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RESEARCH ARTICLE

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Pricing in commercial dental insurance and provider markets

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Abstract

Objective: To examine the impact of commercial dental insurer and provider concentration on dentist reimbursement.

Data Sources: We utilized provider data from the American Dental Association, reimbursement data from IBM Watson MarketScan® Commercial Research Databases, submitted billed charges from FAIR Health®, dental insurance market concentration data from FAIR Health®, and county-level demographic and economic data from the Area Health Resources File and the Council for Community and Economic Research.

Study Design: We used the Herfindahl-Hirschman Index to separately measure commercial dental insurance concentration and dentist concentration. We studied the effect of provider and insurance concentration on dentist reimbursement. Using two-stage least squares, we accounted for potential endogeneity in dental insurer and provider concentration.

Principal Findings: Across the dental procedures we examined, a 10 percent increase in dental insurance concentration is associated with a 1.95 percent (*P*-value = .033) reduction in gross payments to dentists. Conversely, a 10 percent increase in dentist concentration is associated with a more modest 0.71 percent (*P*-value = .024) increase in gross payments. A 10 percent increase in dental insurance concentration is associated with a 1.16 percentage point (*P*-value = .016) decline in the allowed-to-list price ratio, while a 10 percent increase in dentist concentration is associated with a 0.56 percentage point (*P*-value = .001) increase in the allowed-to-list price ratio. Similar patterns were found across dental procedure subcategories.

Conclusions: Dental provider markets are substantially less concentrated than insurance markets, which may limit the ability of dentists to garner higher reimbursement.

KEYWORDS

dental insurance, market structure, reimbursement

1 | INTRODUCTION

Over the last two decades, the $124 billion dental industry has undergone significant changes with respect to providers and payers.[1] Dentists today are more likely to work as employees in large dental organizations.[2,3] Large group dental practices, measured in terms of employee size (500 or more employees), were nearly nonexistent in 1992. By 2012, they comprised about 4 percent of

all dental practices.[4] Dental management service organizations (DMSOs), which centrally handle administrative services, billing, marketing, business operations, and negotiate reimbursement with payers, have become more prevalent.[5,6] Nearly 10 percent of dentists were employed by a DMSO in 2019.[1]

One hypothesis behind the changing dental provider landscape is that dentists are responding to an evolving dental payer environment. Dental insurance markets are moderately concentrated, with one study finding that Delta Dental of California had a 40 percent market share in the state.[7] There has also been recent consolidation among dental insurers. In the last 12 years, Capital BlueCross of Pennsylvania acquired Dominion Dental (2008),[8] Dental Network of America acquired DenteMax (2009),[9] Principal Financial Group acquired First Dental Health (2012),[10] and DentaQuest and The Dental Care Plus Group (DCPG) entered into a merger agreement in early 2019.[11] The mergers of insurers matter because more concentrated insurance markets grant insurers greater bargaining leverage over providers, and with it, the ability to reduce the amount reimbursed to providers.[12,13] The ability of insurers to channel patients to particular providers can allow insurers to reduce reimbursement to providers or negotiate more favorable discounts.[14,15] One of the few ways for providers to offset the leverage of more concentrated dental insurers is to consolidate.[12,13,16,17]

While studies have shown that reimbursement from commercial insurers to dentists has declined over the last decade,[18] it is not clear whether this relationship is due to changes in dental insurance or dental practice structure. This paper fills this gap in the literature by studying the relationship between the price of dental services and the concentration of dental insurance and provider markets in commercial markets. This paper makes at least two additional major contributions. First, we bring together unique datasets to calculate both dental insurer and provider measures of concentration. To our knowledge, no study has examined dental insurer or provider concentration in conjunction. One previous study examined the relationship between dental insurance concentration and dentist fee discounts. The authors of this study did not control for dental provider concentration.[19] Second, previous studies that examined reimbursement used contracted prices and needed to estimate discounts to get actual prices. This study's unique contribution to the dental economics literature is to combine aggregated commercial dental claims data from two sources in order to calculate actual gross payments made to the provider (eg, allowed charges) and the negotiated discount (eg, billed minus allowed charges) for specific dental services commonly performed by general dentists (ie, nonspecialists).

What This Study Adds

- Previous research has examined the impact of changes in health insurance concentration and medical provider concentration on medical prices, but little research has examined the association between dentist concentration, dental insurance concentration, and reimbursement to dentists.
- We find that increased commercial dental insurance market concentration is associated with lower gross payments for dental services and higher insurance discounts relative to billed charges submitted by dentists.
- Given the current structure of the market, dental insurers are able to dampen reimbursement more than dentists are able to increase prices for their services, although this could change as the industry trend is for dentists to join large group practices or dental management service organizations.

2 | CONCEPTUAL FRAMEWORK

Our conceptual framework is adopted from the health insurance literature, which finds that physicians receive higher prices for their services in more concentrated provider markets, but lower reimbursement in more concentrated insurance markets.[12,20] First, it is important to note some differences between dental and health care markets. One significant difference between dental and health care markets is that 40 percent of total dental spending is out-of-pocket, while 11 percent of total health care spending is out-of-pocket.[21] Another difference is that the cost of treatment for most dental services is also lower than for medical services, including high-cost treatments. Despite these differences, the bargaining dynamics between dentists and dental payers should still be similar to the bargaining dynamics between physicians and medical insurers.

As in health care markets,[12,22] we assume that dental providers engage in bilateral Nash bargaining vis-à-vis commercial dental insurers. Each side attempts to extract as much surplus as possible from the other party. Commercial dental insurers with a greater market share can credibly exclude providers from their networks, forcing the price of dental services to approach the marginal cost of providing those services. To counter the bargaining leverage of dental insurers, dentists can join large group practices or DMSOs. Larger dental practices could credibly become "must-have" providers and through the threat of not accepting an insurer's enrollees, increase their bargaining leverage. As a result, dentists in more concentrated provider markets are able to increase the amount they are reimbursed toward the profit maximizing monopolist price.

While insurers and providers primarily focus on gross payments (ie, allowed charges) which reflects the amount paid to the dentist after contractual discounts, in most cases insurers and providers negotiate over two items: (a) list prices (ie, billed charges) and (b) the discount rate the insurer receives on list prices to determine the gross payment. While providers may increase list prices in order to increase reimbursement, contracts are prospective and include terms that limit the increase in list prices year to year. This implies that gross payments and discounts are also likely to be a function of the relative bargaining leverage of insurers and providers.

Similar to medical markets, this leads to two hypotheses. First, as dental insurance markets become more concentrated relative to dental provider markets, the price dentists receive for their services will

decline. The net result is lower gross payments and larger discounts applied to list prices. Second, greater consolidation of dental provider markets will lead to higher gross payments and smaller discounts applied to list prices. Our empirical model directly tests these hypotheses under the assumption that commercial prices are negotiated prospectively between dentists and insurers. That is, price changes are negotiated in advance of those changes actually taking place, which is consistent with insurers and dentists signing multiyear contracts.

3 | DATA AND METHODS

3.1 | Data sources and sample

To understand how dental and insurer concentrations affect the prices of dental services in 2016 and 2017, we construct a county-level dataset from three proprietary databases merged with demographic information from the Area Health Resource File (AHRF), cost of living data from the Council for Community and Economic Research, and data from the US Census. The first proprietary dataset is the IBM Watson MarketScan® commercial dental claims database. This database is a convenience sample of commercial dental insurers that includes data from large employers and health plans in the United States. It is estimated that IBM Watson captures approximately 7.6 percent of the commercial dental insurance market. MarketScan® includes claims from a variety of fee-for-service (FFS), preferred provider organization (PPO), and capitated health plans.[23] To assure compliance with HIPPA, we were able to obtain average gross payments (ie, allowed charges) for commercially insured patients at the county level for 23 common dental procedures (Table S1) for counties in which at least 30 claims for the procedure were billed. We verified with dentists at the American Dental Association (ADA) that these 23 common dental procedures are commonly performed by general dentists.

These data are merged to the FAIR Health® Dental Module, which captures dental claims representing 75 percent of the commercial dental insurance market in the United States[24] and is the source of average list prices (ie, billed charges) and dental insurer Herfindahl-Hirschman Index (HHI). Data from FAIR Health® are provided at the 3-digit zip code level. To convert this to county-level data, we identify the county of each 3-digit zip code using the Housing and Urban Development zip code-to-county crosswalk.[25] We then convert list prices and HHI calculations to county-level values by weighting each 3-digit zip code based on the number of people living in each 3-digit zip code within a county.

Characteristics of dentists are obtained from the ADA office database, which includes a census of all professionally active dentists in the United States and contains the address of each dentist. The office database has identifiers for unique offices, dentists, and large group practices. These data have been used to study dental providers.[26]

In constructing our sample, we restrict our analysis to counties where IBM Watson data are able to provide complete information across 23 common dental procedures. Because many rural counties did not have information on all 23 procedures, we further restrict the analysis to urban counties that had complete demographic information or have pricing information that are not clear outliers (eg, reported gross payments that were zero). After imposing these restrictions, our analysis includes a balanced two-year panel of 465 counties for which we have complete pricing and demographic information.

3.2 | Reimbursement rates and discounts

We utilize two sets of dependent variables. The first set of dependent variables is the log of average prices paid to dentists for dental procedures. The average price of a procedure is defined as the total gross payment for a particular dental service after applying discounts but before applying copayments and deductibles (ie, allowed charge). The second set of dependent variables is the ratio of gross payments to list prices submitted by dentists or the allowed-to-list price ratio. This ratio, which is bounded between zero and one, measures the proportion of the list price that insurers/patients pay, with lower values indicating that the insurer was able to obtain a larger discount. While the gross payment is more relevant for the price paid by insurers and consumers, dentists may attempt to increase their gross payments via higher list prices at the same time insurers attempt to obtain extract larger discounts. This means that the allowed-to-list price ratio is likely noisier than the gross payment measure, but it provides valuable information about the contracting process and the relative bargaining power of insurers and dentists.

For ease of presentation and because some dentists may be more likely to bill one procedure over another, we create composite measures based on the type of dental service: diagnostic, preventive, restorative, and periodontal. We also calculate a composite measure of reimbursement covering all 23 procedures provided by IBM Watson. These composite measures are a weighted average of reimbursement across all 23 procedures and a subset of diagnostic, preventive, restorative, and periodontal procedures (Table S1). Weights are based on total billings submitted by dentists in the FAIR Health® Dental module.

3.3 | Dental insurance concentration

In calculating market concentration, it is imperative to define each geographic market properly. However, as noted in previous research,[13] it is not feasible to precisely define every geographic market for national studies such as this. Hence, proxies are used. Past work has used the state as the geographic market because insurers are regulated at the state level.[13] However, insurers may provide coverage only in select parts of a state, and if this occurs, defining a market as the state can lead to underestimation of dental insurer concentration. Other studies have used smaller geographic markets,

such as 3-digit zip codes [27] and metropolitan statistical areas.[12] Defining a market too small can lead to overestimation of concentration. Because dental provider markets are likely to be smaller, dental insurers need to have dentists in each market to sell coverage, and some Medicare Advantage plans which offer dental coverage are priced at the county-level, we use county as our proxy for geographic markets of dental insurers.

Commercial dental insurance concentration is measured via a Herfindahl-Hirschman Index (HHI) that is provided by FAIR Health®. Because we do not have access to claims level data, FAIR Health® calculated an HHI for each 3-digit zip code using the number of paid claims for each insurer to calculate market share, denoted S_{INS}. FAIR Health® followed the standard formula of $HHI_{INS} = \sum_{INS \in Three\ digit\ zip} S^2_{INS}$ to calculate HHI. We then calculate county-level HHIs using population weighting techniques. It should be noted that some prior work may have based HHIs on number of covered lives. However, these data were not available to us from FAIR Health® or other sources. While this may be a limitation, the advantage of using paid claims to calculate HHI is it may better reflect the insurance market dynamics that dentists face when negotiating reimbursement.

3.4 | Dental provider concentration

Information on the number of general practice and pediatric dentists from the ADA office database is used to construct a measure of dental provider concentration. We exclude specialists because our dental procedures focus on preventative and primary care services.

In constructing our dentist HHIs, we utilize a fixed travel time approach.[12,28] The first step in this approach is to identify the probability that an individual assumed to be living at the centroid of a census tract, c_0, is willing to travel to a dentist. This probability assumes that patients in each census tract are willing to travel a fixed maximum amount of time, denoted $\bar{t}$, and the probability that a patient is willing to travel to dentist located at k_i is given by the following equation:

$$\text{Prob(Visit at } k_i) = \begin{Bmatrix} 1 - \left(\frac{1}{\bar{t}}\right) t_k \text{ if } t_k \leq \bar{t} \\ 0 \text{ if } t_k > \bar{t} \end{Bmatrix} \quad (1)$$

where for dentists further away from $\bar{t}$, the probability is zero, and for dentists within $\bar{t}$, there is a positive probability. Following past work,[12] we assume a uniform distribution between 0 and $\bar{t}$ for dentists that are within $\bar{t}$. The next step, from the perspective of each census tract, is to calculate an expected market share for each dental practice as follows:

$$E\left(\text{Share}_i\ (c_0)\right) = \frac{N_i * \text{Prob}\left(\text{Visit at } k_i\right)}{\sum_j N_j\ \text{Prob (Visit at } k_j)} \quad (2)$$

where j indexes each dentist in the ADA office database and N_j is the number of dentists in each dental practice. Dentists considered to be part of a DMSO or large group practice within a market constitute a unique share in our calculation. Finally, these expected market shares are used to calculate census tract HHIs that are distinct for each census tract h and year t: $HHI_{ht} = \sum_i [E(\text{Share}_i(c_0))]^2$. While this approach identifies an HHI for each census tract, our analysis is at the county

TABLE 1 Descriptive statistics of the analytic sample

Variable	Mean	Standard deviation
Composite gross payments		
All procedures	78.290	12.262
Diagnostic	47.357	7.232
Preventive	61.711	9.662
Restorative	133.400	23.423
Periodontal	140.081	23.265
Allowed-to-list price ratio		
All procedures	0.723	0.077
Diagnostic	0.721	0.074
Preventive	0.780	0.068
Restorative	0.702	0.089
Periodontal	0.699	0.090
Dental market concentration		
Commercial dental insurance HHI	2125.521	708.490
20-min dentist HHI	612.062	485.741
40-min dentist HHI	170.570	152.585
Instrumental variables		
Unemployment rate	4.938	1.240
County population	498 286.600	732 381.700
Log of county population	12.660	0.885
Control variables		
Population density	1052.260	3116.455
Dentist per square mile	0.819	4.122
Log of real median household income	11.008	0.233
Dental HPSA	0.015	0.122
Percent black	11.798	11.842
Percent Hispanic	12.221	13.082
Percent Asian	3.602	4.453
Percent high school education	11.164	4.609
Percent college education	31.261	9.921
Cost of living index	108.240	15.827
Northeast	0.185	0.388
Midwest	0.237	0.425
South	0.430	0.495
West	0.148	0.356

Notes: Sources: 2016-2017 IBM Watson MarketScan Commercial Dental Claims Database; 2015-2016 FAIR Health Dental Module; 2015-2016 American Dental Association Office Database; Area Health Resource File; The Council for Community and Economic Research; US Census.
Abbreviations: HHI, Herfindahl-Hirschman Index; HPSA, Health Professional Shortage Area.

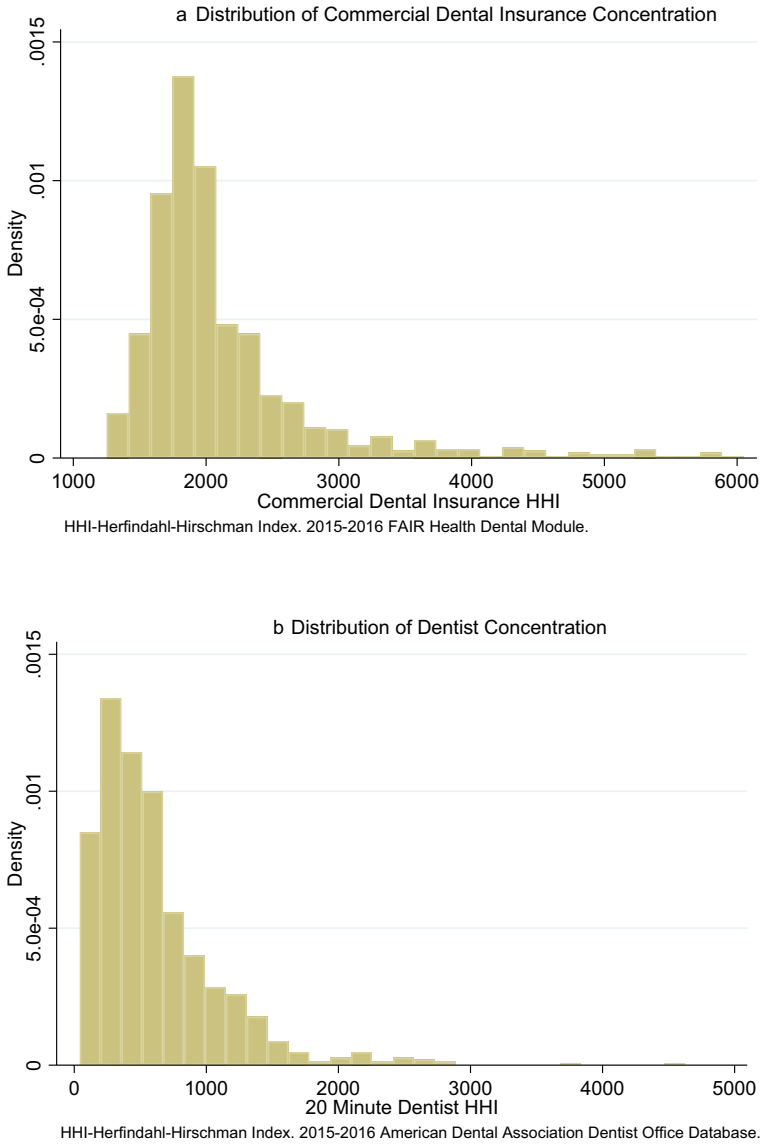

FIGURE 1 A, HHI-Herfindahl-Hirschman Index.
Source: 2015-2016 FAIR Health Dental Module. B, HHI-Herfindahl-Hirschman Index.
Source: 2015-2016 American Dental Association office database [Color figure can be viewed at wileyonlinelibrary.com]

level. Therefore, the final step is to calculate a county-level dentist HHI by taking the population-weighted average of each census tract in the county.

While the travel time approach still defines the relevant geographic market for dentists as the county, this approach has a few advantages. Foremost, by calculating expected HHIs for each census tract and then weighting each census tract by its population, we are assigning more importance to closer dentists and to geographic areas with greater population. This is more likely to lead to a more accurate reflection of market concentration than calculating HHI based on the total number of dentists in a county. Another advantage is that we are using expected patients instead of actual patient flow. It is well known that actual patient flow can be biased because dental practices with higher quality may be able to attract more patients, leading to an endogeneity issue. One key limitation of the approach is that we need to define a maximum fixed travel time threshold, $\bar{t}$. Following previous research,[12] we utilize 20- and 40-minute thresholds. In our main results, we report findings using a 20-minute threshold. Our results are robust when we use a 40-minute threshold (see Table S2–S4).

3.5 | Empirical strategy

To study the relationship between dental insurer concentration, dentist concentration, and reimbursement, we employ two different empirical approaches. First, we estimate these relationships using cross-sectional regression techniques. The dependent variables of log total gross payment and the allowed-to-list price ratio in 2017 are regressed against logged dentist and logged insurer HHI measured in 2016. We also include a number of county demographic and economic control variables measured in 2016: population per square mile, dentist per square mile, log of real median household income, whether the county is a dental health professional shortage area (HPSA), percent black, percent Asian, percent Hispanic, percent by education level, cost of living index,[29] and a categorical variable for census region (Midwest, West, South, Northeast). We use HHIs and control variables from the prior year because contracts between insurers and providers take time to negotiate and are likely to take in effect at a future time. Therefore, current year prices are likely to reflect the state of the market of the prior year.

We first estimate our cross-sectional regression using ordinary least squares (OLS), but a concern with this approach is that prices and level of market concentration may be endogenous. To account for potential endogeneity bias, we also estimate our models using instrumental variables. This requires us to estimate a first-stage model where the dependent variable is HHI. In order for instrumental variables to be valid, this first stage must have an instrument, which is a variable that explains HHI but is uncorrelated with the error term in the price regressions. Our instruments, which have been previously used in this type of application,[12,30,31] are log of county population and unemployment rate (unemployment rate, unemployment rate squared, and unemployment rate cubed). As in Dunn and Shapiro, the inclusion of squared and cubic terms for the unemployment rate allows us to achieve better statistical properties in our first stage estimates.[12]

County population and short-run unemployment rates in the market have economic validity as instruments because like health insurance, most working-age adults (92 percent) purchase dental benefits through their employers.[32] This means as employers hire and lay off workers, commercial dental insurer market shares are more likely to fluctuate with the short-run strength of the economy. However, dentists make longer term decisions when deciding to set up a practice or choosing to consolidate with other providers. Hence, short-term economic conditions should have little effect on the structure or size of dental practices. Likewise, short-run unemployment rates should have little effect on the short-term pricing decisions of commercial dental insurers and dentists except through the number of rivals in a market. This is because prices are negotiated as a part of contracts, which could last multiple years. Furthermore, it is unlikely that even if contracts are renegotiated, that prices are significantly different from contract to contract without there being significant change in the negotiating leverage of one party. Hence, while the unemployment rate may affect the number of individuals that are insured, this variable should not affect the prices paid to dentists except through the bargaining that occurs between dentists and insurers.

In addition to unemployment rate, the other instrument is county population. Dental insurer and provider firms are more likely to enter more populated markets. However, the decision of rivals to enter a market is longer term in general and is likely to be unrelated to the short-term pricing decisions of dentists and insurers. In addition to passing economic validity, these instrumental variables also satisfy standard econometric tests, which we discuss in the results section.

The second empirical strategy we employ is to estimate a two-year fixed-effects panel regression. More specifically, our dependent variables were from 2016 to 2017. For the same reason outlined in the cross-sectional approach, we use one-year lags of HHI and control variables. Additional variables in the panel regressions include a year fixed effect and county fixed effects. The key advantage of the county fixed effects is that they control for time-invariant county-level heterogeneity that could lead to confounding between market concentration and reimbursement. Moreover, because market shocks that could confound the relationship between market concentration and reimbursement were unlikely to vary over the two-year time frame used in this study (eg, unobserved heterogeneity is assumed to be fixed in a short time frame), the fixed-effect panel regression is likely to account for potential endogeneity that occurs in our cross-sectional regressions. Similar assumptions were made in previous research.[33]

TABLE 2 Association of county unemployment rate and population with dentist and dental insurer concentration

Variable	Log (20-minute dentist HHI)	Log (dental insurance HHI)
Unemployment rate	−0.760*** (0.362)	−0.156 (0.188)
(Unemployment rate)^2	0.119*** (0.060)	0.009 (0.032)
(Unemployment rate)^3	−0.006*** (0.003)	0.0007 (0.002)
Log (County population)	−0.366*** (0.039)	−0.039*** (0.018)
First stage *F*-statistic	23.42	13.24
P-value	0	0
Number of counties	465	465

Notes: The table reports the regression results where the dependent variable is the log of either dentist or dental insurer HHI. Control variables not listed include population density, dentist per square mile, log of real median household income, whether the county is dental health professional shortage area, percent black, percent Asian, percent Hispanic, percent by education level, cost of living index, and a categorical variable for census region (Midwest, West, South, Northeast). Robust standard errors in parentheses.

Sources: 2016-2017 IBM Watson MarketScan Commercial Dental Claims Database; 2015-2016 FAIR Health Dental Module; 2015-2016 American Dental Association Office Database; Area Health Resource File; The Council for Community and Economic Research; US Census.

Abbreviation: HHI, Herfindahl-Hirschman Index.

***$P < .01$, **$P < .05$, *$P < .1$.

4 | RESULTS

Summary statistics are presented in Table 1 for our analytic sample. Across the 23 procedures, average total gross payments for procedures are about $78. Diagnostic procedures cost about $47, preventive procedures cost about $62, restorative procedures cost about $133, and periodontal procedures cost about $140 in commercial dental markets. Insurers, on average, are paying between 69.9 and 78.0 percent of the list price, indicating discounts of 20 to 30 percent. Preventive procedures have the smallest discounts, whereas periodontal services have the largest discounts on a percentage basis.

Dental insurance markets are substantially more concentrated than dental provider markets in the average urban county. The average HHI for a commercial dental insurance market is 2126, which would be considered to be moderately concentrated according to the US Department of Justice.[34] Relative to dental insurance markets, dental provider markets are much more competitive, with the

TABLE 3 Effect of dentist and dental insurer concentration on gross payments to dentists

	Ordinary least squares	Instrumental variables (Insurer HHI)	Instrumental variables (insurer and dentist HHI)	Fixed-effect panel regression
	(1)	(2)	(3)	(4)
All procedures				
Log (Commercial dental insurance HHI)	0.006 (0.023)	−0.077 (0.077)	−0.195*** (0.091)	−0.029*** (0.009)
Log (20-min dentist HHI)	0.002 (0.013)	0.007 (0.013)	0.071*** (0.032)	0.003 (0.006)
Diagnostic				
Log (Commercial dental insurance HHI)	−0.002 (0.021)	−0.070 (0.075)	−0.197** (0.092)	−0.039*** (0.009)
Log (20-min dentist HHI)	0.008 (0.012)	0.012 (0.012)	0.081*** (0.031)	0.006 (0.005)
Preventive				
Log (Commercial dental insurance HHI)	−0.011 (0.020)	−0.123*** (0.066)	−0.208*** (0.079)	−0.031*** (0.012)
Log (20-min dentist HHI)	0.003 (0.012)	0.010 (0.012)	0.056*** (0.029)	0.001 (0.004)
Restorative				
Log (Commercial dental insurance HHI)	0.021 (0.027)	−0.064 (0.094)	−0.198*** (0.109)	−0.015 (0.012)
Log (20-min dentist HHI)	−0.006 (0.015)	−0.0004 (0.015)	0.073*** (0.037)	−0.010 (0.012)
Periodontal				
Log (commercial dental insurance HHI)	0.020 (0.028)	−0.038 (0.086)	−0.145 (0.095)	−0.036 (0.023)
Log (20-min dentist HHI)	0.008 (0.014)	0.011 (0.015)	0.069*** (0.035)	0.022*** (0.013)
Number of counties	465	465	465	465
Number of observations	465	465	465	930

Notes: The table reports the regression results where the dependent variable is the log gross payment for each composite index listed. Control variables in Columns 1-3 include population density, dentist per square mile, log of real median household income, whether the county is dental health professional shortage area, percent black, percent Asian, percent Hispanic, percent by education level, cost of living index, and a categorical variable for census region (Midwest, West, South, Northeast). Control variables in Column 4 include population density, dentist per square mile and log of real median household income. Standard errors are in parentheses with robust standard errors in Columns 1-3 and standard errors clustered by county in Column 4.

Sources: 2016-2017 IBM Watson MarketScan Commercial Dental Claims Database; 2015-2016 FAIR Health Dental Module; 2015-2016 American Dental Association Office Database; Area Health Resource File; The Council for Community and Economic Research; US Census.

Abbreviation: HHI, Herfindahl-Hirschman Index.

***$P < .01$, **$P < .05$, *$P < .1$.

average county having a dentist HHI of 612. The relative sizes of the insurer and provider HHIs are consistent with commercial dental insurers having significant bargaining leverage over dentists. There also appears to be sufficient variability in dental insurer HHI and dentist HHI across counties (Figure 1A, B), indicating there is enough variation to identify the association between dental market concentration and dentist reimbursement.

Before we present our main results, we first assess the quality of the instrumental variables in first-stage regressions (Table 2). For both dentist and insurer HHI, we perform standard weak instrument tests (eg, F test on instruments).[35] The F-statistics on the instruments are above 10 in the dental insurance HHI and dentist HHI first-stage regressions. This indicates that our instruments explain the level of competition in the insurance and dentist markets. For example, both regressions find that markets are less concentrated in more populated counties. We also find that insurance markets become more concentrated in areas with high levels of unemployment, consistent with insurers entering counties with more robust economies.

Table 3 presents the results of the regression models that estimate the effect of market concentration on gross payments. In Column 1, we present the cross-sectional results that are estimated by OLS. Columns 2 and 3 present cross-sectional results using instrument variables. In Column 2 only, insurer HHI is treated as endogenous, whereas in Column 3, both insurer and dentist HHI are treated as endogenous. Column 4 presents the results from the fixed-effect panel regressions. Finally, each panel in the table reports the results for a different composite measure, starting with a composite measure of all 23 procedures and then each type of service: diagnostic, preventative, restorative, and periodontal.

TABLE 4 Effect of dentist and dental insurer concentration on the allowed-to-list price ratio

	Ordinary least squares	Instrumental variables (Insurer HHI)	Instrumental variables (Insurer and dentist HHI)	Fixed-effect panel regression
	(1)	(2)	(3)	(4)
All procedures				
Log (Commercial dental insurance HHI)	0.010 (0.012)	−0.018 (0.041)	−0.116*** (0.048)	−0.014*** (0.007)
Log (20-min dentist HHI)	0.002 (0.006)	0.003 (0.006)	0.056*** (0.017)	0.002 (0.004)
Diagnostic				
Log (Commercial dental insurance HHI)	0.009 (0.012)	−0.010 (0.044)	−0.113*** (0.052)	−0.029*** (0.007)
Log (20-min dentist HHI)	0.006 (0.006)	0.007 (0.006)	0.063*** (0.016)	0.005 (0.004)
Preventive				
Log (Commercial dental insurance HHI)	0.008 (0.011)	−0.023 (0.035)	−0.119*** (0.043)	−0.020*** (0.010)
Log (20-min dentist HHI)	−0.000 (0.006)	0.002 (0.006)	0.054*** (0.015)	−0.002 (0.004)
Restorative				
Log (Commercial dental insurance HHI)	0.014 (0.014)	−0.010 (0.048)	−0.119*** (0.056)	0.009 (0.009)
Log (20-min dentist HHI)	−0.001 (0.008)	0.000 (0.008)	0.059*** (0.019)	−0.006 (0.008)
Periodontal				
Log (Commercial dental insurance HHI)	0.004 (0.015)	−0.039 (0.049)	−0.117*** (0.053)	−0.033*** (0.019)
Log (20-min dentist HHI)	0.005 (0.007)	0.008 (0.008)	0.050*** (0.018)	0.015 (0.010)
Number of counties	465	465	465	465
Number of observations	465	465	465	930

Notes: The table reports the regression results where the dependent variable is the allowed-to-list price ratio for each composite index listed. Control variables in Columns 1-3 include population density, dentist per square mile, log of real median household income, whether the county is dental health professional shortage area, percent black, percent Asian, percent Hispanic, percent by education level, cost of living index, and a categorical variable for census region (Midwest, West, South, Northeast). Control variables in Column 4 include population density, dentist per square mile and log of real median household income. Standard errors are in parentheses with robust standard errors in Columns 1-3 and standard errors clustered by county in Column 4.

Sources: 2016-2017 IBM Watson MarketScan Commercial Dental Claims Database; 2015-2016 FAIR Health Dental Module; 2015-2016 American Dental Association Office Database; Area Health Resource File; The Council for Community and Economic Research; US Census.

Abbreviation: HHI, Herfindahl-Hirschman Index.

***$P < .01$, ** $P < .05$, * $P < .1$.

For all composite measures, we find the same general pattern. In the OLS regressions, increases in dental insurer HHI or dentist HHI have a negligible impact on gross payments, with all models being statistically insignificant at conventional levels. When we only assume that dental insurer HHI is endogenous (Table 3, Column 2), increases in insurer HHI or dentist HHI have a negligible and statistically insignificant association with payments. However, when we account for the potential endogeneity of both dental insurer HHI and dentist HHI by instrumental variables (Table 3, Column 3), higher insurer concentration is associated with lower gross payments made to dentists, while higher dentist concentration is associated with higher gross payments made to dentists. These results are generally confirmed by the fixed-effects panel regressions (Table 3, Column 4), but the smaller affect sizes may be due to the attenuation bias which causes the coefficient estimates to be biased toward zero.

Depending on the type of service, in the models that account for the endogeneity of insurer and dentist HHI, a 10 percent increase in dental insurance HHI is associated with a 1.95-2.08 percent reduction in prices. A similar change in insurer HHI in the fixed-effect panel regression indicates lower prices in the range of 0.15-0.39 percent. When dental insurance markets go from moderately concentrated (HHI = 1500) to highly concentrated (HHI = 2500), the composite gross payment across all procedures declines from $82.51 to $74.71 (9.5 percent reduction). In the fixed-effects model, the same change in dental insurance concentration leads to a 1.4 percent decline in the composite gross payment.

In contrast to insurer concentration, higher concentration in dentist markets is associated with higher prices, but the effects are smaller. When both insurer and provider HHI are estimated via instrumental variables (Column 3), a 10 percent increase in dentist HHI

is associated with a 0.56-0.81 percent increase in prices. If a hypothetical dental provider market went from competitive (HHI = 500) to moderately concentrated (HHI = 1,500), gross payments based on the composite index would increase from $78.38 to $84.77 (8.1 percent increase).

The estimated relationship between concentration and the allowed-to-list price ratio are reported in Table 4. The setup of the table is similar to Table 3, and the results follow the same general patterns we found when examining the relationship between market concentration and gross payments, including the attenuation bias in the panel fixed-effects regressions. Focusing on the results that account for the potential endogeneity of insurer and dentist HHI via instrumental variables (Table 4, Column 3), we find that insurers in more concentrated markets tend to pay a smaller share of the list price (1.13-1.19 percentage points for a 10 percent change in HHI) and more concentrated dentist markets increase the allowed-to-list price ratio (0.50-0.63 percentage points for a 10 percent change in HHI).

In a series of robustness checks, we estimated models using a 40-minute maximum travel time threshold when calculating dentist HHIs. The F-statistics from the first-stage regressions using the 40-minute maximum travel time threshold are above 10 (Table S2). The models using a 40-minute maximum travel threshold, which are reported in Tables S3 and S4, come to qualitatively similar conclusions as those reported in Tables 3 and 4. We also removed procedures that specialists are more likely to preform (D4341, D4910, and D7140) from the composite measure of reimbursement. Excluding these procedures lead to qualitatively similar results.

5 | CONCLUSION

Reimbursement for dental services responds to changes in commercial dental insurance concentration and provider concentration. Dental insurers are able to dampen reimbursement more than dentists or dental groups are able to increase prices for their services. One potential explanation for this finding is that dental insurance markets are substantially more concentrated than provider markets. This suggests that dental insurers may have significant bargaining leverage over dentists. The latest data suggest that about 10 percent of dentists are in a DMSO.[36] Still, the scale of consolidation in dental provider markets still has not approached the level of consolidation that has occurred in hospital and physician markets.[37-41]

Given the lack of information on the prices paid for dental services, our study highlights the need to conduct further research into the pricing and quality of dental services, as well as the need for better data on dental markets. Our analysis was limited to using HHIs calculated at the 3-digit zip code level provided by FAIR Health.® While these data are extensive, reflecting over a 75 percent share of commercial dental insurance, the inability to obtain information at a more granular level means our measures of dental insurer concentration have some degree of measurement error. This leads to attenuation bias that can cause coefficient estimates to be biased toward zero, underestimating the effect of market concentration on price. Furthermore, our pricing information comes from IBM Watson MarketScan®. Although the database covers a wide variety of health plans and employers, the database only covers approximately 7.6 percent of the commercial dental insurance market.

Our results have important implications for understanding the future of the dental marketplace. Reimbursement declined in recent years,[18] possibly due to dental insurers having more negotiating leverage over their provider counterparts. However, there is some evidence that DMSOs are able to extract higher reimbursement for their dentists. For example, dentists in group practices were able to get modestly higher reimbursement for services provided in 2017 and 2018, yet over the same period, reimbursement for solo practitioners declined 6-9 percent per year.[42] This suggests that consolidation among dentists may be on the horizon.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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