture the entire market as long as he offers a contract that is better than the null contract. He will thus choose the profit-maximizing contract on the same indifference curve as the null contract (or a contract arbitrarily close to it). As it is possible that a monopolist insurer will offer a contract with greater expected utility than the null contract when individuals do have preference shocks, this means that a larger magnitude of preference shocks is not strictly worse for individuals in all cases. To better understand the ambiguous effects of preference shocks on individuals’ welfare in non-extreme cases, specific examples are necessary. Tables 5 and 6 demonstrate the welfare effects when the variance of preference shocks is doubled and halved respectively. In each example, the base parameters in Table 1 are used, with only the relative magnitude of preference shocks altered.

In Table 5, where preference shocks are larger, individuals are strictly worse off (relative to their welfare in Table 3), regardless of the number of insurers or medical providers. In contrast to the benchmark scenario, an additional insurer always harms individuals (with one exception), as competition between insurers is much weaker and thus the gains from competition cannot overcome the loss of threat power and the shift in the total demand function. For example, when there are three medical providers, welfare is 7.2% above baseline with one insurer but falls to 4.55% with two insurers, steadily down to 2.71% with nine insurers. Surprisingly, individuals can even be made worse off than they are when medical care is unavailable, as in the lower left portion of Table 5. As more insurers enter the market and a larger portion of the population is insured, the high price of care due to the provider’s monopoly and shifted demand function more than offsets the improvement from being able to purchase care.

Table 6 represents the opposite case, where the magnitude of preference shocks is smaller than the benchmark case. The U-shaped pattern of welfare in each column returns, with the trough shifted to the row with two insurers rather than the original three. As expected, individuals’ welfare is almost always higher when they face smaller informational barriers to choosing an ideal contract; they are “better shoppers”, forcing insurers to compete for their business. The only exception is when there is exactly one insurer and at least two medical providers. As described above, this situation allows the monopolist insurer to only surpass the null contract by a small amount of utility and still capture much of the market to maximize his profit; reducing imperfections in the market can actually harm individuals in limited circumstances. While the price tables are omitted for space, it is worth noting that when the variance of preference shocks is small the equilibrium price of care is consistently
higher than in the benchmark parameterization. This arises precisely because the equilibrium contract is so favorable to individuals that they are able to purchase care for their medical needs more often. The reverse is true when the preference shock variance is low, so that welfare does not track with the price of care as closely as Tables 2 and 3 seemingly indicate.

While eliminating preference shocks over insurance contracts vastly improves consumer welfare, the equilibrium of this market is not actually the ideal outcome for consumers. Under perfect competition, consumers collectively “get greedy” and want to purchase large quantities of care. Neither consumers nor insurers take into account the effect their additional demand for care has on the price insurers are willing to sell for. It is thus possible for a social planner to offer an insurance contract with even higher expected utility than achieved under perfect competition by maximizing individuals’ utility with the constraint that the contract must result in an outcome where \( p = \gamma D(p) \), on providers’ pseudo-supply curve (under a monopolist or collusively bargaining insurers). The social planner thus “slides down” the supply curve to achieve a lower equilibrium price. As shown in Table 12, consumer welfare improves significantly even as the quantity of care purchased falls by nearly 8%. The welfare gains are achieved through significantly higher utility when consumers don’t purchase care, due to a 40% lower premium, blunted by somewhat lower utility when they do purchase care (as \( z + c \) is larger than under perfect competition). The social planner’s demand curve is also plotted on Figure 8, and derivations are provided in Appendix F.

4.3 Decomposition of the Effects of Insurer Entry

This section decomposes the total effect of insurer entry on consumer welfare into the portions attributable to the competition, demand, and bargaining effects by presenting equilibrium results of alternative games where one or more of these effects are “turned off”. In summary, the U-shaped pattern of welfare with respect to the number of insurers can occur even if only the bargaining or demand effect is present to counteract the competitive effect; when both effects are turned off, insurer entry strictly improves consumer welfare.

The increase in the equilibrium price of care from the shift in demand can more than offset the gains from increased competition among insurers even if there is no loss of bargaining power. Table 7 shows consumer welfare when insurers use the simple strategy rather than the threatening strategy assumed in the other examples, so that the equilibrium price is defined by the top end of (21) instead of (25). Graphically, the equilibria for this scenario can be seen in Figure 6 as the intersection of the light green pseudo-supply curve (for zero insurers, when bargaining cannot occur) with each of the demand curves.\(^{21}\) That is, when

\(^{21}\)Figure 6 shows pseudo supply curves for \( M = 2 \) only; the slope of the light green pseudo-supply curve
an additional insurer enters, we move to a higher demand curve but the pseudo-supply curve remains as if $N = 0$. As in the benchmark example, welfare initially declines as insurers enter the market before increasing at larger numbers; the trough consistently occurs when there are exactly two insurers. While the top row and the leftmost column are identical (as the threatening strategy cannot be used on a monopolist provider), all other values in Table 7 are smaller than their counterparts in Table 3, with the largest losses occurring when there is only one insurer, when threat power would be highest.

In a similar exercise, the rightmost column of Table 7 (labeled “C”, for “collusion”, “cartel”, or “coordination”) presents consumer welfare when insurers maintain the full threat power of a single insurer, regardless of their actual number.²² This represents a situation in which insurers coordinate their randomization, selecting the same single provider to cover. Turning again to Figure 6, this corresponds to the intersection between the red pseudo-supply curve ($N = 1$) and each successive demand curve (other than the blue “zero insurers” curve), as all insurers coordinate as a single insurer when bargaining for prices. The familiar non-monotone pattern to individuals’ welfare is also present here, reinforcing that the demand effect can overcome the competition effect even without the bargaining effect. Comparing the values in column “C” to any column of Table 3 reveals the extent of welfare loss from the bargaining effect, which ranges from 8% to 38% of the total welfare benefit of access to medical care. Predictably, the bargaining effect harms individuals most when there is a large number of insurers and a small number of providers.

Going one step further, Table 8 eliminates the demand effect along with the bargaining effect by solving the model as if the total demand curve did not change as insurers enter the market, isolating only the competitive effect. This could represent an odd world in which only a single individual is offered insurance by potentially multiple firms, allowing him to experience only the benefits of the competition effect, without either countervailing effect.²³ Graphically, we change neither the demand curve nor the pseudo-supply curve, remaining permanently pinned at the intersection of the blue lines; price is identical for any number of insurers. Comparing values in Table 8 to their corresponding entries in Table 7 reveals that upwards of 50% of the potential welfare gains from access to medical care are lost to the demand effect. Note that individual welfare is strictly increasing in the number of insurers (after the first one), quickly overtaking the values in the top row in the absence of insurance.

²²Only a single column is needed, as the equilibrium price does not change with the number of providers, as long as there are at least two so that the threatening strategy can be used. The top row is omitted because there are no insurers and thus no threat power, while the row with a single insurer is obviously identical to its benchmark counterpart.

²³The threatening strategy cannot be used, as insurers each have a measure zero set of customers. The welfare table is shown from the perspective of the lucky individual being offered insurance.
Welfare drops slightly when the first insurer enters, as in this case a monopolist insurer will offer a slightly worse contract than the null contract. Finally, Table 9 presents welfare results from an impossible world in which there is no demand effect from additional insurers, but insurers maintain bargaining or threat power in determining the equilibrium price of care. The U-shaped pattern returns, with welfare falling as the second insurer enters (when there are fewer than seven providers).

### 4.4 Observable Medical Needs

The demand effect arises from moral hazard: as individuals are offered more favorable contracts, they purchase medical care a greater portion of the time (they have a lower critical level of medical need) thus increasing total demand for care and the equilibrium price. Similarly, moral hazard harms individuals as it prevents insurers from offering complete insurance— a copayment is necessary to prevent individuals from purchasing care 100% of the time. As an alternative model, Table 10 presents welfare results from a world in which this problem does not occur because medical needs are observable and contractible by insurers. In this model (whose details can be found in Appendix E), insurance contracts specify a premium and a threshold medical need level, above which individuals are entitled to medical care at no out-of-pocket cost.

These welfare values are clearly much higher than any other scenario presented, as insurers can offer much more favorable contracts when they can control the rate at which their customers will purchase care; moreover, individuals face no consumption risk, further boosting welfare. Notably, the competition effect consistently dominates the demand and bargaining effects as additional insurers enter the market, in contrast to the baseline scenario.

As shown in Table 11, part of the welfare gains are due to the lower equilibrium price of care as compared to the baseline in Table 2; in nearly all columns, equilibrium price is lower than in the baseline model when there is only one insurer, and grows more slowly than in Table 2 as insurers enter. The only exception is when there is a monopolist medical provider, and even then welfare is still much higher under observable medical needs due to complete insurance.\(^{24}\) While perfect observability of the health shock is an extreme assumption, the example illustrates how insurers’ efforts to monitor customers’ need for particular services

\(^{24}\)Prices under a monopolist medical provider are much higher under observable medical needs than in the baseline scenario because of the slope of the demand curves; see Figure 7. When there is at least one insurer, the demand curve is much steeper than baseline at low prices, as individuals get benefits from lower consumption risk even as they buy care less often. Demand levels off and is very inelastic at higher prices. The profit maximizing monopolist provider is thus free to raise price without sacrificing much quantity. Note than equilibrium price exceeds individuals’ income \((y = 2)\) in most cases, so that uninsured individuals cannot buy care at all.
might actually benefit consumers ex ante.

Just as in the baseline model, we can compute the perfect competition demand curve when medical needs are observable rather than private information. In this case, both demand and price are even lower than the social planner’s solution when medical needs are not contractible, while premiums are much higher (as expected, as it is the only source of insurers’ revenue). Even with slightly lower demand (and thus individuals’ facing the pain cost of their medical conditions more often), consumer welfare is more than double that of either “ideal outcome” under private information, and much higher than the imperfectly competitive equilibria presented in Table 10. With observable medical need and complete contracts, there is no loss of consumption utility when care is purchased. Thus the insurer is able to fully complete both of its welfare enhancing roles: allowing individuals to purchase care more often (reducing the probability and magnitude of losses) and eliminating consumption risk. Once again, the perfect competition outcome can be improved by a social planner who can commit to offering the utility-maximizing contract conditional on the provider-side constraint. As seen in the baseline private information model, the social planner’s solution slides down the pseudo-supply curve, reducing demand by 12% as premiums fall by over 22% due to the lower price achieved (note that $z = pD$ with a zero profit condition and observable medical needs). Consumer welfare increases slightly, but proportionately less than in the baseline model.

5 Conclusion

This paper presents a three-way model of the medical care market among individuals, insurers, and providers. The model is solved for a range of subgame perfect equilibria prices, where one endpoint of the range is a stable sink for best responses to non-equilibrium strategies and thus the natural choice for the equilibrium that will actually occur. The relationship between the number of insurers and individuals’ welfare is shown to be not strictly monotonic, instead following a U-shaped pattern as insurers enter the market. These results are consistent with empirical literature that shows ambiguous effects on insurer competition on premiums and negotiated hospital prices.

The pattern occurs because there are three effects that arise from the entry of an additional insurer. First, an additional insurer creates additional competition among insurers, resulting in more favorable contracts being offered to individuals conditional on the price of care set by providers. Second, the new contract changes the probability that an insured individual will purchase care, (usually) increasing the total demand for care conditional on price and thus increasing the equilibrium price. Third, the new insurer cannibalizes the
bargaining or threat power of existing insurers when determining the equilibrium price of care. The demand and bargaining effects can overwhelm the competition effect, leading to a net welfare loss; more strongly, either the demand or bargaining effect can be sufficient on its own to overcome the competition effect.

References


Table 1: Baseline Values of Parameters Used In Examples

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Table 2: Equilibrium Price of Care by Number of Insurers and Medical Providers, Baseline

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Table 3: Individuals’ Welfare by Number of Insurers and Medical Providers, Baseline

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Note: Tables 3-10 present individuals’ welfare as the percentage change in certainty equivalent consumption for the given combination of insurers and medical providers. The baseline is when medical care is not sold at all, and all medical needs shocks are experienced as pain, represented by 0%.
Table 4: Individuals’ Welfare by Number of Insurers and Providers, Large Medical Needs

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Table 5: Individuals’ Welfare by Number of Insurers and Providers, Large Preference Shocks

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Table 6: Individuals’ Welfare by Number of Insurers and Providers, Small Preference Shocks

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Note: Tables 4, 5, and 6 present individuals’ welfare under alternative parameter sets: when medical needs shocks are larger than baseline ($\lambda = 0.5$), when preference shocks (over insurance plans) are larger than baseline ($\sigma = 0.1$), and when they are smaller than baseline ($\sigma = 0.025$), respectively. See Section 4.2.
Table 7: Individuals' Welfare by Number of Insurers and Providers, No Bargaining Effect

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Table 8: Individuals’ Welfare by Number of Insurers and Providers, Only Competitive Effect

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Table 9: Individuals’ Welfare by Number of Insurers and Providers, No Demand Effect

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Note: Tables 7, 8, and 9 present a decomposition of individuals' welfare as the bargaining effect and demand effect are turned off. The competitive effect is operative in all tables. See Section 4.3.
Table 10: Individuals’ Welfare by Number of Insurers and Providers, Observable Needs

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<td>14.90%</td>
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<td>15.44%</td>
<td>15.60%</td>
<td>15.73%</td>
<td>15.83%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 11: Price of Care by Number of Insurers and Medical Providers, Observable Needs

<table>
<thead>
<tr>
<th># of Insurers</th>
<th># of Medical Providers</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.607</td>
<td>1.092</td>
<td>1.076</td>
<td>1.066</td>
<td>1.060</td>
<td>1.056</td>
<td>1.052</td>
<td>1.050</td>
<td>1.048</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1.750</td>
<td>1.008</td>
<td>1.008</td>
<td>1.008</td>
<td>1.008</td>
<td>1.008</td>
<td>1.008</td>
<td>1.008</td>
<td>1.008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2.003</td>
<td>1.129</td>
<td>1.101</td>
<td>1.086</td>
<td>1.078</td>
<td>1.071</td>
<td>1.067</td>
<td>1.064</td>
<td>1.061</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2.162</td>
<td>1.201</td>
<td>1.158</td>
<td>1.135</td>
<td>1.121</td>
<td>1.112</td>
<td>1.105</td>
<td>1.100</td>
<td>1.096</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2.258</td>
<td>1.241</td>
<td>1.190</td>
<td>1.163</td>
<td>1.147</td>
<td>1.136</td>
<td>1.128</td>
<td>1.121</td>
<td>1.117</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>2.318</td>
<td>1.267</td>
<td>1.211</td>
<td>1.181</td>
<td>1.163</td>
<td>1.150</td>
<td>1.142</td>
<td>1.135</td>
<td>1.129</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2.365</td>
<td>1.284</td>
<td>1.224</td>
<td>1.193</td>
<td>1.173</td>
<td>1.160</td>
<td>1.151</td>
<td>1.144</td>
<td>1.138</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>2.402</td>
<td>1.296</td>
<td>1.234</td>
<td>1.201</td>
<td>1.181</td>
<td>1.167</td>
<td>1.158</td>
<td>1.150</td>
<td>1.144</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>2.422</td>
<td>1.305</td>
<td>1.241</td>
<td>1.208</td>
<td>1.187</td>
<td>1.173</td>
<td>1.163</td>
<td>1.155</td>
<td>1.149</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>2.439</td>
<td>1.312</td>
<td>1.247</td>
<td>1.212</td>
<td>1.191</td>
<td>1.177</td>
<td>1.167</td>
<td>1.159</td>
<td>1.152</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 12: Equilibrium Outcomes Under Perfect Competition and Social Planner’s Solution

<table>
<thead>
<tr>
<th>Scenario</th>
<th>p</th>
<th>D</th>
<th>z</th>
<th>c</th>
<th>t</th>
<th>ΔWelfare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private information, perfect competition</td>
<td>1.461</td>
<td>0.487</td>
<td>0.463</td>
<td>0.510</td>
<td>N/A</td>
<td>11.30%</td>
</tr>
<tr>
<td>Private information, social planner</td>
<td>1.330</td>
<td>0.443</td>
<td>0.278</td>
<td>0.703</td>
<td>N/A</td>
<td>12.20%</td>
</tr>
<tr>
<td>Observable needs, perfect competition</td>
<td>1.297</td>
<td>0.432</td>
<td>0.560</td>
<td>0</td>
<td>0.210</td>
<td>24.80%</td>
</tr>
<tr>
<td>Observable needs, social planner</td>
<td>1.140</td>
<td>0.380</td>
<td>0.434</td>
<td>0</td>
<td>0.242</td>
<td>26.25%</td>
</tr>
</tbody>
</table>

Note: Tables 10 and 11 present individual welfare and equilibrium prices in an alternative model in which individuals’ level of medical need $\eta_i$ is observable by insurers. Insurance contracts are thus written conditional on medical need: care is fully reimbursed, with no copay, when need exceeds the contracted threshold level. See Section 4.4 and Appendix E. Table 12 summarizes outcomes when there is perfect competition (individuals have no preference shocks over insurers) or under the social planner’s optimal insurance contract in both the private information (baseline) and observable needs models. See Appendix F.
Figure 1: Contour plot of monopolist insurer’s expected profit across contracts offered; green star is the profit-maximizing contract. Only non-negative contours are shown. Contracts whose premium and copay sum to exceed income are unusable by individuals.

Figure 2: Determination of the equilibrium contract by fixed point analysis. With $N - 1$ rival firms, symmetric equilibrium is defined by $\tilde{u} = \nu((N - 1)\tilde{u})$, where $\nu(\cdot)$ is the best response function to the sum of exponentiated expected utilities of opponents’ contracts.
Figure 3: Insurer’s best response contract for different levels of sum of exponentiated expected utilities of opponents’ contracts, at base parameters. Equilibrium outcomes for different levels of insurers are included (see Figure 2).

Figure 4: Average expected utility of individuals by number of insurers at base parameters.
Figure 5: Total demand for care as a function of price, across different numbers of insurers.

Figure 6: Determination of equilibrium price and quantity of care at different numbers of insurers. Demand curves are as above. Rays from origin represent pseudo-supply curves as in (26): ceiling of equilibrium prices characterized by $D = p/(\gamma(1 + \frac{1}{M} - \frac{1}{MN}))$ when $N > 0$, or $D = p/(\gamma(1 + \frac{1}{M}))$ when there are no insurers. Shown with $M = 2$. 
Figure 7: Determination of equilibrium price and quantity of care at different numbers of insurers in the observable needs model. See Section 4.4.

Figure 8: Determination of equilibrium price and quantity of care at different numbers of insurers under perfect competition and the social planner’s solution in the baseline model and the observable medical needs specification. Insurers are assumed to collude against non-monopolist providers, and all individuals purchase their contract. See Appendix F.
Appendices

A Properties of the Best Response Contract

In Section 3.2, it was asserted that there exists a non-negative best response contract for any menu of rival insurers’ reduced form contracts $X_{-j}$ at any price $p$. This appendix provides proof of the existence of this best response, discusses why it is almost certainly unique, and establishes its monotonicity with respect to $A$.

A.1 Existence of Non-Negative Profit Best Response

If an insurer offered a contract such that $y < z$, then individuals could never purchase care and thus no one would buy the contract, forcing expected profit to zero. Thus if any insurer would earn negative profit, he can instead offer a contract that no one would purchase and improve his payoff to zero. In equilibrium, no insurer will earn negative profit. Moreover, if at least one insurer would earn positive profit while another would earn zero profit, the latter can improve his payoff by duplicating the former’s contract. The existence of at least one contract that yields positive profit is easy to establish (as long as $p < y$), as the trivial contract $(0, p)$ returns zero profit, and the isoprofit curve through this contract has finite slope. We can move along this isoprofit curve, and a positive profit contract is guaranteed to be found in any epsilon neighborhood of any point on the curve due to the continuity of the profit function. Thus in equilibrium, all insurers will offer feasible contracts that yield positive profit. In searching for a symmetric equilibrium, we can thus assume an interior solution, necessitating that the first order conditions are satisfied.

Demonstrating the existence of a positive profit best response to any combination of rival insurers’ contracts is straightforward. The isoprofit curve corresponding to zero profit (beginning at $(0, p)$ and ending at $(p, 0)$) creates a lower closed boundary, while the $y = c$ and $y = z$ lines serve as an upper closed boundary. As contracts approach $y = z$, their expected profit falls to zero as fewer and fewer individuals purchase that contract (because $\pi(\chi) \to -\infty$ as $z \to y$). When the premium and copay are so high that $y < z + c$, changes in the copay have no effect on $\bar{u}$ or profit because no customers were buying care anyway. Indeed, these “useless contracts” would almost never be purchased by individuals; only those with an extremely large preference shock would purchase a contract that prevents them from buying care. If insurers are barred from offering a negative premium or copay, then this creates a compact set of non-negative profit contracts; with a continuous expected profit

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25 Even if this were allowed, it could never occur in equilibrium. Risk averse individuals prefer insurance to anti-insurance, so this contract is always dominated.
function that has at least one positive profit contract, we are guaranteed to find a profit-maximizing contract on the interior of this set, at which the first order conditions will hold.

A.2 First and Second Order Conditions of Profit Function

Using the definition (as given in (13)) of insurer $j$’s expected profit when offering contract $\chi_j$ and rivals’ offered menu of contracts is $X_{-j}$, the first order conditions for an optimal response to competitors’ offered contracts are:

$$\frac{\partial \pi(\chi_j|X_{-j})}{\partial z_j} = \frac{\partial r(\chi_j)}{\partial z_j} q(\chi_j|X_{-j}) + \frac{\partial q(\chi_j|X_{-j})}{\partial z_j} r(\chi_j) = 0, \quad (27)$$

$$\frac{\partial \pi(\chi_j|X_{-j})}{\partial c_j} = \frac{\partial r(\chi_j)}{\partial c_j} q(\chi_j|X_{-j}) + \frac{\partial q(\chi_j|X_{-j})}{\partial c_j} r(\chi_j) = 0. \quad (28)$$

To establish the uniqueness of a solution to the first order conditions (and thus that the best response to any reasonable offerings from competitors is a singleton), a sufficient condition is that the second order conditions hold everywhere– that the profit function is strictly concave everywhere on the interior of the set of admissible contracts. These second order conditions are:

$$\frac{\partial^2 \pi(\chi_j|X)}{\partial z_j^2} = \frac{\partial^2 r(\chi_j)}{\partial z_j^2} q(\chi_j|X) + 2 \frac{\partial r(\chi_j)}{\partial z_j} \frac{\partial q(\chi_j|X)}{\partial z_j} + \frac{\partial^2 q(\chi_j|X)}{\partial z_j^2} r(\chi_j) < 0, \quad (29)$$

$$\frac{\partial^2 \pi(\chi_j|X)}{\partial c_j^2} = \frac{\partial^2 r(\chi_j)}{\partial c_j^2} q(\chi_j|X) + 2 \frac{\partial r(\chi_j)}{\partial c_j} \frac{\partial q(\chi_j|X)}{\partial c_j} + \frac{\partial^2 q(\chi_j|X)}{\partial c_j^2} r(\chi_j) < 0, \quad (30)$$

$$\frac{\partial^2 \pi(\chi_j|X)}{\partial z_j^2} \frac{\partial^2 \pi(\chi_j|X)}{\partial c_j^2} - \left( \frac{\partial^2 \pi(\chi_j|X)}{\partial z_j \partial c_j} \right)^2 < 0. \quad (31)$$

The various first and second derivatives of precursor functions referenced in the first and second order conditions are as follows, with analysis of their sign (arguments and subscripts are suppressed for brevity and clarity):

$$\frac{\partial r}{\partial z} = 1 + \frac{\partial \Delta u}{\partial z} f(\Delta u)(p - c) > 0, \quad \frac{\partial r}{\partial c} = (1 - F(\Delta u)) + \frac{\partial \Delta u}{\partial c} f(\Delta u)(p - c) > 0. \quad (32)$$

$$\frac{\partial^2 r}{\partial z^2} = \left( \frac{\partial^2 \Delta u}{\partial z^2} f(\Delta u) + \frac{\partial \Delta u}{\partial z} f'(\Delta u) \right)(p - c), \quad (33)$$
\[
\frac{\partial^2 r}{\partial c^2} = \left( \frac{\partial^2 \Delta u}{\partial c^2} f(\Delta u) + \frac{\partial \Delta u}{\partial c} f'(\Delta u) \right) (p - c) - \left( \frac{\partial \Delta u}{\partial c} + 1 \right) f(\Delta u). \tag{34}
\]

\[
\frac{\partial q}{\partial z} = \frac{\partial \pi}{\partial z}(q - q^2) < 0, \quad \frac{\partial q}{\partial c} = \frac{\partial \pi}{\partial c}(q - q^2) < 0. \tag{35}
\]

\[
\frac{\partial^2 q}{\partial z^2} = \frac{\partial^2 \pi}{\partial z^2}(q - q^2) + \frac{\partial \pi}{\partial z}(2q^3 - 3q^2 + q), \quad \frac{\partial^2 q}{\partial c^2} = \frac{\partial^2 \pi}{\partial c^2}(q - q^2) + \frac{\partial \pi}{\partial c}(2q^3 - 3q^2 + q). \tag{36}
\]

\[
\frac{\partial \Delta u}{\partial z} = u_1' - u_0' > 0, \quad \frac{\partial \Delta u}{\partial c} = u_1' > 0, \quad \frac{\partial^2 \Delta u}{\partial z^2} = u_0'' - u_1'' > 0, \quad \frac{\partial^2 \Delta u}{\partial c^2} = -u_1'' > 0. \tag{37}
\]

\[
\frac{\partial \pi}{\partial z} = -(F(\Delta u))u_0' + (1 - F(\Delta u))u_1' < 0, \quad \frac{\partial \pi}{\partial c} = -(1 - F(\Delta u))u_1' < 0. \tag{38}
\]

\[
\frac{\partial^2 \pi}{\partial z^2} = F(\Delta u))u_0'' + (1 - F(\Delta u))u_1'' + \left( \frac{\partial \Delta u}{\partial z} \right)^2 f(\Delta u), \tag{39}
\]

\[
\frac{\partial^2 \pi}{\partial c^2} = (1 - F(\Delta u))u_1'' + \left( \frac{\partial \Delta u}{\partial c} \right)^2 f(\Delta u). \tag{40}
\]

The parameterization of \( f(\cdot) \) used in Section 4 is the exponential distribution, a special case of the Weibull distribution when the shape parameter is set to 1. Thus the signs of some terms above are shown when \( f(\cdot) \) is distributed as a Weibull.

### A.3 Uniqueness of Best Response

Rather than conduct a long and fruitless mathematical analysis, it is worth pointing out that the profit function cannot be concave everywhere. For a “useless” contract such that \( y < z + c \), expected profit per customer is certainly positive (as premiums are being paid, but customers never buy care), and the preference shock for contracts guarantees that the share of customers will be positive but tiny, approaching zero as the premium increases. That is, \( \pi(\chi|X) \) will be strictly positive when \( y < z + c \); this requires that \( \frac{\partial^2 \pi}{\partial z^2} > 0 \) at some point, violating the concavity of expected profit. Instead of concavity, an alternate sufficient
condition must be demonstrated. Possibilities include showing that $\pi(\chi|X)$ is strictly quasi-concave, or that the first order conditions (27) and (28) have a single-crossing property. Either of these will guarantee that the best response to any set of contracts offered by rival insurers is a singleton.

No formal proofs of these conditions are available at this time and may not exist,\footnote{Caplin and Nalebuff (1991) present a proof of a pure strategy equilibrium in a market with spatially differentiated products, even in the presence of consumer heterogeneity. However, they treat these product characteristics as exogenous rather than strategic choices. Thus their proof applies in a situation where copayments are fixed and premia are the only strategic choice variable; the extension in my model to a multi-dimensional strategic space complicates the analysis. Moreover, no proof of uniqueness is offered.} but a contour map of a monopolist insurer’s profit function is presented in Figure 1. As insurers will never sell a contract that yields negative expected profit, only non-negative contour lines are shown. The zero isoprofit curve is the lowest shown, spanning from $(p,0)$ to $(0,p)$ as described above. Contour lines are also omitted for “useless contracts”, when the premium and copay sum to exceed income so that individuals who purchase them can never afford care. As noted above, these contracts would be purchased by nearly no individuals (only those unlucky few with very extreme preference shocks) and thus yield near-zero profit. The contours of Figure 1 demonstrate that the profit function is not quasi-concave, as there are some upper contour sets that are non-convex. However, the function is single peaked and is quasi-concave on the subset of contracts that are beneficial to individuals by offering at least some risk protection: contracts such that $z + c < p$. That is, the violations of quasi-concavity occur quite far away from the peak. These patterns are not specific to the monopolist case (nor to the particular parameter set used), and are consistent when rival firms offer competing contracts. The location of the peak shifts inward to more consumer-favorable contracts, but the profit function continues to be single peaked and quasi-concave among reasonable contracts.

A.4 Monotonicity of Best Response Function

The components of the unique contract that is a best response to a particular menu of rivals’ contracts $X_{-j}$ is defined by:

$$ (\hat{z}(A), \hat{c}(A)) = \arg \max_{z,c} \pi((z,c)|X_{-j}), \quad A = \sum_{\ell \neq j,0} \exp(\bar{u}(\chi_{\ell})). $$

(41)

To determine the shape of these functions, consider a contract on it, representing the best response contract when the sum of rivals’ exponentiated expected utilities is equal to some value $A \geq 0$. Thus the first order conditions for an optimal best response hold at this
contract. Substituting (35) into (28) and (27), we have:

$$\frac{\partial r_j}{\partial c_j} q_j + \frac{\partial \pi_j}{\partial c_j} (q_j - q_j^2) r_j = 0. \quad (42)$$

$$\frac{\partial r_j}{\partial z_j} q_j + \frac{\partial \pi_j}{\partial z_j} (q_j - q_j^2) r_j = 0. \quad (43)$$

The first term of the LHS of both equations is positive, while the second term is of equal magnitude but negative. If $A$ is increased very slightly to $A'$, how does the best response contract change? When rivals’ contracts offer better expected utility for individuals, insurer $j$’s share of individuals $q$ will decrease, while the profit per customer $r_j$ and the partial derivatives in the equations will be unchanged. But when $q_j$ decreases due to rivals’ slightly better contracts, $(q_j - q_j^2)$ decreases by less, so that the second term has greater magnitude. Thus when $A$ increases to $A'$, the LHS of (42) and (43) becomes negative, so that insurer $j$’s expected profit is increasing as both the premium and copay are reduced. Because $\pi(\chi|X_{-j})$ is locally quasi-concave, the best response contract to $A'$ must have lower premium and copay than the best response to $A$. If both the premium and the copay of the new contract are lower, an individual purchasing the new contract attains higher expected utility. In summary, the locus of best response contracts is strictly monotone, and the expected utilities offered to individuals by insurers through their contracts are strategically complementary.

B Properties of Symmetric Equilibrium for Insurers

Section 3.2 demonstrates that there can be a symmetric equilibrium among insurers in which each one offers the same contract. This appendix establishes several properties of the insurers’ symmetric equilibrium: that there are only symmetric equilibria, that a symmetric equilibrium exists, and that it is very likely unique.

B.1 Impossibility of Non-Symmetric Equilibria

To show that only symmetric equilibria are possible, consider an alleged equilibrium with two insurers selling different reduced form contracts. Because it is an equilibrium, each insurer must be offering the best response contract to his rivals’ choices. Suppose insurer 1’s contract offers higher expected utility to individuals than insurer 2’s contract. Then the sum of exponentiated expected utilities of insurer 1’s rivals’ contracts must be lower than that of insurer 2 (as the sets of rivals only differ by these two insurers). As the previous appendix showed that expected utilities of contracts are strategic complements,
this implies that insurer 1’s best response contract gives lower expected utility than insurer 2’s, contradicting the supposition that insurer 1 gives higher expected utility (or that these are both best responses to the other). Thus any two insurers must offer the same expected utility to individuals in equilibrium, and indeed identical contracts.

B.2 Existence of a Symmetric Equilibrium

To establish that a symmetric equilibrium exists, there must be at least one solution to (14). The proof will be performed by applying the intermediate value theorem. When rivals offer only contracts with \( \bar{u} = -\infty \Rightarrow \exp(\bar{u}) = \tilde{u} = 0 \), this is equivalent to when there is only a single monopolist insurer who will offer a contract with finite exponentiated utility \( \nu_2(0) > 0 \). This utility must be positive, as it was established above that there exists a non-negative profit contract in response to any menu, and thus individuals can attain expected utility above \(-\infty\). In the presence of competition, the symmetric equilibrium is defined by a fixed point of a function with positive slope. As \( \bar{u} \to \infty \), the exponentiated utility of the best response contract does not also become arbitrarily large. Rather, the utility of any offered contract is bounded by the zero profit locus. Because the first term of (27) and (28) are always negative, the second term must be positive, with the insurer earning strictly positive profit per customer. Thus the expected utility of a best response contract is bounded above by the highest expected utility contract that yields zero profit. Simple application of the intermediate value theorem requires that there exists at least one solution to (14), as the RHS exceeds the LHS when \( \tilde{u} = 0 \) but is overtaken at values of \( \tilde{u} \) greater than the maximum exponential utility zero profit contract.

B.3 Uniqueness of Symmetric Equilibrium

To ensure that there is only one symmetric equilibrium, a sufficient condition is that \( \nu_2(A) \) is strictly concave. While a formal proof of concavity is not available, an informal semi-proof demonstrates that this property almost certainly holds. Note that as \( A \) becomes large, \( \nu_2(A) \) asymptotes to some finite level, thus it must eventually be strictly concave. Similarly, the best response function must converge to some contract, so the best response premium and copay functions are eventually concave in \( A \), and possibly always so. Even if these functions are not concave everywhere, (39) and (40) indicate that expected utility is likely increasing concavely as the premium and copay fall when \( A \) rises. Thus even if the best response contract were to change convexly with \( A \) for some range, it may be tempered by the concave translation to expected utility. In this way, the function \( \nu_2(A) \) is almost certainly concave so that there is only one symmetric equilibrium. Indeed, it is concave at every price and

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parameterization tested.

B.4 Other Properties of Insurers’ Equilibrium

It is reasonable to expect that when the number of insurers becomes very large, competition causes the equilibrium contract to converge to some ideal point for individuals: the expected utility-maximizing contract on the zero profit locus. However, this is not the case. As $N$ becomes very large, the share of individuals of any insurer approaches zero. Substituting (35) into (29) and (30), taking the limit as $q \to 0$, applying l’Hôpital’s rule and rearranging reveals that per customer profit converges to a positive value. Using the version with $z$:

$$
\lim_{q \to 0} r(\chi^*) = - \left( \frac{\partial \Delta u}{\partial z} \right)^{-1} - f(\Delta u)(p - c) > 0.
$$

(44)

A similar equation using the copay can also be found. No matter how many competitors there are, the equilibrium contract will always yield positive per customer profits.

If the magnitude of the utility function (and the medical need shocks) is increased relative to the size of the preference shocks, so that differences in expected utility between contracts become greater, then individuals are effectively “better shoppers”, less likely to purchase suboptimal contracts. That is, when the preference shocks are small relative to the utility function, competition among many insurers will result in an equilibrium contract with very small per customer profit– the preference shocks act as a barrier to a perfectly competitive solution. As discussed in Section 2.6, the magnitude of the preference shocks could represent the extent of individuals’ imperfect ability to learn about, understand, or have access to the different insurance contracts offered. In Section 4.2, the effects of these barriers to perfect competition on individuals’ welfare are explored more fully.

C Properties of the Demand Function

Section 3.2.3 introduced the total demand function $D_N(p)$ and noted that it is downward sloping in price but has a more complex relationship with the number of insurers. Proofs and evidence of these properties are provided in this appendix.

C.1 Demand Function is Negatively Sloped

A critical property of $D_N(p)$ is that it is decreasing in price. When the price paid to the medical provider increases slightly, per customer profit decreases (due to higher cost sharing) but the share of individuals buying a contract increases (as the null insurance option is less
attractive). Starting from the equilibrium contract when the lowest price is \( p \), suppose price is raised slightly to \( p' \). Define \( \hat{u}'_1 \) as the marginal utility of consumption under the null contract when care is purchased, with related objects defined likewise. To determine how an insurer should change his contract in response, take the derivative of the first order condition for optimal premium (27):

\[
\frac{\partial r}{\partial p} = -(1 - F(\Delta u)), \quad \frac{\partial q}{\partial p} = \frac{F(\Delta u_0)\hat{u}'_0 + (1 - F(\Delta u_0))\hat{u}'_1}{N\hat{u} + \tilde{u}_0} q = Bq > 0, \tag{45}
\]

\[
\frac{\partial^2 r}{\partial z \partial p} = \frac{\partial \Delta u}{\partial z} f(\Delta u), \quad \frac{\partial^2 q}{\partial z \partial p} = \frac{\partial \pi}{\partial z} Bq(1 - 2q) = B\frac{\partial \pi}{\partial z}(q - 2q^2) = B\frac{\partial q}{\partial z} - B\frac{\partial u}{\partial z}q^2. \tag{46}
\]

\[
\frac{\partial^2 \pi}{\partial z \partial p} = \frac{\partial \Delta u}{\partial z} f(\Delta u)q + \frac{\partial r}{\partial z} Bq + \left( B\frac{\partial q}{\partial z} - B\frac{\partial u}{\partial z}q^2 \right) r - \frac{\partial q}{\partial z} (1 - F(\Delta u)) = \\
= \frac{\partial \Delta u}{\partial z} f(\Delta u)q + B \left( \frac{\partial r}{\partial z} q + \frac{\partial q}{\partial z} r \right) - B\frac{\partial \pi}{\partial z} q^2 r - \frac{\partial q}{\partial z} (1 - F(\Delta u)) > 0. \tag{47}
\]

The second term of this equation is zero because it is exactly the first order condition for the optimal premium, and the remaining terms all contribute positively. A parallel equation can be derived for the copay when \( p \) changes, which is also strictly positive. Thus an insurer will want to raise both the premium and copay in response to an increase in \( p \), holding his rivals’ contracts fixed. The best response contract function has a unique fixed point, and the expected utility offered by a contract is strategically complementary, so iterated application of the best response contract function (until convergence at the equilibrium) will only increase the premium and copay further.

In this way, an increase in \( p \) results in an equilibrium contract that offers lower expected utility to individuals through higher \( z \) and \( c \). Moreover, both individuals who purchase insurance and those who do not will be less likely to purchase care after price is raised. The only way that total demand for care \( D_N(p) \) could increase with \( p \) is if the price increase induced so many individuals to buy insurance who previously did not that the drop in propensity to buy care was overwhelmed by the switching behavior. A proof that this cannot occur is not available at this time, but this does not seem to occur in practice.

### C.2 Demand Function and the Number of Insurers

Total demand for care is increasing in the number of insurers \( (D_{N+1}(p) > D_N(p)) \) so long as the equilibrium contract induces individuals who hold it to purchase care more often than the uninsured (when \( \Delta u_j < \Delta u_0 \)). To see this, consider the fixed point defined by (14). When \( N \)
is increased by 1, the RHS is “pulled inward” so that it is higher at any given level of \( \tilde{u} > 0 \) than before. Thus the equilibrium will occur at a higher level of \( \tilde{u} \), with associated lower premium and copay. With greater expected utility from the equilibrium contract (and more insurers offering it), a larger portion of individuals will be (non-null) insured. Moreover, the probability of purchasing care conditional on the contract \((1 - F(\Delta u))\) is decreasing in both \( z \) and \( c \), as (37) says that both \( \frac{\partial \Delta u}{\partial z} \) and \( \frac{\partial \Delta u}{\partial c} \) are positive, and so individuals who purchase the equilibrium contract are more likely to buy care when the number of insurers goes up. Both factors of (16) increase with \( N \), thus \( D_N(p) \) increases with \( N \).

This logic breaks down in the odd situation where individuals purchasing the equilibrium contract are less likely to buy care than the uninsured, which can occur at very low prices, as shown in the lower range of prices in Figure 5. When the price is very low, even uninsured individuals will almost always purchase care, so no insurance contract can offer much risk protection. Moreover, bad contracts that strictly hurt individuals (because \( z + c > p \)) aren’t much worse than being uninsured in absolute terms. Thus in equilibrium insurers will offer bad contracts that make individuals who buy them worse off and less likely to purchase care. Each additional insurer offering a bad contract increases the probability that any given individual will receive a preference shock large enough to “trick” them into buying that contract, and thus total demand for care is decreasing in \( N \) at very low prices.

\section*{D Only Symmetric Equilibria Among Providers}

According to the equilibrium strategies from Sections 3.1 and 3.2, only medical providers who offer the lowest price among the competitors will receive any customers, whether insured or not; demand will be split evenly among them as individuals randomize. Thus if some providers are earning positive profits by charging \( p_0 \) while another provider is earning no profit with \( p_1 > p_0 \), then the latter provider can improve his outcome by choosing \( p_0 \) instead. To illustrate, suppose \( \tilde{M} \) providers are offering the lowest price \( p_0 \). They earn profits of:

\[
\frac{D_N(p_0)}{\tilde{M}} p_0 - \kappa \left( \frac{D_N(p_0)}{\tilde{M}} \right) > 0. \tag{48}
\]

If the provider offering \( p_1 \) switches to \( p_0 \), it will get:

\[
\frac{D_N(p_0)}{\tilde{M} + 1} p_0 - \kappa \left( \frac{D_N(p_0)}{\tilde{M} + 1} \right) > 0. \tag{49}
\]

This expression is greater than zero because the per unit profit is higher when the outsider joins them at \( p_0 \): sale price is the same, but the average production cost is lower because
Each provider might earn less when another provider adopts the lowest price, but it can never force positive profits to become negative. If a provider is earning negative profit, he can improve his payoff by choosing a price higher than the current lowest price to earn zero instead.

It is also possible to rule out as possible equilibria situations in which some providers are earning zero profit when offering lowest price $p_0$, and another insurer is earning zero profit with $p_1 > p_0$. If this were to happen, the insurer offering $p_1$ could switch to $p_0$ and gain positive profits (and boost his competitors into the black as well). To see this, note that per unit profit among the $\hat{M}$ offering $p_0$ is zero, so that average production cost must exactly equal the price. Thus when the outsider joins the group offering the low price, average production cost will fall below the sale price, resulting in positive per unit profits for all. Thus only all providers offering the same price can possibly be an equilibrium—the equilibrium is guaranteed to be symmetric. This holds whether the simple or threatening strategies are employed by insurers.

E Alternative Model: Observable Medical Needs

Section 4.4 presented an alternative specification in which each individual’s medical needs $\eta_i$ were observable and contractible by insurers. Welfare and price results were presented without elaboration or detail about this model. This appendix fleshes out the alternative specification and its solution.

E.1 Alternative Model Formalized

The formal description of the alternative model is mostly identical to that presented in Section 2; specific differences are laid out here. First, the medical need or pain shock $\eta_i$ for each individual is not private information, but instead is observable to insurers and insurance contracts can be conditioned on it. Next, the space of permissible contracts for insurers to offer is expanded from $\mathbb{R}_+^{M+1}$ to $\mathbb{R}_+^{M+2}$ to account for the threshold $t$. A contract is specified as $\hat{\chi}_j = (z, \vec{c}, t)$ and the null contract is $\hat{\chi}_0 = (0, \vec{p}, 0)$. A strategy for an insurer is thus a function $\phi : \mathbb{R}_+^M \rightarrow \mathbb{R}_+^{M+2}$ that takes a vector of prices for each medical provider and returns a valid contract. Individual $i$ who holds contract $\hat{\chi}_j$ and purchases care from provider $k$ will pay $c_{jk}$ if $\eta_i > t_j$ and $p_k$ otherwise. The expected utility\(^{27}\) of holding contract $\hat{\chi}_j$ with lowest

\(^{27}\)This equation ignores a corner case in which $t_j$ is so high that individuals choose to sometimes pay the full price of care out of pocket. It does not arise in equilibrium for the model simulated in Section 2.6.
copay $c_j$ can be expressed as:

$$F(\tau_j)u(y-z_j)+(1-F(\tau_j))u(y-z_j-c_j)-\int_0^{\tau_j} \eta F(\eta)\,d\eta, \quad \tau_j = \max(t_j, u(y-z_j)-u(y-z_j-c_j)).$$

(50)

Insurer $j$’s expected profit per customer is slightly changed from the original model, as described in Appendix E.2. All aspects of the model from the perspective of medical providers are identical to the original model.

### E.2 Equilibrium Insurance Contracts Are Complete

In the baseline model, insurers could not profitably offer useful contracts with no copay. If individuals pay nothing out of pocket for care, they will always purchase it regardless of how small their medical needs shock $\eta_i$ is; this contract is only profitable if the premium is set at or above $p$. In contrast, when $\eta_i$ is observable and contractible, (reduced form) insurance contracts are written as a triplet of the premium, copay, and threshold level of pain: $\chi = (z, c, t)$. When $\eta_i < t$, the insurer will not pay for care and the individual must pay the full price. While this specification may seem more complex due to the addition of a third contract variable, all copays will be zero in equilibrium, and so reduced form contracts are only an ordered pair $(z, t)$.

Consider the analogue to (12) for this model, expected per customer profit of $\chi_j$:

$$r(\chi_j) = z_j - (1-F(\max(\Delta u_j, t_j)))(p - c_j).$$

(51)

Rather than paying for care $(1-F(\Delta u_j))$ portion of the time, the insurer only pays when the threshold level of medical need is exceeded. The threshold only binds when $t_j > \Delta u_j$, otherwise this equation is identical to (12). Suppose this condition is met at contract $\chi_j$, and the insurer considers changing the premium and copay so as to leave per customer profit unchanged (while holding the threshold fixed). Using the implicit function theorem, the rate at which the copay should be changed relative to the premium is:

$$\frac{dc}{dz}\bigg|_{\Delta r(\chi)=0} = \frac{-1}{1-F(t)}. \quad (52)$$

When the contract changes in this way, individuals purchasing it see their marginal utility change at a rate of:

$$\frac{du}{dz}\bigg|_{\Delta r(\chi)=0} = -F(t)u'_0 + (1-F(t)) \left( \frac{1}{1-F(t)} - 1 \right) u'_1 = F(t)(u'_1 - u'_0) > 0. \quad (53)$$
Individuals’ expected utility improves when the contract is adjusted in this way, as they are shifting consumption from a lower marginal utility state to a higher marginal utility state at the actuarially fair rate.

This property holds for any contract, and is only bounded by \( c \geq 0 \) both due to restrictions on the space of allowable policies and the fact that the inequality above would flip if a negative copay were reached in this way. If the contract offers higher expected utility and thus a higher share of customers while holding per enrollee profit fixed, expected profit is higher when the contract is changed in this way. From the insurer’s perspective, all contracts with a positive copay are dominated by another contract with a lower copay. Thus in equilibrium, only complete contracts with \( c = 0 \) will be offered. Intuitively, the alternative model works like a simple insurance model in which the probability of loss does not depend on whether the individual is insured, as holding \( t \) constant directly controls this probability. Individuals thus prefer more complete insurance when the additional insurance is provided in an actuarially fair way.

### E.3 Insurer’s Equilibrium In Alternative Model

With the introduction of the threshold \( t \) and the above result that the lowest copay of all contracts will be zero in equilibrium, \( t \) effectively replaced \( c \) as the second policy dimension of reduced form contracts in the alternative model. With this change, similar arguments as those in Section 3.2 can be used to establish that there is a unique equilibrium reduced form contract \( \chi^*(p) = (z^*(p), t^*(p)) \) for each level of \( p = \min(\vec{p}) \) that medical providers can offer. Analogously to the original model, both the equilibrium premium and threshold are decreasing in the sum of the exponentiated expected utilities of rivals’ contracts, and thus both contract dimensions are decreasing in the number of insurers.

The formal equilibrium strategy in the alternative model modifies (15) as follows:

\[
\phi(\vec{p}) = (z^*(\vec{p}), 1(\vec{p} > p) + g(S), t^*(\vec{p})), S \subset \{k|p_k = \min(\vec{p})\} \equiv S. \tag{54}
\]

That is, a non-empty subset of the providers who offer the lowest price are assigned a copay of zero, while those choose a higher price are assigned an arbitrarily higher copay that will not be used by any individuals. The premium and threshold follow the optimal policy functions that can be derived using the same logic as Section 3.2. As in the original model, \( p^{**} \) is defined by the unique equilibrium price ceiling in (25). All other aspects of the equilibrium for insurers are identical to the original model (including the choice of \( S \) for the simple and threatening strategies); welfare analysis proceeds as in Section 4.
F Socially Efficient Outcomes

In Sections 4.2 and 4.3, I presented equilibrium results for four “socially efficient” outcomes: perfect competition and the social planner’s solution under both the private information (baseline) and observable medical needs models. This appendix presents derivations of the demand curves described in those sections and shown in Figure 8.

F.1 Private Information and Perfect Competition

Under perfect competition, individuals have infinitesimal preference shocks over insurers’ contracts. So long as one contract offers higher utility than all others, that contract will be purchased by all consumers. Insurers are still limited by the zero profit condition and will not offer a contract that loses money in expectation. As reductions in both $z$ and $c$ are welfare-improving for individuals and profit-reducing for insurers, firms will compete down to the zero profit locus and then along it to the expected utility-maximizing contract on it when market imperfections are removed. To find this contract at any given price of care $p$, the following algorithm call be followed.

First, recall the definition of demand for care:

$$D = 1 - F(u(y - z) - u(y - z - c)). \quad (55)$$

In combination with the zero profit condition that says that the premium must equal spending on care, $z = (p - c)D$, this yields:

$$0 = (p - c)(1 - F(u(y - z) - u(y - z - c))) - z. \quad (56)$$

For any given value of $c$, this equation has only one root in $z$: the zero profit premium of buying a contract with a given level of generosity (holding $p$ fixed). Individuals’ expected utility of this contract can be found using (8). Maximizing $\pi(z, c)$ such that the equation above is satisfied gives the perfect competition contract at that price of care; demand for care is found using the definition of demand. The entire perfect competition demand curve can be found by varying $p$ and repeating this analysis.

The equilibrium outcome is found as the intersection of the demand curve and the pseudo-supply curve and thus depends on the assumptions on bargaining between insurers and providers. For simplicity, I assume that there are at least two providers, so that the threatening equilibrium can be employed, and that insurers either collude in their negotiations or there is only a single benevolent insurer offering the perfect competition contract. Thus the
F.2 Private Information and Social Planner’s Solution

The social planner accounts for the supply-side constraint that \( p = \gamma D \) when selecting the utility-maximizing contract to offer to individuals. To find this optimal contract, first solve the definition of demand for care for copay \( c \):

\[
c = (y - z) - \frac{1}{u^{-1}} (u(y - z) - F^{-1}(1 - D)).
\]

Next, rearrange the supply constraint and substitute into the zero profit condition:

\[
D = \frac{p}{\gamma}, \quad z = (p - c)D \implies z = (p - c)\frac{p}{\gamma} = (\frac{p^2}{\gamma} - \frac{pc}{\gamma}).
\]

These can be substituted into the equation for copay above; slight rearranging yields:

\[
0 = (y - \frac{(p^2 - pc)}{\gamma}) - \frac{1}{u^{-1}} (u(y - \frac{(p^2 - pc)}{\gamma}) - F^{-1}(1 - \frac{p}{\gamma})) - c.
\]

At any price of care \( p \), this equation has only a single root in \( c \); the corresponding premium can be recovered from the latter half of (58). This is the zero profit contract at that price that yields a level of demand consistent with the providers’ constraint. As before, the expected utility of this contract can be found with (8). The social planner’s solution is found by maximizing \( u(z, c) \) such that (59) and (58) are satisfied by varying \( p \)– sliding along the pseudo supply curve. Demand and price can be found using the definition of demand and the first half of (58).

Note that the social planner’s solution only provides a single point, not an entire demand curve– the supply side was accounted for when maximizing utility of the demand side! To generate the entire demand curve, we vary \( \gamma \) and find the social planner’s contract (and accompanying price and demand) under different slopes of the marginal cost function.

F.3 Observable Needs and Perfect Competition

The perfect competition demand curve is somewhat easier to derive when medical needs are observable. Here, insurance contracts will be complete, with no copay; instead, they specify a threshold \( t \) below which individuals cannot purchase care. The relationship between demand and the threshold is simple: \( D = 1 - F(t) \). The zero profit condition likewise simplifies to \( z = pD \) as there is no copay. The choice of \( t \) can thus be reframed as a choice over \( D \) as if it were the contractible object. With \( F(\cdot) \) specified as exponential and \( \Delta u = 0 \) with no
copay, we can find the expected utility of any zero profit contract as a function of demand by rearranging (8) as:

\[
\pi(D) = u(y - pD) + \lambda(D(1 - \log(D)) - 1), \quad \pi'(D) = -(p(y - pD)^{-\rho} + \lambda \log(D)). \quad (60)
\]

The first derivative of expected contract utility with respect to demand is strictly decreasing, so there is a single root and thus a unique expected utility maximizing contract any given price. The threshold of the contract can be found by \( t = F^{-1}(1 - D) \). Varying \( p \) and repeating this procedure generates the entire perfect competition demand curve. The intersection with the pseudo-supply curve \( p = \gamma D \) establishes the perfect competition equilibrium.

**F.4 Observable Needs and Social Planner’s Solution**

As before, the social planner takes account of the provider’s constraint that \( p = \gamma D \) when selecting the utility-maximizing contract. Combined with the zero profit constraint \( z = pD \), we find that \( z = \gamma D^2 \). Substituting this expression for the premium into the first term of (60), we find that expected utility as a function of (implicitly chosen) demand is:

\[
\pi(D) = u(y - \gamma D^2) + \lambda(D(1 - \log(D)) - 1), \quad \pi'(D) = -(2\gamma D(y - \gamma D^2)^{-\rho} + \lambda \log(D)). \quad (61)
\]

Once again, expected utility is strictly concave in \( D \), yielding a unique utility maximizing zero profit contract that obeys the provider’s constraint. The threshold can be recovered as before, and \( p \) by \( p = \gamma D \). As with private information, this generates only a single point; the social planner’s demand curve can be found by varying \( \gamma \) to find the optimal contract under different marginal costs of producing care.