Auburn University
Department of Economics
Working Paper Series

Competition and Consume Choice in Option Demand Markets

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AUWP 2015-12

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September 2015

Abstract

Two medical providers choose their geographic location and medical-care specialization, and then compete in prices under health insurance sales. When buying insurance consumers know their geographic address, but they do not know their preferred medical treatment before getting sick. This uncertainty generates option demand for multiple providers: consumers may desire access for both providers although eventually attending only one. I show that this market presents equilibria-multiplicity by characterizing two types of symmetric equilibria. In the first equilibrium providers locate at the two ends of the city and choose to provide the same medical product. Hence each consumer buys access only to the geographically-nearest provider. In the second equilibrium providers locate at the city center and at the quartiles of the products line. Under these locations and products choices all consumers buy access to both providers. The efficient market outcome depends on the relative size of the mismatch and commuting costs parameters. The market may provide efficient, excessive, or insufficient level of consumer choice in terms of product differentiation and geographic dispersion. However, regulating providers' geographic locations properly can always support first best market outcome.

JEL Classification: : I11, I13, I-18, L13

Key-words: Consumer Choice, Option Demand, Medical Care, Spatial Competition

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†This is an update on the earlier version of the paper circulated in september 2015. It corrects an error in the analysis of equilibeium with single access purchaes.

1 Introduction

The works by Town and Vistnes (2001) and Capps et al.(2003) on competition and market power in option demand markets initiated a growing empirical research on the topic. This literature shows that both geographic dispersion and medical specialization are key factors in evaluating hospitals market power and consumers welfare under alternative networks of medical providers[1]. Yet, the theoretical work on competition in option demand markets is scarce.

The present work analyzes two-dimensional spatial competition in option demand markets - over the geographic dimension and the products-line dimension. Medical providers sell their products through health insurance to consumers who know their exact geographic location (address) and the distribution of their possible medical needs. The exact medical need of each consumer reveals only after getting sick. This uncertainty regarding future medical needs generates option demand for multiple providers. That is demand for including both providers under insurance coverage, although each consumer will eventually attend only one of them.

I find that providers choices of geographic location and product differentiation may coincide with the socially optimal ones, but the market may also provide too little or too much of product differentiation and geographical dispersion. I will show that the socially optimal outcome can be always achieved by properly regulating providers' geographic location.

There is substantial theoretical literature on competition between differentiated medical providers under insurance sales. Horizontal differentiation is interpreted in terms of geographic distance and (or) distinctive products characteristics - e.g. hospitals area of specialization[2]. Beside few exceptions this literature assumed consumers know their preferred medical provider before getting sick (See for example Barros and Martinez-Giralt 2002, Bardey and Bourgeon 2011, and Katz 2011).

This assumption seems realistic with respect to the geographic dimension, as consumers know their address and distance from each provider before getting sick[3]. However, when thinking of horizontal differentiation in terms of product characteristics it seems more plausible that consumers do not know their preferred product before getting sick[4].

[1] This literature was recently reviewed by Gaynor and Town (2012, Ch. 9.3) and Gaynor et al.(2015).

[2] See Bardey et al. (2012) for more detailed examples on horizontal differentiation in health care markets.

[3] In this case each consumer would like having only the *ex-ante* preferred provider under insurance coverage.

[4] As stressed by Capps et al.(2003): "Patients commit to a network of medical providers at the time they purchase their health insurance, but before they know their specific medical needs" (p.737).

Among the few papers that accounted for consumers' *ex-ante* uncertainty regarding future medical needs are Gaynor and Ma (1996), Ma (1997), Gal-Or (1997) and Douven et al.(2014). These papers study markets with two differentiated providers and two insurers, focusing on the circumstances under which exclusionary equilibria may emerge, and their welfare implications[5]. In another related paper by Lyon (1999) consumers' uncertainty regarding hospitals' future quality of service generates option demand for multiple providers.

This literature was motivated by the increased prevalence of exclusionary contracts between providers and insurers, as Health Management Organizations (HMO) became the common private insurers in the US health care market. Such contracts restrict HMO subscribers' accessibility to a network of selected health care providers[6].

However, the value of having access to multiple providers depends on their geographic dispersion and product differentiation. If for example two providers offer exactly the same medical care there is no added value from having them both under insurance coverage, regardless their geographic location. On the other hand if they share the same geographic location all consumers will value access for both providers even for low product differentiation (because having access to additional provider does not incur additional commuting cost). Yet, all aforementioned works assume medical providers are exogenously differentiated along one (horizontal) dimension only.

Hence, the novelty of this paper is in endogenizing providers differentiation choices along two prime-dimensions of health care markets: the geographic dimension where consumers know their location before getting sick and the products line (medical needs) dimension where consumer's preferred product reveals only after getting sick. The motivation here is to characterize and evaluate these differentiation choices that determine consumers' value of access to multiple providers. Hence I am interested in verifying whether option demand markets can provide efficient level of product diversification and geographic dispersion, and exploring possible welfare improving policies.

To this end I will assume consumers have complete choice over which providers are included under insurance coverage. Each provider sets option price for utilizing its medical product upon the emergence of medical need, and then consumers choose which option to buy - possibly both.

[5] The first two papers assume insurers are homogenous. In the latter two both insurers and providers are differentiated and terms of provision are set through simultaneous bilateral bargaining. Arie and Rachmilevitch (2015) point at some shortcomings of the simultaneous bargaining that was commonly assumed also in the empirical literature and provide alternative sequential bargaining procedure.

[6] For empirical studies on the welfare implications of restricting consumers' choice see Ho (2006) and Wedig (2013).

The option price set by each provider is equivalent to insurance premium (with zero co-pays)[7], hence one can think of this market as if each provider is fully integrated with one insurer.

This modeling approach reveals the principle nature and outcomes of providers' competition in option demand market, which is not interfered by insurers' intermediation. The important implications of more realistic and elaborated insurance markets to the present analysis are left for future research.

Within this framework I show that the market presents equilibrium-multiplicity by characterizing two types of symmetric equilibria. In the first equilibrium providers choose to locate at the two ends of the city and at the middle of the products line. As both providers offer identical medical product each consumer prefers buying access only to the geographically nearest provider. In the second equilibrium providers cluster at the market's geographic center and locate on the first and third quartiles of the products line. Under these geographic location and product choices, and implied prices, all consumers buy access to both providers.

The first equilibrium characterized here for option demand markets corresponds the Max-Min principle established for two-dimensional competition in spot markets by Tabuchi (1994) Veendorp and Majeed (1995), Ansari et al.(1998) and Irmen and Thisse (1998).

The maximal differentiation in spot market competition presents on the dominant dimension, which was modeled either as the longer one (as in Tabuchi 1994 and Veendorp and Majeed 1995) or the one along which cost increases faster in spatial distance (as in Ansari et al.1998 and Irmen and Thisse 1998)[8]. However, Ansari et al.(1998, p.214) showed that these two modeling approaches are equivalent: the longer dimension can be transformed into one with higher distance-cost parameter. On the option market, consumers' uncertainty regarding their future medical need implies that the dominant dimension is always the geographic one, as consumers have no *ex-ante* preference for specific medical good.

The socially-optimal locations for the spot and option markets coincide: those locations that minimize the sum of expected mismatch and commuting cost for healthy consumers in the option market also minimize the sum of mismatch and commuting costs for the sick consumers in the spot market.

[7] Hereafter I will use both terms.

[8] The dominant dimension is also interpreted as the one that consumers care more about.

Tabuchi (1994, p.217) showed that spatial costs are minimized with zero differentiation on the dominated dimension and intermediate differentiation on the dominant dimension - i.e. with providers at the first and third quartiles. Hence the Max-Min-differentiation equilibrium presented here is never efficient and the second equilibrium is efficient (only) if mismatch costs are higher than commuting costs[9]. However, if commuting cost is relatively high optimal locations reverse and the second equilibrium is not efficient as well. Overall, the option market can provide too much or too little of product differentiation and geographic dispersion. Nonetheless I will show that the first-best market outcome can be always achieved by regulating providers' geographic locations.

The remarkable differences between spot market and option market outcomes highlighted here, are due to consumers uncertainty regarding future medical needs. Under the second equilibrium the option demand for multiple-access shifts providers from competing over the marginal consumers to competition over marginal inclusion under insurance coverage. Here, providers that are perceived as substitutes in the spot market are perceived as complements in the option market. Hence each provider aims at maximizing the option value its products for consumers who buy insurance also from the rival. Under the first equilibrium, where providers compete over the marginal consumer like in spot markets, this uncertainty implies that the dominant dimension in the option market is always the geographic one. Therefore, providers maximize differentiating over this dimension regardless the values of commuting and mismatch cost-parameters (whereas in spot markets the dominant dimension is of the higher spatial cost).

The remainder of the paper develops as follows: Section 2 presents the detailed market model. Section 3 analyzes two equilibria - with single and multiple access purchases. Section 4 studies market equilibrium under regulated geographic locations. Section 5 concludes this study.

2 The Model

I study two-dimensional spatial competition in the same framework employed by Ansari et al.(1998) and Irmen and Thisse (1998) for spot market analysis. Consumers of unit mass, who are indexed i,

[9]This result of market efficiency is consistent with the one I obtained in earlier work for unidimensional spatial competition in option demand markets (Sorek 2015). The main innovation of the present work is introducing the geographical dimension which induces ex-ante heterogeneity in consumers' preferences, whereas in Sorek (2015) consumers are ex-ante identical. This heterogeneity gives room for different insurance choices by consumers, whereas in Sorek (2015) all consumers will have same insurance choices by assumption.

are uniformly distributed over a linear city of a unit length. When buying insurance each consumer knows her geographic address $z_i \in [0,1]$, and faces the probability π of becoming sick with a medical need x_i. All possible medical needs are independently and uniformly distributed over the unit interval $x \sim U[0,1]$. The distribution x is a common knowledge and is independent of the address distribution z. Each sick consumer draws one medical need from the distribution x, which is then correctly diagnosed at no cost and becomes a common knowledge. The above assumptions imply that sick consumers are uniformly distributed over a 1×1 square.

There are two medical providers denoted $j = (1,2)$. Each provider is defined by its geographic location (address) w_j and its location in the medical products line, denoted y_j, which resemble clinical specialization area. When healthy, consumer utility is v, and when sick it drops to zero if not treated. Once treated, consumer's utility depends on the effectiveness of the medical product utilized and the cost of commuting to the medical provider. The effectiveness of a medical product is decreasing with its horizontal distance from the treated medical need. Hence the utility of the sick consumer i from being medically treated by provider j is

$$u = v - m\left(x_i - y_j\right)^2 - c\left(z_i - w_j\right)^2$$

The parameter $m > 0$ measures the degree of differentiation over medical conditions, or the cost of mismatch between medical needs and treatments. Similarly the parameter $c > 0$ measures commuting cost in the geographic dimension. For the healthy consumer, expected utility from buying an option to utilize medical product y_j when sick is

$$E\left(u_i\right) = (1-\pi)\,v + \pi\left\{\int_0^1 \left[v - m\left(x - y_j\right)^2\right]dx - c\left(z_i - w_j\right)^2\right\} - op_j \tag{1}$$

Where op_j is the option price set by provider j that is an insurance premium with zero co-pays.

The expected utility function (1) is conventional to the relevant literature[10]. It implies neutrality with respect to the financial risk associated with medical expenses. Abstracting from risk aversion greatly simplifies the analysis, but adding risk-aversion should not alter my main results. Finally, I assume zero marginal cost of provision, and $\frac{4v}{5m} > 1$[11].

[10] See Gal-Or (1997) and Douven et al.(2014).

[11] To assure that all product utilizations are beneficial to consumers (at zero spot price) and thus socially desired.

The game follows a three stage time line:

1) First both providers choose geographic location w_j and product specialization y_j

2) Then providers set option prices and consumers make their insurance purchase decisions.

3) Lastly medical needs are realized and consumers are treated by their preferred provider under insurance coverage.

3 Equilibrium

I confine attention to symmetric equilibria with $w_1 \leq w_2$ and $y_1 \leq y_2$. I will explore two possible equilibria types. First I will characterize equilibrium with single access purchases in which each consumer buys an option to access one provider only. Then I will turn to characterize equilibrium where at least some consumers choose to buy option to access both providers.

3.1 Single-access purchases

If equilibrium with single-access purchases exists, under such equilibrium providers are competing over the marginal consumers just like in spot price competition. The following condition defines the option demand faced by provider 1, put up by all consumers who prefer buying option to utilize product 1 over an option to utilize product 2

$$\pi \left\{ \begin{array}{c} \int\limits_0^1 \left[v - m \left(x - y_1 \right)^2 \right] dx - \\ -c \left(z_i - w_1 \right)^2 \end{array} \right\} - op_1 \geq \pi \left\{ \begin{array}{c} \int\limits_0^1 \left[v - m \left(x - y_2 \right)^2 \right] dx - \\ -c \left(z_i - w_2 \right)^2 \end{array} \right\} - op_2 \tag{2}$$

Condition (2) compares the expected utility from buying option (insurance) from each provider, considering all possible medical conditions and associated costs. For the marginal (indifferent) consumer, denoted $\widetilde{z}$, condition (2) holds with equality and can be written as

$$\widetilde{z} = \frac{1}{2} \left\{ \frac{m \left[(y_1 - y_2) + \left(y_2^2 - y_1^2 \right) \right] + \frac{(op_2 - op_1)}{\pi}}{(w_2 - w_1)\, c} + (w_2 + w_1) \right\} \tag{2a}$$

Hence the surplus for provider 1, PS_1, is given by

$$PS_1 = \frac{1}{2}\left\{\frac{m\left[\left(y_2^2 - y_1^2\right) - \left(y_2 - y_1\right) +\right] + \frac{(op_2 - op_1)}{\pi}}{\left(w_2 - w_1\right)c} + \left(w_2 + w_1\right)\right\} op_1 \tag{3}$$

Maximizing (3) with respect to op_1 yields the optimal option price

$$op_1^* = \frac{\pi m\left[\left(y_2^2 - y_1^2\right) - \left(y_2 - y_1\right)\right] + op_2 + \pi c\left(w_2^2 - w_1^2\right)}{2} \tag{4}$$

Deriving the corresponding optimal option price for provider 2 yields[12]

$$op_2^* = \pi\left(w_2 - w_1\right)c - \frac{\pi m\left[\left(y_2^2 - y_1^2\right) - \left(y_2 - y_1\right)\right] - op_1 + \pi c\left(w_2^2 - w_1^2\right)}{2} \tag{4a}$$

Solving the equations system (4)-(4a) yields optimal option prices as a function of product and geographic location choices

$$op_1^* = \frac{\pi}{3}\left\{2\left(w_2 - w_1\right)c + m\left[\left(y_2^2 - y_1^2\right) - \left(y_2 - y_1\right)\right] + c\left(w_2^2 - w_1^2\right)\right\} \tag{5}$$

$$op_2^* = \frac{\pi}{3}\left\{4\left(w_2 - w_1\right)c - m\left[\left(y_2^2 - y_1^2\right) - \left(y_2 - y_1\right)\right] - c\left(w_2^2 - w_1^2\right)\right\} \tag{5a}$$

Plugging (5)-(5a) back into (3) I rewrite the surplus

$$PS_1 = \frac{\pi}{18c}\frac{\left\{\left(2\left(w_2 - w_1\right)c + m\left[\left(y_2^2 - y_1^2\right) - \left(y_2 - y_1\right)\right] + c\left(w_2^2 - w_1^2\right)\right)\right\}^2}{\left(w_2 - w_1\right)} \tag{6}$$

Differentiating (6) for y_1 yields the first order condition for optimal product choice by provider 1: $y_1^* = \frac{1}{2}$. Because y_1^* is independent of all the parameters and the endogenous variables, it will be chosen also by provider 2 who maximizes a symmetric surplus function. Plugging $y_1 = y_2 = \frac{1}{2}$ back into (6) I obtain

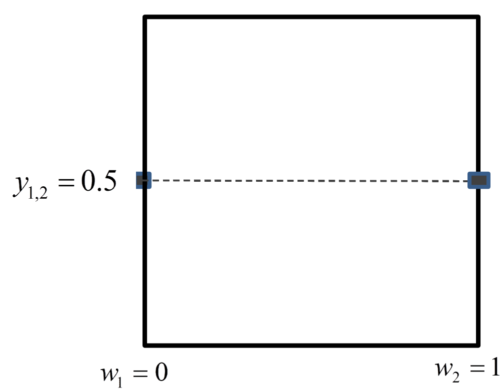
$$PS_1 = \frac{c\pi\left(w_2 - w_1\right)}{18}\left[2 + \left(w_2 + w_1\right)\right]^2 \tag{6a}$$

[12] The surplus expression for provider 2 is given by $PS_2 = (1 - \widetilde{z})\, op_2$

Proposition 1 *There exists unique symmetric equilibrium with single-access purchases and Max-Min differentiation:* $w_1^* = 0, w_2^* = 1, y_{1,2}^* = \frac{1}{2}$.

Proof. Differentiating (6a) for w_1 yields $\frac{\partial PS_1}{\partial w_1} = \frac{c\pi[2+(w_2+w_1)]}{18}\{2(w_2 - w_1) - [2 + (w_2 + w_1)]\}$. $\frac{\partial PS_1}{\partial w_1} = 0 \ iff \ w_2 - w_1 = 1$, and otherwise $\frac{\partial PS_1}{\partial w_1} < 0$. Hence $w_1^* = 0$ and thus due to symmetry $w_2^* = 1$. The second part of the proposition was derived by differentiation (6) for y_1: $\frac{\partial PS_1}{\partial y_1} = 0 \Rightarrow y_1^* = \frac{1}{2}$,hence by symmetry $y_2^* = \frac{1}{2}$. As $y_1^* = y_1^*$ each consumer prefers buying access only to her nearby provider. ■

Figure 1: Equilibrium with single-access purchases



The Max-Min differentiation defined in proposition 1 is consistent with the results obtained for spot price competition by Ansari et al.(1998) and Irmen and Thisse (1998). Here also, providers maximize differentiation over the dominant dimension that is the geographic one: as for each consumer medical conditions are ex-ante uniformly distributed over the products line, there is no preferred product ex-ante. This Max-Min equilibrium is the only one to prevail if consumers are restricted to buy access from one provider only, as in Lyon's (1999) analysis of HMOs market for example. This means that direct restriction on consumers' choice eliminates product differentiation. By Tabuchi (1994), the efficient market outcome is given by

$$\text{for } m > c\text{:} \quad y_1 = \frac{1}{4}, y_2 = \frac{3}{4}, w_{1,2} = \frac{1}{2}$$
$$\text{for } m < c\text{:} \quad w_1 = \frac{1}{4}, w_2 = \frac{3}{4}, y_{1,2} = \frac{1}{2}$$

Hence the equilibrium with single-access purchases is never efficient. Next we will show that the efficient market outcome may prevail under equilibrium with multiple-access purchases.

3.2 Multiple-access purchases

Consumer who buys options from both providers will choose which one to attend after getting sick, in light of the realized medical need. In particular, the consumer will choose attending provider 1 only if this minimizes the sum of mismatch and commuting cost

$$m\left(x_i - y_1\right)^2 + c\left(z_i - w_1\right)^2 \leq m\left(x_i - y_2\right)^2 + c\left(z_i - w_2\right)^2 \tag{7}$$

Simplifying (7) I obtain the range of medical conditions $(0, \widetilde{x}_1)$ for which the consumer who resides at z_i will *ex-post* choose attending provider 1

$$\widetilde{x}_1 \leq \frac{\frac{c}{m}\left[w_2^2 - w_1^2 - 2z_i\left(w_2 - w_1\right)\right] + \left(y_2^2 - y_1^2\right)}{2\left(y_2 - y_1\right)} \tag{7a}$$

As medical conditions are uniformly distributed on the unit interval, $\widetilde{x}_1$ is also the probability that the consumer who resides at z_i will *ex-post* prefer attending provider 1. I then use (7a) to define the indifference condition for the marginal consumer who prefers buying options from both providers over buying an option only from provider 2

$$\pi\begin{bmatrix} \int\limits_0^1 \left[v - m\left(x - y_2\right)^2\right] dx- \\ -c\left(z_i - w_2\right)^2 \end{bmatrix} - op_2 < \pi\left\{\begin{array}{c} \int\limits_0^{\widetilde{x}_1} \left[v - m\left(x - y_1\right)^2\right] dx+ \\ +\int\limits_{\widetilde{x}_1}^1 \left[v - m\left(y_2 - x\right)^2\right] dx- \\ -\left(1 - \widetilde{x}_1\right) c\left(w_2 - z_i\right)^2 - \widetilde{x}_1 c\left(z_i - w_1\right)^2 \end{array}\right\} - op_1 - op_2 \tag{8}$$

Condition (8) compares expected utility from buying an option from provider 2 only (on the left), with the expected utility from buying options to utilize both services, accounting for the propensity to utilize each one of them - as defined in (7a). Elaborating (8) yields its following simplified presentation

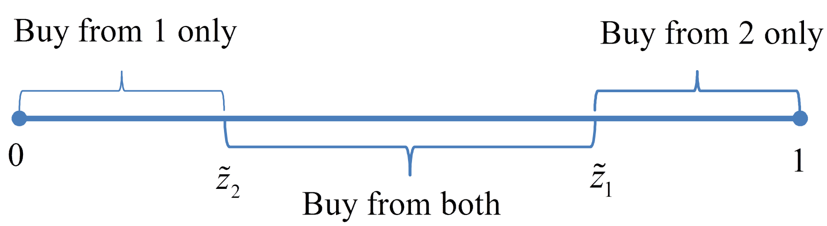
$$op_1 < \widetilde{x}_1^2 \pi m\left(y_2 - y_1\right) \tag{9}$$

Lemma 1 $\exists \widetilde{z}_1$ *such that all consumers with* $z_i < \widetilde{z}_1$ *buy insurance from both provider and those with* $z_i > \widetilde{z}_1$ *buy insurance from provider 2 only.*

Proof. The upper bound on op_1 given in (9) depends positively on $\widetilde{x}$, which by (7a) is decreasing with consumer's geographic location z_i. Hence for a given $op_1, w_{1,2}$ and $y_{1,2}$ conditions (9) and (7a) define a cut-off geographic location $\widetilde{z}_1$ below which condition(8) holds, and above which it holds with reverses inequality. ■

Due to the symmetry of the model conditions similar to (7a) and (9) define the marginal consumer $\widetilde{z}_2$ who is indifferent between buying insurance from both providers and buying insurance only from provider 1. Hence the fraction of consumers who buy insurance from both providers is given by $\widetilde{z}_1 - \widetilde{z}_2 \equiv \triangle\widetilde{z}$. All consumers with $z_i < \widetilde{z}_2$ buy insurance from provider 1 only and all consumers with $z_i > \widetilde{z}_1$ buy insurance only from provider 2. Hence $\widetilde{z}_1$ defines the share of consumers who buy option from provider one. If $\triangle\widetilde{z} \geq 1$ all consumers buy insurance from both providers and if $\triangle\widetilde{z} = 0$ no one buys insurance from both providers. Note that having some consumers demanding access for both providers under symmetric equilibrium implies $\triangle\widetilde{z} = (1 - 2\widetilde{z}_1) \leq 1 \Rightarrow \widetilde{z}_1 > \frac{1}{2}$. Figure 2 illustrates consumers symmetric purchase choices for $0 < \triangle\widetilde{z} < 1$.

Figure 2: Insurance purchases for $0 < \triangle\widetilde{z} < 1$



Substituting (7a) into (9) I write the surplus of provider 1 as a function of the marginal consumer $\widetilde{z}_1$

$$PS_1 = op_1 \cdot \widetilde{z}_1 = \frac{\pi m \left[\frac{c}{m}\left[w_2^2 - w_1^2 - 2\widetilde{z}_1 (w_2 - w_1)\right] + \left(y_2^2 - y_1^2\right)\right]^2}{4\,(y_2 - y_1)} \widetilde{z}_1 \tag{10}$$

Maximizing (10) with respect to $\widetilde{z}_1$ yields the marginal consumer who is targeted by provider 1, denoted $\widetilde{z}_1^*$, for given geographic-locations and products choices

$$\widetilde{z}_1^* = \frac{\frac{c}{m}\left[w_2^2 - w_1^2\right] + \left(y_2^2 - y_1^2\right)}{\frac{c}{m}(w_2 - w_1)\,6} \tag{11}$$

Plugging (11) into (9) I derive the corresponding optimal option price

$$op_1^* = \frac{\pi m4\left[\frac{c}{m}\left(w_2^2 - w_1^2\right) + \left(y_2^2 - y_1^2\right)\right]^2}{9\left(y_2 - y_1\right)} \tag{12}$$

Then, substituting (11) and (12) into (10) I obtain

$$PS_1^* = \frac{\pi m2\left[\frac{c}{m}\left(w_2^2 - w_1^2\right) + \left(y_2^2 - y_1^2\right)\right]^3}{27\left(y_2 - y_1\right)\frac{c}{m}\left(w_2 - w_1\right)} \tag{13}$$

Differentiating (13) with respect to y_1 and w_1 yields the first-order conditions

$$6\left(y_2 - y_1^*\right)y_1^* = \frac{c}{m}\left(w_2^2 - w_1^2\right) + y_2^2 - \left(y_1^*\right)^2 \tag{14}$$

$$\frac{c}{m}6\left(w_2 - w_1^*\right)w_1^* = \frac{c}{m}\left[w_2^2 - \left(w_1^*\right)^2\right] + y_2^2 - y_1^2 \tag{15}$$

Lemma 2 *There is no symmetric equilibrium with interior solution to satisfy conditions (15)-(16)*

Proof. Comparing (11) and (15) reveals that w_1^* coincides with $\widetilde{z}_1^*$. However for multiple-access purchases to sustain under symmetric equilibrium it must be that $z_1^* > \frac{1}{2}$ (and $z_2^* < \frac{1}{2}$). but if $w_1^* = \widetilde{z}_1^*$ as implied by (11) and (15) the requirement $z_1^* > \frac{1}{2}$ contradicts with the assumption $w_1^* < \frac{1}{2}$. ■

Lemma 2 implies that under symmetry the optimal geographic locations are approaching the city center. Then however, by (11), under symmetric equilibrium $\widetilde{z}_1^* > 1$. This makes conditions (15)-(16) for interior optimal choices redundant. Hence I turn now to analyze a constraint equilibrium with $\widetilde{z}_1^* = 1$, for which the surplus function (10) becomes

$$PS_1 = \frac{\pi m\left[\frac{c}{m}\left[w_2^2 - w_1^2 - 2\left(w_2 - w_1\right)\right] + \left(y_2^2 - y_1^2\right)\right]^2}{4\left(y_2 - y_1\right)} \tag{16}$$

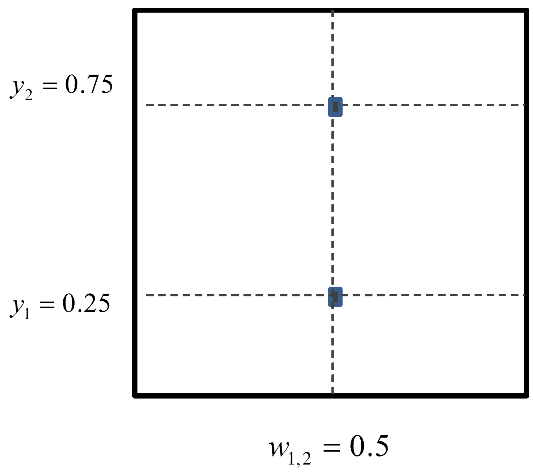
Maximizing (16) for w_1 yields $1 - w_1^* > 0$, implying a corner solution with $w_1^* = \frac{1}{2}$. As the optimal location for provider 1 is given by a corner solution that is independent of all other variables, symmetry implies the same optimal location choice for provider 2. Imposing this outcome on (16) the surplus expression becomes

$$PS_1 = \frac{\pi m \left(y_2 + y_1\right)^2 \left(y_2 - y_1\right)}{4} \tag{17}$$

Proposition 2 *There exists unique symmetric equilibrium where* $w_1^* = w_2^* = \frac{1}{2}$ *and* $y_1^* = \frac{1}{4}, y_2^* = \frac{3}{4}$*, and* $\triangle\widetilde{z} = 1$ *- hence all consumers buy access to both providers.*

Proof. Maximizing (17) for y_1 yields $y_1^* = \frac{y_2}{3}$ and then symmetry implies $y_1^* = \frac{1}{4}$ $y_3^* = \frac{3}{4}$. ■

Figure 3: Equilibrium with multiple-access purchases



Hence, the equilibrium with multiple multiple-access purchases is efficient if $m \geq c$. However if $m < c$, the efficient locations flip and thus the options market offers too much product choice and excessive geographic concentration. The next section shows that in this case, and in the case of equilibrium with single access purchases, regulating providers' geographic locations can achieve the first best outcome.

4 Regulated locations

Suppose now that locations are symmetrically regulated and denote the regulated distance between providers $\triangle\overline{w}$.

Proposition 3 $\forall\triangle\overline{w} \in (0,1) : y_{1,2}^* = \frac{1}{2}$*. For any regulated distance there exists unique equilibrium with both providers offering the same medical product and thus with single-access purchases.*

Proof. By (5) under single-access purchases optimal product choice is $y_1^*, y_2^* = \frac{1}{2}$ independent of locations. Under complete product assimilation no one buys two options hence indeed each consumer buys access only to her geographically nearby provider. ■

Proposition 3 implies that if $c > m$ the efficient market outcome can be achieved by setting $\triangle\overline{w} = \frac{1}{2}$. Next I will complete the equilibrium analysis under regulated locations for the case of multiple-access purchases. I will show that for $\triangle\overline{w} = \frac{1}{2}$ the only possible (symmetric) equilibrium is $y_1^* = y_2^* = \frac{1}{2}$, that is the socially optimal one for $c > m$. In case of multiple-access purchases condition (14) still applies with respect to optimal product choice

$$6\left(y_2 - y_1^*\right) y_1^* - \left[y_2^2 - \left(y_1^*\right)^2\right] = \frac{c}{m}\triangle\overline{w} \tag{18}$$

Under symmetric equilibrium condition (18) becomes

$$\left(1 - 2y_1^*\right)\left(6y_1^* - 1\right) = \frac{c}{m}\triangle w \tag{18a}$$

The left side of (18a) is a quadratic function that yields non-negative values for $\frac{1}{6} \leq y_1^* \leq \frac{1}{2}$. However the optimality condition (18) is valid (as an interior solution) only if $\frac{1}{2} < z^* < 1$. By (12) this requirement holds iff

$$\frac{1}{2} < \frac{\frac{c}{m}\triangle\overline{w} + \left(y_2^2 - y_1^2\right)}{\frac{c}{m}\triangle\overline{w}6} < 1 \tag{19}$$

Combining (18a) and (19) I obtain the following condition for (18) to yield interior solution

$$\frac{1}{5} < y_1^* < \frac{1}{4}\ ,\ \frac{3}{25} < \frac{c}{m}\triangle\overline{w} < \frac{1}{4} \tag{19a}$$

A lower regulated distance (i.e. $\frac{c}{m}\triangle\overline{w} \leq 0.12$) implies $z^* \geq 1$ and thus provider 1 maximizes the following modified version of the surplus expression in (16)

$$PS_1 = \frac{\pi\theta\left[\left(y_2^2 - y_1^2\right) - \frac{c}{m}\triangle\overline{w}\right]^2}{4\left(y_2 - y_1\right)} \tag{20}$$

Imposing symmetry on the first order condition for maximizing (20) I obtain

$$(1-2y_1^*)\,(1-4y_1^*) = \frac{c}{m}\triangle\overline{w} \tag{21}$$

The left size of (21) is a quadratic function which yields non-negative values for $y_1^* \leq \frac{1}{4}$.

Proposition 4 *(a)*$\forall\frac{c}{m}\triangle\overline{w} \in (0, 0.12)$ *there exists unique symmetric equilibrium with corresponding product choices* $\triangle y^* \in \left(\frac{1}{2}, \frac{3}{5}\right)$ *and* $\triangle\widetilde{z} = 1$ *(b)* $\forall\frac{c}{m}\triangle\overline{w} \in (0.12, 0.25)$ *there exists unique symmetric equilibrium with corresponding product choices* $\triangle y^* \in \left(\frac{1}{2}, \frac{3}{5}\right)$, *and* $0 < \triangle\widetilde{z} < 1$ *(c)* $\forall\frac{c}{m}\triangle\overline{w} > 0.25$ *there exits an equilibrium with no product differentiation* $\triangle y^* = 0$, *hence* $\triangle\widetilde{z} = 0$.

Proof. For $\triangle\overline{w} = 0$ (21) implies $y_1^* = \frac{1}{4}$, $y_2^* = \frac{3}{4}$as in proposition 2. for $\frac{c}{m}\triangle\overline{w} \in \left(0, \frac{3}{25}\right)$ condition (21) implies that y_1^* is decreasing (thus $\triangle y^*$ is increasing) with $\triangle\overline{w}$, up to $\triangle y^* = \frac{3}{5}$. Within this range of regulated distance all consumers buy insurance for both providers. For $\frac{c}{m}\triangle\overline{w} \in \left(\frac{3}{25}, \frac{1}{4}\right)$ condition (18) for interior solution holds, implying that y_1^* is increasing with $\triangle\overline{w}$ down to $y_1^* = \frac{1}{4}$ and $\triangle\widetilde{z} < 1$, for $\frac{c}{m}\triangle\overline{w} = \frac{1}{4}$. Finally, for $\frac{c}{m}\triangle\overline{w} > \frac{1}{4}$ condition (19) implies that $z^* < \frac{1}{2}$ hence provider are competing under single-access purchases and, by proposition 1, $y_1^* = y_2^* = \frac{1}{2}$. ■

Figure 4: Product differentiation under regulated locations for $\frac{c}{m} > \frac{1}{4}$

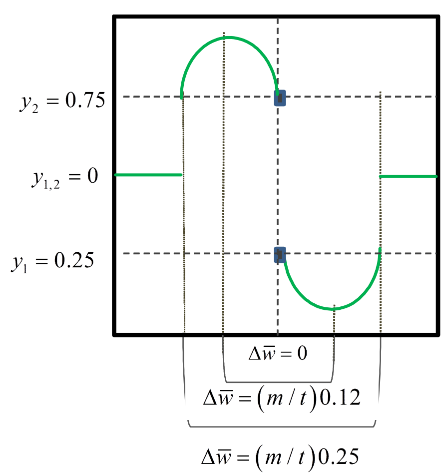


Figure 4 shows all possible equilibria under regulated locations for the case $\frac{c}{m} > \frac{1}{4}$, in which all three parts of Proposition 4 hold. Note however that if $\frac{c}{m} < \frac{3}{25}$ only part (a) of proposition 4 holds, and thus only the inner range of the curve for $0 \leq \triangle\overline{w} \leq 0.12\frac{m}{c}$ applies.

If $\frac{3}{25} < \frac{c}{m} < \frac{1}{4}$ only parts (a) and (b) of Proposition 4 hold, hence only the range $0 \leq \triangle\overline{w} \leq 0.25\frac{m}{c}$ of the curve in figure 4 applies.

For $m > c$, by Proposition 1, the unregulated equilibrium with single-access purchases yields insufficient product differentiation and excessive geographic dispersion. Then, setting $\triangle\overline{w} = \frac{1}{2}$ can turn the market to the equilibrium defined in Proposition 2 which is efficient for $m > c$.

For the case $c > m$ the unregulated market equilibrium with multiple-access purchases provides excessive product differentiation and insufficient geographic dispersion. Then, part (c) of Proposition 4 implies that setting $\triangle\overline{w} = \frac{1}{2}$ will yield identical product choices $y_{1,2} = \frac{1}{2}$, which is the socially optimal outcome. In summary, for $m > c$ $(m < c)$ regulating locations at $\triangle\overline{w} = 0$ $(\triangle\overline{w} = \frac{1}{2})$ guarantees market efficiency.

5 Conclusions

This work studied spatial competition in option demand markets along the geographic and medical specialization dimensions. The demand for optional access to multiple providers is generated by consumers' uncertainty regarding their future medical needs.

It was shown that the option market may yield two types of equilibria - in the first one all consumers buy access to only one provider and in the other all consumers buy access to both providers. The first equilibrium is never efficient and the second equilibrium is efficient (only) if mismatch costs are high relative to commuting costs.

Overall the market may provide too much or too little product differentiation, geographic dispersion. Nonetheless it was shown that whenever the market outcome is suboptimal efficiency can be restored by properly regulating providers' geographic location. The welfare improving policy may be such that effectively increasing or eliminate consumers' choice, that is switching the market from single to multiple-access purchases or vice versa.

The present work can be viewed as a benchmark analysis for two-dimensional competition in option demand markets, where providers sell insurance directly to consumers. Future research is called to explore the implications of more realistic insurance market, which composes dominant insurers that act as intermediaries: negotiating with providers over the terms of provision and reimbursement and forming providers' networks for the insured.

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