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SCREENING FOR CANCER AND MARKET STRUCTURE: A MULTILEVEL ANALYSIS FOR MAMMOGRAM AND PAP-SMEAR UTILIZATION IN THE U.S.[1]

By

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ABSTRACT: This paper investigates the relationship between health care market structure and utilization of preventive care services, namely mammogram and Papanicolaou (Pap-smear) screening. In addition to their life saving aspects, it is always believed that preventive health care services are important due to their cost-effectiveness which would prevail under managed competition. Yet, the nature of managed competition has been changing as a result of the backlash against it since the mid-1990s. We have yet to provide a clear answer to the question of how market structure affects the utilization of preventive care in general, and how the latest changes in health care market have been affecting it. These are the primary research questions of the paper. These research questions are answered by employing a new methodology that has not been used before. A multilevel modeling technique is employed to study the impact of changes in the structure of health care market on the utilization of mammogram and Pap-smear tests. In addition, an unusual data source, insurance claims data, rather than surveys or discharge data, is used in this study.

1. INTRODUCTION

Since the accelerating presence of managed care organizations (MCOs) in the mid-1980s, a new insurance regime has arisen in the U.S. health care system. For many, this new regime is a welcomed change from the previous one, characterized by overprovision and overutilization of expensive curative medical services in a less competitive health care market. In contrast, MCOs, especially health maintenance organizations (HMOs), of the new regime are believed to have increased the level of competition in the health care market. It is also believed that along with new methods of cost containment via different finance and delivery methods of health care services they have brought their emphasis on preventive care, rather than expensive curative care. Cost containment, competition, and the emphasis on preventive care are considered important and dominant aspects of this new regime in the U.S. health care system.

Despite its initial success in declining health care expenditures and increasing utilization rates for preventive care, this new regime has changed structurally since the mid-1990s. In a prosperous economy with a tight labor market, consumers and providers have resisted limited physician choice and restrictive financial and organizational aspects of health delivery, respectively (Miller, 1996; Berenson, 1997; Draper, 2002; Nichols et al., 2004;

Robinson, 2001, 2002, and 2004). This, so-called, "backlash" against managed competition has resulted in just the opposite of what was promised by managed competition: loose network structures, elimination of some cost containment methods such as gate-keeping, referral system, restrictive out-of-network use, and a shift from emphasis on restrictive supply-side reimbursement methods (i.e., capitation) to less restrictive ones (i.e., partial capitation or fee-for-service), as well as the ever increasing role of demand-side cost sharing methods (i.e., copayments, deductibles, and coinsurance). As a result of these structural changes, the health care system has been dominated by new health plan types that are hybrids of traditional fee-for-service (FFS) plans and conventional HMOs.

Inevitably, these interrelated aspects of changes in health care market structure and utilization of preventive care call into question those well established views on the relationship between competition in the health care market and utilization of preventive care through different health plans. In other words, whatever has happened to the utilization of preventive care as a result of these changes in the health care market structure? More importantly, what role, if any, does market structure play in terms of utilization of preventive care by different health plans? These are the primary research questions that are raised and empirically investigated in this study by employing a new methodology, namely multilevel analysis.

However, do we need a new methodology to answer these questions? The answer is yes for two reasons: the lack of empirical studies that consider the relationship between market structure and utilization of preventive care in general, and in relation to this, the lack of application of appropriate methodological tools to investigate the very same question. Regarding the former, existing studies in the empirical literature have always treated utilization of preventive care through FFS plans and HMOs as a yardstick to measure the

performances of old and new regimes respectively (Luft, 1978, 1980; Bernstein et al., 1991; Newman, 1997; Gordon et al., 1998; Potosky et al., 1998; Kemper et al. 1999/2000). Yet this dichotomy can no longer apply due the ongoing structural changes in health care market. Moreover, the majority of these empirical studies have been interested in demographic factors (i.e., age, sex, schooling, income level, etc.), and organizational and financial aspects of health plan types (i.e., HMO vs. FFS) to explain differential rates of utilization usually by taking the market structure as given. Those studies that take into account market structure (i.e., either HMO penetration rates or HMO competition index), however, have only explained the impact of these forces in terms HMOs' utilization rates for preventive services, rather than considering new plan types within the changing structure of the market (Wan et al., 1998; Decker and Hempsted, 1999).

Another reason for a new study is the lack of application of appropriate methodology when a hierarchical data is used. By treating individual and market level variables at the same level in the same model, traditional linear and nonlinear models (i.e., logistic, ordinary least squares, etc.) have only partially explained the impact of these variables on the outcome. This would not be enough to consider, for example, variance within and among market level variables and thereby their direct and indirect impact on the outcome. As a result, estimation results would not be statistically sound since hierarchical structure of the data would result in biased parameter estimations in these models. Therefore, from a methodological point of view, those studies in the empirical literature that do not include market variables can be considered incomplete. On the other hand, those that include market variables into their analysis along with individual ones at the same level in traditional models simply ignore the hierarchical structure of data that they use. In order to avoid these problems of hierarchical structure of data, the present study proposes to employ

a hierarchical linear or multilevel modeling technique to understand the role played by individual and market level variables in terms of likelihood of receiving preventive care (Guo and Zhao, 2000).

In addition, data used in this study is different than the traditional ones extensively used in the literature such as surveys and (hospital) discharge data. This study employs insurance claims data for large employers. Therefore, the data makes it possible to figure out both actual utilization of services and detailed employment characteristics. In comparison with the existing studies, the present study has another advantage regarding employment characteristics. It employs detailed information about employment characteristics such as full-time or part-time employment, salary or hourly paid, unionized or not, which have been used rarely, if not at all, in the literature. In an employment-based private health insurance system, it is really important to see the impact of employment characteristics on the utilization of preventive care, especially mammogram and Pap-smear screening.

2. A REVIEW OF MAMMOGRAM AND PAP-SMEAR UTILIZATION AND MARKET STRUCTURE IN THE U.S.

As representative preventive care, mammogram and Pap-smear screening for breast and cervical cancer are analyzed in this study for two reasons. First, given the arguments about the effectiveness of many preventive care services, the mammogram and Pap-Smear are also considered cost-effective and life saving procedures. Second, it is well documented that the life saving aspect of these two procedures helps them to be ranked higher in priority lists of preventive care services (Marks and Lee, 2000).

However, it is important note that there is still a tension concerning the question of what the appropriate balance between curative and preventive services is. Public health professionals are in favor of more preventive services to improve health. On the other hand,

some economists argue that not all the preventive services may be cheaper than curative ones (Russell, 1994). Other economists, who explain the phenomenon within the context of welfare analysis, try to figure out the most efficient or socially optimal level of prevention, which exists when the marginal benefits equal the marginal costs of preventive care (Kenkel, 2000). In the final analysis, however, they are considered important preventive cares in general and utilization of such services depends upon availability, type, and characteristics of health insurance.

Regarding the importance of having coverage for such services, it is well documented that insurance coverage increases (i.e., 5 percent) the utilization of preventive services, particularly mammogram and Pap-smear tests (Kenkel, 1994; Ayanian et al., 2000). In a similar vein, the likelihood of getting cancer detection procedures increased if one had private outpatient health insurance during 1989-1990 (Gordon et al., 1998). Despite the evidence, coverage and demand for preventive services do not necessarily lead to increasing utilization of such services. For example, coverage of mammography services is not sufficient to guarantee equivalent utilization of screening across income groups (Barton et al., 2001).

Prior to the 1980s, HMOs clearly provided more preventive care than fee-for-service, FFS, plans did (Luft, 1978, 1980). This trend continued during most of the 1990s (Bernstein et al., 1991). Some studies observed this explicit difference between HMOs and FFS even until late 1990s (Newman, 1997). For example, compared with indemnity type plans, HMO and independent practice association (IPA) type HMO coverage were associated with approximately three and two times greater likelihood of receiving a mammogram and Pap-smear for women aged between 50 and 64 and between 20 and 64, respectively (Gordon et al., 1998). However, this gap between traditional FFS and

conventional HMO screening rates has been disappearing since mid-1990s (Kenkel, 1994; Potosky et al., 1998; Weinick and Beauregard, 1997). Although mammography screening was higher in managed care plans compared with FFS plans for women aged between 40 and 64 years (i.e., 64.2 percent vs. 58.2 percent) and between 20 and 64 (i.e., 83.5 percent vs. 80.2 percent) for mammogram and Pap-smear, respectively, the difference was not statistically significant for mammogram in a nationally representative cross-sectional survey in 1992 (Potosky et al., 1998).

One reason for the closing gap between traditional FFS and conventional HMO plans may be the fact that several states --at least 42 of them-- started to mandate the coverage of such services during the mid-1990s (Gordon et al., 1998; Potosky et al., 1998). Another reason may have to do with HMO specific organizational features such as greater access to plan based reminder systems by the physicians in staff or prepaid group model HMOs as well as the increasing numbers of new forms of managed care organizations such as for-profit IPAs, "managed-fee-for-service" type plans (i.e., PPOs or EPOs) (Potosky et al., 1998). Therefore, the clear-cut organizational differences between HMOs and FFS plans have disappeared, and so have respective screening rates by these plans.

For example, compared to plans without gate-keeping mechanisms, individuals enrolled in HMOs were more likely to receive mammograms by 20 percentage points, while the effect of HMOs on Pap smear was not significant (Deb and Trivedi, 2003). In a similar vein, compared to group and staff model HMOs, for profit IPA and network model HMOs achieved a lower rate of mammography and Pap-smear tests for their enrollees (Wan et al., 1998).

HMOs inevitably had an impact on providers and the way they deliver preventive services as well. For example, as health care organizations consolidated into integrated

systems, they expected to see increasing delivery of preventive services (especially mammography) (Kellie et al., 1996). In a similar vein, increasing HMO penetration resulted in a reduction in the number of mammography facilities/providers through consolidation and an increase in the number of services produced by the remaining providers (Baker and Brown, 1999).

Another inevitable aspect of changes in health care market is the impact of demand-side cost sharing methods (i.e., copayments, deductibles, etc.). For example, for HMO enrollees, a $5 office visit copayment for preventive care resulted in a decrease in physical examinations but did not significantly affect cancer screening tests received by women (Cherkin et al., 1990; Kenkel, 2000). Similarly, the probability of seeking preventive screening individually decreases for Pap-smear (from -3 percent to -9 percent) in both HMOs and PPO/Indemnity plans, and for mammography (-3 percent to -9 percent) but only in PPO/Indemnity plans (Solanski et al., 2000).

In an employment-based private health insurance system, employers and employees too can affect the utilization of preventive services due to their bargaining power over the content of coverage. One of factors in this regard is the presence of any worksite health promotion activities that are provided by employers. For example, overall the proportion of large employers in manufacturing and service industries that offered some type of cancer screening increased nationwide from about 4 percent in 1985 to 12 percent in 1992 (U.S. Department of Health and Human Services,1992). The same trend is observed when more of the firm's employees are eligible for employment-related group health insurance (Kenkel and Supina, 1992), but likelihood of offering such programs decline with high employment

turnover (Decker and Hempstead, 1999; Dowd, 1982) and for small size firms (McMahan et al., 2001). [2]

3. A THEORETICAL FRAMEWORK

The available analytical models on prevention in health economics literature are preoccupied with the demand for preventive care that is explained as consumers' decision or insurers' decision under uncertain circumstances (as in human capital and insurance models respectively) (Grossman, 1972; Schlesinger and Venezian, 1986; Kenkel, 2000). Empirical research on the utilization of preventive care, on the other hand, is based on ad hoc empirical modeling that does not necessarily follow analytical models suggested in the literature (Luft, 1978, 1980; Bernstein et al., 1991; Kenkel and Supina, 1992; Gordon et al., 1994; Kenkel, 1994; Potosky et al., 1998; Wan et al., 1998; Decker and Hempstead, 1999; Solanki et al., 2000; Barton et al., 2001).

In addition, while the existing empirical studies put the emphasis on factors affecting utilization of such services at the individual level (i.e., age, sex, health status, income, type of health plan, etc.), they do not take into account market structure with the exception of few (Decker and Hempstead, 1999; Wan et al., 1998). However, utilization of such services depends also on health care market structure where the interactions between and among different health plans, and health plans and providers result in constantly changing benefit designs, premiums, cost-sharing mechanisms, and organizational structures to gain more share of the market. These strivings for higher market share lead to different market structures where individual level factors would ultimately be affected.

[2] However, to my knowledge, health promotion programs seem the only aspect that has been studied in the literature in the context of preventive care utilization. That's why the present study may contribute to the literature by taking into consideration different aspects of employment as mentioned in the introduction.

Accordingly, I propose a conceptual framework in which consumer level factors such as demographic and employment characteristics of consumers and organizational and financial characteristics of health plans and market level factors such as market share of health plans and degree of competition among them in the same market are related to each other in a hierarchical relationship. Hierarchical relationship (or multilevel relationship) is inspired from hierarchical linear modeling techniques (Hox, 2002). As is explained in the introduction, in such an empirical model, consumers are treated as members who are nested within different health insurance plans at the first level of this hierarchical structure. At the second level, consumers and their plans are perceived as nested within different health care markets that are characterized by market share of and competition between health plans. Specifically, I consider different levels of HMO penetration as the primary market structure variable due to this influence on other plans and providers. Then I consider different competitive strategies such as product differentiation and price competition under different levels of HMO penetration.

***Individual Level Factors*:** The first set of individual level variables is consumers' demographic characteristics such as age, sex, race, income, and education. According to the empirical evidence, there is an association between utilization of such services and higher income and education level. This may indicate the consciousness of consumers and their ability to afford preventive care. Both mammogram and Pap-smear screening are sex and age sensitive services (AHRQ, 2003). They are also mandated in some states as mentioned before. Race may also play an important role, since it is known that some racial groups fall behind the average in terms of preventive care utilization.

Despite few empirical investigations of direct effect of employment characteristics on the utilization of preventive care, they also play a major role. In general, availability of a

health insurance through employment may increase the likelihood of receiving preventive care. On the basis of empirical evidence and intuitive reasoning, it is safe to argue that full-time, high-wage, unionized employees who are working in large firms with a worksite health promotion program are more likely to receive health insurance with better coverage and maybe higher contribution. Family coverage may also have a positive impact on the utilization.

Organizational characteristics of health plans must be taken into consideration as well. It is argued that centralized health plan structure that limit patients' choice of providers with information sharing mechanisms (i.e., screening guidelines, newsletters, provider manuals, and other reminder systems) may increase utilization of preventive care (Tye et al., 2004). Such a more established plan structure with established communication channels usually has a defined network, restricted out-of-network coverage, use of gatekeepers, and the use of cost containment measures such as penalty for second surgical opinion (Weinick and Beauregard, 1997; Tye et al., 2004).

The most centralized health plan with such information sharing mechanisms, use of gatekeeper, and restricted out-of-network is the conventional or closed panel HMOs. However, there are hybrid health plans that range between the conventional HMOs and traditional FFS plans such as POS plans and PPOs. In comparison with conventional HMOs, most of these plans have relatively loose networks, gatekeepers, and information sharing mechanisms. Therefore, it may be appropriate to expect more preventive care through conventional HMO plans than hybrid plans contingent upon how they comply with organizational requirements similar to what conventional HMOs have. The traditional FFS plans that have none of these organizational features may rank last.

Finally, demand- and supply-side cost sharing mechanisms adopted by health plans can determine the utilization. Both empirical and theoretical evidences suggest that as the financial burden put on the shoulder of consumers via extensive demand-side cost sharing mechanisms (i.e., copayments, deductibles, and coinsurance) utilization of preventive care may decline. As a matter of fact, this has been a trend followed by almost all types of health plans in the U.S. As far as supply-side cost sharing mechanisms (i.e., fee-for-service, salary, and capitation) are considered, it has been argued that capitation based reimbursement (of physicians) usually encourage the utilization of preventive care. This financial strategy has still been followed by conventional or closed panel HMOs and some open panel HMOs (such as POS). However, majority of hybrid plans (such as PPOs and POS) have been adopting fee-for-service type of reimbursement. In sum, it may be highly likely to observe higher utilization rates among those plans that still use capitation payments.

***Market Level Factors*:** Following empirical literature, market level variables are HMO penetration rate and HMO competition index in a given market, namely metropolitan statistical area, MSA. To understand the effect of HMO penetration in any health care market, I consider two simplifying market structures that affect utilization of preventive care differently: low and high HMO penetration. Then I discuss different competitive strategies under these scenarios.

Low HMO Penetration: Low HMO penetration implies that traditional plans are dominant in the market. In such a traditional indemnity dominated market, barriers to entry such as a huge fixed cost of establishing a brand name and developing a network are higher (Nichols et al., 2004). Therefore, the number of HMOs that can sustain themselves in such markets will be fewer. Conventional HMOs may initially enter such traditional indemnity dominated markets with an offer of low premiums and copayments without or low

deductibles (i.e., price competition) to increase their market share as they did historically in the U.S. They may also differentiate their product by emphasizing preventive care more. This, in turn, may attract younger and healthier patients (i.e., market segmentation). The impact of price competition, product differentiation, and market segmentation may be reinforced further with conventional HMOs' alternative organization and delivery of services. That is, under a conventional HMO plan, a patient has to use a network of providers; otherwise he/she has to pay the full cost of services from an out-of-plan provider. In addition, conventional HMOs usually have well established information sharing systems such as reminder systems, especially for preventive care. As a result, traditional FFS plans may be left with older and less healthy patients. However, there may be still no reason for the FFS to react by changing its benefit structure as suggested in the literature since these plans still have the higher share of market. Thus, it may be more likely to receive preventive care through conventional HMOs than traditional FFS plans, $P_{HMO} > P_{FFS}$.

One may question the absence of hybrid plans in this picture. As suggested above, due to high entry barriers and fixed costs, it may be really difficult to enter such markets from scratch. This may be true especially for hybrid plans. Historically hybrid HMO plans (i.e., POS) as well as PPOs have entered local markets by using the existing networks there (Nichols et al., 2004; Hurley et al., 2004). In addition, such plans historically emerged as a reaction of consumers and providers toward managed care and competition that are identified as well as idealized by conventional HMOs. Given the low density of conventional HMOs in a market dominated by traditional FFS plans, there may be no room for such a reaction yet. Therefore, hybrid HMOs and PPOs may not have a big role to play in such markets. In short, in a market where HMO penetration is low, I expect to see the highest likelihood of receiving preventive care through conventional HMOs. This may be

followed by hybrid plans (i.e., POS and PPOs), if they exist, and traditional FFS plans respectively, $P_{HMO} > P_{HYBRID} > P_{FFS}$ where P stands for probability.

High HMO Penetration: If conventional HMOs can use their competitive price, market segmentation, and product differentiation strategies to increase their market share, they may dominate the market unless they confront any credible competitive pressure from their rivals including hybrid plans. This would be the scenario that has been suggested by the proponents of managed competition. Assuming that conventional HMOs do not face a credible threat from their rivals, they will lose market segmentation advantage due to high share of enrollees who would be enrolled in such HMOs. In addition, there may be an indirect pressure on traditional FFS plans since increasing HMO penetration may result in a spillover effect on FFS plans in terms of benefit structure through adopting some conventional HMO benefits including the emphasis on preventive care (Weinick and Beauregard, 1997). Moreover, increasing numbers of providers with conservative practice styles (i.e., spillover effects on providers) that are working for conventional HMOs may, in turn, help reduce the cost of health services received through FFS plans and increase the utilization of preventive care in the same market. However, at the same time, there may be an increasing cost on the HMO end of this development due to high HMO penetration. Besides losing market segmentation advantage, total cost of health care may be increasing due to increasing number of potential users of health services which become a significant financial burden for insurers (Russell, 1994). In sum, if conventional HMOs dominate and influence the market in terms of their impact on providers and FFS plans as suggested by the managed competition theory, it may still be highly or equally possible to receive preventive care through conventional HMOs and traditional FFS plans, $P_{HMO} \geq P_{FFS}$.

What if conventional HMOs face a credible threat from their rivals that offer different organizational and financial incentives for consumers and providers? In other words, increasing HMO penetration may result in a backlash against conventional HMOs by consumers and providers as has been happening in reality (Miller, 1996; Berenson, 1997; Draper et al., 2002; Robinson, 2001, 2002, and 2004; Hurley et al., 2004; Nichols et al., 2004). Such changes would shift market power from conventional HMOs to providers may result in observing a new hybrid type of health plans.

These new hybrid plans design their benefit structure in such a way that it is not restrictive in terms of choosing providers for consumers and practicing styles for providers. In addition, they shift the financial responsibility from providers to consumers by imposing partial or no capitation and fee-for-service as supply-side cost sharing mechanisms, and by adopting coinsurance in addition to office copayments and deductibles as demand-side cost sharing mechanisms. Moreover, these plans differentiate their prices as well as products by creating tiers of networks and providers (Robinson, 2001, 2002, 2004). This last strategy can be considered a different type of market segmentation. In any event, these competitive strategies may make conventional or closed panel HMOs plans more open by loosening their network structure, softening requirements for gatekeeping, and imposing more demand-side cost sharing mechanisms. In a similar vein, traditional FFS plans may look more like PPOs by developing some relatively loose networks and adopt different demand-side cost sharing mechanisms (i.e., copayments, coinsurance, and deductibles).

In comparison with a market dominated by conventional HMOs or FFS plans, these changes blur the differences among health plans. Ultimately they negatively affect utilization of preventive care for two reasons. First, loosening structure of networks and information sharing mechanisms, elimination of gatekeeping, and return to fee-for-service type

reimbursement methods may reduce the likelihood of receiving preventive care in general. Second, the presence of multiple contracts of providers with different health plans in such a market implies loosening affiliated network structure, multiple utilization review programs, and divergent practice guidelines from individual providers' point of view which result in a limited, if not negative, impact on physicians' practice styles that include their role in provision of preventive care (Berenson, 1997; Nichols et al., 2004).

What would be the overall implication of such a market structure? Due to their organizational and financial advantages, conventional HMOs may still rank first. Increasing competitive pressure on traditional FFS plans may change their benefit structure in such a way that it may be equally or less possible to receive preventive care through such plans in comparison with conventional HMOs. Depending on the degree of loosening their organizational structure and the degree of applying demand-side cost sharing mechanisms, hybrid plans may perform as well as or less well than conventional HMOs. However, the difference between some open and closed panel HMOs may not be high. Therefore, $P_{HMO} \geq P_{HYBRID}$ and $P_{HMO} \geq P_{FFS}$. Moreover, there may be no big difference even between traditional FFS plans and hybrid ones, $P_{HYBRID} \geq P_{FFS}$. However, if competition over market share further intensifies with increasing numbers of plans in the same market, it may even be possible to observe a better performance by traditional FFS plans over hybrid ones, $P_{FFS} \geq P_{HYBRID}$, since hybrid plans may loosen their network structure via further reducing their influence on physicians.

4. AN EMPIRICAL FRAMEWORK: MULTILEVEL ANALYSIS

A multilevel logit model is utilized to study the individual and market level determinants of the likelihood of receiving preventive care. The dependent variable in this study is binary: a person either receives preventive care (i.e., '1') or does not receive it (i.e.,

'0'). This requires using multilevel models that are specifically designed for binary outcomes such as the following (Guo and Zhao, 2000, and Hox, 2002).

The outcome variable can be defined as

y_{ij} = Binary response variable for i^{th} person (i.e., level-1) within j^{th} market (i.e., level-2).

The probability of the response variable is defined as

$$p_{ij} = Pr(y_{ij} = 1)$$

The probability of the response variable, p_{ij}, can be modeled by using logit link function with the standard assumption that y_{ij} has a Bernoulli distribution. Now, the model for the first level of analysis can be written as:

Level-1 Model:

$$\log [p_{ij} / (1 - p_{ij})] = a_{0j} + \boldsymbol{\beta}_j \boldsymbol{X}_{ij} \qquad (1) \text{ where}$$

a_{0j} = Intercept term for j^{th} market,

$\boldsymbol{\beta}_j$ = A vector of coefficients for individual or level-1 variables in j^{th} market,

$\boldsymbol{X}_{ij}$ = A vector of individual level variables for i^{th} person within j^{th} market.

Level-2 Models:

$$a_{0j} = \gamma_{00} + \boldsymbol{\gamma} \boldsymbol{Z}_j + u_{oj} \ (2) \text{ and}$$

$$\boldsymbol{\beta}_j = \beta_{10} + \boldsymbol{\beta} \boldsymbol{Z}_j + u_{1j} \quad (3) \text{ where}$$

a_{0j} = Intercept term for j^{th} market in Level-1 model,

γ_{00} = Intercept term for Level-2 model, or grand mean (i.e., the logit of the average probability of receiving a preventive care) for all markets,

$\boldsymbol{Z}$ = A vector of market level or Level-2 variables,

$\boldsymbol{\gamma}$ = A vector of coefficients for market level or Level-2 variables.

β_{10} = the coefficient for first level variables that depends upon market variables.

$\boldsymbol{\beta}$ = A vector coefficients for the interaction between individual and market level variables.

Let's plug (2) and (3) in (1);

$$\log [p_{ij} /(1- p_{ij})] = \gamma_{00} + \beta_{10}\boldsymbol{X}_{ij} + \boldsymbol{\beta}\boldsymbol{X}_{ij}\boldsymbol{Z}_j + \boldsymbol{\gamma}\boldsymbol{Z}_j + u_{1j} + u_{0j} \quad (4) \text{ where}$$

$u_{1j} + u_{0j}$ =Random effect due to random error terms

$\gamma_{00} + \beta_{10}\boldsymbol{X}_{ij} + \boldsymbol{\beta}\boldsymbol{X}_{ij}\boldsymbol{Z}_j + \boldsymbol{\gamma}\boldsymbol{Z}_j$ = Fixed or systematic effect due to fixed coefficients or deterministic part of the model.

While the fixed effect part of the model shows the impact of each variable (i.e., both individual market levels) on the outcome, the random part helps to figure out the varying likelihood of receiving a preventive care across different markets. In this study, I will plug only equation (2) into equation (1) and not use equation (3) above. [3]

To justify a need for a multilevel analysis, however, it is necessary to compare intercept-only model for individual as well as multilevel logit models (Guo and Zhao, 2000). That is,

$$\log [p_{ij} /(1- p_{ij})] = a_{0j} \quad (5)$$

$$\log [p_{ij} /(1- p_{ij})] = \gamma_{00} + u_{0j} \quad (6)$$

[3] The present study employs SAS© statistical software from data compiling to regression analyses. Since multilevel modeling requires a different program from readily available ones, I use the %GLIMMIX macro for SAS©. It was written by Russ Wolfinger from SAS© Institute and it is available from the SAS© homepage. The address is the following (last visited on 01/19/2004): http:/ftp.sas.com.techsup/download/stat/glmm800.html. The macro is designed for the analysis of Generalized Linear Mixed Models (GLMM) (Little et al., 1996). It uses the principle of quasi-likelihood based on Wolfinger and O'Connell's (1993) pseudo-likelihood function and an approximation to the likelihood function of the model that results in an iterative procedure repeatedly fitting a linear fixed model to a pseudo response.

The purpose of intercept-only model estimations is to understand the significance of market variables in terms mammogram utilization analysis. One can use three important pieces of information by comparing (5) with (6). The first information is the comparison of the estimated values of intercept term in two models to see if there is any overestimation because of not taking into account differences among markets (i.e., MSAs). The second is the extent of random effect, that is, the variance of the intercept term in the intercept-only multilevel logit model (i.e., $\sigma^2_{\gamma 00}$). In other words, the variance of the intercept term shows the extent of variance across markets. The last is the intraclass correlations that is calculated as

$\rho = \sigma^2_u / (\sigma^2_u + \sigma^2_e)$ where σ^2_u is the total variance of errors and

$\sigma^2_e = \pi^2/3$ is the variance of the standard logistic distribution.

The intraclass, or intramarket in this study, correlation is the proportion of market level variance compared to the total variance. This will measure the extent to which a market level analysis can explain changes in the dependent variable (i.e., probability of utilization).

***Data, Sampling, and Variables*:** Two major data sources are used for consumer and market characteristics. Consumer characteristics including both demographic and medical variables came from Medstat's the 1998 MarketScan® Commercial Claims & Encounters Database (2001). For market characteristics Interstudy MSA Profiles for 1998, Version 9.1 (1998) was used.

The MarketScan databases reveal both inpatient and outpatient medical claims and demographic characteristics of more than 7 million employees and dependents covered by the health benefit programs of large employers. These claims data are collected from approximately 100 different insurance companies, Blue Cross Blue Shield plans, and third-

party administrators. The data used in this study represent the medical experience of insured employees and their dependents for active employees regardless of whether they receive mammogram and Pap-smear or not.

Utilization of mammogram and Pap-smear services and patient characteristics are obtained from healthcare service use of individuals nationwide in outpatient commercial claims and encounters table in the database. [4] Utilizations of mammogram and Pap-smear tests are identified according to primary procedural codes provided in the same data. These codes that indicate the use of mammography and Pap-smear tests for only routine screening (i.e., preventive) purposes are determined from 1998 Physicians' Current Procedural Terminology (CPT-4) and screening codes in International Classification of Diseases 9th Revision, Clinical Modification (ICD-9-CM). [5] The codes that are used to identify preventive mammogram and Pap-smear test are presented in Table 1 in the appendix.

Having identified mammogram and Pap-smear utilization, I created two initial samples for mammogram and Pap-smear by keeping the age range between 40 and 64 for the former and 20 and 64 for the latter by following the previous studies in the literature and official guidelines for such services.

The initial samples consisted of a small number of enrollee with more than one plan. To be able to compare the likelihood of receiving mammograms and Pap-smears for enrollees with equal chance of access to the service, I included those enrollees with only one health plan in my analysis. In addition, in order to conduct empirical analysis on a common

[4] The data used in empirical analysis include only those who used the service once in 1998. The original data included those who used the services more than once as well. The maximum was eight times–only for one patient- and seven times–only for two patients- for mammogram and Pap-smear respectively.
[5] Codes were identified with the help of Regula Burki, MD and Fellow of the American College of Obstetricians and Gynecologists (FACOG), a clinical instructor in Obstetrics and Gynecology at the University of Utah and for the St. Mark's Family Medicine residency program in Salt Lake City, Utah.

and reliable denominator of characteristics of patients, I only considered enrollees with at least 365 days of enrollment in the present study. [6]

As a result of data compilation, the following individual level variables are used in the analysis: consumers' demographic characteristics (i.e., AGE, SPOUSE v.s. SELF, MEMBER DAYS OF ENROLLMENT), [7] employment characteristics (i.e., PARTTIME vs. FULLTIME, UNION v.s. NONUNION, SALARY v.s. HOURLY), plan type (HMO, HMOPOS, HMOPOSCAP, PPO vs. TRADITIONAL), and coinsurance rate (20 percent or above, COIN1, vs. less than 20 percent, COIN2).

The second major data source is Interstudy MSA Profiles used for market variables. From this data set, I used estimated HMO penetration rates (PEN798) and HMO competition index (IOC) for each MSA. HMO penetration is defined as the ratio of total numbers of HMO enrollees in an MSA to total numbers of enrollees in the same MSA. Index of competition is used as a measure of competitiveness of HMO market in an MSA. It is calculated as one minus the sum of the market shares squared. Therefore, the most competitive markets have values near one, while the least competitive will have values near zero.

Market characteristics data were merged with consumer characteristics data with the help of MSA flags that were available in both data. For mammogram and Pap-smear samples, 298 and 302 different MSAs were observed, respectively. A complete list of variables and associated descriptive statistics for analysis of mammogram and Pap-smear utilization are provided in Table 2, 3, and 4, respectively in the appendix..

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[6] I did not include those enrollees whose days of enrollment indicated irregularities and potential recording errors such as one day of enrollment or very short, interrupted enrollment days (i.e., 30 days) during 1998.
[7] Although empirical analysis is done for mammogram for two different age groups (between 35 and 64 v.s. 40 and 64), only the latter is provided in this paper. For Pap-smear, four age groups are considered: 20-30, 31-40, 41-50, and 51-64. The age group between 20 and 30 functions as the reference group.

5. RESULTS

A simple logistic regression model and a multilevel logistic regression model are employed at the individual and market level analyses, respectively. The results for mammogram are provided first in Table 5, and this is followed by Pap-smear in Table 7.

***Mammogram Utilization*:** At the individual level, both an increase of 5 years in age and of 100 days in member days of enrollment increase, but not significantly, the likelihood of receiving mammogram approximately 1.1 times (see Table 5). On the other hand, compared with primary beneficiary, receiving the same service through a family coverage as a spouse reduces the likelihood 16 percent. Regarding employment characteristics, being a salary paid and unionized, rather than hourly paid and non-union, employee increases the likelihood 1.6 and 2.2 times, respectively. However, as expected, being a part-time, rather than full-time, employee reduces the likelihood approximately 25 percent.

Among health plans, both closed (i.e., HMO) and open panel HMOs (i.e., only HMOPOS) and PPOs reduce the likelihood 12, 18, and 20 percent in comparison with the TRADITIONAL plans, respectively. [8] In addition, if the coinsurance is below 20 percent (COIN2), this increases the likelihood approximately 1.6 times.

Before presenting the results for multilevel analysis, the need for such an analysis must be justified by comparing intercept-only individual level logistic model with that of multilevel one (see Table 6). The difference between logit and multilevel logit results for the intercept term estimation indicates that logistic regression fails to consider clustering within markets by overestimating the intercept by about 63 percent. [9] Statistically significant variance of the intercept term also indicates the random effect of each individual market in addition to the fixed intercept term. Moreover, intramarket correlation in the same table

[8] Closed panel HMOs are significant at 10 percent while HMOPOSCAP is not statistically significant.
[9] exp(-1.330) =0.26 v.s. exp(-2.316)=0.09).

simply indicates that 63 percent of the variance of the outcome variable (i.e., mammogram utilization) can be explained at the market level. This significant magnitude implies that there is statistical evidence for market level analysis. Finally, since the extra-dispersion variable is not substantially different from 1 (i.e., 0.980), it can be concluded that the conditional variance of the errors is consistent with the assumed distribution (i.e., binomial). Therefore, there is no evidence for over- or under-dispersion that results in unreliable test statistics and standard errors.

According to the results (see Table 5), the impacts of age, member days of enrollment, and being a spouse do not change in terms of the likelihood of receiving mammogram at the market level. Although employment characteristics follow the same pattern in terms of their signs, their magnitude changes at the market level. While being a salaried and unionized employee increase the likelihood approximately 2 and 1.4 times, respectively, being a part-time employee reduces it 18 percent. Taking into account market variables certainly makes a difference.

In a similar vein, market level analysis changes the results for plan types. Compared with traditional plans, both open and closed panel HMOs (i.e., HMO, HMOPOS, and HMOPOSCAP) as well as PPOs increase the likelihood approximately 2, 1.2, 1.8, and 1.8 times, respectively. [10] Paying a coinsurance rate below 20 percent (COIN2) further increases the likelihood (i.e., 1.8 times) at the market level.

Finally, while a 10 percent increase in HMO penetration rates (PEN798) increases the likelihood 1.3 times, a simultaneous 10 percent increase in both HMO penetration and

[10] All variables are statistically significant at 0.0001 except that HMOPOS is significant at 3 percent.

competition reduces it 5 percent. [11] However, HMO competition index is not found statistically significant.

Pap-Smear Utilization: According to individual level logistic regression results (see Table 7), increasing age reduces the likelihood of receiving Pap-smear approximately 22, 23, and 33 percent for age groups 31-40, 41-50, and 51-64, respectively, in comparison with the reference age group, 20-30. As in mammogram case, being a secondary beneficiary (SPOUSE) reduces the likelihood about 14 percent. On the other hand, a 100 member days of enrollment increases it approximately 1.8 times. In terms of employment characteristics, again being a salaried and unionized employee increase the likelihood almost 2 and 3 times, respectively, but part-time employment reduces it about 59 percent. Although signs of coefficients of these variables are the same for both mammogram and Pap-smear, their magnitude increases significantly for the latter.

As far as plan types are concerned, a similarity exists between mammogram and Pap-smear: in reference to the traditional plan types, closed panel HMOs (HMO), an open panel HMO (HMOPOS), and PPOs reduce the likelihood 48, 26, and 24 percent, respectively. Yet, point-of-service plans with capitation (HMOPOSCAP), another type of open panel HMO, increase it about 1.3 times. In comparison with above 20 percent coinsurance rate, a coinsurance rate less than 20 percent increases the likelihood approximately 1.4 times.

Does market level analysis make a difference? [12] For example, as in individual level analysis, increasing age reduces the likelihood with a relatively lesser amount: 20, 19, and 29

[11] In addition to the intuitive reasoning (i.e., an increase in both penetration and competition), the use of interaction term in the multilevel model is justified on the grounds of improvements in statistical significance of market variables and increasing value of the extra dispersion scale that indicates an improvement in having reliable test statistics and standard errors.

[12] Market level analysis for Pap-smear is justified in a similar way that for mammogram. Again, the intercept only logistic regression for Pap-smear overestimates the intercept term by about 77 percent (i.e., exp(-2.0262) =0.13 v.s. exp(-3.5022)=0.03) and overdispersion parameter does not deviate much from 1 (i.e., 0.9501). These justify a statistically sound and necessary market level analysis.

percent for age groups 31-40, 41-50, and 51-64. Being a spouse, rather than the primary beneficiary and an increase of 100 member days of enrollment have almost the same impact on the outcome: 20 percent less and about 1.1 more times likelihood. Although they have the same signs, employment characteristics have different values. For example, salaried and unionized employee are about 2.2 and 1.6 times more likely while part-time employees are approximately 33 percent less likely to receive the service. Note that since value and even signs of explanatory variables change at the market level, one can argue that relying on only individual level analysis can result in misleading conclusions.

Plan types have similar impacts at the market level as well. Only exception is that point of service plans with capitation (HMOPOSCAP) too have a negative impact on the outcome this time. In other words, both open (i.e., HMO) and closed panel HMOs (i.e., HMOPOS and HMOPOSCAP) as well as PPOs reduces the likelihood about 34, 67, 20, and 27 percent, respectively. These are striking results in the sense that first, they are just the opposite of the results for mammogram, and second, they are different than individual level analysis for Pap-smear. One more time, these results imply that taking into account market level variables with an appropriate methodology has a vital importance in terms of sound statistical inference.

Finally, market level variables follow a similar pattern as in mammogram analysis. That is, a 10 percent increase in HMO penetration rate increases the likelihood about 1.4 times while a 10 percent increase in both HMO penetration rate and competition index decreases it approximately 5 percent. However, HMO competition index (IOC) by itself is not statistically significant.

***The Impact of Unions*:** Before finishing the presentation of results, it is worthwhile to look at some simulation exercises on the basis of empirical results in terms of

understanding the impact of labor unions on the utilization of mammogram and Pap-smear. Table 8 and 9 present probabilities of mammogram and Pap-smear utilization by plan type for a representative enrollee, respectively. [13] When both HMO penetration rates and the interaction term are at their mean values, being a labor union member or not significantly affects the probability. For example, if the enrollee has a closed panel HMO plan (HMO), the probability of receiving mammogram would be 21 and 16 percent for union and non-union members, respectively (see table 8). The associated percentages for Pap-smear utilization would be 7 and 4 percent (see table 9). These estimations are consistent with both actual averages in the sample in Table 4 and logistic regression results in Table 5 and 7, respectively.

To demonstrate the impact of competition in health care market, one can consider estimation based on a one standard deviation below and above the mean value of the interaction term while the penetration rates are at their mean value (see column III in Table 8 and 9). A one standard deviation below the interaction term, the probability of receiving mammogram increases up to 30 and 24 percent for the same representative enrollee with and without union membership, respectively. On the other hand, a one standard deviation above the interaction term, the associated percentages decline significantly: 14 and 11 percent. The same pattern applies to Pap-smear utilization with the exception that the impact is much more significant in terms of the magnitude (i.e., 10 and 7 percent v.s. 4 and 3 percent, see Table 9).

6. DISCUSSION

There are three important areas of findings in this study: demographic characteristics, health plan type, and impact of market forces. It seems that both Pap-smear

[13] Characteristics of representative enrollees are explained at the bottom of each table.

and mammogram utilization are affected by the demographic characteristics in a similar way. According to the multilevel logit regression results for Pap-smear and mammogram, member days of enrollment help increase the likelihood of receiving these services. However, its overall impact is negligible. Being a secondary beneficiary (i.e., spouse) reduces the likelihood of receiving both mammogram Pap-smear tests. On the basis of these results, it is reasonable to conclude that having a family plan may not automatically guarantee access to the preventive care services for spouses.

Employment related variables significantly contribute to the explanation of the likelihood of receiving mammogram and Pap-smear. For example, working in a part-time job always and significantly reduces the likelihood of receiving these services. In a similar vein, labor union membership significantly and positively affects the outcome. Despite the declining overall unionization rates across different industries in the U.S., it seems that unions still have a strong influence on health benefits in general, and preventive care in particular.

As a demand-side cost sharing mechanism, coinsurance rates also affect the outcome. Paying less than 20 percent coinsurance positively affects the likelihood of receiving mammogram and Pap-smear test. In addition, the magnitude of its impact is also considerable. Given the current trend in which insurers adopt coinsurance rates more often and shift the financial responsibility from employers and providers toward the consumer with such demand-side cost sharing mechanisms, the importance of coinsurance rates with respect to preventive care utilization is very important.

One of the most important findings of this study is the role played by health insurance plans. It is evident that closed panel HMOs and open panel HMOs (i.e., HMOPOS, HMOPOSCAP) increase the likelihood of receiving mammograms in

comparison with the traditional plans. However, this is not true for Pap-smears. One explanation for these opposite findings may be state mandates that are imposed for mammograms, but not for Pap-smears. In addition, the latter is suggested for a wider range of age group that may result in a significant cost from insurers' point of view. Increasing trends of loose networks, less restrictive reimbursement methods with increasing demand-side cost sharing methods through hybrid plans create an environment in which even the most standardized and suggested preventive care may not be adequately provided by such plans.

These results also indicate that traditional dichotomy between HMO vs. FFS plans may no longer apply. It is more realistic to take into consideration changes in health plan organization and financing of health care services. This can be done by taking into account health care market structure as well as individual level characteristics in an appropriate model that can promote better understanding of the existing trend that has been observed in the literature.

In relation to the findings mentioned above, there is no doubt that changes in the utilization of preventive care are closely related to and affected by market structure. For example, for both mammograms and Pap-smears, increasing HMO penetration per se increases the likelihood of receiving services. HMO competition per se, however, is not significant for both Pap-smear and mammogram utilization. But one thing is clear: a simultaneous increase in HMO penetration and competition certainly reduces the likelihood of receiving both mammograms and Pap-smears. This last result calls into question the faith in competitive markets that competition yields more preventive care. Both the estimated odds ratios and probability estimations on the basis of the empirical results show that highly

competitive HMO markets with high HMO penetration reduce the likelihood of receiving both types of preventive care through all health plan types.

On the basis of empirical results of this study, one may partly explain why the likelihood of receiving the mammogram is higher than that of Pap-smear in the context of mandates about preventive care coverage that are imposed by many states. It seems that some of the plans such as PPOs enjoy the lack of any mandates and regulations that are imposed by local governments on other plans types such as conventional HMOs. This in turn makes PPO type organizational and financial arrangements attractive for other plan types. The ultimate result is that one way or another health plans may avoid mandates and regulations, including those related to preventive care. In other words, market forces seem to say the final words. These results imply that the faith in market forces in terms of receiving more preventive care must be seriously reconsidered on the basis of the nature of competition in the health care market. This consideration becomes vital when one takes into account the proven efficiency of the Pap-smear test and mammogram in terms of life saving. Therefore, I argue that the lack of any specific regulation or mandate about Pap-smear coverage may be the primary reason why we have such a low likelihood of receiving it through even the most popular health plan types. If one cannot change the direction of structural changes that have been taking place in the health care market, one can at least make sure about the coverage of preventive care by all types of health insurance arrangements with such mandates or regulations.

Given the empirical results, what type of policy recommendations can be suggested? There is no doubt that any solution to the provision and utilization of preventive care is not independent of the structural changes and other problems in the U.S. health care system. However, this does not change the fact that preventive care is still considered one of the

important health services reducing increasing health care costs that is the epicenter of the problems in the system. Therefore, an ideal solution that concerns preventive care has to do with the fact that all the parties involved in decision making should make such services their priority in their agenda. Although it may not be easy or feasible to change the direction of the health care market in the short run, I suggest an immediate policy measure that can be conducted: to make preventive care provisions and coverage mandatory for both insurers and employers.

Of course, this process also involves employers and employees. The existing trend shows that employers are offering health plans with broad benefits but with more contribution by employees in a slow growing economy with a less tight labor market. There is no doubt this is possible due to very flexible labor market conditions in the U.S., which are characterized by the increasing number of hourly paid part-time jobs and declining unionization rates. Since employees receive their health benefits through their jobs and they have not much saying in terms of the extent and the cost of those benefits especially in a relatively relaxed labor market environment, as an immediate solution in the short-run, there should be some labor market regulations that mandate employers' provision of and contribution to health insurance plans with at least basic and standard preventive care coverage. Of course, this may not be welcomed by employers although such basic health benefits that are defined around preventive care can reduce their overall health care costs and increase the productivity of work force. At the same time, it seems that unions can play a significant role by demanding such health benefits despite their declining popularity and presence. However, increasing unionization is not a short term issue since it is determined by historical, political, and economic factors.

Limitations of the Study: There is no doubt that this study has certain limitations. For example, compared to many studies in the empirical literature, the data used in this study lacked certain key demographic variables such as income and schooling levels of enrollees, race, and health status. Absence of these control variables may result in biased estimations with respect to different plan types.

The data are also limited by mostly large corporations providing information. Therefore, small business firms and other large corporations that did not provide information are not considered in the study. In that sense, the results cannot be generalized for employers of all sizes.

In addition, claims data are used in this study. One shortcoming of using claims data is that they report only those paid claims. If the service is used but not paid, it will not show up in the data. Finally, only utilization of Pap-smears and mammograms are studied here. Despite their importance and effectiveness against cancer, the results of the study may not be generalized to other cancer screening tests and procedures due to diverse features and natures of these types of tests and procedures.

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APPENDIX

Table 1. CPT-4 and ICD-9 Codes of Mammography and Pap-smear Tests for Screening Purposes

Procedure & Screening codes	For Mammogram	For Pap-Smear
Physician's Current Procedural Terminology (CPT-4), 4th Edition-1997 Procedure Codes	76092: Screening mammography, bilateral (two view film study of each breast)	88141:Cytopathology, cervical or vaginal (any reporting system); requiring interpretation by physician (list separately in addition to code for technical services) 88142: Cytopathology, cervical or vaginal (any reporting system); collected in preservative fluid, automated thin layer preparation, screening by cytotechnologist under physician supervision 88150:Cytopathology, smears, cervical or vaginal, up to three smears; screening by technician under physician supervision 88152: With manual cytotechnologist screening and automated screening under physician supervision 88156: Cytopathology, smears, cervical or vaginal, (the Bethesda System (TBS)),up to three smears; screening by technician under physician supervision
The International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) Screening Codes	V76.11: Screening mammogram for high risk patients	V72.3: Gynecological examination; Papanicolaou cervical smear as part of general gynecological examination

Table 2. List of Variables That Are Used in Empirical Analysis

Variable Name	Description of Variable	Value of variable
MAMO	Mammogram utilization indicator	Dichotomous
PAP	Pap-Smear utilization indicator	Dichotomous
AGE	Age of enrollee (For mammogram analysis)	Continuous
AGE_1	20 ≤ Age of enrollee ≤30 (For Pap-smear analysis)	Dichotomous
AGE_2	31 ≤ Age of enrollee ≤40 (For Pap-smear analysis)	Dichotomous
AGE_3	41 ≤ Age of enrollee ≤50 (For Pap-smear analysis)	Dichotomous
AGE_4	51 ≤ Age of enrollee ≤64 (For Pap-smear analysis)	Dichotomous
SPOUSE	Relation to employee (Secondary Beneficiary)	Dichotomous
SELF	Relation to employee (Primary Beneficiary)	Dichotomous
MEM_SUM	Total Member Days of Enrollment	Continuous
SALARY	Salary paid employee	Dichotomous
HOURLY	Hourly paid employee	Dichotomous
FULLTIME	Employment Status: Full-time Employee	Dichotomous
PARTTIME	Employment Status: Part-time Employee	Dichotomous
NOUNION	Union Membership: Non-Union Member	Dichotomous
UNION	Union Membership: Member	Dichotomous
COIN1 or COINS_1	Coinsurance Rate: 20% and above	Dichotomous
COIN2 or COINS_2	Coinsurance Rate: Less than 20%	Dichotomous
TRAD	Traditional Plan	Dichotomous
HMO	Health Maintenance Organization	Dichotomous
HMOPOS	Point-of-Service Plan	Dichotomous
HMOPOSCAP	Partially or Fully Capitated Point-of-Service Plan	Dichotomous
PPO	Preferred Provider Organization	Dichotomous
PEN798	HMO Penetration Rate (%)	Continuous
IOC	HMO Competition Index (%)	Continuous
PEN798*IOC	Penetration * Competition	Continuous

Table 3. Descriptive Statistics for Mammogram: Age Between 40 and 64

Variable Name	Description of Variable	Mean (Std. Dev.) All (N=85487)	Mean (Std. Dev.) MSA Only (N=70280)	Minimum	Maximum
MAMO	Mammogram utilization (0=Not received, 1=Received)	0.213 (0.409)	0.209 (0.407)	0	1
AGE	Age of enrollee	48.388 (5.656)	48.344 (5.681)	40	64
SPOUSE	Relation to employee (Secondary Beneficiary)	0.375 (0.484)	0.371 (0.483)	0	1
SELF	Relation to employee (Primary Beneficiary)	0.625 (0.484)	0.629 (0.483)	0	1
MEM_SUM	Total Member Days of Enrollment	462.843 (120.026)	461.874 (123.356)	365	730
SALARY	Salary Paid Employee	0.746 (0.435)	0.714 (0.452)	0	1
HOURLY	Hourly Paid Employee	0.254 (0.435)	0.286 (0.452)	0	1
FULLTIME	Employment Status: Full-time Employee	0.951 (0.216)	0.944 (0.229)	0	1
PARTTIME	Employment Status: Part-time Employee	0.049 (0.216)	0.056 (0.229)	0	1
NOUNION	Union Membership: Non-Union Member	0.376 (0.484)	0.412 (0.492)	0	1
UNION	Union Membership: Member	0.624 (0.484)	0.588 (0.492)	0	1
COIN1	Coinsurance Rate: 20% and above	0.112 (0.316)	0.108 (0.310)	0	1
COIN2	Coinsurance Rate: Less than 20%	0.888 (0.316)	0.892 (0.310)	0	1
TRAD	Traditional Plan	0.648 (0.477)	0.585 (0.493)	0	1
HMO	Health Maintenance Organization	0.057 (0.233)	0.068 (0.252)	0	1
HMOPOS	Point-of-Service Plan	0.054 (0.226)	0.065 (0.247)	0	1
HMOPOSCAP	Partially or Fully Capitated Point-of-Service Plan	0.157 (0.363)	0.188 (0.391)	0	1
PPO	Preferred Provider Organization	0.084 (0.277)	0.094 (0.292)	0	1
PEN798	HMO Penetration Rate (%)	32.099 (10.347)	32.099 (10.347)	0.05	75.71
IOC	HMO Competition Index (%)	74.277 (11.344)	74.277 (11.344)	0	99.99
PEN798*IOC	Penetration * Competition	2416.960 (905.318)	2416.960 (905.318)	0	5593.39

Table 4. Descriptive Statistics for Pap-Smear Data: Age Between 20 and 64

Variable Name	Description of Variable	Mean (Standard Deviation) All (N=148734)	Mean (Standard Deviation) Only MSA (N=125312)	Minimum	Maximum
PAP	Pap-Smear utilization	0.117 (0.321)	0.116 (0.321)	0	1
AGE_1	20≤Age≤30	0.139 (0.346)	0.144 (0.351)	0	1
AGE_2	31≤Age≤40	0.313 (0.464)	0.322 (0.467)	0	1
AGE_3	41≤Age≤50	0.350 (0.477)	0.341 (0.474)	0	1
AGE_4	51≤Age≤64	0.198 (0.398)	0.193 (0.394)	0	1
SPOUSE	Relation to employee (Secondary Beneficiary)	0.390 (0.488)	0.386 (0.487)	0	1
SELF	Relation to employee (Primary Beneficiary)	0.610 (0.488)	0.613 (0.487)	0	1
MEM_SUM	Total Member Days of Enrollment	447.005 (116.686)	445.165 (119.222)	365	975
SALARY	Salary paid employee	0.650 (0.477)	0.614 (0.486)	0	1
HOURLY	Hourly paid employee	0.350 (0.477)	0.386 (0.486)	0	1
FULLTIME	Employment Status: Full-time Employee	0.895 (0.306)	0.883 (0.321)	0	1
PARTTIME	Employment Status: Part-time Employee	0.105 (0.306)	0.117 (0.321)	0	1
NOUNION	Union Membership: Non-Union Member	0.482 (0.500)	0.522 (0.499)	0	1
UNION	Union Membership: Member	0.518 (0.500)	0.478 (0.499)	0	1
COINS_1	Coinsurance Rate: 20% and above	0.127 (0.333)	0.116 (0.321)	0	1
COINS_2	Coinsurance Rate: Less than 20%	0.873 (0.333)	0.884 (0.321)	0	1
TRAD	Traditional Plan	0.553 (0.497)	0.482 (0.500)	0	1
HMO	Health Maintenance Organization	0.090 (0.286)	0.105 (0.306)	0	1
HMOPOS	Point-of-Service Plan	0.049 (0.216)	0.058 (0.233)	0	1
HMOPOSCAP	Partially or Fully Capitated Point-of-Service Plan	0.229 (0.420)	0.268 (0.443)	0	1
PPO	Preferred Provider Organization	0.079 (0.270)	0.087 (0.281)	0	1
PEN798	HMO Penetration Rate (%)	32.756 (10.973)	32.756 (10.973)	0.05	75.71
IOC	HMO Competition Index (%)	75.006 (11.972)	75.006 (11.972)	0	99.99
PEN798*IOC	Penetration*Competition	2497.26 (956.320)	2497.26 (956.320)	0	5593.39

Table 5. Individual & Multilevel Logistic Regression Results for Mammogram Utilization

	Individual Level Logistic Regression (N=70280; LR=5100.3831; p<0.0001)			*Multilevel Logistic Regression (N=70280; Deviance=64369.6120; Extra-Dispersion Scale =0.9762)*		
Variable Name	*Coefficient (Std. Er.)*	*Odds Ratio (95% CI)*	*P-Value*	*Coefficient (Std. Er.)*	*Odds Ratio (95% CI)*	*Pr>/t/*
INTERCEPT	-4.325 (0.109)		<0.0001	-4.866 (0.282)		<0.0001
AGE	0.026 (0.002)	1.142[a] (1.132-.151)	<0.0001	0.031 (0.002)	1.168[a] (1.158-1.178)	<0.0001
SPOUSE (Refer=Self)	-0.177 (0.021)	0.838 (0.804-0.874)	<0.0001	-0.177 (0.022)	0.838 (0.820-0.855)	<0.0001
MEM_SUM	0.001 (0.001)	1.099[b] (1.089-1.108)	<0.0001	0.0005 (0.001)	1.053[b] (1.043-1.062)	<0.0001
PARTTIME (Refer=Fulltime)	-0.294 (0.074)	0.745 (0.645-0.861)	<0.0001	-0.193 (0.078)	0.824 (0.765-0.888)	0.0133
SALARY (Refer=Hourly)	0.484 (0.041)	1.622 (1.496-1.760)	<0.0001	0.661 (0.046)	1.937 (1.854-2.024)	<0.0001
UNION (Refer=Nonunion)	0.792 (0.045)	2.208 (1.021-2.412)	<0.0001	0.311 (0.056)	1.365 (1.293-1.441)	<0.0001
COIN2 (Refer= ≥20%)	0.468 (0.062)	1.596 (1.413-1.803)	<0.0001	0.574 (0.071)	1.775 (1.658-1.901)	<0.0001
HMO (Refer=Traditional)	-0.129 (0.073)	0.879 (0.761-1.014)	0.0778	0.703 (0.096)	2.020 (1.841-2.215)	<0.0001
HMOPOS (Refer=Traditional)	-0.192 (0.060)	0.825 (0.734-0.927)	0.0013	0.209 (0.098)	1.233 (1.122-1.355)	0.0324
HMOPOSCAP(Refer=Traditional)	0.073 (0.054)	1.076 (0.968-1.196)	0.1754	0.564 (0.086)	1.758 (1.619-1.909)	<0.0001
PPO (Refer=Traditional)	-0.218 (0.056)	0.804 (0.720-0.897)	0.0001	0.595 (0.080)	1.813 (1.678-1.959)	<0.0001
PEN798 (HMO Penetration Rates)	*N.A.*	*N.A.*	*N.A.*	0.027 (0.013)	1.308[c] (1.150-1.486)	0.0443
IOC *(HMO Competition Index)*	*N.A.*	*N.A.*	*N.A.*	0.005 (0.004)	1.048[d] (1.004-1.093)	0.2888
PEN798*IOC (Interaction Term)	*N.A.*	*N.A.*	*N.A.*	-0.0005 (0.0001)	0.948[e] (0.931-0.966)	0.0068

(a)= Estimated odds ratios for an increase of 5 years in age; (b)= Estimated odds ratios for an increase of 100 days in member days of enrollment; (c)= Estimated odds ratios for an increase of 10% in HMO penetration rate; (d)= Estimated odds ratios for an increase of 10% in HMO competition index; (e)= Estimated odds ratios for an increase of 100 units in the interaction term.

Table 6. Intercept-Only Logistic and Multilevel Intercept-Only Logistic

Models for Mammogram & Pap-Smear

	Mammogram (40-64) (0=Not received: 61460; 1=Received: 15227)		*Pap-Smear (20-64) (0=Not received: 110716; 1=Received: 14596)*	
	Logit	*Multilevel*	*Logit*	*Multilevel*
Fixed Effect				
INTERCEPT	-1.330 (0.009)[a]	-2.316 (0.066) [b]	-2.0262 (0.009)[a]	-3.5022 (0.084) [b]
Random Effect				
$\sigma^2_{intercept}$		0.711 (0.093)[c]		1.3184 (0.004)[c]
Deviance		65219.057		76189.3591
Extra-Dispersion Scale		0.980		0.9501
Intra-Market (i.e., MSA) Correlation (ϱ)		0.63		0.77
-2Log L	72090.96		90186.28	
N	70280	70280	125312	125312

a Pr>ChiSq <0.0001;
b Pr > [t] <0.0001;
c Pr [Z] <0.0001
$\varrho = \sigma^2_u/(\sigma^2_u + \sigma^2_e)$, where σ^2_u =the total variance of errors and $\sigma^2_e = \pi^2/3$ is the variance of the standard logistic distribution.

Table 7. Individual & Multilevel Logistic Regression Results for Pap-Smear Utilization

	Individual Level Logistic Regression (N=125312; LR=10201.5784 p<0.0001)			*Multilevel Logistic Regression (N=70280; Deviance=64369.6120; Extra-Dispersion Scale =0.9762)*		
Variable Name	*Coefficient (Std. Er.)*	*Odds Ratio (95% CI)*	*P-Value*	*Coefficient (Std. Er.)*	*Odds Ratio (95% CI)*	*Pr>/t/*
INTERCEPT	-3.955 (0.076)		<0.0001	-4.297 (0.306)		<0.0001
AGE_2 (Refer= AGE_1)	-0.251 (0.030)	0.778 (0.733-0.826)	<0.0001	-0.219 (0.030)	0.803 (0.780-0.827)	<0.0001
AGE_3 (Refer= AGE_1)	-0.263 (0.028)	0.768 (0.727-0.812)	<0.0001	-0.207 (0.028)	0.813 (0.791-0.836)	<0.0001
AGE-4 (Refer= AGE_1)	-0.397 (0.031)	0.672 (0.633-0.714)	<0.0001	-0.339 (0.031)	0.712 (0.691-0.734)	<0.0001
SPOUSE (Refer=Self)	-0.148 (0.020)	0.863 (0.829-0.898)	<0.0001	-0.150 (0.021)	0.860 (0.844-0.878)	<0.0001
MEM_SUM	0.002 (0.001)	1.175 [a] (1.165-1.184)	<0.0001	0.001 (0.001)	1.077[a] (1.068-1.086)	<0.0001
PARTTIME (Refer=Fulltime)	-0.895 (0.074)	0.409 (0.353-0.473)	<0.0001	-0.404 (0.077)	0.667 (0.620-0.719)	<0.0001
SALARY (Refer=Hourly)	0.682 (0.042)	1.978 (1.821-2.148)	<0.0001	0.810 (0.047)	2.247 (2.148-2.350)	<0.0001
UNION (Refer=Nonunion)	1.151 (0.045)	3.160 (2.895-3.450)	<0.0001	0.448 (0.054)	1.565 (1.486-1.647)	<0.0001
COIN2 (Refer= ≥20%)	0.321 (0.066)	1.378 (1.210-1.569)	<0.0001	0.806 (0.077)	2.239 (2.079-2.411)	<0.0001
HMO (Refer=Traditional)	-0.662 (0.082)	0.516 (0.439-0.606)	<0.0001	-0.417 (0.107)	0.659 (0.595-0.730)	<0.0001
HMOPOS (Refer=Traditional)	-0.297 (0.061)	0.743 (0.659-0.838)	<0.0001	-1.110 (0.101)	0.330 (0.299-0.363)	<0.0001
HMOPOSCAP(Refer=Traditional)	0.232 (0.053)	1.261 (1.136-1.399)	<0.0001	-0.225 (0.091)	0.799 (0.732-0.872)	0.0140
PPO (Refer=Traditional)	-0.271 (0.061)	0.762 (0.676-0.859)	<0.0001	-0.311 (0.085)	0.733 (0.675-0.796)	0.0003
PEN798 (HMO Penetration Rates)	*N.A.*	*N.A.*	*N.A.*	0.031 (0.014)	1.362[b] (1.191-1.558)	0.0270
IOC *(HMO Competition Index)*	*N.A.*	*N.A.*	*N.A.*	-0.005 (0.005)	1.054[c] (1.001-1.110)	0.3262
PEN798*IOC (Interaction Term)	*N.A.*	*N.A.*	*N.A.*	-0.0005 (0.0002)	0.948[d] (0.929-0.968)	0.0140

(a)= Estimated odds ratios for an increase of 100 days in member days of enrollment; (b)= Estimated odds ratios for an increase of 10% in HMO penetration rate; (c)= Estimated odds ratios for an increase of 10% in HMO competition index; (d)= Estimated odds ratios for an increase of 100 units in the interaction term.

Table 8. Estimated Probabilities of Mammogram Utilization by Plan Types*

Probabilities by Plan Type	*(I) Both PEN798 & PEN798*IOC are at their mean values*		*(II) PEN798 varies; PEN798*IOC is at its mean value*				*(III)PEN798*IOC varies; PEN798 is at its mean value*			
	(μ_{PEN798}; $\mu_{PEN798*IOC}$)		*1 ($\mu_{PEN798} - \sigma_{PEN798}$)*		*2 ($\mu_{PEN798} + \sigma_{PEN798}$)*		*1 ($\mu_{PEN798*IOC} - \sigma_{PEN798*IOC}$)*		*2 ($\mu_{PEN798*IOC} + \sigma_{PEN798*IOC}$)*	
	Union	Non-union	Union	Non-union	Union	Non-union	Union	Non-union	Union	Non-union
P_{HMO}:	0.21	0.16	0.17	0.13	0.26	0.20	0.30	0.24	0.14	0.11
P_{POS}:	0.14	0.11	0.11	0.08	0.18	0.14	0.21	0.16	0.09	0.07
P_{POSCAP}:	0.19	0.15	0.15	0.12	0.23	0.18	0.27	0.21	0.13	0.10
P_{PPO}:	0.19	0.15	0.16	0.12	0.24	0.19	0.28	0.22	0.13	0.10
P_{TRAD}	0.12	0.09	0.09	0.07	0.15	0.11	0.17	0.13	0.08	0.06

* All the estimations in the table based on the results for multilevel model with the interaction term in Table5.15. Estimated probabilities for a primary beneficiary who is at the mean age (i.e., 48.3), working full-time, unionized/non-union (see shaded columns) with a health plan that offers less than 20% coinsurance rate with the mean member days of enrollment (i.e., 461.9). In probability calculations, market variable of interest (columns labeled with roman numerals I, II, and III of the table below) are subject to the following calculations:
(I): Mean values of both PEN798 & PEN798*IOC.
(II): Mean value of PEN798*IOC; (1) mean value of PEN798 minus one standard deviation of PEN798; (2) mean value of PEN798 plus one standard deviation of PEN798.
(III): Mean value PEN798; (1) mean value of PEN798*IOC minus one standard deviation of PEN798*IOC; (2) mean value of PEN798*IOC plus one standard deviation of PEN798*IOC.

Table 9. Estimated Probabilities of Pap-smear Utilization by Plan Types*

Probabilities by Plan Type	*(I) Both PEN798 & PEN798*IOC are at their mean values*		*(II) PEN798 varies; PEN798*IOC is at its mean value*				*(III)PEN798*IOC varies; PEN798 is at its mean value*			
	(μ_{PEN798}; $\mu_{PEN798*IOC}$)		*1* ($\mu_{PEN798} - \sigma_{PEN798}$)		*2* ($\mu_{PEN798} + \sigma_{PEN798}$)		*1* ($\mu_{PEN798*IOC} - \sigma_{PEN798*IOC}$)		*2* ($\mu_{PEN798*IOC} + \sigma_{PEN798*IOC}$)	
	Union	Non-union	Union	Non-union	Union	Non-union	Union	Non-union	Union	Non-union
P_{HMO}:	0.07	0.04	0.05	0.03	0.09	0.06	0.10	0.07	0.04	0.03
P_{POS}:	0.04	0.02	0.03	0.02	0.05	0.03	0.06	0.04	0.02	0.01
P_{POSCAP}:	0.09	0.05	0.06	0.04	0.11	0.07	0.12	0.08	0.05	0.03
P_{PPO}:	0.08	0.05	0.05	0.04	0.10	0.07	0.12	0.08	0.05	0.03
P_{TRAD}	0.11	0.07	0.07	0.05	0.13	0.09	0.15	0.10	0.06	0.04

* All the estimations in the table based on the results for the multilevel model with the interaction term in Table 7. Estimated probabilities for a primary beneficiary who is in the base age group (i.e., 20-30), working full-time, unionized/non-union (see shaded columns) with a health plan that offers less than 20% coinsurance rate and with the mean member days of enrollment (i.e., 445.2). In probability calculations, market variable of interest (columns labeled with roman numerals I, II, and III of the table below) are subject to the following calculations:
(I): Mean values of both PEN798 & PEN798*IOC.
(II): Mean value of PEN798*IOC; (1) mean value of PEN798 minus one standard deviation of PEN798; (2) mean value of PEN798 plus one standard deviation of PEN798.
(III): Mean value PEN798; (1) mean value of PEN798*IOC minus one standard deviation of PEN798*IOC; (2) mean value of PEN798*IOC plus one standard deviation of PEN798*IOC.