

*Stanford University
Walter H. Shorenstein Asia-Pacific Research Center
Asia Health Policy Program*

*Working paper series
on health and demographic change in the Asia-Pacific*

**Has the Use of Physician Gatekeepers Declined among
HMOs? Evidence from the United States**

Hai Fang, University of Miami, US

Hong Liu, Central University of Finance and Economics, PRC

John A. Rizzo, Stony Brook University, US

**Asia Health Policy Program working paper #2
December 2008**

<http://asiahealthpolicy.stanford.edu>

For information, contact: Karen N. Eggleston (翁笙和)

Walter H. Shorenstein Asia-Pacific Research Center
Stanford University
616 Serra St., Encina Hall E311
Stanford, CA 94305-6055
(650) 723-9072; Fax (650) 723-6530
karene@stanford.edu

Has the Use of Physician Gatekeepers Declined among HMOs?

Evidence from the United States

Hai Fang*, PhD MPH

*Research Assistant Professor
Health Economics Research Group
University of Miami
5665 Ponce de Leon Blvd
Flipse Building, Room 120
Coral Gables, FL 33146-0719
USA
Phone: (305)284-5405
Fax: (305)284-5716
E-mail: hfang@miami.edu*

Hong Liu, PhD

*Assistant Professor
China Economics and Management Academy
Central University of Finance and Economics
No. 39 Xueyuan Nan Road
Haidian District, Beijing 100081
China
E-mail: liuhong@cufe.edu.cn*

John A. Rizzo, PhD

*Professor
Department of Economics & Department of Preventive Medicine
Stony Brook University
HSC, Level 3, Room 094
Stony Brook, NY 11794-8036
USA
Phone: (631)444-6593
Fax: (631)444-9744
E-mail: john.rizzo@stonybrook.edu*

December 2008

* The corresponding author.

ABSTRACT

Since the mid-1980s, health maintenance organizations (HMOs) have grown rapidly in the United States. Despite initial successes in constraining health care costs, HMOs have come under increasing criticism due to their restrictive practices. To remain viable, this would seem to suggest that HMOs have to change at least some of these behaviors. However, there is little empirical evidence on how restrictive aspects of HMOs may be changing. The present study investigates one mechanism for constraining costs that is often associated with HMOs – the role of the primary care physician as a gatekeeper (e.g., monitoring patients’ use of specialist physicians). In particular, we estimate the effect of primary care physician involvement with HMOs on the percentage of their patients for whom these physicians serve as gatekeepers. We examine these relationships over two time periods: 2000-2001 and 2004-2005. Because physicians can choose whether and to what extent they will participate in HMOs, we employ instrumental variables (IV) estimation to correct for endogeneity of the HMO measure. Although the single-equation estimates suggest that the role of HMOs in terms of requiring primary care physicians to serve as gatekeepers diminished modestly over time, the endogeneity-corrected estimates show no changes between the two time periods. Thus, one major tool used by HMOs to constrain health care costs – the physician as gatekeeper – has not declined even in the era of managed care backlash.

Keywords: physician gatekeeper; health maintenance organization; physician behavior

JEL Classification Codes: I11; I18

I. INTRODUCTION

Since the mid-1980s, the health insurance system in the United States has been dominated by managed care (Glied 2000). Health maintenance organizations (HMOs) are the most restrictive type among managed care, which covered approximately 50 percent of the U.S. insured population in the 1990s (Cutler and Sheiner 1997). Despite initial successes in constraining health care costs (Goldman 1995; Cutler and Zeckhauser 2000), managed care, particularly HMOs, have come under increasing criticisms due to their restrictive practices (Blendon et al. 1998; Enthoven and Singer 1998; Robinson 2001). Indeed, there is considerable evidence pointing to physician and consumer dissatisfaction with restrictive practices typically associated with HMOs, such as using primary care physicians as gatekeepers, limited provider choice, physician profiling, prior approval and constraints on covered treatments (Miller and Luft 2002).

To remain viable, this would seem to suggest that managed care, especially HMOs, have to change at least some of these behaviors (Robinson 2001; Draper et al. 2002). Fang and Rizzo (2008) find that the effects of HMOs and managed care as a whole on physician financial incentives to limit care declined from 2000 to 2005. Others have noted that managed care plans have relaxed many restrictive practices, such as closed physician networks, prior authorization, and concurrent review controls (Mays et al. 2003; Marquis et al. 2004). However, there is little empirical evidence on how other aspects of HMOs may be changing. The present study investigates one mechanism for constraining costs that is often associated with HMOs – the role of the physician as a gatekeeper (e.g., monitoring patients' use of specialist physicians).

Primary care physicians often serve as gatekeepers due to patients' lack of medical knowledge and/or cost controls required by health care plans. In his role as a gatekeeper, a

physician regulates access to specialists and hospital services. Researchers have argued that primary care physicians should not be restrictive gatekeepers for health care plans, since the rationale for gatekeeping is cost reduction rather than the efficient allocation of resources. Moreover, the physician's role as gatekeeper raises questions about the moral authority of the medical profession (Starfield 1992; Manson 1995).

Patients often desire to be referred to specialists due to the need for reassurance or the belief that primary care physicians lack sufficient expertise (Lin et al. 2000), but primary care physicians frequently fail to explicitly recognize patients' desires for referrals (Albertson et al. 2000). For their part, many primary care physicians are dissatisfied in their role as gatekeepers and believe that gatekeeping hurts the doctor-patient relationship (Grumbach 1999). Although most physicians recognize the positive effects of gatekeepers on cost control, appropriateness of preventive services, and knowledge of a patient's overall care, they are also concerned about the negative effects on the overall quality of care, access to specialists, and freedom in clinical decision making (Halm et al. 1997).

HMOs are more likely to require primary care physicians to serve as gatekeepers for their patients than other health care plans (Feldman et al. 1998). While patients in HMOs value the role of primary care physicians, they want their physicians to be coordinators instead of gatekeepers (Bodenheimer et al. 1999). The role as gatekeeper potentially undermines patients' trust, satisfaction, and confidence in their primary care physicians (Kerr et al. 1999; Grumbach et al. 1999; Haas et al. 2003; Bodenheimer 2006). Some have suggested that, in response to these patient concerns, HMOs have started to limit the roles of physician gatekeepers (Kazel 2003). However, there are no empirical studies that ascertain whether this relationship is changing over time or that directly quantify the changing effects of HMOs on the use of physician gatekeepers.

Using a unique set of data that provides information for a large sample of physicians over time, the present study seeks to bridge these gaps in the literature. In particular, we estimate the effect of physician involvement with HMOs on the percentage of their patients for whom the physicians serve as gatekeepers. We examine these relationships in two time periods: 2000-2001 and 2004-2005. Because physicians can choose whether and to what extent they will participate in HMOs (Cutler and Zeckhauser 2000; Baker and Corts 1996), we employ instrumental variables (IV) estimation to correct for endogeneity of the HMOs measures. Although the single-equation results suggest that the role of HMOs in terms of requiring primary care physicians to serve as gatekeepers diminished modestly over time, the endogeneity-corrected estimates show no changes between 2000-2001 and 2004-2005.

The remainder of this paper is organized as follows. Section II describes data sources and variables. Our empirical estimation approach is discussed in Section III and the results are provided in Section IV. Section V summarizes the results and the policy implications.

II. DATA AND VARIABLES

Data

We use the Community Tracking Study (CTS) physician surveys for 2000-2001 and 2004-2005, maintained at the Center for Studying Health System Change. The CTS physician surveys achieve response rates of about 60 percent and comprise a nationally representative sample of physicians in the United States.¹ The surveys include approximately 12,000

¹ A review of the CTS database concluded that “there was little evidence of a systematic under representation among demographic and practice characteristics available for all physicians from the American Medical Association Masterfile” (Center for Studying Health System Change 2003, pp. C19-C20)

physicians in 2000-2001 and 6,000 physicians in 2004-2005. Physicians in the CTS surveys engaged in direct patient care for at least 20 hours per week in 60 selected communities in the United States. The CTS survey questionnaires include information on HMO revenue, medical care management, and a variety of other physician and practice characteristics.

This study examines the changing effects of HMOs on physicians as gatekeepers from 2000-2001 to 2004-2005. Only physicians in the following three specialties: internal medicine, general/family medicine, and pediatrics were asked to provide responses to the gatekeeping question, as the role of gatekeepers are typically assigned to primary care physicians (Manson 1995). Our study sample thus includes 7,424 primary care physicians in 2000-2001 and 2,786 primary care physicians in 2004-2005.

Variables

Physicians as gatekeepers. To gauge the extent of physicians' involvement as gatekeepers, the CTS survey asked primary care physicians the following question:

Some insurance plans or medical groups require their enrollees to obtain permission from a primary care physician before seeing a specialist. For what percent of your patients do you serve in this role?

Physician responses range from 0 to 100 percent.

Health maintenance organizations. HMOs involvement for physicians is measured as the percentage of their practice revenues from capitated managed care organizations, which are typically HMOs (Robinson and Casalino 1995). More specifically, the CTS survey asks each physician:

Thinking about the patient care revenue from all sources received by the practice in which you work, what percentage is paid on a capitated or other prepaid basis?

This variable measures physicians' involvement in capitated managed care or HMOs, and we term it as HMOs in the present paper.

Other explanatory variables. Our multivariate regression models also control for a variety of physician and practice characteristics that may be correlated with the percentage of patients for whom physicians serve as gatekeepers. These variables include gender, race (white or non-white), the physician's specialty (internal medicine, family/general practice, and pediatrics), board certification status, foreign medical graduate status, years of practice experience, yearly practice income, practice ownership (not an owner, part owner, and full owner), practice type (solo/2 physicians, group with 3 physicians or more, medical school, hospital based, and other practice type), percentages of practice revenues from Medicare and/or Medicaid, and self-reported competitive situation of practice (not competitive, somewhat competitive, and very competitive).

III. METHODS

Single equation model

Because we have two waves of data and seek to examine the changing effects of HMOs on physicians as gatekeepers, we estimate pooled data from 2000-2001 and 2004-2005 including a dummy variable for 2004-2005 and the interaction of this year dummy with the HMO variable.

Our multivariate regression model is thus:

$$(1) \quad Gatekeeper = \theta_0 + \theta_1 HMO + \theta_2 D + \theta_3 HMO * D + \theta_4 X + \varepsilon$$

where

Gatekeeper = percentage of patients for whom physicians serve as gatekeepers;

HMO = percentage of practice revenue from HMOs;

- D = a dummy variable for the year 2004-2005;
- $HMO*D$ = an interaction term between HMO and the year dummy D ;
- X = a vector of other explanatory variables;
- ε = disturbance term; and
- $\theta_0 - \theta_4$ = coefficients to be estimated.

We use ordinary least squares (OLS) regression to estimate equation (1), since the dependent variable is a continuous variable from 0 to 100. In order to obtain the marginal effects of HMOs on the dependent variable, we take the partial derivative of equation (1) with respect to HMO:

$$(2) \quad \partial Gatekeeper / \partial HMO = \theta_1 + \theta_3 D$$

The marginal effect of HMOs on physician gatekeepers is given by the coefficient θ_1 in 2000-2001 and by $\theta_1 + \theta_3$ in 2004-2005. If the interaction term coefficient θ_3 , is significantly different from 0, this would indicate that the marginal effects of HMOs changed over time.

Equation (1), which pools both waves of data and interacts HMOs with the year dummy, has the advantage of providing direct estimates of whether and to what extent the effect of HMOs on gatekeeping activities changed between the two time periods. However, the model is somewhat restrictive in that coefficients of other explanatory variables in equation (1) are constrained to be constant between two waves. To relax these restrictions, we test the robustness of our single equation model (1) by using OLS estimation on the each wave's data separately as follows:

$$(3) \quad Gatekeeper_t = \beta_{t,0} + \beta_{t,1} HMO_t + \beta_{t,2} X_t + \varepsilon_t$$

t = time subscript for 2000-2001 or 2004-2005; and

$\beta_{t,0} - \beta_{t,2}$ = coefficients to be estimated.

Endogeneity

Our measures of HMOs may be endogenous because physicians and patients are not randomly assigned to each other (Cutler and Zeckhauser 2000; Newhouse 1996; Baker and Corts 1996). Physicians who have a preference for HMOs will tend to treat more HMO patients. Such physicians may differ from doctors who are more averse to HMOs and its restrictive practices. For example, physicians who prefer HMOs may be more willing to serve in the role of gatekeepers. This could lead to an upward bias in the estimated relationship between HMO involvement and gatekeeping in the single equation model. On the other hand, measurement error in physician responses to the HMO variable would bias the estimate relationship downward (e.g., toward zero). Failure to control for potential endogeneity could thus lead to biased estimates of the relationship between HMO involvement and gatekeeping activity, although the direction of this bias is uncertain.

To address this issue, we treat HMOs as endogenous and estimate the following equation:

$$(4) \quad HMO_t = \alpha_{t,0} + \alpha_{t,1}Z_t + \alpha_{t,2}X_t + u_t$$

Where

Z = instrumental variable;

u = disturbance; and

$\alpha_{,0} - \alpha_{,2}$ = coefficients to be estimated.

We then estimate equations (3) and (4) using two-stage least squares (2SLS).

Choice of instrumental variable

The instrumental variable used in this paper is the percentage of HMO enrollees among insured persons from the Community Tracking Study (CTS) household survey in 2000-2001 and 2003. Because both CTS physician surveys and CTS household surveys are drawn from the

same 60 communities in the U.S., we are able to merge the two data sets by these 60 CTS survey locations. We use the percentage of HMO enrollees in 2000-2001 in each of these 60 areas to instrument the percentage of HMO revenue for individual physicians in 2000-2001, and use the percentage of HMO enrollees in 2003 to instrument the percentage of HMO revenue for individual physicians in 2004-2005. The share of HMO enrollees in the market and the physician's revenue from HMOs should be strongly positively correlated. In contrast, there is little reason to expect a direct effect of the percentage of HMO enrollees in the market on an individual physician's gatekeeping activity, independent of indirect effects working through the physician's own HMO involvement. Indeed, in the preliminary statistical testing, we find no evidence of such direct effects. In addition, we also implement excluded instrumental variable test, under-identification tests, weak identification tests of our instrument, and tests of endogeneity. These tests, as well as the first stage regression results, provided in Appendix A1, indicate that the percentage of HMO enrollees is a valid instrument.

IV. RESULTS

Descriptive statistics

Table 1 shows descriptive statistics for each wave of the CTS physician survey. From 2000-2001 to 2004-2005, we find that the percentage of patients for whom physicians serve as gatekeepers declined modestly from 45 percent to 40 percent. From 2000-2001 to 2004-2005, the percentage of revenue from HMOs also declined slightly, from 22 to 19 percent. As for our instrumental variable, on average 55 percent of the insured population was covered by HMOs in 2000-2001, and this percentage declined to 51 in 2003. Thus, physician revenues from HMOs as

well as HMO enrollees declined modestly during this time period. Table 1 also shows descriptive statistics for other explanatory variables used in this study.

(Insert Table 1 Here)

Single equation estimates

Table 2 shows the regression results using the pooled data from 2000-2001 and 2004-2005 with an interaction term between the HMO variable and the year dummy for 2004-2005. The coefficient on managed care is 0.38 while that for the interaction term is -0.09. Both estimates are statistically significant at the 1 percent level. According to equation (2), the marginal effect of HMOs on physicians as gatekeepers was 0.38 in 2000-2001 and $0.38 - 0.09 = 0.29$ in 2004-2005. This indicates that physician involvement with HMOs is less strongly associated with gatekeeping behavior in 2004-2005 relative to that in the earlier time period. Because both the dependent variable and HMO variable are measured in percentages, we can interpret the coefficients as elasticities. In other words, a one percent rise in HMO revenue will increase the patients for whom physicians serve as gatekeepers by 0.38 percent in 2000-2001 but by only 0.29 percent in 2004-2005.

The coefficient on the year dummy is -1.99 and is statistically significant at the 1 percent level. This coefficient shows the inter-temporal trend in gatekeeping activities, after adjusting for all the explanatory variables. The coefficient indicates that the percentage of patients for whom physicians serve as gatekeepers declined by 1.99 from 2000-2001 to 2004-2005, which can not be attributed to any of the explanatory variables in the model. Thus, while HMOs

became more weakly associated with gatekeeping activities over time, the overall gatekeeping activities also decreased over time due to some other unknown factors.

(Insert Table 2 Here)

Table 3 provides the results when we estimate 2000-2001 data and 2004-2005 data separately. The coefficients on HMOs are 0.39 in 2000-2001 and 0.28 in 2004-2005, which are very close to the results in Table 2. This robust test supports our hypothesis that the effect of HMOs on the percentage of patients to whom physicians serve as gatekeepers declined modestly over time.

(Insert Table 3 Here)

Endogeneity-corrected estimates

As noted earlier, however, a limitation of the single equation model is that the measure of HMOs may be endogenous. The two-stage least squares results using instrumental variables from the CTS household survey are provided in Table 4. In 2000-2001, after controlling for endogeneity, the coefficient on HMOs in 2000-2001 becomes substantially more positive (0.85) and is significant at the 1 percent level. In 2004-2005, we also find that the coefficient on HMOs increased in magnitude (0.84) and is significant at the 1 percent level. Comparing the endogeneity-corrected estimates of HMOs in each time period, we see that HMOs have a nearly identical effect in terms of requiring physicians to serve as gatekeepers in 2000-2001 and 2004-

2005, in contrast to the results from the single equation estimates. In other words, the results from the single equation estimates suggesting a decline in physician gatekeeping activities among HMOs in fact reflects unobserved heterogeneity, such as physicians sorting into or out of HMOs, or patients switching from HMOs to non-HMO plans. After we adjust for the endogeneity of the HMO measure, the relationship between HMO involvement and use of physician gatekeepers is unchanged over the time period from 2000 to 2005.

(Insert Table 4 Here)

From the multivariate results in Tables 2-4, we also find that physicians with high revenue shares from Medicare are less likely to be involved in gatekeeping activities, while physician revenue share from Medicaid is significantly and positively associated with a gatekeeping role. More experienced physicians, white, and male physicians have lower percentages of patients for whom they serve as gatekeepers.

V. CONCLUSION

The role of physician as gatekeeper has been an important feature of HMOs for many years. While intended as a cost control mechanism, gatekeeping has potentially important implications for the agency relationship between doctors and their patients and ultimately for quality of care. Hence, understanding the extent to which physicians perform as gatekeepers is important from a policy perspective.

The present study provides direct quantitative evidence that greater physician involvement in HMOs leads to more gatekeeping. However, we find that this relationship has

not weakened in recent years, even though managed care, particularly HMOs, have come under increasing criticism over their restrictive practices (Blendon et al. 1998; Robinson 2001).

While research has shown that gatekeeping can achieve cost control (Delnoij et al. 2000) and increase the use of preventive services (Phillips et al. 2004), there remains a dearth of evidence on the effects of gatekeeping on quality of care. Some recent evidence does suggest that use of a physician gatekeeper is associated with poorer health outcomes (Jancin 2006). Given the persistently high usage rate of physician gatekeepers among HMOs, more evidence is needed on the quality implications of this cost control measure. Such evidence would provide insight into whether this practice confers health benefits or costs on patients.

REFERENCES

- Albertson, G.A., Lin, C., Kutner, J., Schilling, L.M., Anderson, S.N., Anderson, R.J. (2000). Recognition of patient referral desires in an academic managed care plan: frequency, determinants, and outcomes. *Journal of General Internal Medicine*, 15(4), 242-247.
- Baker, L.C., Corts, K.S. (1996). HMO penetration and the cost of health care: market discipline or market segmentation? *American Economic Review, Papers and Proceedings*, 86(2), 389-394.
- Blendon, R.J., Brodie, M., Benson, J.M., Altman, D.E., Levitt, L., Hoff, T., Hugick, L. (1998). Understanding the managed care backlash. *Health Affairs*, 17(4), 80-94.
- Bodenheimer, T., Lo, B., Casalino, L. (1999). Primary care physicians should be coordinators, not gatekeepers. *Journal of American Medical Association*, 281(21), 2045-2049.
- Bodenheimer, T. (2006). Primary care – will it survive? *New England Journal of Medicine*, 355(9), 861-864.
- Center for Studying Health System Change. (2003). Community tracking study physician survey 2000-2001 methodology report. Center for Studying Health System Change, Technical Publication No. 38, (2003), <http://www.hschange.org/CONTENT/570/570a.pdf> (Accessed on August 30, 2008).
- Cutler, D.M., Sheiner, L. (1997). Managed care and the growth of medical expenditures. National Bureau of Economic Research (NBER) working paper W6140.
- Cutler, D.M., Zeckhauser, R.J. (2000). The anatomy of health insurance. In Culyer, A.J., Newhouse, J.P. (Eds.), *Handbook of Health Economics*, vol. 1A (pp. 563-643). Amsterdam: North Holland.

- Delnoij, D., Van Merode, G., Paulus, A., Groenewegen, P. (2000). Does general practitioner gatekeeping curb health care expenditure? *Journal of Health Services Research Policy*, 5(1), 22-26.
- Draper, D.A., Hurley, R.E., Lesser, C.S., Strunk, B.C. (2002). The changing face of managed care. *Health Affairs*, 21(1), 11-22.
- Enthoven, A.C., Singer, S.J. (1998). The managed care backlash and the task force in California. *Health Affairs*, 17(4), 95-110.
- Fang, H., Rizzo, J.A. (2008). The changing role of managed care on physician financial incentives. *American Journal of Managed Care*, 14(10), 653-660.
- Feldman, D.S., Novack, D.H., Gracely, E. (1998). Effects of managed care on physician-patient relationships, quality of care, and the ethical practice of medicine. *Archives of Internal Medicine*, 158(15), 1626-1632.
- Glied, S.A. (2000). Managed Care. In Culyer, A.J., Newhouse, J.P. (Eds.), *Handbook of Health Economics*, vol. 1A, (pp. 707-753), Amsterdam: North Holland.
- Goldman, D.P. (1995). Managed care as a public cost-containment mechanism. *Rand Journal of Economics*, 26(2), 277-295.
- Grumbach, K. (1999). Primary care in the United States – the best of times, the worst of times. *New England Journal of Medicine*, 341(26), 2008-2010.
- Grumbach, K., Selby, J.V., Damberg, C., Bindman, A.B., Quesenberry, C., Truman, A., Uratsu, C. (1999). Resolving the gatekeeper conundrum: what patients value in primary care and referrals to specialists. *Journal of American Medical Association*, 282(3), 261-266.

- Haas, J.S., Phillips, K.A., Baker, L.C., Sonneborn, D., McCulloch, C.E. (2003). Is the prevalence of gatekeeping in a community associated with individual trust in medical care? *Medical Care*, 41(5), 660-668.
- Halm, E.A., Causino, N., Blumenthal, D. (1997). Is gatekeeping better than traditional care? A survey of physicians' attitudes. *Journal of American Medical Association*, 278(20), 1677-1681.
- Jancin, B. (2006). Primary care gatekeeper model tied to poor CVD outcomes. *Family Practice News*, 36(8), 8.
- Kazel, R. (2003). Managed care easing gatekeeper hassles. *American Medical News* (published by American Medical Association), January 20, 2003. <http://www.ama-assn.org/amednews/2003/01/20/bil20120.htm> (Accessed on August 30, 2008).
- Kerr, E.A., Hays, R.D., Mitchinson, A., Lee, M., Siu, A.L. (1999). The influence of gatekeeping and utilization review on patient satisfaction. *Journal of General Internal Medicine*, 14(5), 287-296.
- Lin, C., Albertson, G., Price, D., Swaney, R., Anderson, S., Anderson, R.J. (2000). Patient desire and reasons for specialist referral in a gatekeeper-model managed care plan. *American Journal of Managed Care*, 6(6), 667-678.
- Manson, A. (1995). Why primary care physicians should not be restrictive gatekeepers. *Journal of General Internal Medicine*, 10(3), 145-146.
- Marquis, S.M., Rogowski, J.A., Escarce, J.J. (2004). The managed care backlash: did consumers vote with their feet? *Inquiry*. 41(4), 376-390.

- Mays, G.P., Hurley, R.E., Grossman, J.M. (2003). An empty toolbox? Changes in health plans' approaches for managing costs and care. *Health Service Research*, 38(1 pt 2), 375-393.
- Miller, R.H., Luft, H.S. (2002). HMO plan performance update: an analysis of the literature, 1997-2001. *Health Affairs*, 21(4), 63-86.
- Newhouse, J.P. (1996). Reimbursing health plans and health providers: efficiency in production versus selection. *Journal of Economic Literature*, 34(3), 1236-1263.
- Phillips, K.A., Hass, J.S., Liang, S., Baker, L.C., Tye, S., Kerlikowske, K, Sakowski, J., Spetz, J. (2004). Are gatekeeper requirements associated with cancer screening utilization? *Health Services Research*, 39(1), 153-178.
- Robinson, J.C. (2001). The end of managed care. *Journal of the American Medical Association*, 285(20), 2622-2628.
- Robinson, J.C., Casalino, L.P. (1995). The growth of medical groups paid through capitation in California. *New England Journal of Medicine*, 333(25), 1684-1687.
- Starfield, B. (1992). *Primary Care: Concept, Evaluation, and Policy*, USA: Oxford University Press.

Table 1: Names and descriptive statistics of study variables

Variables	2000-2001	2004-2005
	N = 7,424	N = 2,786
Percentage of patients physicians as gate keepers	45.06 (29.81)	40.22 (30.51)
Percentage of revenue from HMOs	21.77 (26.58)	18.60 (25.38)
Instrumental variable		
Percentage of HMO enrollees in the local area ¹	55.36 (10.44)	51.18 (11.90)
Percentage of revenue from Medicare	27.92 (22.84)	28.47 (23.38)
Percentage of revenue from Medicaid	15.79 (18.49)	17.03 (19.78)
Yearly practice income (in \$10,000)	13.29 (6.15)	13.70 (7.11)
Years of practice experience	14.31 (10.69)	15.89 (10.83)
Male	0.69	0.66
White	0.74	0.71
Foreign medical graduate	0.23	0.23
Board certified	0.85	0.88
Practice ownership		
Not a owner	0.51	0.49
Part owner	0.20	0.21
Full owner	0.29	0.30
Practice type		
Sole/2 physicians	0.34	0.37
Group practice with 3 physicians or more	0.28	0.27
Medical school	0.06	0.07
Hospital based	0.15	0.12
Other practice type	0.17	0.17
Specialty		
Internal medicine	0.33	0.33
Family/general practice	0.43	0.43
Pediatrics	0.24	0.24
Market competition status		
Not competitive	0.37	0.40
Somewhat competitive	0.45	0.44
Very competitive	0.18	0.16

Table 2: OLS estimation of physician gatekeeper use: pooled data from 2000-2001 and 2004-2005

Variables	Coefficient
Percentage of revenue from HMOs	0.38 ***
Year dummy of 2004-2005	-1.99 ***
Interaction term of percentage of revenue from HMOs * year dummy of 2004-2005	-0.09 ***
Percentage of revenue from Medicare	-0.08 ***
Percentage of revenue from Medicaid	0.07 ***
Yearly practice income (in \$10,000)	-0.06
Years of practice experience	-0.23 ***
Male	-4.41 ***
White	-2.32 ***
Foreign medical graduate	-0.02
Board certified	1.99 **
Practice ownership	
Not a owner (reference)	-
Part owner	-0.78
Full owner	-1.71 *
Practice type	
Sole/2 physicians (reference)	-
Group practice with 3 physicians or more	1.48 *
Medical school	0.75
Hospital based	-1.94 *
Other practice type	2.66 ***
Specialty	
Internal medicine (reference)	-
Family/general practice	1.48 **
Pediatrics	7.73 ***
Market competition status	
Not competitive (reference)	-
Somewhat competitive	0.26
Very competitive	0.70
Constant	42.49 ***
Adjusted R squared	0.18

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 3: OLS estimation of physician gatekeeper use: separate estimates for 2000-2001 and 2004-2005

Variables	Coefficient	
	2000-2001	2004-2005
Percentage of revenue from HMOs	0.39 ***	0.28 ***
Percentage of revenue from Medicare	-0.09 ***	-0.05 *
Percentage of revenue from Medicaid	0.05 **	0.11 ***
Yearly practice income (in \$10,000)	-0.07	-0.06
Years of practice experience	-0.22 ***	-0.25 ***
Male	-4.13 ***	-5.28 ***
White	-2.01 **	-3.12 **
Foreign medical graduate	-0.28	1.06
Board certified	2.53 ***	0.24
Practice ownership		
Not a owner (reference)	-	-
Part owner	-1.20	0.80
Full owner	-1.30	-2.15
Practice type		
Sole/2 physicians (reference)	-	-
Group practice with 3 physicians or more	2.76 ***	-1.78
Medical school	1.43	-0.33
Hospital based	-0.52	-5.42 **
Other practice type	2.37 **	4.16 **
Specialty		
Internal medicine (reference)	-	-
Family/general practice	1.31 *	1.91
Pediatrics	7.61 ***	8.17 ***
Market competition status		
Not competitive (reference)	-	-
Somewhat competitive	0.07	0.88
Very competitive	0.52	1.30
Constant	41.67 ***	42.15 ***
Adjusted R squared	0.19	0.14

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 4: 2SLS Estimation of physician gatekeeper use correcting for endogeneity of HMO measure

Variables	Coefficient	
	2000-2001	2004-2005
Percentage of revenue from HMOs	0.85 ***	0.84 ***
Percentage of revenue from Medicare	-0.09 ***	-0.06 **
Percentage of revenue from Medicaid	0.06 ***	0.13 ***
Yearly practice income (in \$10,000)	-0.07	-0.02
Years of practice experience	-0.22 ***	-0.27 ***
Male	-2.97 ***	-4.04 ***
White	0.56	-0.89
Foreign medical graduate	-1.06	-0.64
Board certified	1.96 *	-1.56
Practice ownership		
Not a owner (reference)	-	-
Part owner	-1.37	0.93
Full owner	-0.45	-1.20
Practice type		
Sole/2 physicians (reference)	-	-
Group practice with 3 physicians or more	1.02	-3.34 *
Medical school	-1.03	-4.68
Hospital based	-0.92	-6.34 ***
Other practice type	-4.24 ***	-6.04 **
Specialty		
Internal medicine (reference)	-	-
Family/general practice	1.57 *	1.25
Pediatrics	6.64 ***	6.96 ***
Market competition status		
Not competitive (reference)	-	-
Somewhat competitive	0.17	0.08
Very competitive	-1.08	-0.27
Constant	31.42 ***	34.37 ***

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Appendix A1: First stage estimation of 2SLS model and tests of instrumental variable

Variables	Coefficient	
	2000-2001	2004-2005
Instrumental variable		
Percentage of HMOs enrollees in the local area	0.68 ***	0.51 ***
Percentage of revenue from Medicare	0.01	0.03
Percentage of revenue from Medicaid	-0.01	-0.02
Yearly practice income (in \$10,000)	0.06	-0.04
Years of practice experience	-0.02	0.01
Male	-2.15 ***	-2.01 *
White	-5.16 ***	-3.61 ***
Foreign medical graduate	0.92	2.81 **
Board certified	0.75	2.86 **
Practice ownership		
Not a owner (reference)	-	-
Part owner	0.19	0.23
Full owner	-1.96 *	-1.44
Practice type		
Sole/2 physicians (reference)	-	-
Group practice with 3 physicians or more	4.13 ***	3.48 ***
Medical school	5.07 ***	7.93 ***
Hospital based	2.64 **	1.78
Other practice type	13.70 ***	16.79 ***
Specialty		
Internal medicine (reference)	-	-
Family/general practice	0.80	2.43 **
Pediatrics	2.51 ***	2.77 *
Market competition status		
Not competitive (reference)	-	-
Somewhat competitive	0.41	1.90 *
Very competitive	3.39 ***	2.77 **
Constant	-17.25 ***	-13.76 ***
Adjusted R squared	0.13	0.13
Tests of endogeneity: percentage of revenue from HMOs		
Wu-Hausman F test	116.64 ***	41.65 ***
Durbin-Wu-Hausman Chi-square test	115.16 ***	41.34 ***
Tests of instrumental variables		
Test of excluded instrument: F statistic	583.89 ***	174.54 ***

Under-identification test: Anderson canon LM statistic	542.67 ***	165.37 ***
Weak identification test: Cragg-Donald Wald F statistic	583.89 ***	174.54 ***
Weak instrument robust inference: Stock-Wright LM S statistic	316.53 ***	82.94 ***

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.