Cost Efficiency and Clinical Quality in Health Maintenance Organizations, 1998-2002

Woolton Lee
Post Doctoral Fellow, Virginia Commonwealth University

Dennis Scanlon
Associate Professor, Pennsylvania State University

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Abstract

Objective: The relationship between clinical quality and firm efficiency remains an important unresolved question in health care. Although a recent cross section study suggests that improved quality and organizational efficiency may be at odds in provider organizations such as hospitals (Jha et al. 2009), analysts have argued that enhancements in clinical quality and efficiency may be achieved in certain cases by improving the coordination of health services across care settings (Beaulieu et al. 2003, Kongstevdt 2007). Unlike provider organizations, managed health plans such as health maintenance organizations (HMOs) are involved in the management of a wide range of health services that often span different care settings. HMOs engage in a wide variety of clinical and non-clinical activities reportedly designed to ensure that health services provided to member populations adhere to evidence based standards of care (Baker et al., 2004a; Beaulieu et al., 2003; Fireman et al., 2004; Kongstevdt, 2007; Leatherman et al., 2003; Scanlon et al., 2001; Sidorov et al., 2002). While these activities are often costly to implement, they appear to have some potential to reduce the likelihood of preventable acute care events among plan members (American Diabetes Association, 2003; Basu & Mobley, 2007; Beaulieu et al., 2003; Kongstevdt, 2003, 2007; Leatherman et al., 2003; Scholle et al., 2005; Smits et al., 2003). This paper estimates HMO translog cost functions adjusted for clinical quality and member condition prevalence differences among firms. The estimated cost functions are used to examine the relationship between firm level clinical performance and cost efficiency for an unbalanced panel of HMOs during the period 1998-2002.
Data Sources: This paper uses HMO firm data for the period 1998-2002. Measures of clinical performance for commercial, Medicare and Medicaid populations were obtained from the Health Effectiveness Data and Information Set (HEDIS) obtained from the National Committee for Quality Assurance (NCQA) and the Centers for Medicare and Medicaid Services (CMS). HMO financial data are from the National Association of Insurance Commissioners (NAIC). HMO area enrollment data are from Health Leaders-Interstudy. Area demographic characteristics and metrics of health services utilization were obtained from the Area Resource File (ARF).
Results: Separate translog cost functions were estimated by HMO product mix (commercial, Medicare, and Medicaid; commercial and Medicare; commercial and Medicaid; or commercial coverage only). Translog cost functions were estimated using ordinary least squares (OLS) with HMO and year fixed effects. Although test statistics of the joint significance of quality coefficients for commercial, Medicare, and Medicaid populations indicated that for all of these populations, the effect of quality on costs was not statistically different from zero, marginal effects calculations suggest that improvement in Medicaid quality in HMOs with commercial, Medicare, and Medicaid enrollment adds $5-$9 per member per month (PMPM) in cost annually.
Conclusion: Quality does not appear to have an appreciable effect on costs in HMOs in most cases.

Introduction

Whether improved quality costs money or saves money remains an important unanswered question (Leatherman et al., 2003). Some analysts have argued that because health care markets do not financially reward improvements in quality, it may be necessary to reimburse health care organizations for resources spent on improvements to the quality of care provided to individuals (Beaulieu et al., 2003; Leatherman et al., 2003; March, 2003). However, less is known regarding the magnitude of organizational costs associated with achieving improvements and, how these magnitudes vary for a given increment in performance. In addition, the time horizon for achieving potential cost savings or increased costs is also not known. Nearly all of the work in this area has focused on the hospital or nursing home industry, with very few studies examining the relationship between quality and cost in health plans (Braeutigam & Pauly, 1986; Caldis, 2004; Carey & Burgess, 1999; Chen & Shea, 2004; Gertler & Waldman, 1990).

Health maintenance organizations (HMOs) are involved in the reimbursement for and the management of a comprehensive range of health services that often span different care settings. Although HMOs have declined in prominence since the end of the last century, they still remain an important component of private, Medicare, and Medicaid coverage in the United States (Henry J. Kaiser Family Foundation, 2005, 2007; Mechanic, 2004).[1] HMOs engage in a wide variety of clinical and non-clinical activities designed to ensure that health services provided to member populations adhere to evidence based standards of care (Baker et al., 2004a; Beaulieu et

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[1] As of 2007, roughly 20% of commercial coverage, 18% of Medicare coverage and more than 60% of Medicaid coverage is provided through HMOs or related arrangements.

al., 2003; Fireman et al., 2004; Kongstevdt, 2007; Leatherman et al., 2003; Scanlon et al., 2001; Sidorov et al., 2002). The activities that HMOs use to improve quality are costly to implement, but may result in reductions in the likelihood of preventable acute care events among plan members and may also result in improvements in societal health (American Diabetes Association, 2003; Basu & Mobley, 2007; Beaulieu et al., 2003; Borenstein et al., 2004; Kongstevdt, 2003, 2007; Leatherman et al., 2003; Scholle et al., 2005; Smits et al., 2003).

This paper estimates quality adjusted HMO cost functions for all HMOs operating in the United States during 1998-2002.[2] The estimated cost functions are used to examine the relationship between plan clinical quality and the cost of coverage. HMO quality provided under a plan is measured using composites derived from measures in the Health Effectiveness Data and Information Set (HEDIS). HMO financial data come from the National Association of Insurance Commissioners (NAIC).

This analysis is distinguished from the sole existing study of HMO cost and quality (Caldis, 2004), in two ways. First, this study utilizes HEDIS performance specific to commercial, Medicare, and Medicaid populations as opposed to using only commercial HEDIS performance as a proxy for overall HMO quality. Second, this study utilizes multiple imputation for plans missing data in HEDIS measures. Unlike regression imputation, which assumes that imputed values correctly reflect raw data, multiple imputation adjusts regression coefficients and standard errors for uncertainty due to data imputation (Rubin, 1996). The paper is organized into six sections, section 2 provides a literature review of studies analyzing HMO costs, section 3 presents the conceptual framework, section 4 discusses data sources and methods used, section 5

[2] Financial filings data for HMOs in the state of California were not included in the NAIC data across all years of the study period. Filings data were also unavailable in the state of Minnesota in the years 1998-1999.

presents the results, and section 6 concludes the paper.

Section 2. Literature Review

HMOs are multi-product firms that may provide some combination of commercial, Medicare, or Medicaid health insurance coverage. Previous studies of HMO operations have analyzed costs associated with product diversification and returns to scale (Given, 1996; Wholey et al., 1996), the effect of HMO mergers on economies of scale (Engberg et al., 2004), and the relationship between health care quality and economies of scale (Caldis, 2004). These studies find that economies of scale in HMOs are generally exhausted fairly rapidly at enrollments below 100,000 members. The studies also find that HMOs realize diseconomies of scope when providing commercial and Medicare coverage, which indicates that plans on average have an incentive to specialize in either of these coverage lines but not both (Caldis, 2004; Engberg et al., 2004).

Although product quality differences are an important component of firm cost and production, differences in the clinical quality of health services provided to HMO members have been incorporated into analyses of HMO production only recently because of limitations in the availability of data (Braeutigam & Pauly, 1986; Caldis, 2004; Gertler & Waldman, 1990). Caldis (2004) is the only study that accounts for quality explicitly in estimating HMO cost functions. He analyzes data from 1996-1999 and estimates separate cost functions by model type and by whether an HMO offers only commercial coverage or Medicare and/or Medicaid coverage in addition to commercial coverage. A composite of commercial HEDIS measures combined via principle components was used to measure HMO quality .

Caldis (2004) finds that for both multi-product independent practice association[3] (IPA) HMOs and single product non-IPA HMOs, higher quality is related to higher costs. In contrast, higher quality was linked to lower costs in single product IPA HMOs and multi-product non-IPA HMOs. Overall, this study concludes that the percentage of total costs associated with improved quality is small (ranging between 4 and 6% of total variable cost).

There are several limitations to Caldis' (2004) analysis that this study improves upon. First, comparisons of HEDIS performance between different populations in HMOs providing commercial, Medicare, and Medicaid coverage (see Table 1) indicate substantive differences in performance. Some of the difference in HEDIS performance is probably attributable to socioeconomic differences between these populations (Zaslavsky and Epstein, 2003). These differences indicate that using commercial HEDIS performance as a proxy for performance in other coverage lines may introduce measurement error in models of HMO cost and quality. Second, Caldis (2004) imputed missing HEDIS data using regression imputation, which does not adjust regression coefficients and standard errors for uncertainty associated with the use of imputation. Third, while Caldis (2004) controls for area differences in medical utilization using the number of hospital days per county population, he does not account for differences in the prevalence of illness or other conditions among members, which, depending on the condition, may be an important determinant of plan expenses.

Section 3. Conceptual Framework

[3] An IPA or Independent Practice Association is a group of solo practice physicians contracting as a group with health plans. IPA model HMOs are typically HMOs that have contracted with one or more IPAs. Non-IPA model HMOs are HMOs that contract with one or more consolidated physician groups or may hire physicians as employees to provide health services exclusively to members.

HMO Outputs: Fully Insured Member Months and Clinical Quality of Care

Economic theory summarizes the generic cost minimization problem faced by firms using cost functions. A firm is assumed to take the prices of inputs and the amount of output produced as given, while selecting the cost minimizing combination of inputs subject to the firm's constraints in production. Following previous studies, HMO output is taken as member months of insurance coverage for which a plan is liable (Wholey et al. 1996, Engberg et al. 2004, Caldis 2004). In addition, the quality of health services provided to members is also taken as an output of HMO operations. While health care quality is a broad concept, in this paper, it is defined as the likelihood that a member of an HMO receives needed or recommended care conditional on the member's existing clinical conditions. This definition most closely describes the aspects of quality captured by the HEDIS measures. Within Donabedian's (1980) framework, this definition primarily relates to processes of care rather than structure or outcome. Although, much of the influence over observed HMO quality depends on the behavior of physicians and patients, health plans may influence the delivery of medical care for their members through selection of providers or through arrangements such as utilization, disease or case management (Baker et al., 2004a; Beich et al., 2006; Borenstein et al., 2004; Dranove, 2000; Felt-Lisk & Mays, 2002; Kongstevdt, 2003; Whellan et al., 2002; Wholey et al., 1997; Wholey et al., 1996; U.S. Congressional Budget Office, 2004).

The number of fully insured member months of coverage generally reflects the volume of service demands placed on an HMO's provider network, medical management system, claims administration, and customer service departments over the course of a year (Caldis, 2004; Engberg et al., 2004; Given, 1996; Kongstevdt, 2007; Schlesinger et al., 1986; Wholey et al., 1996). While a proportion of plans in the HMO industry also function as third party administrators (TPAs) for self-insured employers, this type of membership represents coverage for which a firm is not financially liable for medical benefits and was excluded from the analysis in this paper, though importantly, many TPAs do still provide care management services for self insured employers.

Section 4. Data and Methods

Data Sources

Financial data for this study originates from HMO annual state insurance filings compiled by the NAIC. HMOs are subject to solvency and reserve requirements imposed by state insurance regulators across all 50 states (Levy & Stauffer, 2000). Requirements for HMO licensure are determined by individual states and may vary greatly. The NAIC sets uniform filing standards for HMOs to provide guidance for state regulators. HMO filings are typically audited for accuracy by state examiners, outside accounting firms, and other outside organizations such as Interstudy which reformats and resells the data.[4] NAIC HMO financial data have been used both within the peer-reviewed literature and by federal agencies such as the Centers for Medicare and Medicaid Services (CMS) (Born & Simon, 2001; Bothwell & Cooley, 1982; Engberg et al., 2004; Feldman et al., 1998; Given, 1996; Pauly et al., 2002; Wholey et al., 1997; Wholey et al., 1995; Wholey et al., 1996).

[4] This information is based on email correspondence with Mark Driggs, financial project manager for Interstudy publications (now called Health Leaders / Interstudy). According to this source, cases where the data submitted by individual plans contains inconsistencies are returned to the health plan for corrections.

Financial data for all HMOs operating within the United States for the years 1998-2002, excluding California and Minnesota, were used in this study. Quality data in this study come from several databases. Commercial and Medicaid HEDIS data originate from the National Committee for Quality Assurance (NCQA). Medicare HEDIS data were obtained from CMS. HMO national and metropolitan statistical area (MSA) enrollment data and characteristics such as profit status, HMO model type, and plan age, were obtained from Interstudy's Competitive Edge and MSA profiler database. Wage data used as input prices were obtained from the Bureau of Labor Statistics' (BLS) Occupational Employment Survey (OES).

Linking HMO financial, operational, and quality data

Because Interstudy, NAIC, and NCQA each uses separate plan identifiers, observations among these data sources were matched through a three-step process to ensure the best accuracy possible. Interstudy and commercial HEDIS data from NCQA were previously linked using plan names and MSA of operation and have been used in several other published studies (Scanlon et al., 2005; Scanlon et al., 2006; Scanlon et al., 2008). The particular challenge in this study involved linking the different data sources given inconsistent assignment of plan identifiers over time and occasional differences in the level of health plan aggregation among these data sources.[5] Existing matched data were used as templates to link additional Medicare and Medicaid NCQA observations to the Interstudy and NAIC databases using plan name and state of service in the following steps. First, commercial, Medicare, and Medicaid HEDIS data were

[5] For example, in the NCQA and Interstudy data, Aetna's NJ operations appear as two firms, Aetna of Northern NJ and Aetna of Southern NJ. In contrast, the NAIC data report these operations as a single HMO, Aetna of NJ.

merged into a single database using plan identifiers and state of service. Second, the existing commercial HEDIS-Interstudy crosswalk was matched to observations linking HEDIS plans for all coverage lines. This yielded a data crosswalk matching plans from the Interstudy database to commercial, Medicare, or Medicaid HEDIS submissions. Third, this Interstudy-HEDIS crosswalk was matched to units in the NAIC data by year using plan name and state of service.

All plans in the NAIC database matched to one or more years of HEDIS submissions were retained. Duplicate matches between the NAIC and HEDIS databases were aggregated to the level of a plan in the NAIC dataset. Out of 992 plans in the NAIC database representing 3074 plan-years, 56% or 1722 plan-years representing 430 plans were matched to one or more years of HEDIS data. Matched plans accounted for an average of 89% of total annual HMO enrollment in the NAIC data over the study period. After excluding units with unusable or missing values in the NAIC data, the sample size was reduced to 1394 plan-years or 356 plans. For analysis only plans categorized as HMOs that reported HEDIS data for 2 or more years of the study period were retained. In addition, plans with total cost per member per month less than $100 or greater than $700 were excluded from the analytic sample as being too extreme.[6] The application of these criteria to the data yielded 1298 HMO-years or 326 plans.

[6] Wholey et al. (1996) also utilize a similar threshold criterion to exclude plans with implausible values in their financial filings.

Multiple Imputation (MI) and the Construction of HEDIS Composites as Measures of HMO Quality

This study uses composites of HEDIS measures to measure HMO quality. However, in any given year, a large fraction of plans reported missing values in one or more of the HEDIS measures. Among Medicaid HEDIS measures the fraction of observations with missing values ranged between 54%-72%, among commercial HEDIS measures the fraction ranged between 11%-41%, and among Medicare HEDIS measures the fraction ranged between 20%-57%.[7] This is a problem because the quality composites used in this study rely on multiple HEDIS measures and only retaining plans without missing values would result in the loss of a substantial fraction of the analysis sample. Missing values occurred either because of failure of NCQA's audit (NA), which may result if there are too few members available to calculate reliable HEDIS rates or because a plan refused to report data (NR).[8]

Multiple imputation (MI) via chained equations was used to impute missing values and was implemented on the matched NAIC-HEDIS dataset, yielding five rectangular datasets containing commercial, Medicare, and Medicaid HEDIS measures. HEDIS composites were then constructed using the imputed values. First, exploratory factor analysis was used to delineate quality domains for the HEDIS measures (Table 2). HEDIS measures in each of the respective quality domains were then combined by averaging across measures within a domain

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[7] For the analysis sample the proportion of observations originally missing values for Medicaid HEDIS measures ranged between 54%-71%. For Medicare HEDIS measures the proportion ranged between 20%-55%. For commercial HEDIS measures the proportion missing ranged between 9%-38%. Measures originally missing 70% or more units were excluded from analysis.

[8] NCQA's audit examines the validity of data collection methods used by plans, calculation of numerators and denominators, sample size considerations, and rate calculations. Guidelines for these procedures are described in the HEDIS technical specifications.

weighted so that conditions with more measures are weighted equally relative to conditions with fewer measures. The logarithm of each domain was taken and the composite for a given population (e.g. commercial, Medicare or Medicaid) was computed as the product of its logged quality domains. This particular approach was utilized to allow for calculation of marginal effects for individual quality domains.

Estimation Approach

Specification of the Translog Cost Function

Previous studies estimating translog cost functions for HMOs employ a multivariate estimation approach which constrains parameters so that the estimated cost functions are linearly homogeneous (input prices and total costs rise in proportion to one another) and satisfy Shepherd's lemma (the demand for inputs is determined by the input prices) (Caldis, 2004; Engberg et al., 2004; Wholey et al., 1996). This study differs from previous approaches in that it uses ordinary least squares (OLS) to estimate the translog cost function and multiple imputation to combine estimates across imputation datasets. This choice was made because attempts to implement the multivariate approach with HMO fixed effects were unsuccessful in obtaining convergence.

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\begin{aligned}
\ln(TC_{nt}) &= \sum_{i=1}^{W_c} \alpha_i^c \ln(Y_{i,nt}) + \sum_{j=1}^{3} \beta_j^c \ln(P_{j,nt}) + \sum_{i=1}^{W_c}\sum_{j=1}^{3} \gamma_{ij}^c \ln(Y_{i,nt}) \ln(P_{j,nt}) \\
&+ \sum_{i=1}^{W_c}\sum_{h=1}^{W_c} \delta_{ik}^c \ln(Y_{i,nt}) \ln(Y_{h,nt}) + \sum_{j=1}^{3}\sum_{l=1}^{3} \rho_{jl}^c \ln(P_{j,nt}) \ln(P_{l,nt}) + \omega^c \ln(Z_{nt}) \qquad (1) \\
&+ \sum_{i=1}^{W_c} \theta_i^c \ln(Z_{nt}) \ln(Y_{i,nt}) + \sum_{j=1}^{3} \eta_j^c \ln(Z_{nt}) \ln(P_{j,nt}) + \phi^c (\ln(Z_{nt}))^2 + \sum_{m=1}^{V_c} \psi_m^c X_{m,nt} + \mu^c{}_n + \varepsilon_{nt}
\end{aligned}
$$

The dependent variable in (1) is the total cost for the n^{th} HMO in year t. The c superscript denotes a HMO's product mix, either commercial only (c=1); commercial and Medicare (c=2); commercial and Medicaid (c=3); or commercial, Medicare, and Medicaid (c=4).[9] Y denotes firm outputs, P denotes input prices, X denotes a vector of control variables, Z denotes a measure of fixed input use, μ is the fixed effect for the n^{th} HMO, and ε is the error term. W_c denotes the number of outputs given an HMO's product mix (W_1=2, W_2=4, W_3=4, W_4=6). Similarly, V_c denotes the number of control variables included in the X vector given an HMO's product mix (V_1= 29, V_2=41, V_3=42, V_4=53).

Past studies have noted substantive cost differences between IPA and non-IPA HMOs[10] and between HMOs with different product mixes (Caldis, 2004; Engberg et al., 2004; Wholey et al., 1996). However, cost differences between IPA and non-IPA HMOs arguably have diminished over time because many closed panel plans have adopted open panel or even point of service arrangements to remain competitive with insurers that provide greater choice of provider (Kongstevdt, 2003; 2007). Similarly, in several instances, open panel plans have incorporated closed panel arrangements because of their potential to contain costs. Consequently, the IPA distinction was not modeled explicitly.

Quality enters Equation (1) as one of three outputs (Y's): commercial quality, Medicare quality, or Medicaid quality. Each of these variables are composites of the HEDIS measures.

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[9] The NAIC data included HMOs with only Medicare, only Medicaid or Medicare and Medicaid coverage, but there were an insufficient number of observations to allow estimation of separate cost functions for these product mixes.
[10] Traditionally, staff, group, network, or mixed model HMOs have included closed panel components in their provider networks. Expenses linked to closed panel components may have lower costs and comparable quality when compared with less centralized arrangements because physicians practice under more direct oversight from peer physicians and health plan administrators. Physicians usually have more autonomy in IPA model or direct contract HMOs where it is often more costly to manage medical utilization and quality from the HMO’s perspective (Kongstevdt 2007).

Because some HEDIS measures are not reported for all populations, each HEDIS composite included in equation 1) does not contain all five of the individual quality domains listed in Table 2. For example, the prenatal care HEDIS rate is not reported for the Medicare population. All five domains are included for commercial quality, three domains were included in the Medicare composite and four were used in the Medicaid composite (see Table 3).

The algorithms used to estimate the cost functions in this study first estimate equation 1) via OLS for each of the five imputed datasets. Then, coefficients and standard errors from the five regressions are combined using equations (2) and (3) (Rubin, 1996).

$$\bar{\phi} = \frac{1}{5}\sum_{m=1}^{5}\phi_m \qquad (2)$$

$$\operatorname{var}(\bar{\phi}) = \frac{1}{5}\sum_{m=1}^{5}\operatorname{var}(\phi_m) + \frac{1}{5-1}\sum_{m=1}^{5}(\bar{\phi}-\phi_m)^2 \qquad (3)$$

The ϕ in equations (2) and (3) denote one of the coefficients from equation (1) and $\bar{\phi}$ denotes the estimate after combining the coefficients from regressions using individual imputed datasets.

Description of Variables

HMO Financial and Input Price Variables

Total costs (*TC* in equation (1)) were computed as the sum of hospital and medical expenses and administrative expenses.[11] The *Y* variables in the equation include commercial, Medicare, or Medicaid member months and commercial, Medicare and Medicaid HEDIS composites. The three input price variables (the *P*'s) are the price of an ambulatory visit, inpatient day, and administrative labor. These input prices were used to capture differences in prices associated with a plan's areas of operation and price bargaining leverage. Following Wholey et al. (1996) and Engberg et al. (2004) a variable denoted as a quasi fixed factor was included to capture differences in fixed input use across HMOs.

Input prices for ambulatory visits and hospital days were constructed using medical expenses reported for inpatient or ambulatory care and the number of hospital days or ambulatory encounters.[12] Beginning in 2001, the NAIC altered its reporting format so that inpatient care and physician service expenses were reported as a single field. As a result, inpatient care expenses and physician expenses for 2001 and 2002 were approximated by obtaining fitted values of the ratio of physician expenses to the sum of physician and inpatient expenses.[13]

Where it is appropriate, plans may seek to substitute health services provided in the ambulatory setting for inpatient admissions because care provided in the ambulatory setting may be less costly (Wholey et al., 1997). Consequently, firm expenses for ambulatory and inpatient expenditures may be endogenous with the prices of ambulatory and inpatient care. The fees for ambulatory and inpatient care may also be endogenously determined because of a HMO's

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[11] Douglas Wholey and John Engberg were contacted to verify that the fields used were consistent with those used in their work. Expenditures for administrative services only operations, supplemental Medicare coverage, dental, diability income, long term care, and a field denoted as 'other' were removed from the dependent variable.

[12] Inpatient care expenses were computed by summing the expenses for inpatient care, emergency room services, and health services provided out of network. Ambulatory expenses were computed as the sum of expenditures reported in the physician service, outside referral, and non-physician service fields of the NAIC filings.

[13] See the notes section of the paper for details.

bargaining leverage. A price blending approach similar to that used in previous studies was applied to attenuate endogeneity in the input prices (Caldis, 2004; Engberg et al., 2004). First, the expense per hospital day (or per ambulatory visit) was computed and assigned to each of a plan's MSAs. Second, the expense per day was then averaged across HMOs in the MSA weighted by each plan's market share in the MSA. Third, the hospital day price or ambulatory visit price within each MSA was aggregated up to the level of an HMO by calculating the average price across each plan's MSAs weighted by the proportion of the plan's enrollment in each MSA.[14]

The hourly wage for insurance examiners obtained from the BLS contained data by year and state. The wage rate was computed as the average wage across a plan's states weighted by the proportion of its enrollment in a state. The quasi fixed factor includes expenditures for building rental, electronic data processing equipment, but may also include expenses for prescription drugs or durable medical equipment. Since information for specific fixed inputs was not available, a capital input price could not be calculated. Instead, this variable was divided by a plan's total member months to standardize its measurement across plans.[15]

Control Variables for Member Costliness and Area Variation

The percent of members with acute cardiovascular events, diabetes, pregnancy, depression, asthma, hypertension, mental illness hospitalization, or those who are infants within

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[14] In some cases, a plan reported positive ambulatory or inpatient expenditures but zero ambulatory visits or zero inpatient days. In these cases, regression imputation was used to impute a value for ambulatory visits or inpatient days and a binary variable was set to 1 wherever ambulatory visits or inpatient days were imputed in computing the price.

[15] In a fraction of cases, expenditures for the quasi fixed factor variable totaled a negative number or zero. To avoid losing these cases, an indicator variable was set to equal 1 wherever other medical expenses were negative or zero and the value 10^{-12} was substituted as an approximation for zero.

the first 15 weeks of life were calculated and included as control variables. These variables were calculated separately for commercial, Medicare and Medicaid populations and included as control variables. Some studies have found significant differences in the rate at which medical procedures are performed across geographic areas (Guadagnoli et al., 1995; Garg et al., 2002). To control for cost differences among HMOs that may arise due to this variation, the number of inpatient days per MSA population and hospital outpatient visits per MSA population were also included as control variables.

HMO organization

Indicator variables for HMO model type (staff, group, network, and mixed) were included to control for organizational or contractual distinctions among plans related to a plan's ability to manage utilization among its membership, an important determinant of costs. Indicator variables for Blue Cross Blue Shield affiliation or affiliation with a national managed care company were included to control for managerial characteristics specific to these organizations that may affect costs. An indicator variable for profit status was included to control for differences in incentive for cost efficiency between for- and not-for-profit plans. HMO age was used to capture managerial learning over time (Berndt, 1991).

Quality Measurement, Provider Turnover and Reporting

Plans may assemble the data used to report HEDIS measures using only administrative data systems or by supplementing administrative data with information extracted from medical charts. The former data collection method is called administrative only data, and the latter is called hybrid collection (Pawlson et al., 2007). Plans are required to use hybrid collection for certain measures, while for others, a plan may use either method. Hybrid collection is more costly to implement but generally yields more accurate estimates of HEDIS numerators (Keating et al., 2003; Pawlson et al., 2007). Consequently, the percentage of HEDIS measures for which a plan used hybrid collection was included as a control for cost differences linked to the collection method used. Lastly, separate variables capturing the percent of HEDIS measures for which a plan failed NCQA's audit (NA) or for which a plan refused to report (NR) were calculated and included to control for cost differences attributable to quality reporting by plans. The commercial, Medicare or Medicaid physician turnover rate for primary care physicians (PCPs) and specialty care physicians (SCPs) was also included as a measure of the relationship between a HMO and its physicians, which may reflect a plan's ability to manage utilization and affect behavior change among its network physicians. Lastly, among commercial and Medicaid plans, whether a plan permitted public reporting of its HEDIS rates was included as a control variable (all Medicare plans are required to publicly report data). Descriptive statistics for the dependent variable and all explanatory variables are presented in Tables 3-6.

Endogeneity, HMO Costs, and Quality

HMOs may influence HEDIS performance through quality improvement (QI) activities, member selection or selective contracting of providers (Baker et al., 2004a; Gaskin et al., 2002; Kongstevdt, 2007; Wholey et al., 1996). Greater intensity of QI activities by health plans may not always correspond with higher performance, however. Borenstein et al. (2004) analyzed the relationship between self reported QI activities and HEDIS performance in 50 health plans and found for several measures, small effects or even negative effects. Although health plans may influence quality of care, the extent of that influence is debatable. This study uses HMO fixed effects along with time varying characteristics such as HEDIS data collection method, a plan's physician turnover rate and a plan's choice to publicly report HEDIS to capture omitted characteristics that may be correlated with costs and quality.

Section 5. Results

Cost functions were estimated for each product mix (commercial only; commercial & Medicare; commercial & Medicaid; commercial, Medicare, & Medicaid) yielding a total of four models. Results for the parameter estimates for each cost function are included in the appendix. Separate hypothesis tests were performed to test the effect of commercial quality, Medicare quality, and Medicaid quality on costs. Hypothesis tests of the joint significance for quality in each of these populations indicated that across all models, the coefficients for quality were not jointly significant.

We computed the marginal effect of a change in quality on cost to further examine the characteristics captured in the estimated cost functions. Given potential cost quality endogeneity, our marginal effects calculations are computed under the assumption that quality is exogenous. We calculated the marginal effect of an improvement in commercial, Medicare, and Medicaid quality from the 50th to the 75th percentile holding all other continuous variables at their median values. Categorical variables in the model were fixed at values for a for-profit IPA model HMO in 2002. Since the model dependent variable was log transformed, all fitted cost estimates were corrected using Duan's smearing estimate (Duan, 1983; Mullahy, 1998).[16] Table

[16] Cost predictions were first calculated for regression estimates of individual imputed datasets because it was not clear that residuals obtained from the combined estimates were valid. Fitted costs for each observation were

7 presents the estimated change in cost per member per month (PMPM), given the change in clinical quality in each population for each regression model.

The marginal effects estimates in Table 7 indicate that improved commercial quality is associated with small savings (relative to total cost), while the effects of improvements in Medicare or Medicaid quality vary by an HMO's product mix. To put the estimates into perspective, the cost effect of a change in quality was compared against fitted total costs computed with quality and all other variables at their median values. Although most of the effects in Table 7 are not statistically different from zero, we interpret the point estimates as providing some indication of the effect of improved quality. The results suggest that improved commercial quality yields very modest savings. Since median commercial enrollment varied among the four product mixes,[17] the total annual savings implied by the point estimates for commercial quality in Table 7 varied by product mix, ranging between \$153,142 to \$11 million. When compared against total fitted costs with quality at the 50th percentile, these savings only accounted for a small fraction, approximately 0.1%-0.2%.

The effect of improved Medicare and Medicaid quality also varied among HMOs of differing product mix. In three product HMOs (i.e. HMOs with commercial, Medicare and Medicaid enrollment), the PMPM estimates in Table 7 imply \$1.7 million in savings while HMOs with commercial/Medicare product mix have \$196,092 in additional expenses associated with improvement. As a proportion of fitted total costs, these amounts accounted for 0.02% of

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averaged across imputed datasets after application of Duan's smearing estimate to account for imputation uncertainty.

[17] The estimates in Table 7 were annualized using median commercial enrollment and multiplying by 12. Median member months varied between the different product mixes. For example, median commercial member months ranged from 1.627 million in three product HMOs, 1.245 million in commercial & Medicare HMOs, 549,279 in commercial & Medicaid HMOs, and 403,649 in commercial only HMOs.

total costs in three product HMOs and 0.05% in HMOs with commercial/Medicare product mix. The estimate for Medicaid quality in three product HMOs implies that improvement is associated with an added $26 million annually in these HMOs, a total that accounts for 3% of total costs. By comparison, the estimate in commercial/Medicaid HMOs implies $6.6 million in savings or 1% of total costs in these plans.

Plots of the cost PMPM against member months of coverage were also used to conduct comparisons of quality at the 50th and 75th percentiles. Figures 1-4 present cost trajectories given an improvement in quality over member month values observed in the data. In each graph, separate trajectories for cost PMPM were calculated with quality at the 50th and 75th percentiles. All other continuous variables were held at their median values and categorical variables were fixed for a for profit IPA model HMO in 2002.

The trajectories yield similar conclusions to the marginal effects estimates presented in Table 7. The trajectories for commercial quality (Figures 1 and 2) in three product HMOs, commercial/Medicare HMOs, commercial/Medicaid HMOs, and commercial only HMOs suggest that HMO quality as measured by HEDIS makes little to no difference in the cost PMPM. In both figures, the cost PMPM trajectories are overlaid almost on top of one another suggesting a very small cost difference. This result may reflect the limited number of conditions covered by the HEDIS measures including several such as chlamydia screening or childhood immunizations which seem unlikely to have a substantial cost impact from the perspective of an HMO's total annual expenditures.

Figure 3 presents the cost PMPM for three product HMOs and commercial/Medicare HMOs. This figure contains separate trajectories for Medicare quality at the 50th and 75th percentiles for each product mix. While the plots for three product HMOs again appear to be indistinguishable from one another, the 50th and 75th percentile trajectories for commercial/Medicare HMOs suggest that improved quality is costly to achieve. At enrollments above 500,000 Medicare member months, costs are roughly $3.50 PMPM higher on average.

The trajectories in Figure 4 also indicate that the effect of quality in the Medicaid population varies by an HMO's product mix. Improvement in Medicaid quality is associated with a decline in the cost PMPM in commercial/Medicaid HMOs which becomes larger at higher enrollment. The decline ranges between $3-$4 at enrollments above 500,000 member months. In three product HMOs, improved Medicaid quality corresponds with higher costs with the difference in cost PMPM diminishing as enrollment rises.

Robustness

We investigated whether the imprecision of the quality coefficients was specific to the form used in equation 1). To examine this variants of equation 1) excluding the interaction, square and/or control terms were estimated. We also estimated OLS models including only the log of input prices and the log of outputs from equation 1), without HMO fixed effects. Across these alternate specifications, test statistics for the null hypothesis that the quality parameters are jointly zero indicated that the null hypothesis could not be rejected.

We also estimated models to see whether lagged measures of quality might not more appropriately model HMO costs. Quality measures lagged by one year were computed and included in each of the cost functions described in equation 1). Models using 1 year lagged quality measures also included models with only the log of input prices and the log of outputs from equation 1). Hypothesis tests in all of the models using quality measures lagged by 1 year also indicated that the quality parameters were not jointly significant.

Possible Explanations for the Results

These results suggest that improved clinical quality as measured by HEDIS is not a significant driver of HMO costs, except in the case of Medicaid quality. There are several explanations for these results. First, the results may reflect error in the measurement of HMO quality. Because of missing values in the HEDIS measures, multiple imputation (MI) was used to impute missing values. MI assumes that missing values in the data are missing at random (MAR),[18] which implies that the likelihood of missingness in the data is conditional only on the observed data values. If the MAR assumption does not hold for the HEDIS measures, MI may have introduced measurement error into the analysis. Second, although the study used HMO and year fixed effects along with several time varying characteristics of HMOs related to cost and quality, these controls may still inadequately account for unmeasured differences within HMOs over time that are correlated with HEDIS performance and HMO total costs.

Third, it is possible that on average, the costs of improving HEDIS performance may not account for an appreciable share of HMO total expenses. Although some studies of disease management programs do find cost savings resulting from increasing the delivery of recommended care, such savings may be a relatively small fraction of HMO total costs in aggregate (U.S. Congressional Budget Office, 2004; Fireman et al., 2004). Enrollment turnover may have also dampened the cost savings plans realize from improvements in quality. The cost of improving HEDIS performance includes fixed input purchases for electronic data processing equipment or external vendors, which may be incurred at one point in time (Scanlon et al., 2001;

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[18] Given unobserved values of Y (Y_{miss}), and observed values of Y (Y_{obs}), MAR assumes that Pr(Y is missing | Y_{miss}, Y_{obs}) = Pr(Y is missing | Y_{obs}).

Baker et al., 2004a). Relative to these fixed costs of quality improvement, the marginal costs of quality improvement activities may be much smaller (Kongstevdt, 2007).

Section 6. Conclusion

Ensuring efficiency and quality in the medical care delivery system remains a high priority for US health care policy. Health care spending continues to consume an increasing share of the gross domestic product (GDP) while fundamental deficiencies in the quality of health services remain (Hartman et al., 2009; Jha et al., 2005; McGlynn et al. 2003). Analysts have argued that improvements in the quality of care may lead to reductions in medical expenditures in the "long run" as the health of insured populations improves (Beaulieu et al., 2003; Goetzel et al., 2005; Hillestad et al., 2005; Leatherman et al., 2003; NCQA, 2007a; Neumann & Levine, 2002; Pignone et al., 2001). However, this assertion has been debated primarily because of the lack of evidence of savings due to improved quality (Fireman et al., 2004; Glickman et al., 2007; U.S. Congressional Budget Office, 2004).

This study has sought to add empirical evidence to this debate through an analysis of a national panel of HMOs over five years: 1998-2002. Quality was measured using composites of HEDIS measures which reflect the delivery of recommended care for eligible populations. Separate quality measures were used for commercial, Medicare, and Medicaid populations in a translog cost function with HMO and year fixed effects. Hypothesis tests of the quality coefficients were used to assess significance separately for each population. The results indicate that improvements in quality for the most part, do not have an appreciable effect on costs in HMOs.

Limitations

This study has several limitations. First, the choice to estimate separate cost functions by HMO product mix reduced the sample size available for each regression model, limiting the precision of model estimates. Second, although this study uses HMO fixed effects and several time varying attributes to control for the potential endogeneity of quality and costs, whether the controls used are sufficient to purge bias from the estimates could not be verified because we were not able to identify plausible instruments for quality. Third, this study uses multiple imputation to handle missing values in the quality measures. Although this approach incorporates uncertainty due to missingness in the regression parameters, it is uncertain whether the imputation itself introduced error in the measurement of quality due to possible violation of the MAR assumption. Fourth, conceptually, the use of HEDIS rates to measure HMO quality primarily relate to the problem of underuse of health services and may not capture other aspects of the clinical quality of care under HMOs such as misuse or overuse of health services.

Next Steps

We are considering the Arellano Bond estimator as one possible approach that may allow us to test for cost quality endogeneity in HMOs.

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Notes

1. The ratio of total physician expenses to the sum of total physician and inpatient expenses were computed for years 1998-2000. This ratio was modeled in a regression including total inpatient days, total ambulatory visits, the total cost per member per month, total commercial group member months, total commercial individual member months, Medicare member months, and Medicaid member months, year indicator variables and an indicator variable = 1 for cases where any of the previous variables were missing. The fitted values of this ratio for 2001 and 2002 was multiplied to reported hospital/medical expenses in 2001 and 2002 to calculate physician expenses and inpatient expenses in these years.

Figures and Tables

Table 1. Comparison of HEDIS Performance Among Health Plans with Commercial, Medicare, and Medicaid Coverage Lines for Selected HEDIS Measures[1], 1998-2002

HEDIS Variable Name	N	Mean			Standard deviation		
		Commercial	Medicare	Medicaid	Commercial	Medicare	Medicaid
Breast Cancer Screening	170	75.95	74.36	56.26	5.28	9.70	9.50
Hypertension Control	97	49.79	48.15	47.66	11.16	12.31	12.87
Hemoglobin A1c Screening Rate	152	78.77	83.12	71.62	11.92	11.74	14.92
Poor Hemoglobin A1c Control	146	39.92	29.31	49.81	15.98	16.62	17.59
Diabetes Eye Exam Rate	152	51.65	64.70	47.05	14.93	15.91	16.56
Diabetes Lipid Control Rate	148	44.56	51.28	34.26	13.52	15.06	12.84
Nephropathy Screening Rate	150	45.31	47.43	42.81	17.29	17.43	18.03
30 Day Follow-up After Mental Illness Hospitalization	54	70.64	62.65	51.89	13.20	15.01	20.20
Anti-Depressant Medication Management, Continuation Phase	63	42.27	34.42	27.80	10.88	12.66	9.70

[1] All HEDIS measures with observations for multi-product plans with commercial, Medicare, and Medicaid enrollment were included.

Table 2. Quality Domains for the HEDIS Measures Identified Via Exploratory Factor Analysis

Quality Domain	HEDIS Measure
Illness Prevention and Management (IPM)	Mammography Rate
	Cervical Cancer Screening Rate
	Prenatal Care Rate [1]
	Postnatal Care Rate [1]
	Controlling Hypertension
	Beta Blocker Medication After AMI [2]
	LDL-C screeening Rate [2]
	LDL-C control Rate [2]
	HbA1c screening Rate
	HbA1c control Rate
	Retinopathy Screening Rate
	Diabetic LDL-C screening Rate
	Diabetic LDL-C control Rate
	Nephropathy Screening Rate
Chlamydia Screening (CHL)	Chlamydia Screening age 16-20 Rate [1]
	Chlamydia Screening age 21-26 Rate [1]
Anti-Depressant Medication Management (AMM)	Anti-Depressant Medication Management: Effective Acute Phrase Treatment
	Anti-Depressant Medication Management: Effective Continuation Phrase Treatment
Access to Preventive Care (ACC)	Adult Access to Preventive Care Age 20-44 Rate
	Adult Access to Preventive Care Age 45-64 Rate
	Adult Access to Preventive Care Age 65 + Rate
	Child Access to Preventive Care age 1-2 Rate [1]
	Child Access to Preventive Care age 2-6 Rate [1]
	Child Access to Preventive Care age 7-11 Rate [1]
Well Care & Immunization (WCI)	Childhood Immunization Combination 1 Rate [1]
	Childhood Immunization Combination 2 Rate [1]
	Adolescent Immunization Combination 1 Rate [1]
	Adolescent Immunization Combination 2 Rate [1]
	Well Child Visits: 6+ Visits Rate in Week 15 of life [1]
	Well Child Visits: Visit Rate in year 3-6 of life [1]
	Adolescent Well Child Visit Rate [1]

Notes: For the Medicare HEDIS measures only the IPM, AMM and ACC domains were computed. For the Medicaid HEDIS measures, the IPM, CHL, ACC and WCI domains were computed. All five domains were computed for the commercial HEDIS measures.

[1] These measures are not available for the Medicare population

[2] These measures were excluded for the Medicaid population because more than 70% of observations were impu

Table 3. Clinical Performance by Quality Domain and Coverage Population, 1998-2002 (Mean Across Imputation Datasets is Reported)

HEDIS Composite (*Q*)	N	Mean	Std
<u>*Commercial Quality Domains*</u> (N=1298)			
Illness Prevention and Management (IPM)	6490	0.60	0.17
Chlamydia Screening (CHL)	6490	0.25	0.24
Anti-Depressant Medication (AMM)	6490	0.37	0.21
Access to Preventive Care (ACC)	6490	0.87	0.09
Well Care (WCC)	6490	0.39	0.18
Commercial HEDIS Composite	6490	-0.001	0.003
<u>*Medicare Quality Domains*</u> (N=642)			
Illness Prevention and Management (IPM)	3210	0.49	0.25
Anti-Depressant Medication (AMM)	3210	0.55	0.23
Access to Preventive Care (ACC)	3210	0.31	0.19
Medicare HEDIS Composite	3210	-0.004	0.007
<u>*Medicaid Quality Domains*</u> (N=472)			
Illness Prevention and Management (IPM)	2360	0.51	0.12
Chlamydia Screening (CHL)	2360	0.40	0.23
Access to Preventive Care (ACC)	2360	0.77	0.09
Well Care (WCC)	2360	0.31	0.11
Medicaid HEDIS Composite	2360	0.0005	0.001

Notes: Descriptive statistics presented are averages across the five imputed datasets. HEDIS measures in the Well Care and Chlamydia Screening factor are not collected for Medicare population. Anti-depressant medication management Medicaid HEDIS measures were excluded from analysis because 70% or more observations in these measures were imputed.

Table 4. HMO Financial and Operations Variables, 1998-2002

	N	Mean	Std
Total Costs (in millions)	1298	340.80	480.49
Commercial Member Months (in millions)	1298	1.47	2.01
Medicare Member Months (in millions)	1298	0.16	0.34
Medicaid Member Months (in millions)	1298	0.15	0.37
Price of Hospital Day	1298	1961.43	628.34
Price of Ambulatory Visit	1298	248.37	96.56
Hourly Wage for Administrative Labor[1]	1298	20.54	2.21
Quasi Fixed Factor[2]	1298	32.64	34.15
HMO Age	1298	14.22	8.05
For Profit Status	1298	0.75	0.43
Staff Model Type	1298	0.01	0.11
Group Model Type	1298	0.02	0.15
Network Model Type	1298	0.13	0.33
Mixed Model Type	1298	0.31	0.46
BCBS affiliation	1298	0.15	0.36
National managed care firm affiliation	1298	0.49	0.50
No. of Inpatient Days per MSA population	1298	0.95	0.35
No. of Hospital Outpatient Visits per MSA population	1298	2.79	1.04
= 1 if Utilization Variable in NAIC Data was Imputed	1298	0.19	0.39
= 1 if Quasi Fixed Factor was Negative or Zero	1298	0.02	0.13

Notes: Descriptive statistics presented are for one of the five imputed datasets.
[1] Administrative labor was measured using the mean hourly wage for insurance examiners obtained from the BLS.
[2] In dollars per member per month. Cases where the quasi fixed factor variable had negative or zero values were set to 1×10^{-12} and an indicator variable = 1 was included in regressions.

Table 5. HMO Condition Prevalence Variables 1998-2002

	N	Mean	Std
% of Commercial Members with Asthma	1298	0.007	0.018
% of Commercial Members with Diabetes	1298	0.017	0.025
% of Commercial Members with Hypertension	1298	0.026	0.044
% of Commercial Members with an Acute Cardiovascular Event	1298	0.0008	0.001
% of Commercial Members Pregnant	1298	0.008	0.009
% of Commercial Members with Depression	1298	0.002	0.003
% of Commercial Members Hospitalized for Mental Illness	1298	0.001	0.002
% of Commercial Members who are Infants in the first 15 weeks of life	1298	0.005	0.005
% of Female Medicare Members age 65-69 years	1298	0.037	0.103
% of Medicare Members with an Acute Cardiovascular Event	1298	0.003	0.009
% of Medicare Members with Diabetes	1298	0.036	0.076
% of Medicare Members Hospitalized for Mental Illness	1298	0.0008	0.003
% of Medicare Members with Depression	1298	0.001	0.004
% of Medicaid Members with Asthma	1298	0.0004	0.01
% of Medicaid Members with Diabetes	1298	0.0007	0.018
% of Medicaid Members with an Acute Cardiovascular Event	1298	0.00002	0.0006
% of Medicaid Members Pregnant	1298	0.0008	0.019
% of Medicaid Members with Depression	1298	0.00002	0.0001
% of Medicaid Members Hospitalized for Mental Illness	1298	0.00005	0.0004
% of Medicaid Members who are Infants in the first 15 weeks of life	1298	0.0005	0.011

Table 6. HMO Physician Turnover, Collection Method, and Quality Reporting Variables 1998-2002

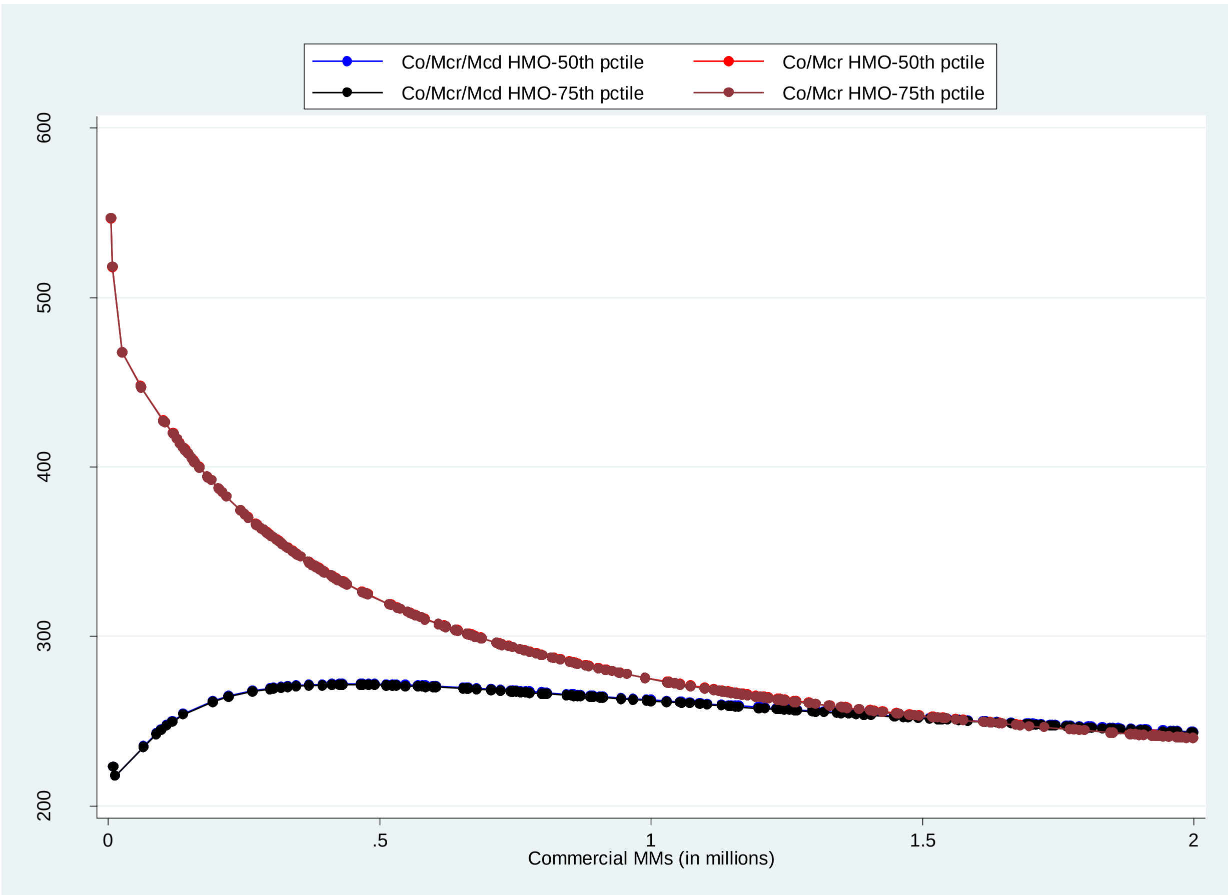
	N	Mean	Std
Commercial Primary Care Physician (PCP) Turnover Rate	1298	0.19	0.20
Commercial Specialty Care Physician (SCP) Turnover Rate	1298	0.30	0.36
Medicare Primary Care Physician (PCP) Turnover Rate	1298	0.07	0.11
Medicare Specialty Care Physician (SCP) Turnover Rate	1298	0.17	0.26
Medicaid Primary Care Physician (PCP) Turnover Rate	1298	0.02	0.08
Medicaid Specialty Care Physician (SCP) Turnover Rate	1298	0.26	0.41
% of commercial HEDIS Measures using Hybrid Collection	1298	0.40	0.44
% of Medicare HEDIS Measures using Hybrid Collection	1298	0.22	0.37
% of Medicaid HEDIS Measures using Hybrid Collection	1298	0.09	0.22
% of commercial HEDIS Measures Plan Reported NA	1298	0.04	0.09
% of commercial HEDIS Measures Plan Reported NR	1298	0.05	0.12
% of Medicare HEDIS Measures Plan Reported NA	1298	0.06	0.13
% of Medicare HEDIS Measures Plan Reported NR	1298	0.02	0.09
% of Medicaid HEDIS Measures Plan Reported NA	1298	0.01	0.03
% of Medicaid HEDIS Measures Plan Reported NR	1298	0.02	0.09
Public Reporting of Commercial HEDIS measures	1298	0.57	0.49
Public Reporting of Medicaid HEDIS measures	1298	0.08	0.28

Table 7. Estimated Change in Cost Per Member Per Month (PMPM) of An Improvement in Clinical Performance from the 50th to the 75th Percentile
(Standard errors in parentheses)

	Model			
	Model 1: HMOs with Commercial, Medicare and Medicaid coverage	Model 2: HMOs with Commercial and Medicare coverage	Model 3: HMOs with Commercial and Medicaid coverage	Model 4: HMOs with only Commercial coverage
Cost PMPM of Improvement in Commercial Quality from the 50th to 75th Percentile	-\$0.55 (\$1.03)	-\$0.47 (\$1.59)	-\$0.15 (\$2.80)	-\$0.03 (\$5.52)
Cost PMPM of Improvement in Medicare Quality from the 50th to 75th Percentile	-\$0.07 (\$1.03)	\$0.12 (\$1.60)	NA	NA
Cost PMPM of Improvement in Medicaid Quality from the 50th to 75th Percentile	\$7.22 (\$1.03)	NA	-\$2.40 (\$2.81)	NA

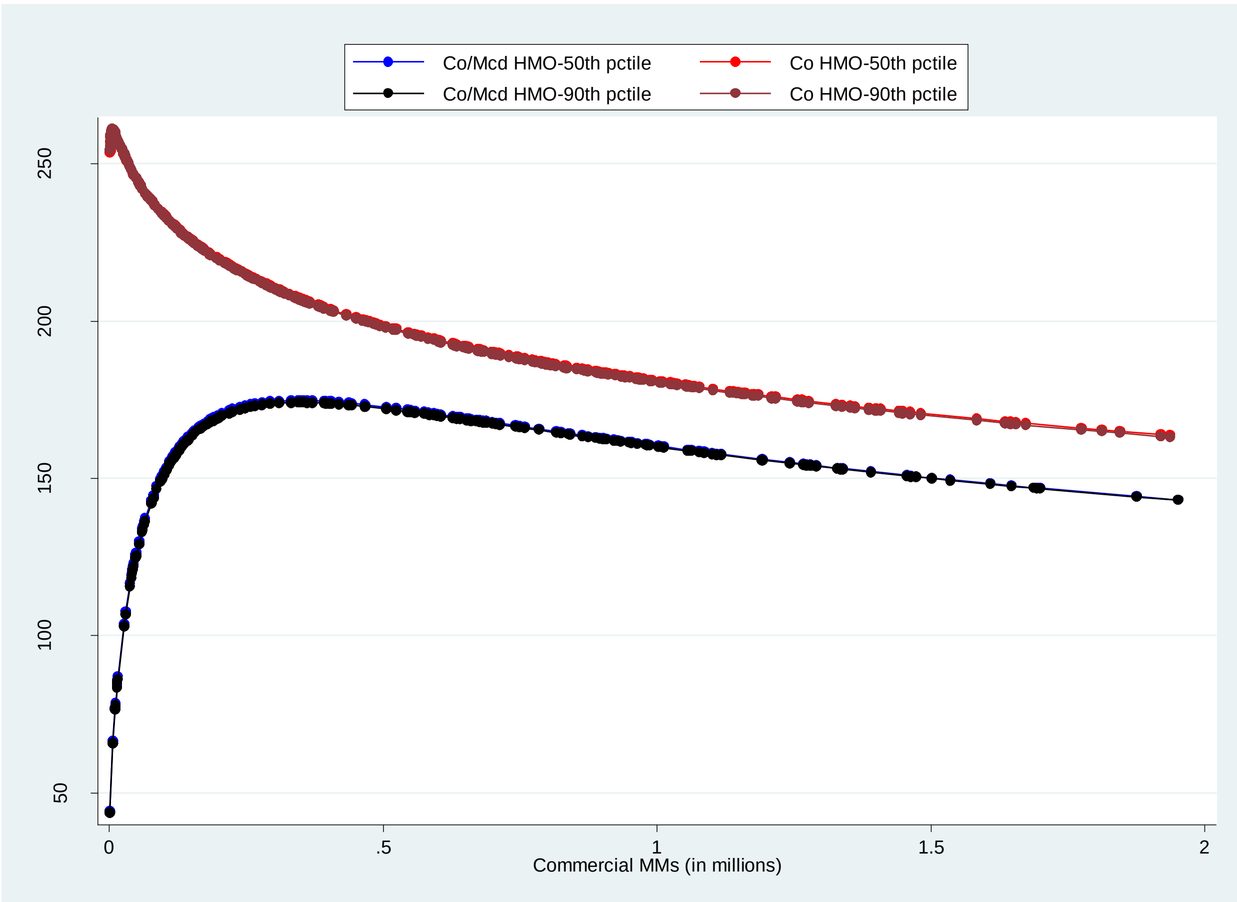
Notes: Enrollment and other continuous variables were fixed at median values for predicted costs. The values of categorical variables were determined so that predicted costs correspond to a for-profit IPA model HMO in 2000

Figure 1. Comparison of Improved Commercial Quality in Three Product HMOs and Commercial/Medicare HMOs



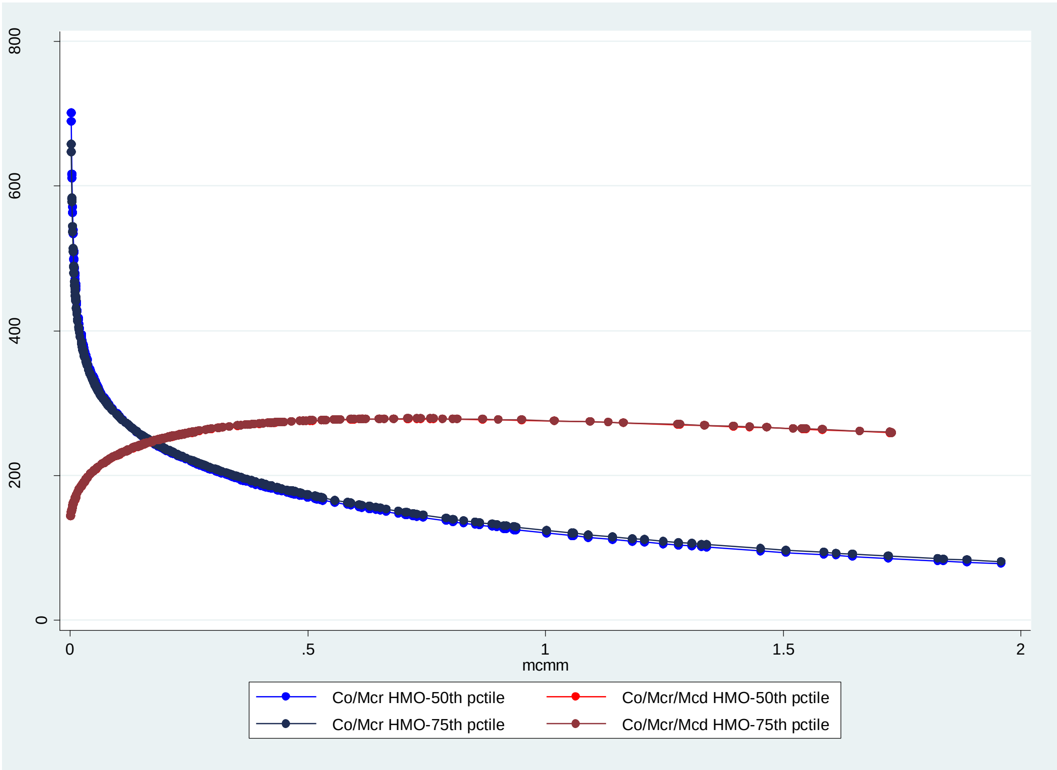
Notes: Costs were fitted for a for-profit IPA model HMO in 2002. Medicare and Medicaid enrollment and all continuous variables were fixed at median values. "Co/Mcr" are HMOs with commercial and Medicare product mix with quality fixed at the named percentile. "Co/Mcr/Mcd" are HMOs with the commercial, Medicare, and Medicaid product mix.

Figure 2. Comparison of Improved Commercial Quality in Commercial/Medicaid HMOs and Commercial Only HMOs



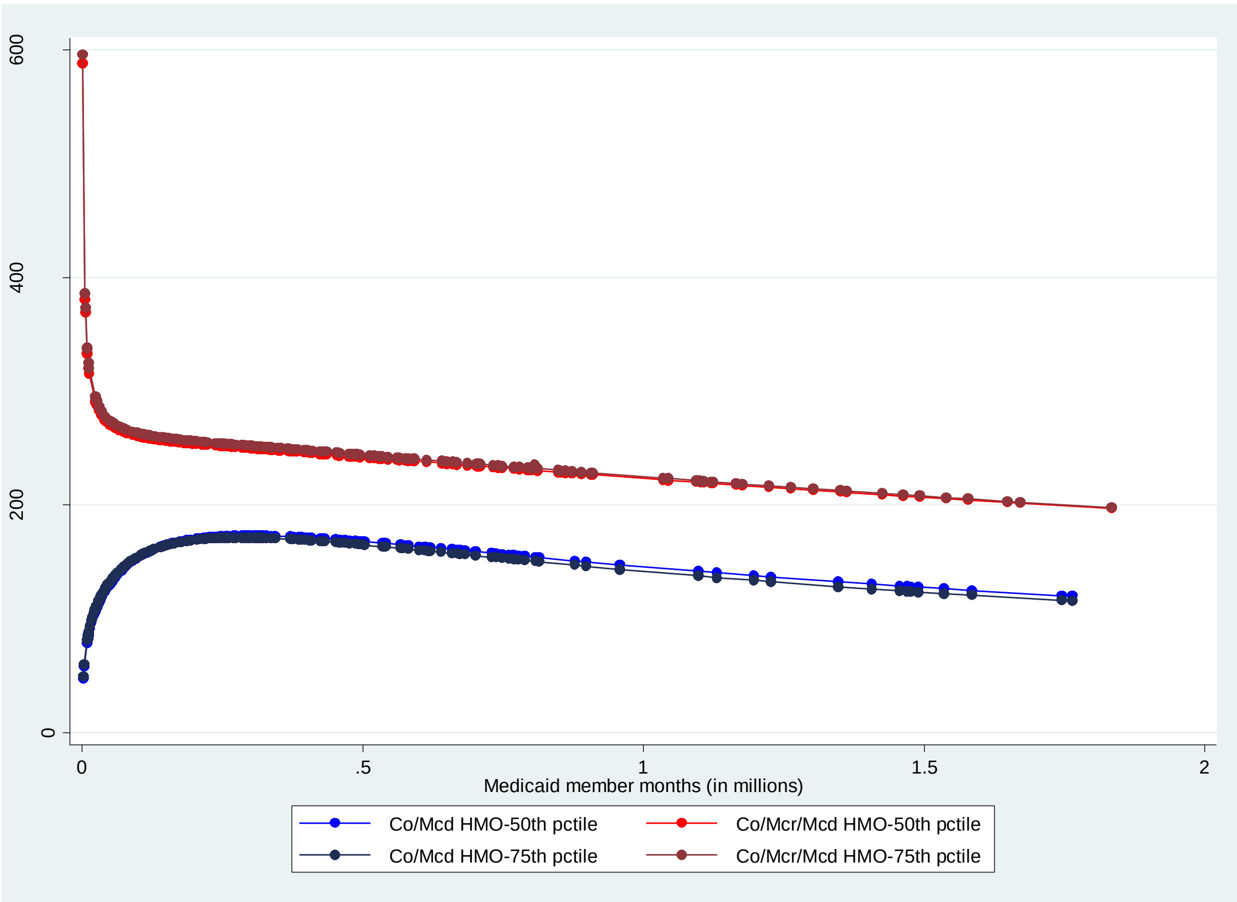
Notes: Costs were fitted for a for-profit IPA model HMO in 2002. Medicare and Medicaid enrollment and all continuous variables were fixed at median values. "Co/Mcd" are HMOs with commercial and Medicaid product mix with quality fixed at the named percentile. "Co/Mcr/Mcd" are HMOs with the commercial, Medicare, and Medicaid product mix.

Figure 3. Estimated Cost Trajectory for Improved Medicare Quality in Commercial/Medicare HMOs & Commercial/Medicare/Medicaid HMOs



Notes: Costs were fitted for a for-profit IPA model HMO in 2002. Commercial and Medicaid enrollment and all continuous variables were fixed at median values. "Co/Mcr" is commercial/Medicare HMO with quality fixed at the named percentile. "Co/Mcr/Mcd" is commercial/Medicare/Medicaid HMO.

Figure 4. Comparison of Improved Medicaid Quality in Three Product HMOs and Commercial/Medicaid HMOs



Notes: Costs were fitted for a for-profit IPA model HMO in 2002. Medicare and Medicaid enrollment and all continuous variables were fixed at median values. "Co/Mcd" are HMOs with commercial and Medicaid product mix with quality fixed at the named percentile. "Co/Mcr/Mcd" are HMOs with the commercial, Medicare, and Medicaid product mix.

Appendix

Table A1. Cost Function Parameter Estimates
(Combined robust standard errors in parentheses)

VARIABLES	(1) HMOs with Commercial, Medicare and Medicaid coverage	(2) HMOs with Commercial, Medicare coverage	(3) HMOs with Commercial and Medicaid coverage	(4) HMOs with only Commercial coverage
ln(Commercial MMs)	0.153 (1.110)	1.150** (0.536)	0.684* (0.389)	-1.271* (0.676)
ln(Medicare MMs)	0.948 (0.580)	-0.159 (0.447)		
ln(Medicaid MMs)	-0.535 (0.650)		0.269 (0.382)	
Commercial HEDIS composite	1869 (4328)	2048 (4525)	-577.1 (3850)	325.4 (1987)
Medicare HEDIS composite	-23.16 (160.1)	90.26 (109.4)		
Medicaid HEDIS composite	2851 (3821)		-92.47 (3226)	
ln(hospital day price)	-2.075 (2.744)	0.773 (2.131)	-0.604 (2.602)	-3.713** (1.614)
ln(ambulatory visit price)	0.236 (2.202)	-1.236 (1.443)	-0.692 (1.499)	6.709*** (2.177)
ln(administrative labor price)	-6.736 (6.826)	8.036 (7.867)	9.431 (6.141)	-1.050 (8.003)
ln(quasi fixed factor)	-0.404 (0.637)	0.567 (0.341)	-0.715** (0.293)	-0.0273 (0.225)
$(\ln(\text{Commercial MMs}))^2$	0.141** (0.0532)	0.200*** (0.0416)	0.0967*** (0.0112)	-0.0193 (0.0207)
$(\ln(\text{Medicare MMs}))^2$	0.0283* (0.0139)	0.0859*** (0.0152)		
$(\ln(\text{Medicaid MMs}))^2$	0.0694*** (0.0217)		0.173*** (0.0167)	
ln(Commercial MMs) × ln(Medicare MMs)	-0.0621** (0.0241)	-0.0572** (0.0268)		
ln(Medicaid MMs) × ln(Commercial MMs)	-0.202* (0.0993)		-0.314*** (0.0248)	
ln(Medicaid MMs) × ln(Medicare MMs)	-0.0408 (0.0622)			
$(\text{Commercial HEDIS composite})^2$	-98753 (307259)	-195797 (483894)	36216 (98983)	-5998 (33342)
$(\text{Medicare HEDIS composite})^2$	1698 (3631)	934.0 (2359)		

VARIABLES	(1) HMOs with Commercial, Medicare and Medicaid coverage	(2) HMOs with Commercial, Medicare coverage	(3) HMOs with Commercial and Medicaid coverage	(4) HMOs with only Commercial coverage
(Medicaid HEDIS composite)^2	117317 (272182)		-52994 (152392)	
ln(Medicare MMs) × ln(Commercial MMs)	-5722 (19113)	-9663 (18474)		
ln(Medicaid MMs) × ln(Commercial MMs)	281026 (920426)		104362 (331995)	
ln(Medicaid MMs) × ln(Medicare MMs)	-30932 (62590)			
(Commercial HEDIS composite) × ln(Commercial MMs)	-22.99 (116.6)	-34.66 (117.5)	8.020 (38.38)	-34.93 (102.2)
(Medicare HEDIS composite) × ln(Medicare MMs)	-2.390 (4.603)	-5.955 (5.099)		
(Medicaid HEDIS composite) × ln(Medicaid MMs)	-66.97 (167.2)		18.68 (126.2)	
ln(hospital day price) × ln(Commercial MMs)	0.0509 (0.0772)	-0.0343 (0.0438)	-0.0280 (0.0320)	0.0298 (0.0480)
ln(ambulatory visit price) × ln(Commercial MMs)	0.0703 (0.0780)	0.00722 (0.0473)	0.000411 (0.0209)	0.0483 (0.0541)
ln(admin. labor price) × ln(Commercial MMs)	-0.182 (0.283)	-0.129 (0.122)	-0.0260 (0.0777)	0.545*** (0.189)
ln(quasi fixed factor) × ln(Commercial MMs)	0.00816 (0.0221)	-0.000954 (0.0147)	-0.0108*** (0.00240)	-0.00343 (0.00599)
ln(hospital day price) × ln(Medicare MMs)	-0.0230 (0.0320)	0.0804** (0.0351)		
ln(ambulatory visit price) × ln(Medicare MMs)	-0.0456 (0.0439)	0.0139 (0.0380)		
ln(admin. labor price) × ln(Medicare MMs)	-0.0532 (0.138)	-0.0338 (0.0988)		
ln(quasi fixed factor) × ln(Medicare MMs)	-0.0537*** (0.0131)	0.00200 (0.0114)		
ln(hospital day price) × ln(Medicaid MMs)	0.00200 (0.0399)		0.0179 (0.0331)	
ln(ambulatory visit price) × ln(Medicaid MMs)	0.0448 (0.0433)		-0.0867** (0.0343)	
ln(admin. labor price) × ln(Medicaid MMs)	0.125 (0.160)		0.206* (0.115)	
ln(quasi fixed factor) × ln(Medicaid MMs)	0.0311* (0.0156)		-0.00518 (0.00995)	
ln(hospital day price) × (Commercial HEDIS composite)	-85.65 (274.9)	-96.80 (270.4)	76.90 (362.1)	71.08 (467.3)
ln(ambulatory visit price) × (Commercial HEDIS composite)	-46.31 (251.4)	-93.93 (276.6)	-40.66 (219.3)	-37.48 (313.4)

VARIABLES	(1) HMOs with Commercial, Medicare and Medicaid coverage	(2) HMOs with Commercial, Medicare coverage	(3) HMOs with Commercial and Medicaid coverage	(4) HMOs with only Commercial coverage
ln(admin. labor price) × (Commercial HEDIS composite)	-396.9 (876.6)	-291.2 (505.0)	57.31 (655.9)	-218.2 (671.7)
ln(quasi fixed factor) × (Commercial HEDIS composite)	30.57 (70.44)	-7.968 (52.85)	22.78 (52.77)	-10.52 (32.41)
ln(hospital day price) × (Medicaid HEDIS composite)	-283.0 (391.4)		27.04 (257.6)	
ln(ambulatory visit price) × (Medicaid HEDIS composite)	-17.16 (344.8)		-34.22 (205.0)	
ln(admin. labor price) × (Medicaid HEDIS composite)	-151.8 (782.4)		63.79 (695.1)	
ln(quasi fixed factor) × (Medicaid HEDIS composite)	-62.49 (94.89)		-17.32 (89.58)	
ln(hospital day price) × (Medicare HEDIS composite)	-1.857 (10.03)	-18.49 (12.19)		
ln(ambulatory visit price) × (Medicare HEDIS composite)	-8.151 (15.69)	-4.423 (5.510)		
ln(admin. labor price) × (Medicare HEDIS composite)	29.22 (28.95)	25.94 (29.34)		
ln(quasi fixed factor) × (Medicare HEDIS composite)	0.488 (3.495)	-0.861 (0.902)		
ln(hospital day price) × ln(hospital day price)	0.103 (0.230)	0.377* (0.197)	0.233 (0.271)	0.207 (0.225)
ln(ambulatory visit price) × ln(ambulatory visit price)	-0.216 (0.213)	0.0773 (0.135)	0.0525 (0.0994)	-0.155 (0.139)
ln(admin. labor price) × ln(admin. labor price)	0.711 (1.978)	0.186 (1.981)	-3.568** (1.338)	0.0336 (2.404)
ln(quasi fixed factor) × ln(quasi fixed factor)	0.0353 (0.0341)	0.0135 (0.0131)	-0.0230 (0.0316)	0.0332 (0.0304)
ln(ambulatory visit price) × ln(hospital day price)	0.0324 (0.371)	0.0812 (0.270)	-0.263 (0.213)	-0.466 (0.314)
ln(admin. labor price) × ln(hospital day price)	0.875 (1.150)	-2.339* (1.183)	-0.362 (0.854)	2.228* (1.239)
ln(quasi fixed factor) × ln(hospital day price)	-0.0191 (0.102)	-0.115 (0.0917)	0.102 (0.0392)	0.0260 (0.0572)

VARIABLES	(1) HMOs with Commercial, Medicare and Medicaid coverage	(2) HMOs with Commercial, Medicare coverage	(3) HMOs with Commercial and Medicaid coverage	(4) HMOs with only Commercial coverage
ln(admin. labor price) × ln(ambulatory visit price)	0.416 (1.219)	0.266 (0.818)	0.883 (0.852)	-2.597*** (0.916)
ln(quasi fixed factor) × ln(ambulatory visit price)	0.0442 (0.0914)	0.0795** (0.0379)	-0.0249 (0.0348)	-0.0456 (0.0545)
ln(admin. labor price) × ln(quasi fixed factor)	0.167 (0.291)	-0.248* (0.135)	0.318** (0.127)	-0.0545 (0.113)
Percent of Commercial Members with Asthma	0.552 (1.151)	0.0786 (2.510)	1.172 (2.395)	-2.376 (4.202)
Percent of Commercial Members with Diabetes	-0.372 (0.699)	0.929 (1.106)	0.849 (1.171)	-0.0116 (2.727)
Percent of Commercial Members with Hypertension	-0.178 (0.592)	-0.241 (0.243)	0.273 (0.295)	2.255** (1.086)
Percent of Commercial Members with an Acute Cardiovascular Event	-7.275 (13.89)	13.48 (14.05)	-14.39 (18.90)	-29.92 (30.17)
Percent of Pregnant Commercial Members	-0.208 (1.525)	-3.989 (2.404)	1.644 (3.408)	-7.985* (4.461)
Percent of Commercial Members with Depression	-0.533 (3.704)	1.251 (5.034)	1.317 (4.786)	1.557 (7.245)
Percent of Commercial Members Hospitalized for Mental Illness	13.49 (8.410)	15.99 (10.89)	32.71*** (11.13)	75.75*** (28.45)
Percent of Infant Commercial Members in the First 15 Weeks of Life	-0.0782 (2.525)	4.268 (3.531)	-7.358 (4.466)	-16.26** (6.990)
Percent of Medicare Members who are Women aged 65-69	-0.146 (0.198)	-0.114 (0.273)		
Percent of Medicare Members with Hypertension	-0.00561 (0.0129)	0.0448 (0.0821)		
Percent of Medicare Members with An Acute Cardiovascular Event	1.319 (2.435)	-1.217 (2.599)		
Percent of Medicare Members with Diabetes	0.108 (0.159)	0.0579 (0.197)		
Percent of Medicare Members with Hospitalization for Mental Illness	-4.499 (6.676)	0.438 (5.234)		
Percent of Medicare Members with Depression	-0.419 (2.008)	4.872 (3.706)		
Percent of Medicaid Members with Asthma	-39.98 (44.80)		-4.090 (7.622)	
Percent of Medicaid Members with Diabetes	18.32 (35.86)		-18.53 (18.64)	

VARIABLES	(1) HMOs with Commercial, Medicare and Medicaid coverage	(2) HMOs with Commercial, Medicare coverage	(3) HMOs with Commercial and Medicaid coverage	(4) HMOs with only Commercial coverage
Percent of Medicaid Members with Diabetes	623.1 (530.9)		853.7 (754.3)	
Percent of Pregnant Medicaid Members	-6.381 (14.00)		-9.409 (10.74)	
Percent of Medicaid Members with Depression	-93.52 (117.6)		91.24 (86.76)	
Percent of Medicaid Members Hospitalized for Mental Illness	158.4 (123.5)		19.60 (20.29)	
Percent of Infant Medicaid Members in the First 15 Weeks of Life	-9.396 (25.37)		6.292 (6.103)	
No. of Inpatient Days Per MSA population	-0.182 (0.125)	-0.0279 (0.0910)	0.0819 (0.0826)	-0.125 (0.182)
No. of Hospital Outpatient Visits Per MSA population	0.0426 (0.0328)	0.0146 (0.0204)	-0.0206 (0.0188)	-0.0161 (0.0417)
HMO Age	0.00181 (0.0120)	0.0171* (0.00965)	0.00266 (0.00368)	-0.00154 (0.00669)
= 1 if Staff Model HMO		0.0286 (0.0707)		
= 1 if Group Model HMO	-0.0432 (0.132)	0.0383 (0.0952)	0 (0)	-0.0820 (0.305)
= 1 if Network Model HMO	-0.0449 (0.0664)	0.156* (0.0828)	0.0462 (0.0564)	0.0196 (0.0761)
= 1 if Mixed Model HMO	-0.0369 (0.0422)	0.0306 (0.0561)	-0.0193 (0.0504)	0.0838 (0.0721)
= 1 if HMO is For Profit	0.0359 (0.135)	0.0509 (0.0904)	-0.00988 (0.0681)	0.0627 (0.101)
= 1 if HMO is Affiliated with BCBS	0 (0)	0.00757 (0.0888)	0.0274 (0.0605)	-0.149* (0.0803)
= 1 if HMO is Affiliated with a National Managed Care Firm	0.0741 (0.0524)	0.00782 (0.0769)	0 (0)	0.131 (0.103)
= 1 if Commercial HEDIS Measures were Publicly Reported	0.0289 (0.0307)	-0.0309 (0.0316)	-0.0366 (0.0465)	0.0310 (0.0540)
= 1 if Medicaid HEDIS Measures were Publicly Reported	-0.0278 (0.0376)		0.0737* (0.0405)	
Commercial PCP Turnover Rate	0.0232 (0.167)	0.0130 (0.0988)	-0.0569 (0.0590)	0.00871 (0.160)
Commercial SCP Turnover Rate	-0.00415 (0.0315)	-0.0189 (0.0497)	0.0221 (0.0554)	-0.0241 (0.0879)
Medicare PCP Turnover Rate	-0.0661 (0.106)	-0.0186 (0.0766)		
Medicare SCP Turnover Rate	0.0582 (0.0703)	0.0262 (0.061)		

VARIABLES	(1) HMOs with Commercial, Medicare and Medicaid coverage	(2) HMOs with Commercial, Medicare coverage	(3) HMOs with Commercial and Medicaid coverage	(4) HMOs with only Commercial coverage
Medicaid PCP Turnover Rate	0.0203 (0.126)		0.0754 (0.162)	
Medicaid SCP Turnover Rate	-0.0126 (0.0633)		0.0401 (0.0508)	
Percent of Commercial HEDIS Measures using Hybrid Collection	-0.00672 (0.0273)	0.0426 (0.0360)	0.0118 (0.0353)	0.0782 (0.0626)
Percent of Medicare HEDIS Measures using Hybrid Collection	0.0133 (0.0491)	-0.0337 (0.0415)		
Percent of Medicaid HEDIS Measures using Hybrid Collection	0.0248 (0.0677)		-0.0789 (0.0715)	
Percent of Commercial HEDIS Measures with Non-reporting because of audit failure	-0.0543 (0.136)	0.0297 (0.137)	-0.243 (0.144)	-0.270 (0.261)
Percent of Medicare HEDIS Measures with Non-reporting because of audit failure	-0.0721 (0.132)	-0.0438 (0.0998)		
Percent of Medicaid HEDIS Measures with Non-reporting because of audit failure	-0.194* (0.114)		0.592** (0.279)	
Percent of Commercial HEDIS Measures with Non-reporting because of Refusal	0.0783 (0.143)	-0.0171 (0.0891)	-0.140 (0.104)	0.0104 (0.143)
Percent of Medicare HEDIS Measures with Non-reporting because of Refusal	-0.180 (0.114)	0.0927 (0.0963)		
Percent of Medicaid HEDIS Measures with Non-reporting because of Refusal	-0.0751 (0.113)		0.126 (0.0998)	
= 1 if year is 1999	0.0116 (0.0389)	0.0123 (0.0323)	0.102*** (0.0321)	0.0990** (0.0486)
= 1 if year is 2000	0.120* (0.0523)	0.103** (0.0443)	0.138*** (0.0351)	0.186*** (0.0528)
= 1 if year is 2001	0.250*** (0.0533)	0.171*** (0.0498)	0.260*** (0.0354)	0.266*** (0.0583)
= 1 if year is 2002	0.375*** (0.0727)	0.329*** (0.0680)	0.382*** (0.0485)	0.480*** (0.0948)
= 1 if NAIC utilization variables were imputed	0.0204 (0.0361)	0.0338 (0.0309)	0.0202 (0.0495)	-0.111* (0.0625)
= 1 if Quasi Fixed Factor is negative or zero	-17.25 (15.40)	-5.861 (5.752)	11.77 (14.11)	-16.54 (13.64)
Constant	23.93 (16.66)	-7.675 (16.70)	-3.622 (18.65)	1.578 (15.32)
Observations	256	386	216	440

Notes: All models included HMO fixed effects.
*** p<0.01, ** p<0.05, * p<0.1