Is Managed Care Still An Effective Cost Containment Device?*

Yu-Chu Shen and Glenn Melnick

Abstract

In this paper we take a historical perspective to examine the effects of managed care growth and hospital competition on hospital cost and revenue growth during managed care's boom period (1990-1994), its mature period (1994-1998), and its backlash period (1998-2003). We find that while higher managed care presence was indeed effective in slowing down hospital cost and revenue growth during the boom and the mature periods, it lost its cost containment effect during the backlash period. This result persists under different estimation methods designed to reduce biases that might result from omitted variable bias and measurement errors. On the other hand, competition effects appear to persist throughout the three periods. However, such persistent competition effects were initially the result of aggressive selective contracting in the high managed care markets, but were later dominated by the less saturated, but growing, managed care markets that seem to catch up with the more developed markets.

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1. Introduction

The managed care industry enjoyed a period of rapid growth in the early 1990s (Figure 1). The explosion of growth was fueled by concerns of rising health care cost during that period. Managed care plans had traditionally adopted strategies that allowed them to aggressively control health care costs, including the use of primary care gatekeepers, negotiating deep discounts with providers, and restricting access to providers outside of the network (Bamezai et al 1999; Draper et al 2002). However, such aggressive strategies created a deep mistrust in consumers in the later part of the 1990s (Swartz 1999, Robinson 2001). The negative portrayals of managed care plans in the media further created a chasm between managed care and consumers/providers, even when a consumer might not have felt dissatisfied with his or her own health plan (Blendon et al. 1998). Several studies found that managed care plans, in order to retain customers and to mitigate negative media exposure, had relaxed their many once restrictive network requirements and deep discounting (Draper et al 2002; Mays et al 2003, 2004; Marquis et al 2005). At the same time, consolidation had increased the hospital's market power in local provider markets (Cuellar and Gertler 2003, 2005). Such movement in the provider markets may have further eroded managed care's ability to slow down the growth of health care cost.

Since its peak enrollment in 1998, managed care plans (especially health maintenance organizations, HMOs) in the private sector have experienced a steady decline in enrollment.[1] During the same period, the Medicare+Choice program also had trouble retaining customers after enjoying a healthy expansion for most of the 1990's (Gold 2003), although the federal government still looked to managed care as a way to control Medicare costs. Contrary to the

[1] Based on author's tabulation of Interstudy data.

decline in private and Medicare enrollment, state and local governments, in the hopes of easing program costs, increasingly put their Medicaid enrollees into managed care plans. (see, for example, Figure 1 in Marquis et al 2005, for the historical trend in HMO penetration). The continuing trend to less capitation and less restrictive practices by managed care plans, and the strengthening of the hospital's market power have left researchers and policymakers to ponder whether managed care can help achieve cost containment goals after the backlash in late 1990s.

In our paper, we take a historical perspective to examine the effects of managed care growth and competition in the hospital market on hospital financial performance during managed care's boom period (1990-1994), its mature period (1994-1998), and the backlash period (1998-2003). As discussed in more detail below, we extend the previous literature in several ways. First, unlike previous studies that focused on just HMOs, we examine growth in system-wide managed care that includes both HMO and PPO (preferred provider organizations). Second, our panel data allows us to examine the cost containment effect after the start of the backlash. Third, we implement empirical strategies to treat the potential endogeneity problem that might exist between managed care growth and hospital cost and revenue growth. Lastly, we estimate interaction effects between the managed care effect and the competition effect. This approach allows us to identify the potential differential competition effects in areas that experienced different rates of managed care growth.

The rest of the paper proceeds as follows. We discuss the background literature in section 2. We present the methodology and data sources in section 3, including details on how the key variables are constructed and other estimation issues. We present the main results as well as sensitivity analysis in section 4, followed by a discussion in section 5.

2. Background

The rise of the managed care industry has been credited for slowing down the cost escalation in the health care industry at least during the first half of the 1990's (Congressional Budget Office 1995; Miller and Luft 1997; Miller and Luft 2002; Glied 2000). There are generally two types of research examining how managed care shapes the US health care market: one type treats managed care plans as sellers in the insurance market while the other views managed care plans as buyers in the provider market. In the former category, most of the studies focusing on the effect of different managed care plan types on utilization and costs, have found that HMO plans have lower expenditure than FFS plans (Newhouse 1993; Cutler et al. 2000). However, more recent literature indicates that managed care premiums were on the rise after the backlash and economic slowdown in the early 2000s and that health plans were shifting costs to consumers (Gold 2003, Mays et al 2004).

In the second type of study, researchers are concerned with the level of managed care penetration in the provider markets (and how it affects provider prices, revenues, and costs). One way that health plans can lower their operating costs and control premium increases is to stimulate price competition amongst providers in order to negotiate lower prices as part of the selective contracting process. Such a process would result in reduced revenue for hospitals, but at the same time encourage efficiency as hospitals are forced to operate at reduced cost. Our study falls into this category and aims to quantify hospitals' financial performance during different phases of the managed care evolution.

Morrisey (2001) reviewed the empirical literature on the effects of selective contracting and hospital competition on various aspects of hospital performance such as prices, travel distance, services, and quality. In general, previous studies that examined the effect of managed

care growth on hospital cost growth before the backlash have consistently found that HMO growth lowered hospital cost inflation (Gaskin and Hadley 1997; Connor et al 1998; Bamezai et al 1999; Shen and Melnick 2004) and that increased HMO buying power was associated with lower prices of hospital services (Feldman and Wholey 2001). However, there was no empirical evidence indicating whether such cost containment effect had continued after the start of the purported backlash period.

Hospital market power can alleviate the financial pressure exerted by the managed care plans. Previous studies have found that increased hospital market concentration is associated with hospitals charging higher prices (Melnick et al 1992; Zwanziger et al 2000; Morrisey 2001; Town and Vistnes 2001). This market power effect continues in the backlash period in two studies that examined the negotiated prices managed care plans obtained after hospital mergers (Zwanziger and 2005, Capps and Dranove 2004). A few studies explicitly examined the interactive effects between hospital competition and managed care: Connor et al (1998) and Bamezai et al (1999) both found that the ability of managed care plans to contain cost and revenue growth was substantially limited when the hospital market was highly concentrated. Whether the reduced ability to contain cost in the presence of provider market power was exacerbated after the backlash started remains to be tested.

3. Data and Methodology

3.1 Data

Data were drawn from a variety of sources. Hospital data primarily came from Medicare hospital cost reports and the American Hospital Association (AHA) Annual Surveys. Together, they provided detailed information on hospitals' financial performance, inpatient and outpatient

utilization, and other characteristics. Managed care penetration data were obtained primarily from Interstudy.[2] In our main analysis, we used total system-wide managed care penetration rates, which included enrollment in commercial HMOs, Medicaid HMOs, Medicare HMOs, and PPO enrollment. We further supplemented this dataset with the area wage index, the Area Resource File, the County Business Patterns, and the PPS Impact file as well as other MSA characteristics such as per capita income and population size.[3]

3.2 Empirical Methods

We examine changes in costs and revenues at the hospital level among all short-term, general, non-federal hospitals located in MSAs in the United States between 1990 and 2003. We focus on growth in three periods: the boom period (1990-1994), the mature period (1994-1998), and the backlash period (1998-2003). The unit of observation is the hospital, and we use a hospital fixed-effects model to remove bias that might result from time-invariant unobserved heterogeneity across hospital markets.

The dependent variable is the logarithm of total operating cost for the cost regression and the logarithm of net patient revenue for the revenue regression. We use the standard translog function to account for the highly skewed distributions of cost and revenue. In our main analysis, we implement three estimation models, each varies by the managed care measures. The general equation for all three models is as follows:

$$LnE_{it} = \alpha_i + \gamma_t + \beta(\ln(O_{it}, P_{it}, I_{it})) + \beta(X_{it}, H * \gamma_t, C_{it} * \gamma_t) + \varepsilon_{it} \qquad (1)$$

[2] All 4 years of HMO data were collected by Interstudy. We thank Dr. Doug Wholey for providing the pro-rating HMO enrollment at the county level for 1990 and 1994 (Wholey et al 1997). We aggregate the county-level enrollment to MSA level. The 1990 and 1994 PPO data were collected by SMG Marketing, Inc. We thank Dr. Jack Zwanziger for providing these data at the MSA level. PPO data were not available for 1998 but were available for 2000, therefore we interpolate the 1998 PPO enrollment using 1994 and 2000 numbers.

[3] Information from Area Resource File (population size and per capita income) were at the county levels. We aggregate these to MSA levels.

Where

E=annual operating costs or net patient revenue

α_i =hospital fixed-effects for each hospital *i*

γ_t =year dummies for each of 4 years, *t*, between and including 1990-2003

O=hospital output (total inpatient discharges, casemix, total outpatient visits; all log transformed)

P=input prices (proxy by relative wage index, log transformed)

I=demand for hospital care (proxy by log per capita income)

X=hospital and market characteristics[4] (hospital ownership, hospital system membership, financial pressure index from Medicaid and Medicare as defined below, percent for-profit and government hospitals in a market).

C=Herfindahl index of the hospital market based on patient flow, log transformed (more in the next section).

H=managed care penetration. In Model 1, this is the actual managed care penetration rate in each year, log transformed. In Model 2, this represents the instrumented managed care penetration rate (log transformed), where historical managed care penetration rates were used to instrument for changes in managed care penetration rates over this period. In Model 3, this set represents indicators for hospitals in low, medium, and high levels of managed care penetration rates (low rate is the omitted group). More details on these managed care measures below.

We also include quadratics of hospital input prices and output in our model to capture possible

[4] Market is defined as an area within a 15-mile radius from the given hospital's zip code location (Luft and Maerki 1984; Phibbs and Robinson 1993).

nonlinear relationships between these variables and costs and revenues. The year dummies effectively capture the average growth rates for hospitals over this period in Models 1 and 2, and the annual growth rates for hospitals in MSAs with low managed care penetration level in Model 3.

The key variables of interest are the interaction terms between year dummies and the managed care measures, and between year dummies and the competition measures. The first set of interaction terms captures whether hospitals in markets with higher managed care penetration experienced differential growth rates in cost and revenue than those in markets with low managed care penetration across 1990, 1994, 1998, and 2003. The second set of interaction terms captures whether hospitals in more competitive markets experienced differential growth rates in cost and revenue than those in less competitive markets over those years. In addition, in Model 3 we include the three-way interactions between year dummies, managed care measures, and competition measures to capture possible differential competition effects across different levels of managed care markets.

3.3 Measures of Managed Care Penetration and Growth

Our managed care measurement captures system-wide managed care penetration that includes commercial HMO, Medicaid and Medicare HMO, and PPO. We believe the system-wide measurement better captures the bargaining power health plans might have with the providers, as many insurers offer both HMO and PPO products in the same market (AMA 2004), and many HMOs couple their products with PPO network. Furthermore, the distinction between HMOs and PPOs is also getting blurred as many HMOs have eliminated physician gatekeepers and have offered broader networks (Draper et al 2002). One problem with using the system-

wide managed care penetration is that PPO covered lives is measured with substantial error.[5] We partially offset this problem in Model 3 using categorical variables. In addition, in our sensitivity analysis, we estimate our model using only the HMO measures.

Ideally, when we want to investigate the relationship between changes in managed care penetration and changes in hospitals' cost and revenue growth, we would regress changes in hospital cost on the change in managed care penetration. However, there might be unobserved market factors that simultaneously influence the managed care penetration rate and hospital cost and revenue across the markets. We address this problem by using a hospital fixed-effects model. This fixed-effects translog model has been used extensively in previous studies (Granneman et al. 1986; Bamezai, et al. 1999; Zwanziger, et al. 2000). To the extent that the unobserved characteristics in the provider market remain stable over time, the hospital fixed-effects model would eliminate this potential selection bias. We present results from this specification in Model 1.

There is a concern that managed care plans selectively enter markets where they think they will have the greatest effect, and as such, growth in managed care and changes in hospital costs and revenues are endogenously related. To the extent that the endogenous relationship across markets is stable over time, the fixed-effects model would be sufficient. While there is a consensus that cross-market variations between the managed care penetration level and the hospital cost level are endogenously related, it is not clear whether the growth variation between the two measures suffers the same estimation problem. To investigate whether our results are sensitive to this assumption, we estimate Model 2 by instrumenting for managed care growth. It should be noted that while several labor market characteristics have been used in the literature as instruments for managed care penetration (Baker 1997, Dranove et al 2002), those instruments

[5] Based on personal communication with Interstudy representative.

were aimed to capture *cross-sectional* variation in managed care and not *growth* variation. In our model, we select historical HMO penetration rates as the instruments for current period growth.[6] The idea is that historical penetration rates are good predictors of current growth rates (if an area already has high managed care enrollment, it is less likely to grow as fast as an area with low managed care enrollment). But the historical penetration rate is unlikely to influence hospital cost growth during the current period. In an alternative specification, we use historical growth rate (HMO penetration growth between 1987 and 1989) to instrument for the growth rate in the current period. We obtain very similar results.

The instrumented managed care measure is constructed using the following steps. In Step 1, we estimate the base-year (1990) penetration level using historical HMO penetration rates (1987) and several labor market characteristics in the base year to capture demand for health plans, such as the unemployment rate, the percent of white collar workers, the percent of workers in manufacturing, the percent of workers in construction, the percent of self-employed workers, and physicians per capita. The predicted value from this regression forms the base of our instrumented managed care measure. In Step 2, we predict the growth rate between 1990 and 1994 using the historical HMO penetration rates and all the other exogenous variables in our model; we do the same for 1990-1998 and 1990-2003 growth rates. In Step 3, we add the predicted growth rate from Step 2 to the predicted base-year penetration rate from Step 1 to generate the penetration rate for the other 3 years. This "hypothetical" managed care measure then becomes the instrument for the actual managed care penetration in the second stage.

One estimation problem with using self-reported managed care measures is that it is measured with substantial error. This is particularly problematic to estimation precision when

[6] We used 1987 HMO penetration rates as the instrument for growth. Historical PPO penetration is not available to us.

we add additional 3-way interaction terms between managed care, competition, and year dummies. In Model 3, instead of using the actual penetration rate in the model, we group hospitals into MSAs with low, medium, and high managed care penetration levels. We do the same with respect to competition measures. We then interact these two sets of categorical measures with year dummies to capture potential differential effects of competition across markets with different levels of managed care growth. This approach can reduce bias that might result from measurement errors (Greene 1997) and increase precision of our estimates. Another benefit of using the categorical variable is that we can interpret the results easily.

3.4 Other Variable Construction

Dependent Variables: Hospital Cost and Revenue

In our analysis we focus on annual total operating costs and net patient revenue[7], because health plans will have a more direct effect on operations than on non-operating activities such as income from investments.[8]

Measure of Hospital Competition

We construct a hospital-level Herfindahl-Hirschman index (HHI) for each year using the 1990-2002 Medicare discharge data extracted from the MEDPAR file. We define hospital markets using actual zip code level patient flow data. The method is described in more detail in Bamezai et al. (1999). We broadly outline the five-step approach here. First, all DRGs are categorized into 48 separate service categories based on the type of physician that typically treats

[7] Net patient revenue is total patient revenue minus contractual allowances and discounts on patients' accounts. Both net and total patient revenues are reported in the Medicare hospital cost reports.
[8] Using total cost and total revenue yield very similar results, since operating cost and patient revenue are the major components of total cost and revenue.

a patient in a given DRG. Second, the hospital's market area for each service is defined using patient origin data. Third, competing hospitals are identified on a zip code level as those facilities that draw at least 3 percent of a zip code area's total discharges for a given service. Fourth, an HHI is calculated for each zip code area's service combination. Finally, the degree of competition facing each hospital is captured by estimating a weighted average of the zip code area's service HHIs in its market, with the proportion of patients it draws from each zip code area service combination serving as the weight. Though this measure is based on Medicare patients only, previously, a comparative correlation analysis was done using data from several states with all payor data, and the two HHI measures were highly correlated (Bamezai et al 1999).

Medicaid and Medicare Financial Pressure

The study covers periods in which Medicare underwent several major transitions in the payments for general acute hospitals. Most hospitals transitioned from a cost-based system to a prospective payment system by 1990. The early 1990s saw several changes in the blends for teaching and disproportionate share payments. In 1998, the Balanced Budget Act (BBA) implemented uniform rate cuts across all general acute hospitals. To capture the effect of the financial pressure from Medicare, we construct a Medicare fiscal pressure index. The Medicare fiscal pressure is the ratio between the PPS payment a hospital receives for a Medicare discharge (weighted by a hospital's Medicare share of patients), relative to the national median PPS payment. If a hospital has an index above 1, it receives a more generous payment compared to the median hospital in the sample. If a hospital's Medicare financial pressure index is below 1, then it receives a more stringent payment than the median hospital in the sample. It should be noted that the Medicare financial pressure measure captures only changes in average payment

due to *exogenous* change in the reimbursement formula. In other words, the index is based not on what the hospitals actually receive but rather what the hospitals would have received if they did not change behaviors at all in response to the changing reimbursement policies from Medicare (Shen 2003, Wu 2005).[9]

The Medicaid financial pressure index was constructed to measure the degree to which the change in Medicaid policies across states and over time had affected hospital's financial operation. We use the state-level Medicaid physician fee index from Norton and Zuckerman (2000) and the follow-up study by Lewin Group (2003) as the Medicaid financial pressure index. The index is the ratio between each state's physician fee schedule for primary care to the median physician fee of the nation. If a state has an index above 1, it is a more generous state compare to the rest of the nation. If a state's Medicaid financial pressure index is below 1, then it pays its physicians less than the median state.

4. Results

We start by looking at the trend in managed care penetration and hospital cost/revenue over the study period. Figure 1 shows the managed care penetration in the four years: 1990, 1994, 1998, and 2003. HMOs grew from 10 percent penetration in 1990 to 24 percent in 1998. The enrollment dropped to 18 percent in 2003. PPOs grew from 23 percent in 1990 to 34 percent of the MSA population in 2003. Overall, managed care penetration (as defined by HMO + PPO) grew from 33 percent of the MSA population in 1990 to 58 percent of the MSA population when it reached the peak in 1998, and the growing trend stopped after 1998.

[9] We would like to thank Vivian Wu for providing the financial pressure measure for payment changes due to BBA 1997. The financial pressure measures for 1990-1994 were obtained from Shen (2003). The payment change between 1994 and 1998 was approximated by the growth rate in updating factor obtained from March 2003 MedPac Report.

Figures 2A and 2B shows the unadjusted trend operating cost and patient revenue (in log transformation), respectively, for 4 groups of hospitals: hospitals in low managed care/low HHI (i.e., highly competitive) markets; hospitals in low managed care/high HHI markets; hospitals in high managed care/low HHI markets; and hospitals in high managed care/high HHI markets. Hospitals are classified as being in high managed care MSAs if the managed care penetration in that MSA belongs to the top 2 quintiles of the managed care penetration distribution in that year, likewise for hospitals that are classified in high HHI markets. Both figures show similar patterns. Take Figure 2A for example, although hospitals in low HHI (more competitive) markets started out having higher operating cost than those in high HHI (less competitive) markets in 1990, they clearly had slower cost growth in subsequent years, regardless of whether they are in low or high managed care markets. By the end of the study period, those hospitals in more competitive markets had lower cost than those in less competitive markets. Among hospitals in low HHI markets (the long dashed and short dashed lines), the effect of managed care appears to be most pronounced during the 1990-1994 period where the hospitals in high managed care areas had much slower growth rates than those in low managed care areas. The cost trends appear to be similar between the two categories after 1994. The pattern is different among hospitals in high HHI markets (comparing the solid and dotted lines), where hospitals in high managed care areas appear to have faster growth rate than those in low managed care areas between 1990 and 1998. But after 1998, the growth rate is slower in high managed care areas.

Table 1 provides descriptive statistics of the explanatory variables in our regression model by years. The top panel provides information on hospitals in high managed care areas and the bottom panel on hospitals in low managed care areas. In general, hospitals in high managed care areas are more competitive (HHI ranges from 0.26 to 0.29) than those in low managed care

areas (HHI ranges from 0.33 to 0.40). They are also more likely to locate in markets with higher labor cost and higher income—their wage indexes and per capita income are all higher than those hospitals in low managed care areas across the 4 years. Hospitals in high managed care areas on average receive higher Medicare payments, but tend to be in states with more stringent Medicaid payment policies. System membership increases substantially over this period such that by 2003, 80 percent of all hospitals belong to a system regardless of the managed care levels.

Cost Regression Results. Table 2 reports the fixed-effects regression results on operating cost. We present the full regression results in Table 2, but focus our discussion on the key variables in the text. As discussed in the method section, the managed care effects in Model 1 are estimated using the actual managed care penetration rate in each year. The main effect of managed care captures any cost differences due to managed care penetration in the base year. The coefficient indicates that there is no difference in 1990. The interaction terms between managed care measure and year dummies indicate that by 1994, a 1 percent increase in managed care penetration is associated with slower cost growth by 0.27 of one percentage point. The gap widens further in 1998, where a 1 percent increase in managed care is associated with almost 1 percentage point reduction in cost growth. However, by 2003, the cost growth differences disappear, indicating that managed care no longer slows down cost growth as in the previous periods. The competition effects are much stronger than the managed care effects, and follow a different pattern over the years. In 1990, hospitals in less competitive markets (higher HHI) tended to have lower cost (0.65 percent). However, by 1994 a 1 percent increase in HHI is associated with almost 1 percentage point growth in cost. The faster growth among hospitals with more market power continues throughout the study period—the cost growth difference is 1.7 and 2.4 percentage points for 1 additional percent of HHI in 1998 and 2004 relative to the

base year, respectively. We do not present the 3-way interaction results for Model 1 because the standard errors become quite large for all variables due to multiple sets of interactions. We will discuss the interaction results when we use categorical variables in Model 3.

Model 2 replaces the actual managed care penetration with the instrumented managed care penetration as discussed in the methods section. The instrumented penetration rate is a strong predictor of the actual penetration rate: the F-statistic from the first stage is 16. The cost growth pattern is similar between Models 1 and 2, but the magnitude of the managed care effect is much stronger in Model 2. This model suggests that the cost growth difference in 1998 is 2.28 percentage point for each additional percent of managed care penetration. But both models support the backlash story: by 2003, the cost containment effect of managed care disappears. The coefficients on the competition measures remain stable and both models indicate that competition effects persist even by 2003.

Model 3 uses categorical variables to capture low, medium, and high managed care markets. We also replace the HHI measure with an indicator of high HHI markets (the indicator is 1 if hospitals belong to the top 2 quintiles of the HHI distribution). We use this approach to reduce measurement errors. The interpretation of the managed care and competition coefficients are different from Models 1 and 2, but all three models consistently support the backlash story. Because of the three-way interaction among managed care, HHI, and year indicators, the main effect of the high managed care indicator effectively captures the cost difference in 1990 between hospitals in low and high managed care areas where hospital markets are competitive. The main effect of the high managed care indicator shows that hospitals in high managed care and low HHI markets started out, on average, 6 percent higher in cost than those in low managed care and low HHI markets. However, the cost growth is kept at a much slower rate—by 1998,

hospital cost in high managed care areas increased by 11 percentage points less than hospital cost in low managed care areas. After the backlash and by 2003, however, there is no longer a cost growth gap between high and low managed care markets. Hospitals in medium managed care markets follow a similar pattern as those in high managed care areas, but the magnitude of the managed care effect is smaller. The competition and time dummy interactions effectively capture the growth rate in low managed care markets. Without a high presence of managed care, the competition effects did not materialize until the last year, where hospitals with stronger market power experience a cost growth rate that is 15 percentage point higher than those in more competitive markets. The three-way interaction terms show competition effects appear to differ between high and low managed care markets only during the initial period between 1990 and 1994. Conditional on being in high HHI markets, hospital cost in high managed care markets is 7.4 percent below those in low managed care markets. But these hospitals experienced a substantial growth between 1990 and 1994 such that their cost growth rate between 1990 and 1994 is 7.5 percent higher than those hospitals in low managed care markets. Such differential effects gradually disappear after the boom period.

To visualize the managed care effects more easily, we show the regression adjusted operating cost in Figure 3A using Model 3 results. The adjusted cost trend for high managed care markets is generated by assuming that all hospitals in the sample are located in high managed care markets. We use the same method to generate cost trend for low managed care markets. The graph shows that although high managed care areas are associated with higher cost level in the beginning of 1990, managed care was effective in keeping the growth rate low up until 1998 and hospital cost levels in high managed care markets were actually below those in low managed care markets in 1998. But the growth rate picked up again after 1998.

Figure 4A shows the trend of competition effects separately for high and low managed care markets using Model 3 results. In both low and high managed care markets, hospitals with more market power start out at a lower cost level than those in more competitive markets, but grow faster over the period such that they end up at a higher cost level by 2003. For hospitals in high managed care markets, the growth gap is most pronounced during 1990-1994, while for hospitals in low managed car markets, the growth gap did not materialize until the 1998-2003 period.

Revenue Regression Results. We also examine the revenue growth during the same period. Full regression results for patient revenue are presented in Table 3, and the regression adjusted growth trend which captures the effect of managed care and competition are also presented in Figures 3B and 4B. The revenue trends follow the same pattern as the cost trends and the managed care and competition coefficients are very similar between Tables 2 and 3.[10] While managed care and competition affects hospitals' patient revenue streams, hospitals appear to be able to adjust their expenditure pattern in response to changes in those two market factors as well.

Sensitivity Analysis. The three models presented above paint a consistent story of managed care losing its cost containment effect during the backlash period (1998-2003). We perform several sensitivity analyses to confirm this finding. First, we experiment with several possible instruments, such as using the historical growth rate instead of the historical penetration levels and using historical penetration levels from different years. These produced very similar results. One concern with our managed care measure is that PPO enrollment, in particular, is measured with much more noise than HMO enrollment. In one specification, we separate out

[10] One noticeable difference between the cost and revenue regression is that the coefficients on Medicare pressure index were not significant in the cost regression, but were much larger and statistically significant at the 0.05 level across all 3 models in the revenue regression.

HMO and PPO penetration. We obtain similar coefficients (magnitude and sign) on the HMO measure but we get larger standard errors. The F-test of linear combination did not find the HMO and PPO coefficients to be statistically significantly different. Third, our imbalanced panel could be due to hospitals entering and exiting the markets or failure to report data throughout the period. In one specification, we limit the samples to hospitals that have all 4 years of data available to us. Although this step reduces sample size substantially, we find even stronger results on our key variables.

5. Discussion

The health care market has experienced several significant changes over the past 15 years. Providers have come under various pressures from the payer side, either through payment policy changes or the growing presence of the managed care industry. Previous literature found that managed care plans (in particular HMOs) were effective in slowing down cost growth in the hospital sector. However, in recent years, the managed care industry reversed their once restrictive management tools to mitigate a backlash related to negative media coverage and employers responding to employee dissatisfaction with restrictive forms of managed care. In our study, we aimed to identify the effects of managed care and hospital competition during three distinctive periods (the boom years, the mature years, and the backlash years), taking into account changes in other aspects of the health care payment and delivery system.

We find that while higher managed care presence was indeed effective in slowing down the hospital cost and revenue growth during the boom and the mature periods, it appears that managed care lost its power to restrain cost growth during the backlash period. In fact, the rate of growth in costs among hospitals in higher managed care markets actually picked up at a faster

pace between 1998 and 2003. This result persists under different estimation methods designed to reduce biases that might result from both unobserved factors that changed over time in the health care market and measurement errors. On the other hand, the cost constraining effects of local market competition appear to persist throughout the three periods: on average hospitals with more market power (higher HHIs) grew at a faster rate than those in more competitive markets.

Our findings on the interactive effect between hospital competition and managed care penetration during the boom period (1990-1994) are consistent with previous findings in Bamezai et al (1999): both studies find that in the boom period greater hospital competition is associated with greater cost containment effects in areas with high levels of managed care penetration and vice versa. Although hospitals in more competitive markets continued to have lower cost growth than those with market power in the later period, the growth gap disappeared by 2003. This result suggests that the selective contracting effect of managed care may be diminishing in saturated managed care areas during the backlash period.

On the other hand, there appears to be little competition effect during the initial boom period for hospitals in the low managed care markets. The small presence of managed care during the initial years (18 percent in 1990) is unlikely to exert much downward pressure even in competitive markets. But the growth gap becomes more pronounced during the mature and backlash periods, when managed care penetration grew to an average of 42 percent in those low managed care markets. It would appear that the persistent competition effect was initially the result of aggressive selective contracting in the high managed care market, but was later present in the less saturated but growing managed care markets that seem to catch up with the more highly penetrated and experienced markets.

Besides the issues raised in the sensitivity analysis, there are two additional limitations to

our findings. First, we cannot identify the sources of the apparent weakening of managed care in 2003. The backlash effect may include relaxation of utilization review, less aggressive selective contracting (possibly associated with broadening of provider networks), and/or a shift in enrollment away from HMOs, with greater cost control features, to PPOs. We have some indirect evidence that the selective contract effect might dominate the utilization effect. Model 3 with interaction effects indicates that competition no longer matters in highly saturated managed care markets during the backlash period. Since managed care plans have been shown to leverage competition among hospitals to negotiate contracts, the diminishing competition effect in these markets suggests a weakening of selective contracting. Second, while our models takes into account hospital competition and local mergers and acquisitions, they do not fully capture the potential effects of multi-hospital systems formation among hospitals both within local markets and from different geographic regions. Hence the competition measure is likely an underestimate of the true level of concentration in the current hospital market. Further research should include a Herfindahl index that takes into account the non-local system membership as well as other measures to capture true system membership effects.

Given our findings, the current trends of rising health care costs and expenditures are potentially troubling in the long run. Our findings suggest that managed care, which had helped control rising health expenditures in the U.S. during much of the 1990's, may have run its course in terms of its effectiveness in controlling health cost inflation. If the observed weakening of managed care is due primarily to a pull back of selective contracting, utilization review, and HMO enrollment, it may be possible to reverse these policies if consumers are willing to accept these restrictions in return for slower rates of growth in health care inflation. Alternatively, if it is due to other more structural factors, such as the formation of multi-hospital systems, then a

return to the boom period where managed care was more effective may not be possible.

In the short run, current policies designed to move more Medicaid and Medicare populations into managed care plans would not have the desired cost saving effect. However, it might have desirable effects on other aspects of care delivery. Even though managed care plans may have cutback on their practices of utilization review and selective contracting, they are reportedly expanding on their disease management and preventive care services (Draper et al 2002; Mays et al 2003). A complete evaluation of the backlash effects necessarily involves an examination of many other aspects of the health care system, such as whether access to care and quality of care improved as hospitals are under less restrictive contracts with the health plans.

Reference

American Medical Association. 2004. *Competition in Health Insuran*ce. Chicago, IL: AMA.

Blendon, RJ, M Brodie, J M Benson, D E Altman, L Levitt, T Hoff, and L Hugick. 1998. Understanding the managed care backlash. *Health Affairs*, July/August 1998; 17(4): 80-94.

Bamezai A, Zwanziger J, Melnick GA, and Mann JM. 1999. Price competition and hospital cost growth in the United States (1989-1994). *Health Economics*, 8(3): 233-43.

Congressional Budget Office (CBO). 1995. The Effects of Managed Care And Managed Competition. *CBO Memorandum.* Washington, DC: U.S. Government Printing Office.

Connor, RA., RD Feldman, and BE Dowd. 1998. The effects of market concentration and horizontal mergers on hospital costs and prices. *International Journal of the Economics of Business* 5(2): 159.80.

Cuellar, AE and PJ Gertler. 2003. Trends in hospital consolidation: the formation of local systems. *Health Affairs*. 22(6): 77-87.

Cuellar, AE and PJ Gertler. 2005. How the expansion of hospital systems has affected consumers. *Health Affairs*. 24(1): 213-219.

Cutler, D.M., M. McClellan, and J.P. Newhouse. 2000. How Does Managed Care Do It? *Rand Journal of Economics,* 31(3): 526-48.

Draper, DA. RE Hurley, CS Lesser, and BC Strunk. 2002. The changing face of managed care. *Health Affairs*, January/February 2002; 21(1): 11-23.

Capps C and Dranove D. 2004. Hospital consolidation and negotiated PPO prices. *Health Affairs*, Mar-Apr;23(2):175-81.

Gold, M. 2003. Can managed care and competition control Medicare costs? *Health Affairs*. 2003 April; Web Exclusive: 176-188.

Marquis, M.S., Rogowski, J.A. and J.J. Escarce. 2004. The managed care backlash: did consumers vote with their feet? *Inquiry*, 41 (winter 2004/2005): 376-390.

Mays GP, Hurley RE, Grossman JM. 2003. An empty toolbox? Changes in health plans' approaches for managing costs and care. *Health Serv Res.* 2003 Feb;38(1 Pt 2):375-93.

Mays GP, Claxton G, White J. 2004. Managed care rebound? Recent changes in health plans' cost containment strategies. *Health Affairs*, 2004 Jul-Dec;Suppl Web Exclusives:W4-427-36.

Melnick, G.A., J. Zwanziger, A. Bamezai, and R. Pattison. 1992. The effects of market structure and bargaining position on hospital prices. *Journal of Health Economics* 11(2): 217-33.

Miller, R.H. and Luft, H.S. 1997. Does managed care lead to better or worse quality of care? *Health Affairs,* 16(1): 1-23

Miller, R.H. and Luft, H.S. 2002. HMO plan performance update: an analysis of the literature, 1997-2001. *Health Affairs,* 21(1): 63-86

Morrisey, MA. 2001. Competition in hospital and health insurance markets: a review and research agenda. *Health Services Research* 36(1, Part II): 191-221.

Newhouse, J.P. 1993. *Free for All?: Lessons From the Rand Health Insurance Experiment.* Cambridge: Harvard University Press.

Norton, S., Zuckerman, S. 2000. Trends in Medicaid physician fees, 1993-1998. *Health Affairs,* Vol. 19 (4): 222-232

Robinson, JC. 2001. The end of managed care. *JAMA.* 2001 May 23-30;285(20):2622-8.

Shen, Y. 2003. The effect of financial pressure on the quality of care in hospitals. *The Journal of Health Economics* 22 (2): 243-269.

Shen, Y. and Melnick, G.A. 2004. The effects of HMO ownership on hospital costs and revenues: Is there a difference between for-profit and not-for-profit plan? *Inquiry* 41(3): 255-267.

Swartz, K. 1999. The death of managed care as we know it. *J Health Polit Policy Law.* 1999 Oct;24(5):1201-5.

Town, R. and Vistnes, G. 2001. Hospital competition in HMO networks. *Journal of Health Economics*. 20 (2001): 733-753.

Wholey, DR., JB. Christianson, J Engberg, and C Bryce. 1997. HMO Market Structure and Performance, 1985 to 1995. *Health Affairs,* 16(6, November/December 1997): 75-84.

Wu, V. 2005. Managed Care's Price Bargaining with Hospitals. Cambridge, MA. *Manuscript.*

Zwanziger, J., G.A. Melnick, and A. Bamezai. 2000. The effect of selective contracting on hospital costs and revenues. *Health Services Research* 35(4): 849-867

Zwanziger J, Mooney C. 2005. Has competition lowered hospital prices? *Inquiry.* Spring;42(1):73-85.

Table 1. Descriptive Statistics of Explanatory Variables

	1990		1994		1998		2003	
Hospitals in high managed care penetration areas	Mean	SD	Mean	SD	Mean	SD	Mean	SD
System-wide managed care penetration	0.50	(0.12)	0.64	(0.12)	0.70	(0.09)	0.64	(0.04)
Herfindahl index	0.29	(0.12)	0.26	(0.09)	0.27	(0.09)	0.29	(0.09)
Medicare casemix index	1.31	(0.18)	1.35	(0.22)	1.40	(0.24)	1.38	(0.24)
Total discharges	8781	(6763)	8447	(7173)	9252	(7937)	11320	(8593)
Total outpatient visits	76155	(75877)	98045	(99949)	131798	(138167)	170546	(160221)
Wage index	1.23	(0.15)	1.03	(0.14)	1.06	(0.14)	1.04	(0.13)
Medicaid pressure index	0.75	(0.15)	0.63	(0.19)	0.60	(0.16)	0.69	(0.14)
Medicare pressure index	1.02	(0.18)	1.01	(0.20)	1.04	(0.21)	1.01	(0.20)
FP ownership	0.19	(0.39)	0.17	(0.38)	0.16	(0.37)	0.18	(0.38)
GOV ownership	0.14	(0.34)	0.13	(0.34)	0.13	(0.34)	0.10	(0.30)
Belong to a system	0.50	(0.50)	0.57	(0.46)	0.70	(0.40)	0.80	(0.39)
County per capital income	19484	(3456)	22425	(4171)	28905	(6368)	33796	(7781)
% FP hospitals	0.17	(0.21)	0.13	(0.17)	0.13	(0.17)	0.13	(0.19)
% GOV hospitals	0.09	(0.12)	0.07	(0.12)	0.08	(0.12)	0.06	(0.11)
Number of hospitals		1129		1524		1305		930
Hospitals in low managed care penetration areas								
System-wide managed care penetration	0.18	(0.05)	0.26	(0.06)	0.40	(0.07)	0.42	(0.08)
Herfindahl index	0.40	(0.10)	0.35	(0.08)	0.35	(0.09)	0.33	(0.11)
Medicare casemix index	1.28	(0.19)	1.31	(0.21)	1.39	(0.24)	1.39	(0.24)
Total discharges	8407	(6607)	7900	(6393)	8485	(7099)	10295	(8257)
Total outpatient visits	69090	(55482)	94866	(100760)	129391	(131670)	174627	(203710)
Wage index	1.09	(0.12)	0.88	(0.09)	0.90	(0.09)	0.97	(0.19)
Medicaid pressure index	0.80	(0.18)	0.72	(0.23)	0.73	(0.23)	0.72	(0.17)
Medicare pressure index	0.92	(0.11)	0.88	(0.12)	0.90	(0.12)	0.95	(0.22)
FP ownership	0.14	(0.35)	0.18	(0.38)	0.22	(0.41)	0.19	(0.39)
GOV ownership	0.15	(0.36)	0.18	(0.38)	0.18	(0.39)	0.19	(0.39)
Belong to a system	0.40	(0.49)	0.47	(0.48)	0.66	(0.44)	0.79	(0.39)
County per capital income	16353	(2860)	18955	(3511)	23529	(4077)	28996	(13004)
% FP hospitals	0.12	(0.19)	0.10	(0.18)	0.12	(0.20)	0.11	(0.19)
% GOV hospitals	0.09	(0.16)	0.08	(0.15)	0.08	(0.15)	0.10	(0.16)
Number of hospitals		384		479		458		423

Note: Hospitals in medium managed care areas are omitted from this table.

Table 2. Regression Results on Log of Operating Cost

	Model 1		Model 2		Model 3	
Independent variables	**Beta**	**SE**	**Beta**	**SE**	**Beta**	**SE**
Time dummies						
year 1994	0.452 **	0.060	0.612 **	0.154	0.274 **	0.035
year 1998	0.906 **	0.095	1.448 **	0.392	0.372 **	0.051
year 2003	0.918 **	0.121	1.259 **	0.395	0.560 **	0.057
Managed care effects						
log of MC penetration (MC)	0.003	0.018	-0.028	0.064		
MCX1994	-0.027 *	0.016	-0.075 *	0.040		
MCX1998	-0.090 **	0.023	-0.228 **	0.094		
MCX2003	-0.005	0.030	-0.090	0.097		
high MC					0.060 **	0.029
high MCX1994					-0.073 **	0.029
high MCX1998					-0.108 **	0.033
high MCX2003					-0.019	0.041
med MC					0.033	0.036
med MCX1994					-0.054	0.040
med MCX1998					-0.087 **	0.042
med MCX2003					-0.003	0.049
Competition effects						
log(HHI)	-0.065 **	0.031	-0.089 **	0.031		
log(HHI)X1994	0.091 **	0.023	0.066 **	0.019		
log(HHI)X1998	0.170 **	0.030	0.134 **	0.029		
log(HHI)X2003	0.240 **	0.028	0.226 **	0.028		
Indicator for high HHI					-0.023	0.029
high HHIX1994					0.005	0.030
high HHIX1998					0.051	0.033
high HHIX2003					0.151 **	0.041
Interaction between MC and competition effects						
high MCXhigh HHI					-0.074 **	0.036
high MCXhigh HHIX1994					0.075 **	0.036
high MCXhigh HHIX1998					0.066	0.041
high MCXhigh HHIX2003					-0.013	0.050
med MCXhigh HHI					-0.022	0.037
med MCXhigh HHIX1994					0.016	0.040
med MCXhigh HHIX1998					0.050	0.043
med MCXhigh HHIX2003					-0.016	0.055

*p<0.10 **p<0.05

Complete regression results continue on the next page

Model 1: Actual managed care penetration rates over the years are used in the hospital fixed-effects model

Model 2: Instrumented managed care penetration rates are used in the hospital fixed-effects model, where historical managed care penetration rate (1987) were used to instrument for changes in managed care penetration rates.

Model 3: Hospitals are classified into low, medium, and high managed care penetration areas based on actual managed care penetration rates in each year.

Table 2. Regression Results on Log of Operating Cost (Continue)

	Model 1			Model 2			Model 3		
Independent variables	**Beta**		**SE**	**Beta**		**SE**	**Beta**		**SE**
Other control variables									
log(Medicare casemix index)	0.295	**	0.089	0.263	**	0.087	0.324	**	0.088
log(Medicare casemix index)^2	-0.090		0.106	-0.095		0.115	-0.091		0.107
log(total discharge)	-0.065		0.172	-0.027		0.136	-0.091		0.163
log(total discharge)^2	0.027	**	0.010	0.025	**	0.008	0.029	**	0.010
log (outpatient visits)	-0.042		0.046	-0.024		0.049	-0.049		0.040
log (outpatient visits)^2	0.006	**	0.002	0.005	**	0.002	0.006	**	0.002
log(wage index)	0.125		0.078	0.137	**	0.067	0.111		0.084
log(wage index)^2	-0.079		0.152	-0.266		0.165	0.081		0.204
Medicaid pressure index	-0.035		0.038	-0.054		0.039	-0.022		0.032
Medicare pressure index	0.106		0.074	0.067		0.066	0.113		0.070
FP ownership	-0.030		0.024	-0.031		0.022	-0.031		0.025
GOV ownership	-0.059	**	0.022	-0.053	**	0.020	-0.070	**	0.023
System membership	0.012		0.008	0.011		0.007	0.011		0.008
log(per capita income)	0.174	**	0.080	0.170	**	0.062	0.189	**	0.095
% FP in the market	-0.003		0.041	-0.005		0.037	0.001		0.040
% Gov in the market	-0.081	**	0.041	-0.075	**	0.034	-0.106	**	0.042
constant term	13.176		1.159	13.718		0.986	13.095		1.189
Number of observations			8236			8017			8281
Number of hospitals			2727			2613			2736

* $p<0.10$ **$p<0.05$

Model 1: Actual managed care penetration rates over the years are used in the hospital fixed-effects model

Model 2: Instrumented managed care penetration rates are used in the hospital fixed-effects model, where historical managed care penetration rate (1987) were used to instrument for changes in managed care penetration rates.

Model 3: Hospitals are classified into low, medium, and high managed care penetration areas based on actual managed care penetration rates in each year.

Table 3. Regression Results on Log of Patient Revenue

	Model 1		Model 2		Model 3	
Independent variables	**Beta**	**SE**	**Beta**	**SE**	**Beta**	**SE**
Time dummies						
year 1994	0.448 **	0.073	0.615 **	0.190	0.299 **	0.039
year 1998	0.905 **	0.114	1.473 **	0.471	0.346 **	0.059
year 2003	0.795 **	0.168	1.337 **	0.475	0.534 **	0.065
Managed care effects						
log of MC penetration (MC)	-0.001	0.020	-0.045	0.078		
MCX1994	-0.022	0.018	-0.072	0.049		
MCX1998	-0.090 **	0.028	-0.230 **	0.111		
MCX2003	0.018	0.040	-0.117	0.113		
high MC					0.051	0.035
high MCX1994					-0.082 **	0.033
high MCX1998					-0.111 **	0.044
high MCX2003					-0.018	0.049
med MC					0.038	0.041
med MCX1994					-0.076 *	0.043
med MCX1998					-0.112 **	0.050
med MCX2003					-0.018	0.056
Competition effects						
log(HHI)	-0.070 **	0.029	-0.102 **	0.032		
log(HHI)X1994	0.090 **	0.030	0.066 **	0.029		
log(HHI)X1998	0.186 **	0.036	0.160 **	0.038		
log(HHI)X2003	0.231 **	0.033	0.216 **	0.039		
Indicator for high HHI					-0.027	0.035
high HHIX1994					-0.006	0.034
high HHIX1998					0.061	0.045
high HHIX2003					0.128 **	0.051
Interaction between MC and competition effects						
high MCXhigh HHI					-0.064	0.041
high MCXhigh HHIX1994					0.080 **	0.041
high MCXhigh HHIX1998					0.057	0.052
high MCXhigh HHIX2003					0.001	0.059
med MCXhigh HHI					-0.038	0.042
med MCXhigh HHIX1994					0.053	0.044
med MCXhigh HHIX1998					0.085	0.054
med MCXhigh HHIX2003					0.059	0.065

*p<0.10 **p<0.05

Complete regression results continue on the next page

Model 1: Actual managed care penetration rates over the years are used in the hospital fixed-effects model

Model 2: Instrumented managed care penetration rates are used in the hospital fixed-effects model, where historical managed care penetration rate (1987) were used to instrument for changes in managed care penetration rates.

Model 3: Hospitals are classified into low, medium, and high managed care penetration areas based on actual managed care penetration rates in each year.

Table 3. Regression Results on Log of Patient Revenue (Continue)

	Model 1		Model 2		Model 3	
Independent variables	**Beta**	**SE**	**Beta**	**SE**	**Beta**	**SE**
Other control variables						
log(Medicare casemix index)	0.381 **	0.137	0.336 **	0.129	0.414 **	0.133
log(Medicare casemix index)^2	-0.220	0.148	-0.229	0.152	-0.227	0.148
log(total discharge)	0.096	0.215	0.171	0.156	0.077	0.203
log(total discharge)^2	0.021	0.013	0.017 *	0.010	0.022 *	0.012
log (outpatient visits)	-0.034	0.045	-0.027	0.047	-0.040	0.038
log (outpatient visits)^2	0.006 **	0.002	0.005 **	0.002	0.006 **	0.002
log(wage index)	0.108	0.095	0.100	0.087	0.097	0.100
log(wage index)^2	-0.078	0.179	-0.290	0.208	0.064	0.220
Medicaid pressure index	-0.064	0.048	-0.065	0.054	-0.046	0.044
Medicare pressure index	0.191 **	0.087	0.154 *	0.083	0.191 **	0.081
FP ownership	0.014	0.029	0.013	0.026	0.013	0.030
GOV ownership	-0.087 **	0.026	-0.079 **	0.025	-0.097 **	0.027
System membership	0.013	0.009	0.014 *	0.008	0.013	0.009
log(per capita income)	0.192 **	0.083	0.192 **	0.064	0.219 **	0.102
% FP in the market	0.011	0.043	0.024	0.041	0.014	0.042
% Gov in the market	-0.063	0.042	-0.055	0.037	-0.085 *	0.043
constant term	11.293	1.263	12.335	1.106	11.097	1.284
Number of observations		8206		7986		8251
Number of hospitals		2722		2608		2731

* p<0.10 **p<0.05

Model 1: Actual managed care penetration rates over the years are used in the hospital fixed-effects model

Model 2: Instrumented managed care penetration rates are used in the hospital fixed-effects model, where historical managed care penetration rate (1987) were used to instrument for changes in managed care penetration rates.

Model 3: Hospitals are classified into low, medium, and high managed care penetration areas based on actual managed care penetration rates in each year.

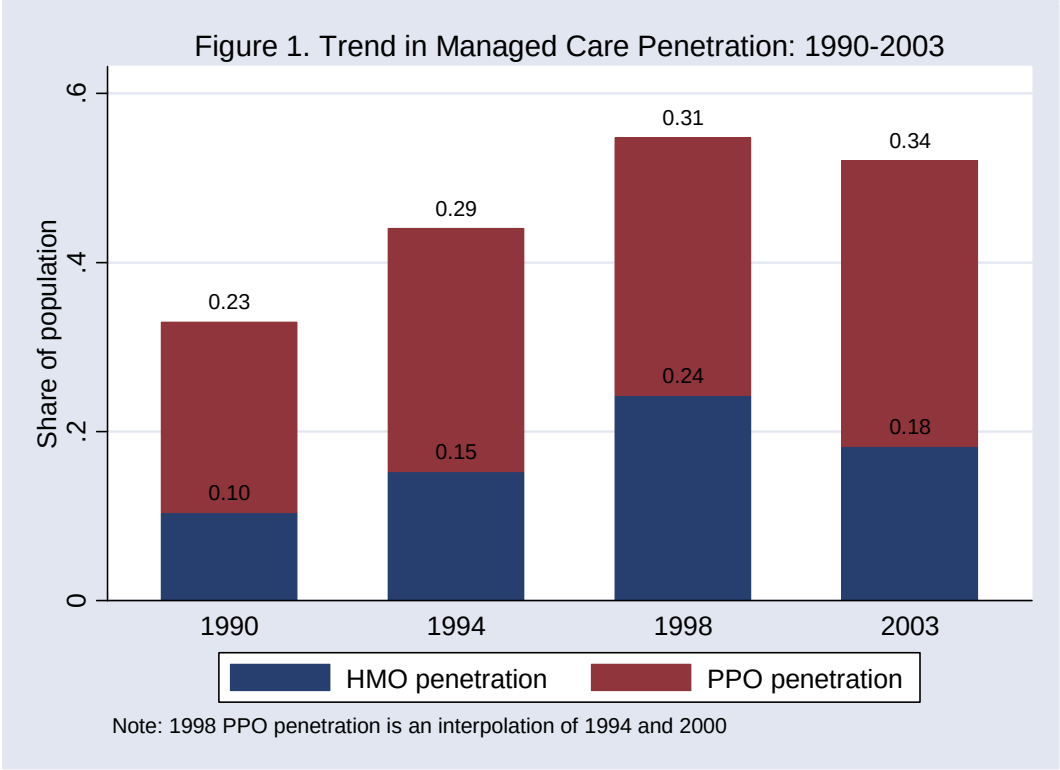
Figure 1. Trend in Managed Care Penetration: 1990-2003
Share of population
0
.2
.4
.6
0.23
0.10
0.29
0.15
0.31
0.24
0.34
0.18
1990
1994
1998
2003
HMO penetration
PPO penetration
Note: 1998 PPO penetration is an interpolation of 1994 and 2000

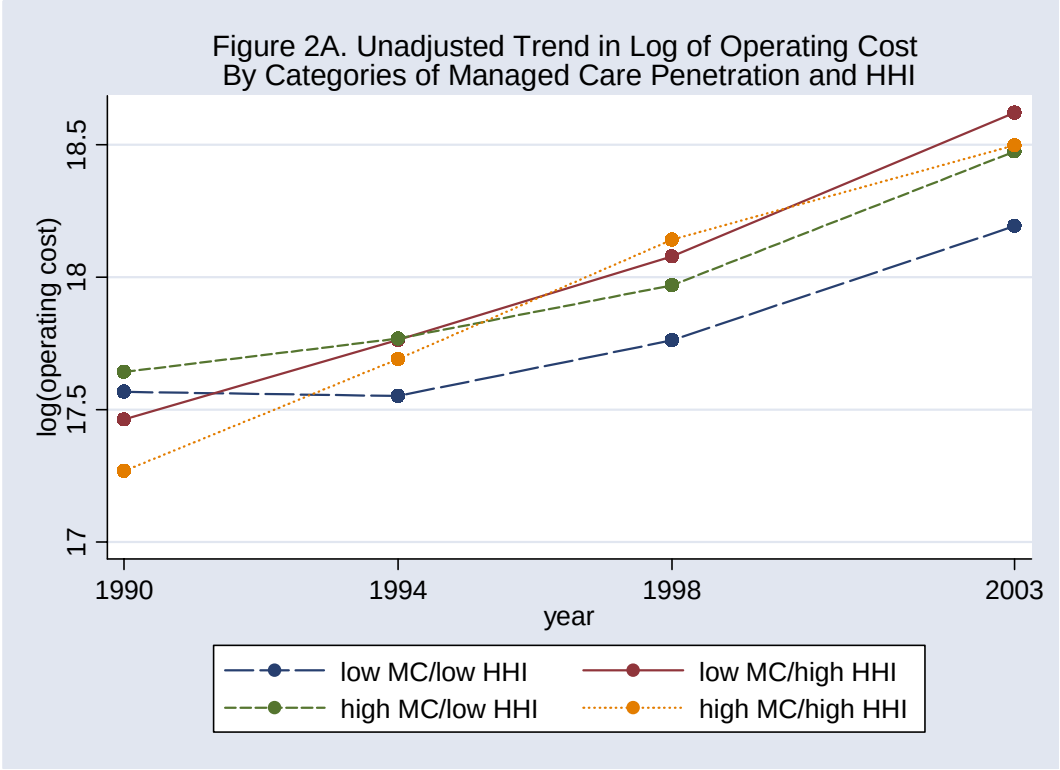
Figure 2A. Unadjusted Trend in Log of Operating Cost
By Categories of Managed Care Penetration and HHI
log(operating cost)
17
17.5
18
18.5
1990
1994
1998
2003
year
low MC/low HHI
low MC/high HHI
high MC/low HHI
high MC/high HHI

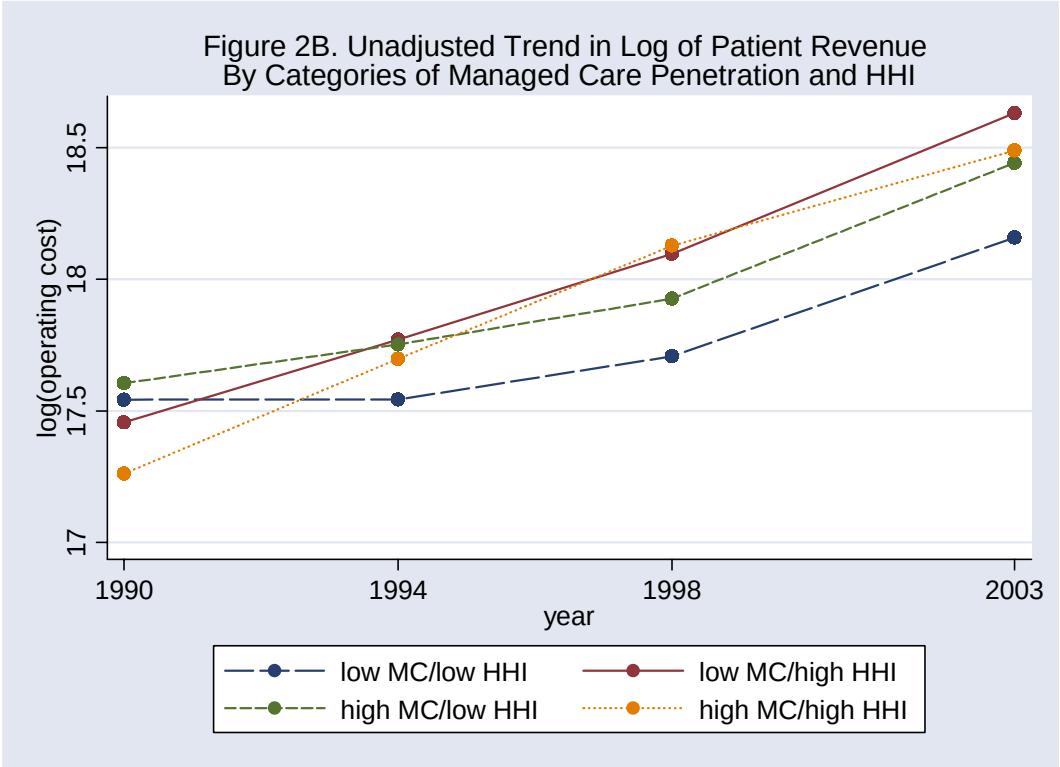
Figure 2B. Unadjusted Trend in Log of Patient Revenue
By Categories of Managed Care Penetration and HHI
log(operating cost)
17
17.5
18
18.5
1990
1994
1998
2003
year
low MC/low HHI
low MC/high HHI
high MC/low HHI
high MC/high HHI

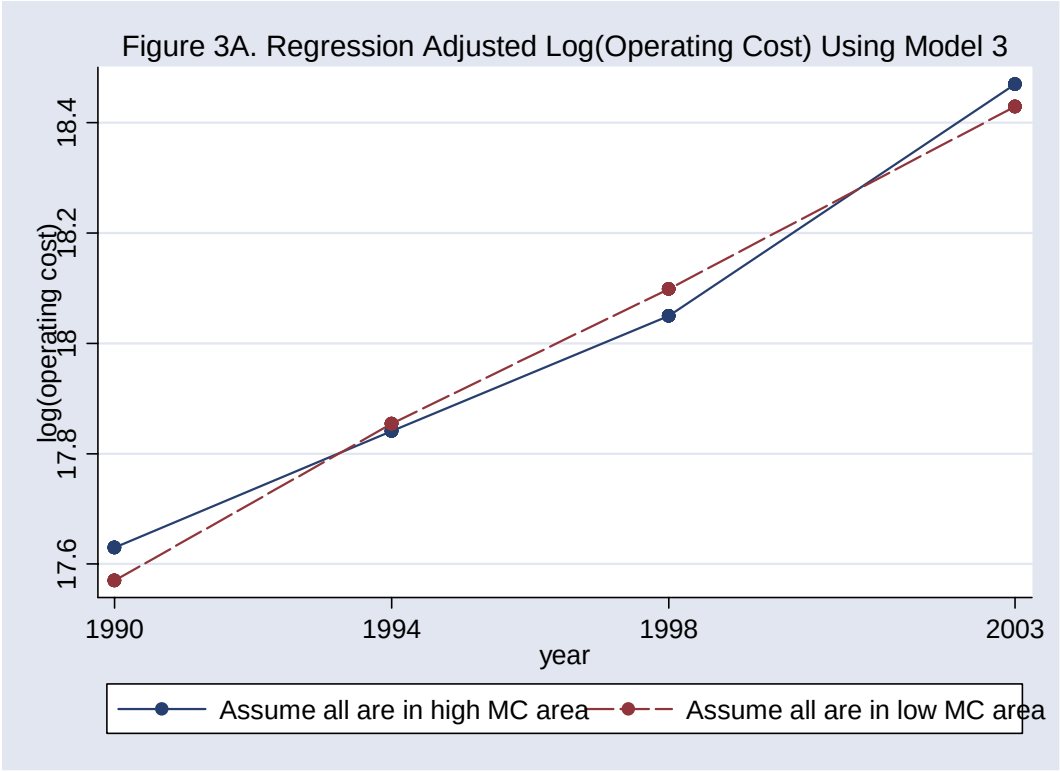
Figure 3A. Regression Adjusted Log(Operating Cost) Using Model 3
log(operating cost)
17.6
17.8
18
18.2
18.4
1990
1994
1998
2003
year
Assume all are in high MC area
Assume all are in low MC area

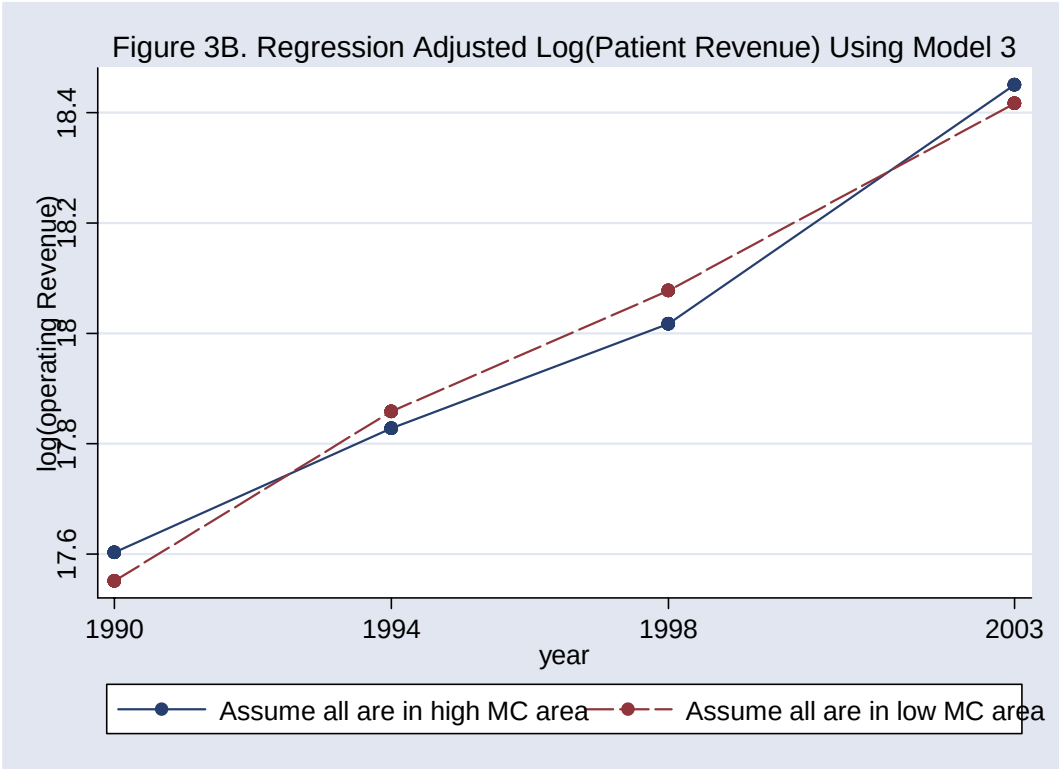
Figure 3B. Regression Adjusted Log(Patient Revenue) Using Model 3
log(operating Revenue)
17.6
17.8
18
18.2
18.4
1990
1994
1998
2003
year
Assume all are in high MC area
Assume all are in low MC area

Figure 4A. Competition Effects on Operating Cost By Managed Care Levels

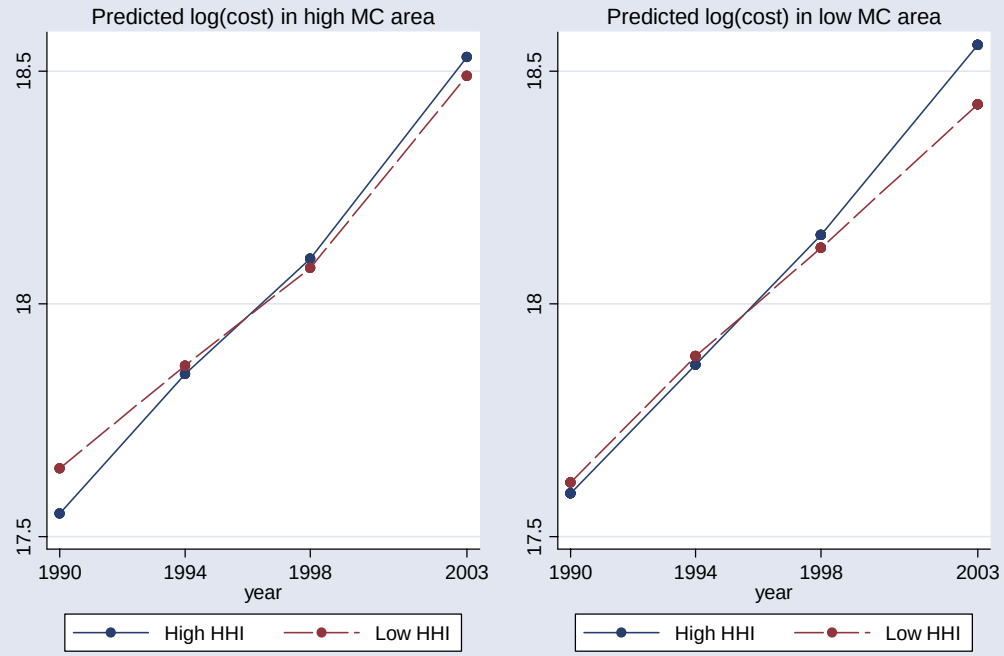

Figure 4B. Competition Effects on Patient Revenue By Managed Care Levels