Profit Sharing and Patient Steering: Foreclosure from Vertical Ties in Dialysis*

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March 2026

Abstract

Health care markets have consolidated substantially over the past three decades following increases in both horizontal and vertical integration. We find that vertical ties in dialysis, the most concentrated U.S. health care sector, have larger economic effects than horizontal combinations: joint ventures increase patient counts much more than acquisitions do, with physicians steering patients to facilities where they have an ownership stake or serve as a highly compensated medical director. Joint ventures have no discernible effect on health outcomes or spending but lead to foreclosure, as markets with more patients treated at JV facilities have a significantly lower likelihood of rivals entering over the next five years compared to no impact from non-JV facilities.

*Chris Behrer, Wanrong Deng, Riley J. League, Mingpei Li, Ekenedilichukwu Okonkwoaguolu, Holly Tamburello, Heather Wong, and Peck Yang provided excellent research assistance. The data reported here have been supplied by the United States Renal Data System (USRDS). The interpretation and reporting of these data are the responsibility of the authors and in no way should be seen as an official policy or interpretation of the U.S. government. McDevitt reports research funding from the American Investment Council, Arnold Ventures, Duke University's Office of the Provost, the Health Management Academy, the National Bureau of Economic Research, the National Institute for Health Care Management, the National Science Foundation, and the Washington Center for Equitable Growth; he has received consulting fees from the American Society of Nephrology, Korein Tillery, and Charles River Associates, including for matters involving DaVita and Fresenius, as well as speaker fees from Heritage Group, InTandem Capital, and Welsh, Carson, Anderson, & Stowe, and in the past served on the advisory board of Renalogic.

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1 Introduction

Health care markets have consolidated substantially over the past three decades. Much of this consolidation has come from horizontal mergers and acquisitions, but a more recent trend towards vertical integration has begun to affect most segments of the U.S. health care system as well. Although consolidation can increase welfare through operational efficiencies and coordinated care, it may also come with tradeoffs such as increased pricing power, incentives to underinvest in quality, conflicts of interest between providers and patients, and the ability to deter rivals' entry through market foreclosure (Baker et al., 2014; Neprash et al., 2015; O'Hanlon et al., 2019).

We study the effects of both horizontal and vertical consolidation in the dialysis industry, where the two largest chains, DaVita and Fresenius, now control nearly 80% of the market following a series of horizontal mergers and acquisitions, making it the most concentrated of all U.S. health care sectors. An increase in vertical integration has reshaped the market as well, with roughly one in four facilities now operating as joint ventures between physicians and chains, a nearly fivefold increase from twenty years ago. Chains also pay their medical directors roughly twice as much as independent facilities do, introducing an additional vertical tie between referrers and providers (Xia et al., 2025).

Horizontal consolidation has well-understood effects on competition, quality, and prices (Gaynor et al., 2015; Cuellar and Gertler, 2006; Dafny et al., 2012; Gaynor and Town, 2012). In dialysis, for example, previous work has shown that acquisitions of independent facilities by large chains lead to increased spending and lower-quality care (Eliason et al., 2020). The implications of vertical integration are less clear, with a growing literature finding it typically results in larger market shares with little evidence on how it affects quality and prices (Baker et al., 2016; Capps et al., 2018; Koch et al., 2017; Heebsh, 2020; Swanson, 2021; Munnich et al., 2026; Cooper et al., 2025).

Complicating this analysis, vertical arrangements can take forms other than traditional mergers and acquisitions, including partnerships, affiliations, directorships, and joint ventures (Ramirez, 2016). Much less is known about these alternative formations. As one prominent example, for-profit dialysis chains' joint ventures with local physicians have raised concerns about the conflicts of interest that could arise from having an ownership stake in a facility's profits (Eliason et al., 2022). Dialysis chains assert that joint ventures benefit patients by improving coordination and quality, but others have questioned whether they might distort treatment decisions in ways that harm patients. A 2022 report from the Medicare Payment Advisory Commission (MedPAC), for example, suggests that providers with financial interests in dialysis facilities might steer patients to the facilities in which they in-

vest, initiate patients on dialysis when it is of questionable value, push patients to in-center dialysis instead of receiving it at home or getting a transplant, and over-furnish profitable separately billed services. Similar allegations about dialysis companies using lucrative medical directorships as a means to induce patient referrals have also recently received scrutiny (Flanagan, 2025).

Multiple state and federal laws seek to limit the potential conflicts of interest that could arise from the gatekeeping role of physicians, including the Physician Self-Referral Law, commonly referred to as the Stark Law, that prohibits physicians from referring patients for services to any entity in which they hold a financial stake. The law contains special exceptions for dialysis, however, which may result in physicians being influenced by the financial incentives that come from sharing in a facility's profits. The Anti-Kickback Statute similarly prohibits dialysis providers from offering, paying, soliciting, or receiving remuneration to induce referrals, with recent work suggesting a correlation between the salaries medical directors receive from dialysis facilities and the number of referrals they send to them (Xia et al., 2025) and whistleblower lawsuits alleging chains use joint ventures to "funnel a bag of money to the physicians" (United States ex rel. David Barbetta, 2009). Despite the outsize importance of dialysis for health care spending in the U.S., empirical studies on the implications of joint ventures and medical directors have so far been stifled by a lack of data.

We study the economic effects of vertical ties in dialysis using a novel dataset identifying all joint ventures among dialysis facilities, ownership ties between physicians and firms, medical director identities and compensation, and patient-level data on treatments and outcomes. From the staggered timing of acquisitions, joint ventures, and medical director relationships, along with within-facility and within-patient variation, we identify the effects of both vertical and horizontal consolidation on market share, provider practices, facility operations, health outcomes, and Medicare spending. We find that entering into a joint venture increases the number of patients treated at a facility by 24%, due largely to an increase in referrals from physicians, whereas horizontal M&A leads to a more modest increase in patients of about 8%. Medical directors have an even larger influence on referrals, sending 70% more patients to the facility after starting a position there, a rate that increases by an additional 0.9% per $1000 in annual compensation.

The effects on quality are inconsequential. Most measures of clinical quality remain unchanged after the start of a JV, and we find no evidence that coordination improves as a result of physician ownership stakes: the likelihood of receiving a kidney transplant or being put on the waitlist during a patient's first year on dialysis both fall slightly. We find modest evidence of cream skimming: new patients at JV facilities have slightly higher average glomerular filtration ratios (GFR), consistent with marginally earlier dialysis initiation, and

JVs are more likely to have lucrative privately insured patients.

We find strong evidence of foreclosure from joint ventures. Across one-, three-, and five-year horizons, markets in which JVs account for a larger share of patients are significantly less likely to have subsequent entry by rival dialysis providers: a 10-percentage-point increase in rival JV patient share is associated with a roughly 0.1–0.2 percentage-point decline in entry within one year, 0.3–0.5 point decline within three years, and a 0.3–0.6 point decline within five. Relative to baseline rates, these percentage-point reductions correspond to roughly 3–7% less entry. By contrast, the share of patients treated by rival non-JV chain facilities has a small and statistically insignificant effect on entry, which suggests that the deterrence effect of rivals does not stem generically from the presence of chain competitors but instead relates specifically to JVs, a result consistent with physician-linked JVs reducing the residual demand available to potential entrants.

We make two primary contributions. First, we provide new insights on the effects of JVs among health care providers, which historically have been opaque due to a lack of data. In dialysis, for example, no publicly available data have previously identified which facilities operate as JVs, who the partners are, or how the ownership stakes are structured. Without these fundamental details, regulators and policymakers have had no way to study how JVs affect patients' quality of care or Medicare spending. Although JVs may align the incentives of chains and physicians in a way that leads to better coordination and care, increasing the profit-seeking motives of physicians may distort treatment decisions, potentially affecting referrals, location of treatment (e.g., home vs. in-center, near vs. far), timing of dialysis initiation, drug prescribing behavior, and transplantation and waitlist practices. As one example, MedPAC noted a trend from 1990 through 2010 of patients initiating dialysis earlier, despite a lack of evidence that this improved outcomes (Medicare Payment Advisory Commission, 2022).

In our second contribution, we simultaneously compare the impact of horizontal consolidation with vertical integration. Although previous work has considered each type in isolation, we are not aware of any studies that have examined their effects together. Focusing specifically on physician integration, Munnich et al. (2026) find that physicians shift procedures to ambulatory surgical centers (ASCs) following formal ownership stakes with these facilities. In related work, Swanson (2021) finds no significant improvement in mortality for cardiac patients treated at physician-owned hospitals. Using aggregate data on ownership to infer physician-owner preferences in a hospital choice model, she can rule out significant cherry-picking within physician-owners' patient populations, but both facility location and a healthier overall patient population among physician-owners drive the advantageous selection of patients into physician-owned hospitals.

Our paper proceeds as follows. Section 2 provides background on the dialysis industry. Section 3 describes our data, including the novel dataset on dialysis JVs. Section 4 presents our empirical evidence on the causal effects of horizontal consolidation and vertical integration on referrals, outcomes, spending, and market structure. Section 5 presents our preliminary structural model and counterfactual analysis, with estimations forthcoming. Section 6 concludes. The appendix contains further details on our data and analysis.

2 Background

Patients with end-stage renal disease (ESRD) effectively have two treatment options: dialysis or a kidney transplant. Due to the scarcity of kidneys, most patients undergo dialysis either indefinitely or for a substantial amount of time using one of two primary modalities. The most common, in-center hemodialysis (HD), is typically administered to patients at a standalone facility three times a week, with each treatment lasting two to five hours.

ESRD patients receive care from a collection of providers. Nephrologists, the physicians who specialize in kidneys, provide pre-dialysis care, where they assist patients with chronic kidney disease, the precursor of ESRD, by advising how to avoid further loss of kidney function, deciding where and what type of dialysis to use, coordinating vascular access, and navigating transplant options. When a patient begins dialysis, their regular treatments are administered and supervised by the staff of a dialysis facility, mostly nurses and dialysis technicians. Although their nephrologist is not typically present during the session, they continue to manage the patient's care, which includes rounding at the facility where the patient receives treatment. During these visits, nephrologists review their patients' charts and request adjustments to their care from the facility's staff. They also coordinate care outside of the facility, such as referring a patient to appropriate specialists.

Dialysis itself is often provided in designated facilities run by firms that specialize in providing dialysis and associated drugs, such as those used to treat anemia. This industry is made up of a mix of for-profit and non-profit firms, ranging in size from sole proprietorships operating one independent facility to national publicly traded chains operating thousands of them. The two largest for-profit chains, DaVita and Fresenius, control over 70% of facilities and earn 90% of the industry's revenue (Shinkman, 2016; Axios, 2019). These firms maintain and operate dialysis machines and water purification systems, train nurses and technicians, and oversee care and other operations. Dialysis patients choose among more than 7,000 dedicated dialysis facilities across the U.S. much like they do in other parts of the health care system, with those covered under Medicare able to receive treatment at any certified facility that has an opening.

Dialysis chains potentially have a number of competitive advantages over independent facilities. Large chains may have lower average costs due to volume discounts for injectable drugs like EPO, as well as centralized clinical laboratories; they may have a stronger bargaining position with commercial insurance companies (Pozniak et al., 2010; League et al., 2022b); and their national brands and networks may make them more attractive to patients. The market power of large chains is reflected in the prices they charge commercial insurers, which are nearly $500 per session higher in markets served by only one large chain and do not decline meaningfully when additional large chains enter the market (Xia et al., 2025). Chains also stand apart from independent facilities by having firm-wide standards that they implement across their facilities (Eliason et al., 2026). These uniform standards may not universally lead to higher-quality care, however, as most quality measures decline at independent facilities after they are taken over by a large chain (Eliason et al., 2020).

Each dialysis facility must also employ at least one medical director, a physician who oversees care and quality at that facility, although the director does not need to be present during treatments. Medical directors at large chains receive substantially higher compensation per patient than those at independent facilities, and these payments are higher still in markets where chains face more competition (Xia et al., 2025).

Quality of care at dialysis facilities can be assessed through specific practice patterns and tests conducted during sessions. Prominent measures include the frequency and duration of dialysis, urea reduction ratio, vascular access, Epogen dosing, and hemoglobin levels. Regular and long-lasting dialysis sessions are thought to benefit health outcomes, as they allow for more clearance of waste water and toxins, but come with costs such as increased interruptions of patients' lives. A blood chemical test measuring the removal of one toxin, urea, is often used to quantify dialysis adequacy, with the standard being that the urea reduction ratio (URR), or the percent of urea removed from a patient's blood during treatment, should exceed 0.65. The method by which providers access a patient's blood stream, known as vascular access, also directly affects patients' outcomes and quality of life. The preferred form of vascular access for most patients is the AV fistula, which requires a surgical procedure but tends to last longer and lead to fewer infections than the alternatives (Ravani et al., 2013). ESRD patients are also often treated for anemia in dialysis facilities using a cocktail of prescription drugs, with Epogen, or EPO, the most common. The severity of a patient's anemia can be quantified using their hemoglobin (HGB) levels. When a patient's anemia becomes too severe, they may require a blood transfusion.

The care patients receive can impact outcomes such as mortality and hospitalizations, both generally and for specific causes. A major cause of death and hospitalization among ESRD patients is septicemia, an infection of the blood often contracted at dialysis facilities.

Properly caring for a patient's vascular access and cleaning dialysis machines between sessions reduces the risk of infections and hospitalizations, making septicemia rates informative of a facility's sanitation practices (Grieco and McDevitt, 2017). Beyond infections, receiving too little dialysis or dialysis of poor quality can increase a patient's risk of cardiovascular episodes and a condition known as fluid overload, which is caused by a buildup of waste fluid and toxins in a patient's blood.

2.1 Reimbursements

Since 1972, Medicare has extended full benefits to all patients with ESRD, regardless of age, paying for both dialysis and anemia treatment under Part B. Those enrolled in an employer group health plan when diagnosed with ESRD retain their commercial insurance as a primary payer for 33 months, during which time Medicare acts as a secondary payer (League and McDevitt, 2026). Although fewer than 10% of dialysis patients have private insurance, their reimbursements have a disproportionate impact on a facility's profits, as they typically exceed Medicare's payments by more than 500% (League et al., 2022b).

Medicare reimburses managing physicians for a broad range of services. Chief among them are ESRD management and vascular access support. Medicare pays nephrologists a monthly capitated rate for ESRD management, according to the number of patient encounters documented each month, ranging from $188 for one monthly visit to $289 for four. A nephrologist can potentially improve the efficiency of these visits by concentrating patients at fewer facilities and can have a licensed nurse fill in for up to three of the four encounters. Nephrologists can increase their income by serving as dialysis facility medical directors and by generating their own business income by owning all or a portion of a dialysis facility (Glickman et al., 2020).

2.2 Joint Ventures

Dialysis JVs consist of shared ownership between a chain and a local physician, physician group, hospital, or university, usually with the chain holding a controlling interest. A facility's profits are generally split by ownership shares (Riley and Pristave, 2005), potentially aligning the incentives of the two parties.

From the perspective of physicians, JVs provide an opportunity to establish a new stream of business income, one not tied directly to seeing patients.[1] A key benefit of partnering with

[1]In addition to profit sharing, some dialysis chains offer additional investment opportunities such as the chance to own the real estate where the facility is located and lease it back to the chain. Sometimes a JV physician is also hired as a medical director, further increasing their compensation from the chain (Medicare Payment Advisory Commission, 2022).

a chain rather than opening their own facility is that chains cover the bulk of the management and operational needs, such as processing payroll, training staff, maintaining the facility, navigating regulatory requirements, and negotiating with medical supply, pharmaceutical, and insurance companies.

From the chain's perspective, JVs may align a physician's profit-seeking incentives with their own. Physicians play a key gatekeeping role in dialysis, as they provide the primary source of referrals. Physicians not only inform patients about their treatment options but are also tasked with prescribing dialysis care and associated drugs as well as overseeing facility operations as medical directors. A primary reason to form a JV with a particular physician is therefore to secure their referrals. The exclusivity of these arrangements is notable: the average owner of a DaVita facility owns shares in 2.80 DaVita facilities and virtually no others, with similar patterns for Fresenius owners (Xia et al., 2025).

Proponents of JVs cite a number of potential benefits, including efficiency gains, improved coordination and communication, and increased quality oversight. Concerns about conflicts of interest are also common, particularly the incentive to distort patient care. Such distortions include starting patients on dialysis earlier than necessary, sending patients to facilities that are not the best fit for them, and promoting dialysis modalities such as in-center hemodialysis over home-based care. Cherry-picking is also a concern, as physicians may preferentially refer some patients to their JV facility because of their health or socioeconomic status while sending less advantageous patients elsewhere, without regard for patients' preferences (Medicare Payment Advisory Commission, 2022). Despite the importance of understanding the potential costs and benefits of JVs, a lack of facility-level data on them has hindered such efforts, a long-standing complaint among industry stakeholders (Medicare Payment Advisory Commission, 2021; Berns et al., 2018).

Concerns about the power of physicians abound throughout much of the health care system, prompting a number of laws to regulate and minimize agency problems, such as Stark and the Anti-Kickback Statute (Medicare Payment Advisory Commission, 2021). Antitrust laws provide an additional way to regulate these arrangements, though many of these deals are well below the Hart-Scott-Rodino threshold that would attract the scrutiny of regulators (Wollmann, 2020).[2] The FTC has also begun investigating whether noncompete provisions in medical director contracts at DaVita and Fresenius restrict physician mobility and limit competition from smaller providers. DaVita disclosed in a 2024 SEC filing that it received two Civil Investigative Demands from the FTC requesting information on restrictive covenants

[2]This may be changing, in part due to research on the impacts of mergers in the dialysis industry: https://www.ftc.gov/news-events/news/press-releases/2021/10/ftc-restrict-future-acquisitions-firms-pursue-anticompetitive-mergers.

with physicians dating back to 2016.[3]

3 Data

3.1 Data Descriptions

To identify physician owners of dialysis facilities, we combine three data sources. First, we filed a Freedom of Information Act (FOIA) request for the historical records of dialysis facility ownership from the Medicare Provider Enrollment, Chain, and Ownership System (PECOS). This dataset includes all group and individual owners of dialysis facilities with more than 5% ownership shares. Individual owners are reported with their National Provider Identifiers (NPIs) if applicable, which we linked with other sources — National Plan and Provider Enumeration System and Physician Compare from CMS — to identify physicians. Joint ventures can also be formed between the facility and a physician group, which are recorded as group owners in PECOS. To identify physician owners via group ownership, we used historical records from PECOS on physician groups, to link physicians to groups and then determine if that group owned any dialysis facilities. When listed as an owner, some groups report different names from their physician group name. In these cases we use the complete archive of registry records of all companies in North America from OpenCorporates to link groups matching the listed agents of the two entities. For more details on our data linkages and physician owner identification, please refer to the appendix in Xia et al. (2025).[4]

Data on medical directors come from the ESRD National Coordinating Center. These were obtained from an additional FOIA request and detail a panel of medical directors for each Medicare-certified dialysis facility between 2003 and 2021.

Finally, data on patients and facilities come from the US Renal Data System (USRDS). USRDS collects, analyzes, and distributes data on ESRD and dialysis providers in the U.S. (United States Renal Data System, 2020). USRDS collects data from Medicare claims, administrative files, and an on-site surveillance system known as CROWNWeb. While Medicare claims data provide a rich picture of patient experience for Medicare beneficiaries, features of USRDS also allow us to include data on patients with payers other than Medicare. First, a Medical Evidence Report (Form CMS-2728) is required for each patient, regardless of payer, when they initiate dialysis to establish their Medicare eligibility. The Medical Evidence file

[3]Maya Goldman, "The FTC Hones [sic] in on Dialysis Noncompetes," *Axios*, July 24, 2024. The non-compete provisions in medical director contracts are distinct from the JV ownership arrangements we study, but they reinforce the same competitive concern: chains use physician relationships to foreclose competition from independent facilities.

[4]Available at: https://jamanetwork.com/journals/jama-health-forum/fullarticle/2835489.

contains rich data on patient health conditions, as well as demographics, employment, and other information. Second, CROWNWeb collects data on virtually all dialysis treatments in nearly all Medicare-certified facilities, regardless of whether the patient is enrolled in Medicare. These data include the type of dialysis received, the length of treatment (in minutes), type of vascular access used, and blood chemical test results. Using data from claims, CROWNWeb, and the Medical Evidence forms, USRDS creates a treatment history file that tracks patients, regardless of payer, and the facilities at which they receive treatment. Other variables available for all patients include patient attributes at dialysis initiation, mortality, transplant-related outcomes, and blood chemical tests from CROWNWeb. Variables only available for Medicare enrollees include those outcomes that can only be inferred from claims data, such as hospitalizations, Medicare spending, and referring physicians.

To identify a patient's referring physician we use the Monthly Capitation Payment (MCP) physician. Because dialysis claims do not provide details on the referring physician, we infer this by identifying the physician responsible for establishing and managing the patient's plan of care. A physician can bill for a MCP for an ESRD patient if they have completed a monthly assessment of the beneficiary, established the patient's plan of care, and provided ongoing management of the patients ESRD-related care throughout the month (Centers for Medicare & Medicaid Services, 2024). We infer that the referring physician for dialysis is the physician billing for a patient's MCP at the time that patient begins dialysis. The managing physician likely plays a key role in helping the patient determine where to go for dialysis, when to begin treatment, and other decisions related to ESRD. According to Medicare Claims Processing Manual, the physician listed as the attending physician on a dialysis claim should be the same as the MCP physician. In cases when the MCP physician is missing but the dialysis claim lists an attending physician, we consider that attending physician the source of referrals.[5]

We define geographic markets as Health Service Areas (HSAs), which group ZIP codes around local hospital referral patterns; we observe market structure at the HSA-year level.

3.2 Summary Statistics

We begin by documenting the extent and growth of JVs in dialysis. Panel (a) of Figure 1 shows the growth of the dialysis industry over the years spanning 2005 to 2019. During this period, the number of dialysis facilities expanded from 4,108 to 7,290 while ownership consolidated, with chains growing from 79% to 89% and the share affiliated with the two largest, Fresenius and DaVita, increasing from 59% to 77%. Panel (a) also documents the

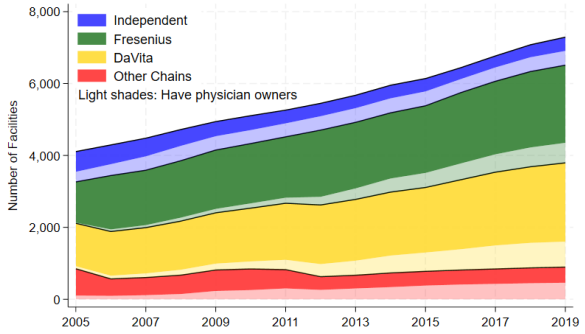
[5]In the initial month of dialysis, the MCP physician is missing 34% of the time. After supplementing with the attending physician from the dialysis claim, we identify a referring physician for about 90% of patients.

rise in JVs, shown in the lightly shaded regions, which have nearly quintupled over the sample period, increasing from 5% of facilities in 2005 to 24% of facilities at the end of 2019.

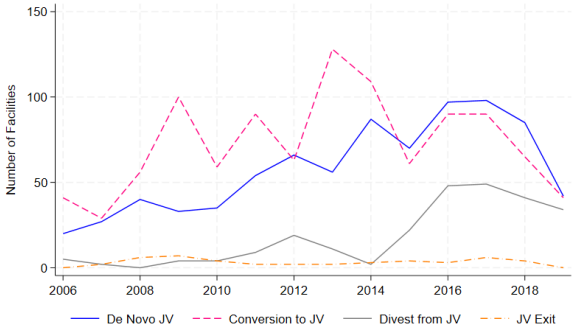
Panel (b) of Figure 1 shows the annual frequency of entry and exit from a JV. The largest category, conversions to JV, captures facilities owned entirely by a chain or physician that then transitioned to become a JV through either an acquisition by a chain in which a physician preserved some ownership stake or through a divestiture of an ownership share of a wholly owned chain facility to a physician partner. The number of conversions to JVs remains steady over the years included in our sample. Facilities may also open directly as JVs, which we term de novo JVs, and can also terminate their JV arrangement. In some rare cases, facilities shut down completely. Figure A.1 in the appendix shows the growth and spread of JVs across the country from 2005 to 2019.

Figure 1: Joint Ventures in the Dialysis Market Over Time

(a) Growth of Joint Ventures



(b) Joint Venture Formations by Type



Note: *Panel (a)*: Annual count of free-standing dialysis facilities in the U.S., by chain ownership. Lighter-shaded areas indicate the number of facilities with physician owners. *Panel (b)*: Facility count by types of JV formations. De novo JV counts a new facility entering as a JV; conversion to JV counts a JV facility that is not a JV in the year before; divest from JV counts a non-JV facility that is a JV in the year before; JV exits counts a JV facility that exits the market in the next year.

Table A.1 presents facility-level summary statistics at the annual level, split according to chain and physician ownership types. Facilities are broadly similar across ownership types in terms of patient volume and station counts, although independent and physician-owned facilities tend to be slightly smaller. Notably, JV facilities serve more privately insured (EGHP) patients than their non-JV counterparts within the same chain. For example, by 2019 DaVita JVs averaged 3.21 EGHP patients per year compared to 2.70 for DaVita non-JV facilities, with a similar gap for Fresenius, which suggests that JVs may be oriented towards capturing a more profitable payer mix. Independent and physician-owned facilities also tend to have higher staffing ratios — more employees and nurses per station — compared to chain-operated facilities, whether JV or not.

For patient outcomes, one-year survival rates improved across all ownership types over

the sample period, rising from roughly 75–77% in 2005 to around 83% by 2019. The differences between JV and non-JV facilities are modest and largely disappear after risk adjustment, indicating that JV status does not appear to affect patients' health outcomes. Transplant rates declined overall, and waitlist placement rates remained relatively stable. Patients' distance from their facilities also remained fairly consistent across types, generally around seven to eight miles.

JV facilities — and physician-owned facilities more broadly — exhibit systematically higher per-procedure and per-patient payments for fistula-related services compared to non-JV chain facilities. Per-patient payments for any fistula procedure at physician-owned facilities in 2019 averaged roughly $1,992 compared to $1,787 at chain non-JV facilities, which could reflect a desire of physician owners to encourage higher-intensity billing for ancillary vascular access procedures.

4 Empirical Evidence

4.1 Patterns of JV Formation

We begin by documenting simple patterns of JV formations. Defining dialysis markets by Health Services Areas (HSA), we estimate the fixed effects model

$$y_{mt} = X'_{m,t-1}\beta + \lambda_{\text{state}(m),t-1} + \epsilon_{mt},$$

where y_{mt} includes different events on JV and non-JV formations at the HSA-year level, denoted mt; $X_{m,t-1}$ includes the lag of market characteristics; $\lambda_{\text{state}(m),t-1}$ is a state-year fixed effect, which allows us to control for state-specific variations and compare across markets within states; and ϵ_{mt} is assumed to be i.i.d. with mean zero.

Table 1 shows the result for different outcome variables y_{mt} in each column, where outcomes are indicator variables multiplied by 100, so the coefficients reflect the percentage point change in the outcome when the covariate increases by one unit in a linear probability model. Larger markets, as measured by total patient counts, are significantly more likely to have both JV and non-JV entry and acquisitions. A higher lagged JV patient share is associated with significantly less non-JV entry and fewer acquisitions but associated with more JV entry. This suggests that markets with an established JV presence tend to deter conventional chain entry while attracting further JV entry, consistent with either JVs conferring a competitive advantage that incumbents seek to replicate and non-JV entrants find difficult to overcome or with markets with JV facilities potentially having other unobserved attributes that make them more amenable to forming JVs (e.g., a receptive pool of

nephrologists).

Market concentration, measured by patient-count HHI, has a strongly negative effect on nearly all types of activity. More concentrated markets have significantly fewer new JVs, have less non-JV entry, and have fewer acquisitions of both types, which is consistent with the standard intuition that highly concentrated markets offer fewer opportunities for profitable entry or expansion. The one exception is JV entry, where the HHI coefficient is small and statistically insignificant, suggesting that JV formation may be somewhat less sensitive to existing concentration than other modes of market entry.

Table 1: JV Formation Patterns

	(1)	(2)	(3)	(4)	(5)	(6)
	Any New JV (%)	Any Non-JV Entry (%)	Any JV Entry (%)	Any Non-JV Acquisition (%)	Any JV Acquisition (%)	Any JV Conversion (%)
Lag of:						
Patient Count	0.0122***	0.0208***	0.00979***	0.00549***	0.00327**	0.00410***
	(0.00134)	(0.00205)	(0.00105)	(0.000823)	(0.00107)	(0.000838)
Patient Count per Facility	0.00675	0.0623***	0.0110**	-0.0134***	-0.00874*	-0.00779**
	(0.00533)	(0.00812)	(0.00377)	(0.00354)	(0.00390)	(0.00288)
Patient Share by JV (%)	-0.0112**	-0.0218***	0.00617+	-0.0118***	-0.00766***	-0.0104***
	(0.00418)	(0.00463)	(0.00326)	(0.00212)	(0.00191)	(0.00203)
Patient Count HHI (0-1)	-6.103***	-4.748***	-0.205	-3.786***	-2.576**	-1.291*
	(0.876)	(1.403)	(0.622)	(0.699)	(0.798)	(0.583)
Patient Count Change from Last Year	0.0139	0.000339	0.00926	0.0139+	0.00931	0.00563
	(0.0144)	(0.0150)	(0.0122)	(0.00834)	(0.00817)	(0.00603)
Constant	7.375***	3.379**	-0.235	5.243***	3.693***	2.294***
	(0.861)	(1.291)	(0.609)	(0.651)	(0.703)	(0.530)
Observations	26,112	26,112	26,112	26,112	26,112	26,112
Dep. Var. Mean	5.01	7.12	2.36	2.21	1.57	1.40
State-Year Fe	Yes	Yes	Yes	Yes	Yes	Yes

SEs clustered by HSA.

+ $p < .1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: OLS regressions with dependent variables on the columns and lags of independent variables in the rows. Each observation is an HSA-year, from 2005 to 2019. Patient Share by JV indicates the percentage of patients at any JV facility in the HSA-year. Patient Count HHI is calculated at the facility level within each HSA-year, ranging from 0 to 1. Patient Count Change from Last Year indicates the change from year $t-2$ to year $t-1$, with the dependent variable constructed at year t. Dependent variables are indicators of the HSA-year having each event, multiplied by 100, so the coefficients can be interpreted as the p.p. change in the probability of each event happening as the independent variable increases by one unit. A JV acquisition is defined as an acquisition where the facility is not a JV before the acquisition and becomes a JV in the year of acquisition (among all 506 JV acquisitions in our sample, 91.5% are chains acquiring independent facilities). All acquisitions are defined broadly as changes in chain types: DaVita, Fresenius, other chains, and independent. A JV conversion is defined as a facility that changes from non-JV to JV within the same chain type. "Any New JV" consists of JVs formed via entry, JV acquisitions, and JV conversions.

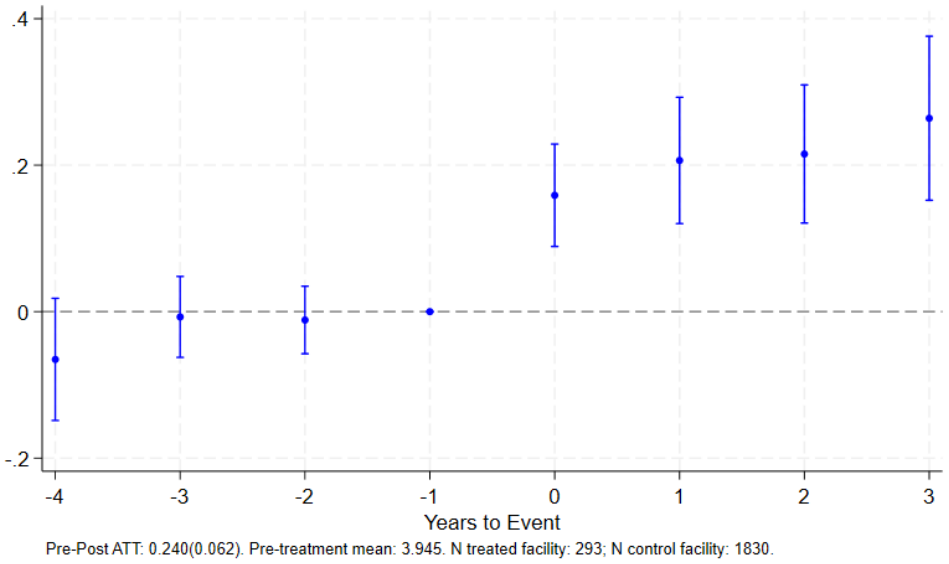
4.2 Joint Ventures Increase Patient Loads

We study the relationship between JV status and a facility's patient load using facility-year data and applying the difference-in-differences estimator proposed by Callaway and Sant'Anna (2021) to estimate the average treatment effect. To isolate the effect of JVs, we begin by defining treatment as an existing chain-operated dialysis facility converting to a JV and restrict our treated sample to facilities that begin as a non-JV chain, switch to a JV by

selling an ownership stake, and then never revert to being a non-JV chain, thereby dropping facilities that are always JV and those that became JVs in other ways, which we consider below in different ways. To disentangle the effect of JV formation from acquisitions, we further restrict the sample to include only chain facilities that never switch chain affiliation during our sample period. Our control group consists of never-treated chain facilities in markets that never have any JVs and that never change ownership. This allows us to rule out within-market interactions such as business-stealing, which we study separately in the following sections. In our baseline outcome model, we control for the number of active months each facility has in each year, since some facilities have partial entry or exit years. Alternative specifications are shown in Figure A.2, discussed below.

Figure 2 reports the baseline event-time ATTs aggregated across cohorts for the outcome of log patient count per facility-year. Prior to starting a JV, we find no statistically significant difference between treated and control samples. In the year the facility becomes a JV, we find a statistically significant and steady increase in log patient count, with the aggregated pre-post ATT estimate translating to a 24.0% increase in the facility's patient load, on a base of around $\exp(3.945) = 51.7$ patients.

Figure 2: ATT of JV formation on ln(Patient Count)



Note: Standard errors clustered at HSA level. Only event times -4 to +4 are shown. Pre-post ATT (SE) calculated from all event times is shown in the figure footnote. The treated group consists of chain-operated dialysis facilities that convert from non-JV chain to JV and never revert and never switch chain affiliation during our sample period. The control group consists of never-treated chain facilities in markets that never have any JVs and that never switch chain affiliation during our sample period. We control for the number of active months each facility has in each year, since some facilities have partial entry or exit years. Alternative specifications are shown in Figure A.2.

We consider alternative specifications in Figure A.2. Panel (a) uses the same specification and sample restriction as the baseline model but uses not-yet-treated facilities as the control group, showing a very similar effect of 0.231, indicating that the results are not sensitive to the choice of control group. Panel (b) relaxes the sample restriction by including facilities that switch chain affiliations at some point during the sample period. The effect is still statistically significant, with a pre-post ATT of 0.215, although it shows a more pronounced increasing trend in effect size after JV formation, likely confounded by acquisitions. Panel (c) adds more covariates to the outcome model, specifically, a linear function of facility age (since its CMS certification number effective year), the number of dialysis stations, full-time-equivalent (FTE) employees, nurses, and technicians at each facility, and the total number of patients and facilities in the local market (HSA), all from the year before treatment. It estimates a smaller, yet still stable and significant increase of 15.9%. Panel (d) drops the partial years of facility entry or exit from the baseline sample, which results in an estimated increase of 8.8%, mainly due to the fact that the outcome variable is on a log scale and JV conversions that occur early in the calendar year have larger percentage increases.

We conduct a similar analysis on other types of chain and JV transitions, detailed in Figure A.3. Here we consider three alternative treatments using always-independent facilities as controls. We define treatment in panel (a) as a horizontal acquisition of an independent facility by a chain, an acquisition that does not result in a JV. Echoing Eliason et al. (2020), the results here suggest that horizontal acquisition increase patient loads, though the effect may be confounded by pre-existing trends, and the increase is notably less than an acquisition that results in a JV. For panel (b), where we define treatment as an acquisition of an independent facility that results in a JV, and panel (c), where we separate physician ownership from chain ownership by defining treatment as the transition of an independent facility from not having a physician owner to having a physician owner, a physician owner increases patient loads but to a lesser extent than the pure JV effect shown in Figure 2. Table A.3 shows the corresponding fixed effects regressions for the change in patient loads following chain and JV transitions, although comparisons with the event studies above are complicated by the fact that they have different control groups.

4.3 Joint Venture Entrants

To compare the growth in patient loads at facilities that enter as a JV, dubbed de novo JVs, to growth at non-JV chain entrants, we use all facilities that entered as JV or non-JV

chains during our sample period and estimate the regression

$$s_{jt} = \sum_{\tau=1}^{4} \beta_\tau \cdot D_{jt}^{\tau} \cdot \mathbb{1}(g = 1) + X_{jt} + \lambda_\tau + \lambda_j + \epsilon_{jt}, \tag{1}$$

where j denotes facilities, $g = 1$ denotes JV entries, $g = 0$ denotes chain entries, t denotes the calendar year, τ the relative year after entry, and D_{jt}^{τ} is an indicator of facility j in year t being τ years away from entry; X_{jt} includes facility- and market-level controls; s_{jt} is the market share of patients within the HSA of facility j in year t; and β_τ's are the coefficients of interest, measuring the average difference in market share between de novo JVs and non-JV entrants τ years after entry. We require all samples to last for at least four years after entry.

Table 2: Growth After Entry

	(1)	(2)	(3)
Dep Var: Market Share (in Patient) of Entrant			
Years after Entry (JV-Chain)=1	1.557*	1.594*	1.449*
	(0.723)	(0.713)	(0.713)
Years after Entry (JV-Chain)=2	2.449**	2.560**	2.405**
	(0.890)	(0.863)	(0.869)
Years after Entry (JV-Chain)=3	2.600**	2.850**	2.726**
	(0.972)	(0.929)	(0.938)
Years after Entry (JV-Chain)=4	3.028**	3.385***	3.236***
	(1.017)	(0.965)	(0.971)
Num of Dialysis Stations		0.272	0.270
		(0.149)	(0.152)
Pat per Fac in HSA		0.0231	0.0212
		(0.0302)	(0.0303)
Num of Non-JV in HSA		0.0316	0.0258
		(0.409)	(0.427)
Num of JV in HSA		0.0265	0.00775
		(0.566)	(0.582)
Num of Total Dialysis Stations in HSA		-0.0370*	-0.0365
		(0.0188)	(0.0197)
Constant	24.78***	26.92***	27.09***
	(0.183)	(4.180)	(4.228)
Observations	9,268	9,268	9,268
Dep. Var. Mean	25.28	25.28	25.28
Fac, Chain, Num Active Motnh FEs	Yes	Yes	Yes
Event Time FE	Yes	Yes	
Entry Year-Event Time FE			Yes

SEs clustered by HSA. All samples lasted at least 4 years after entry.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Each observation is a facility-year. Compares the market share of de novo JVs and non-JV entries, using all facilities that entered as JV or non-JV chains during 2005 – 2019. The dependent variable is the facility market share within the HSA-year. The first rows indicate the difference in market share (%) between a de novo JV and a non-JV entry, one to four years after entry, normalized by the entry year.

We find that JV entrants gain market share more quickly than non-JV chain entrants, with gains increasing each year. After the first year of operation, JVs have a 1.5 percentage

points greater market share than non-JV facilities. By the end of four years, the advantage increases to more than 3 percentage points. With the average facility capturing 25.3% of the market, these differences are substantial, with JV-status increasing market share by 12% four years after entry.

4.4 Patient Outcomes

To study the effect of JVs on patient outcomes, we focus on each patient's first twelve months of care. Using the same treatment definitions and facility samples as above, we apply the estimator from Callaway and Sant'Anna (2021) on a panel with repeated cross-sectional data of patient-level variables. This allows us to flexibly model outcomes using a rich set of patient characteristics

$$\mathbb{E}[Y_t(0) - Y_{t_0}(0)|X, C = 1] = X'_{it}\beta + \lambda_{FEs},$$

where in X_{it} and λ_{FEs} we include transformations of patient age, indicators for chronic diseases, drug and alcohol use, insurance status, education, and demographics. This approach relies on within-facility variation in JV-status, and we assume that, conditional on these covariates, differences in the change in outcomes stem from the facility's behavior.

Figure 3 and Appendix Table A.4 contain the results. Panel (a) of Figure 3 shows a modest, though statistically insignificant, increase in the distance new patients travel to be treated at a facility after it becomes a JV, consistent with referral-based patient steering driving the increased patient load. Panel (b) shows first-year mortality rates, finding no evidence that JVs affect patient mortality. Panels (c) and (d) look at waitlist and transplant rates for patients during their first twelve months of dialysis, showing a small, statistically significant decrease in the share of patients added to the kidney transplant waitlist following conversion to a JV and no effect on the probability of receiving a transplant. Panels (e) shows no change in hospitalization rates.

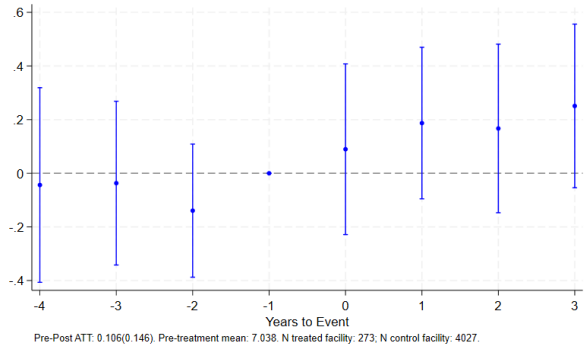
Finally, panel (f) shows the glomerular filtration rate (GFR) among incoming dialysis patients. Rather than reflect care provided at the facility, this provides information about the condition of patients initiating dialysis care, as GFR measures residual kidney function. The results show little change in the mean GFR of new patients, suggesting that JVs do not increase their patient loads by initiating dialysis for patients with better functioning kidneys, which would have been an indication of market expansion.

Appendix Table A.4 includes additional outcomes, including patient blood-chemical tests related to care quality, such as hemoglobin levels and urea reduction ratios, infections, and Medicare spending. Across all measures, JVs do not lead to worse outcomes. Taken

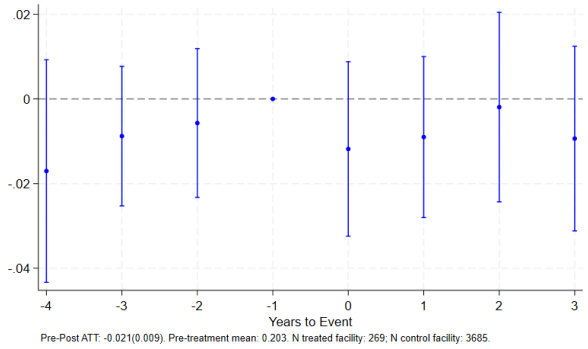
together, these results suggest JVs do not hurt or help patients, aside from a lower likelihood of being placed on the transplant waitlist during the first year of dialysis.

Figure 3: Incident Patient Outcomes

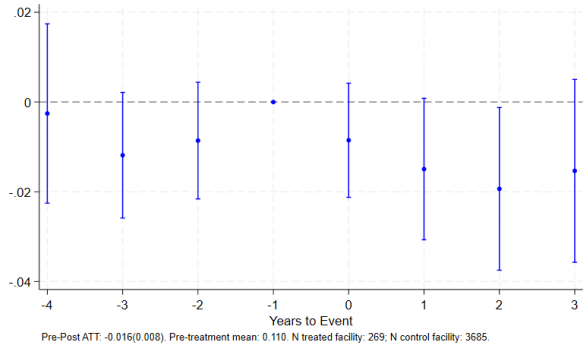
(a) Distance (miles)



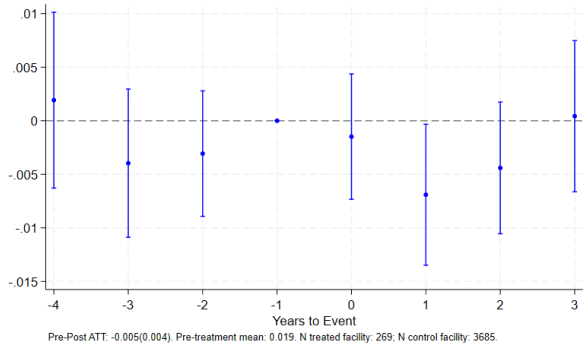
(b) First-year Death



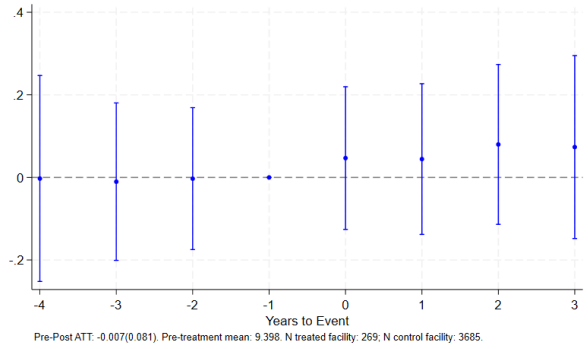
(c) First-year Waitlist



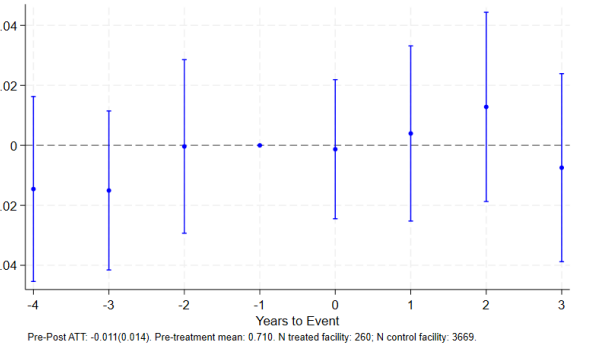
(d) First-year Transplant



(e) GFR



(f) Any Hospitalization



Note: Event study for incident patients at the patient-facility-year level. Standard errors clustered by HSA. Only event times -4 to +4 are shown. Pre-post ATT (SE) calculated from all event times is shown in the figure footnote. Controls for patient characteristics, including indicators for gender, race, cancer, drug use, drinker, smoker, assistance, various chronic conditions (e.g., diabetes, hypertension, chronic obstructive pulmonary disease, atherosclerotic heart disease, pulmonary vascular disease, ischemic heart disease and chronic heart disease), insurance status, and the linear and squared terms for BMI, age, income ($k), ZIP population share with bachelor and high school degrees, and facility age.

4.5 Business Stealing and Patient Steering

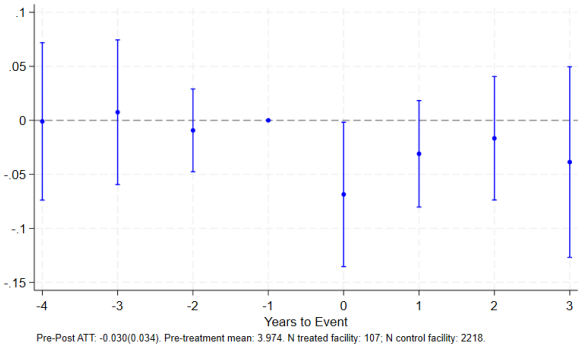
4.5.1 Business Stealing

To investigate whether JVs increase their patient loads through business stealing, we study how the patient loads of incumbent facilities change after a new JV forms in the market. Defining treatment as having a JV rival in the HSA, we restrict our treated group to facilities that are never JVs themselves, never switch chain affiliation, and never have de novo JV entries in their market. Following Section 4.2, we further drop always-treated samples and those whose status reverts to a non-JV facility. We focus on treated samples in markets that never have more than five facilities, as the business stealing in large markets would be diluted and noisier. The control group includes facilities that are never treated and never switch chain affiliation. As in Section 4.2, we control for the number of active months of each facility-year to account for partial entry or exit years.

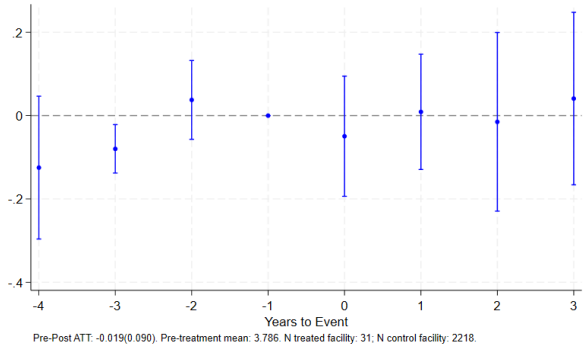
We divide the treated facilities into two groups: (i) having a JV in the market from rival chains and (ii) having a JV in the market from its own chain, with Figure 4 presenting the results for these two groups separately. First, we have many more treated samples that have a rival chain JV than those that have a JV from their own chain, likely due to selective JV formation in more competitive markets. The pre-post ATT on samples that have faced competition from a rival chain's JV in the same market translates to a 3.0% decrease in patient load, with the most pronounced effect in the year of the rival's JV formation. By contrast, markets where their own chain forms a JV do not have a meaningful change in patients, which could stem from either less business stealing from their own chain or a lack of power from a smaller sample size.

Figure 4: Effect of Having JV Rivals on ln(Patient Load)

(a) From Rival Chains



(b) From Own Chain



Note: Standard errors clustered by HSA. Only event times -4 to +4 are shown. Pre-post ATT (SE) calculated from all event times is shown in the figure footnote. Treatment is having a JV rival in the HSA. The treated group consists of facilities that are never JVs themselves, never switch chain affiliation, and never have de novo JV entries in their market; we further drop always-treated samples and those whose treatment reverts to a non-JV facility. We focus on treated samples in markets that never have more than five facilities. The control group consists of facilities that are never treated and never switch chain affiliation. We control for the number of active months of each facility-year to account for partial entry or exit years.

4.5.2 Patient Steering

A key way for JVs to attract patients and steal them from rivals is through patient steering by physicians. In dialysis, patient referrals flow primarily through nephrologists. Because most patients initiating dialysis are doing so urgently, often after a rapid decline in kidney function, and have little independent knowledge of the quality or convenience of nearby facilities, their nephrologist's recommendation of where to receive dialysis carries enormous weight, and in practice many patients simply go wherever their physician sends them.

This referral dynamic creates a natural channel for patient steering when nephrologists hold ownership stakes or serve as medical directors in dialysis facilities. A physician who co-owns a JV facility with a large chain like DaVita or Fresenius has a direct financial incentive to refer their patients to that facility, since more patients translates directly into greater revenue and, ultimately, larger profit distributions to the physician-owner. The American Society of Nephrology, the Office of Inspector General, and investigative journalists have all flagged the concern that JV ownership structures effectively allow chains to purchase referral streams by giving physicians a cut of the profits from sending patients to their facilities.

Insiders suggest steering is often subtle rather than overt. A nephrologist typically manages patients across multiple facilities and may gradually shift the balance of new referrals towards the facility where they hold an ownership stake by recommending the JV facility as

the default option for new patients, citing its proximity or quality, or simply not mentioning alternatives. Because patients rarely comparison-shop for dialysis, and because the referring physician is the most trusted source of information, even a mild bias in recommendations can produce large shifts in patient volume over time.

We observe the referring physician NPI for each incident patient from 2012 to 2019. We focus on the set of referring physicians who either have nephrology as their primary specialty or have ever served as a medical director or owner of a dialysis facility, and assume that each physician is active in referring patients from the first year to the last year in which we observe a referral from them. A physician's referral choice set consists of all facility-years in the HSAs where the physician has ever referred patients, served as a medical director, or held ownership in at least one facility. We provide summary statistics describing physician referrals in Appendix Table A.4.

Each physician can refer to multiple facilities, and each facility can receive referrals from multiple physicians. For this analysis, we estimate a fixed effects model

$$y_{ijt} = D'_{ijt}\beta + \lambda_{ij} + \lambda_{jt} + \lambda_{it} + \epsilon_{ijt},$$

where D_{ijt} is a vector of physician i and facility j relationships in year t. Other terms include a physician-facility fixed effect, which captures unobserved pair-specific referral patterns (e.g., a physician may become an owner at a facility they already refer most of their patients to); a facility-year fixed effect, accounting for facility-specific trends (e.g., the facility may start to expand after getting a physician owner); a physician-year fixed effect, accounting for physician-specific trends (e.g., the physician may start to refer more patients to all centers after becoming an owner at one facility); and ϵ_{ijt} is an i.i.d. shock with mean zero. For outcome y_{ijt}, we focus on referrals of new patients.

Table 3 shows a clear pattern of steering intensity across different types of financial ties. Becoming a facility owner is associated with an increase of roughly 0.1 additional referred patients per year in columns (1) and (2), an economically meaningful increase off pre-ownership baseline of about 0.4 referrals per physician-facility pair, for an increase of nearly 30%. Becoming a medical director has an even larger effect, increasing referrals by about 0.9 patients per year from a baseline of approximately 1.1, nearly doubling the referral volume. Holding both roles simultaneously adds a further increment on top of the individual effects: the interaction term for being both owner and medical director is positive and statistically significant in most specifications, at around 0.2–0.3 additional patients, indicating that the two financial ties amplify referral behavior.

Column (1) includes two additional variables, whether the physician holds ownership or

a medical directorship at a different facility. The coefficient on being an owner elsewhere is negative and statistically significant, suggesting that when a physician acquires an ownership stake in one facility, they modestly reduces referrals to others. This is consistent with reallocation, as the physician shifts patients towards their newly acquired facility and away from others. By contrast, a medical director position elsewhere has no effect on referrals to other facilities.

The decomposition in columns (4) and (5) reveals the source of additional referrals. The largest effects are concentrated among patients who had an established nephrologist prior to starting dialysis, which is the group most directly subject to a physician's influence. The effects are much smaller, but proportionally similar, for patients without a nephrologist before starting dialysis. Column (6) focuses specifically on privately insured patients, the most lucrative type of patient for the facility, showing an especially large increase when the physician is both owner and medical director, amounting to a roughly 45% increase. With DaVita and Fresenius receiving rates for privately insured patients more than six times greater than Medicare rates (Xia et al., 2025), such steering has a meaningful effect on a JV facility's profits

Table 3: Referring Physician Patient Steering

	(1) Num Ref	(2) Num Ref	(3) Num Ref Share	(4) Num Ref w/ Pre Neph	(5) Num Ref w/o Pre Neph	(6) Num Ref Private
Is Owner	0.0923***	0.102***	0.595*	0.0783***	0.0235**	0.0124*
	(0.0195)	(0.0207)	(0.256)	(0.0171)	(0.00836)	(0.00622)
Owner Elsewhere	-0.00669**					
	(0.00251)					
Is Med Dir	0.949***	0.917***	12.51***	0.695***	0.222***	0.108***
	(0.0642)	(0.0650)	(0.796)	(0.0540)	(0.0237)	(0.0179)
Med Dir Elsewhere	-0.000894					
	(0.00252)					
Med Dir Comp ($10k)	0.00617	0.00764	0.135*	0.00876*	-0.00112	-0.000541
	(0.00499)	(0.00505)	(0.0554)	(0.00432)	(0.00172)	(0.00146)
Is Owner and Med Dir	0.219*	0.265*	2.560*	0.275**	-0.0102	0.101***
	(0.105)	(0.103)	(1.063)	(0.0907)	(0.0341)	(0.0296)
Constant	0.153***	0.150***	2.821***	0.115***	0.0348***	0.0263***
	(0.00165)	(0.000927)	(0.0133)	(0.000763)	(0.000344)	(0.000257)
Observations	1957589	1956737	1755059	1956737	1956737	1956737
Pre-Owner DVar Mean	.345	.345	5.24	.273	.0727	.0654
Pre-Meddir DVar Mean	1.08	1.07	17.8	.833	.236	.206
Pre-Meddir&Owner DVar Mean	.992	.904	14.5	.66	.244	.224
Fac-NPI FE and Year-Fac FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year-NPI FE		Yes	Yes	Yes	Yes	Yes

SEs clustered by NPI.

$^{+}$ $p < .1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Each observation is an NPI-facility-year. Standard errors clustered by NPI. We only consider NPIs who have ever referred patients from 2012 to 2019 and are either a nephrologist or ever a medical director/owner of a facility. The potential referral targets of an NPI include all facilities in HSAs where that NPI has ever referred patients, and we assume an NPI is active from the first year to the last year that we observe any referral from that NPI. "Num Ref Share" is the share of patients referred by NPI i to facility j among all patients referred by i at t. "Pre Neph" indicates an established relationship with a nephrologist before the referral. Physician owners include both individual owners directly identified by PECOS and NPIs linked to organization owners via physician groups and OpenCorporates. Table A.5 considers the same specifications using only individual owners from PECOS. Medical director compensation is inflation-adjusted to 2019 dollars.

We next conduct an NPI-facility level event study on patient referrals, using the same estimator from Callaway and Sant'Anna (2021) as in previous sections. Our main outcome is the share of all referred patients from the NPI to the facility in each year. Treated samples are NPI-facilities where the NPI becomes an owner of the facility, the ownership never reverts, and the NPI never serves as a medical director at the same facility. Control samples are NPI-facilities of NPIs who are never an owner or serve as a medical director at any facilities. Because the patient share is calculated within NPI-year and across facilities, the outcomes of control samples for the same NPI-year always sum to 100%; therefore, for the control group

NPIs, we only keep the facility that receives the most patients in total, across all years, from the NPI.

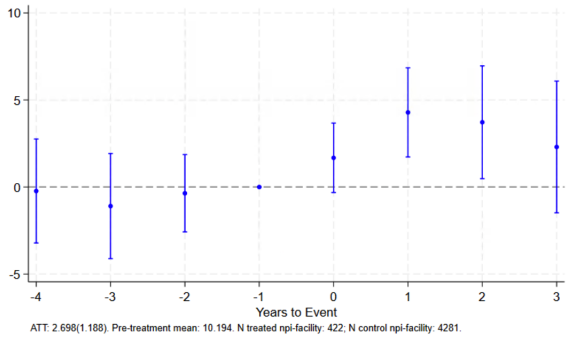
Because we use the share of referred patients from each NPI-year as the outcome variable, the NPI-year-specific trends are normalized and do not affect the comparison. We therfore do not include additional control variables in this analysis and rely on a stronger unconditional parallel trends assumption.

Panel (a) of Figure 5 shows the results, where the treated group only includes physicians who are identified as individual owners in the PECOS data, because their ownership is usually more significant and cleanly identified. Once the NPI becomes an owner of the facility, the share of patients referred to that facility increases by 2.7 percentage points on average, a 26.5% increase off a baseline of 10.2%. Figure A.5 also includes physician owners who are linked through organization owners in PECOS. The effect is less pronounced due to group composition effects, with an increase of 1.0 percentage point on average, reflecting a 19.9% increase off a baseline of 5.2%.

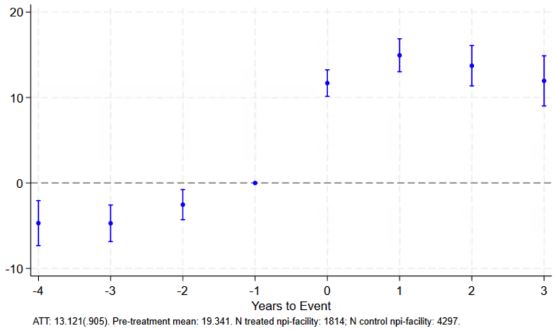
Panel (b) of Figure 5 shows a similar analysis for medical directors, where the event is the NPI becoming a medical director at the facility. We estimate an increase of 13.1 percentage points on average, and increase of 67.8% off a baseline of 19.3%. Referrals jump sharply in the year the position starts, but the event study also shows a significant pre-trend, potentially indicating that facilities may select a medical director who has a growing connection and referrals to the facility.

Figure 5: Patient Steering, Share of Patients Referred to Facility (%)

(a) Individual Owner



(b) Medical Director



Note: Standard errors clustered by NPI. Only event times -4 to +4 are shown. Pre-post ATT (SE) calculated from all event times is shown in the figure footnote.
Panel (a): Treated samples are NPI-facilities where the NPI is an individual owner of the facility identified from ESRD PECOS, the ownership never reverts, and the NPI never serves as a medical director at the same facility. Control samples are NPI-facilities of NPIs that are never owners or medical directors of any facilities; we only keep the facility that received the most patients in total, across all years, from the control group NPIs.
Panel (b): Treated samples are NPI-facilities where the NPI serves as a medical director of the facility, the directorship never reverts, and the NPI never has an ownership stake in the same facility. Control samples are NPI-facilities of NPIs that never are never an owner or medical director at any facility; we only keep the facility that received the most patients in total, across all years, from the control group NPIs.

4.6 Foreclosure

Nephrologists steering patients to their JV facilities may foreclose the entry of rival facilities. Using market-level data, we study how various market conditions, including patient shares of rival JVs, affect the probability of having facilities enter in the future. We categorize facilities into four types: DaVita, Fresenius, other chains, and independent. Table A.6 shows summary statistics of the number of entries by type-market-year. Conditional on having any entry, the majority of market-years have one facility enter from the same chain type.

We estimate a market m, year t, and chain-type c level linear probability model

$$\mathbb{1}(c \text{ has an entry in } m,\ \tau \text{ years after } t) = X'_{cmt}\beta + \lambda_t + \lambda_m + \lambda_c + \epsilon_{cmt},$$

where X_{cmt} includes market conditions c in market m in year t. We include year, market, and chain-type fixed effects, and report results at different values of τ. For each τ, the panel data is truncated such that all regression samples have at least τ years forward.

Table 4 shows results with all outcomes and indicator variables multiplied by 100, so coefficients reflect the percentage point change in the outcome probability. Across all specifications, a higher patient share held by rival JVs in a market significantly reduces the probability that a facility will enter. In column (1), each percentage point increase in the

rival JV patient share reduces the probability of entry within one year by 0.02 percentage points, and this effect scales up over longer horizons to 0.05 percentage points over three years and 0.06 percentage points over five years. These effects are statistically significant and economically meaningful relative to baseline entry rates of 2.6%, 7.1%, and 10.8% over the respective periods.

Columns (2), (5), and (8) add the patient share held by rival non-JV chain facilities as a separate regressor, and this correlation is small, positive, and statistically insignificant in every specification. In short, rival JVs — rather than rival chains per se — deter entry. A rival chain facility without a physician ownership stake does not meaningfully discourage future entry, but a rival JV does, an asymmetry consistent with our earlier results on patient steering and business stealing: potential entrants recognize that competing against a JV-affiliated facility is more difficult because the JV's physician owners funnel referrals towards it, making it harder for a new entrant to attract a critical mass of patients.

Columns (3), (6), and (9) add further market structure controls, including overall patient HHI, total patient count, and patients per station. The inclusion of HHI absorbs some of the rival share effect, but the rival JV coefficient remains negative and statistically significant, albeit somewhat attenuated, confirming that the deterrence effect of JVs operates above and beyond general market concentration. The HHI coefficients themselves are large and positive — that is, more concentrated markets are mechanically more likely to have entry, since there are fewer incumbents and potentially more unmet demand — while the "No Facility" indicator shows that markets with no existing facilities of the chain's type are substantially more likely to have entry, as expected. The patients-per-station coefficient is also positive and statistically significant, indicating that capacity-constrained markets attract entrants. Together, these controls confirm that the rival JV effect is not simply proxying for market size or concentration, but instead reflects the specific competitive threat posed by physician-integrated facilities.

Table 4: Foreclosure from Joint Ventures

	Next 1 Year (%)			Next 3 Year (%)			Next 5 Year (%)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Pat Share, Rival JV (%)	-0.0193***	-0.0150***	-0.0138***	-0.0488***	-0.0361***	-0.0318***	-0.0622***	-0.0395***	-0.0333**
	(0.00220)	(0.00241)	(0.00236)	(0.00612)	(0.00669)	(0.00649)	(0.00957)	(0.0104)	(0.0102)
Pat Share, Rival Chain (%)		0.00305	0.00214		0.00999	0.00785		0.00712	0.00479
		(0.00278)	(0.00279)		(0.00700)	(0.00698)		(0.00970)	(0.00958)
Pat Share, Rival (%)		-0.0151***	-0.0149***		-0.0398***	-0.0395***		-0.0512***	-0.0512***
		(0.00264)	(0.00267)		(0.00649)	(0.00652)		(0.00883)	(0.00879)
Patient Count		0.00272	0.00412*		-0.00469	-0.000497		-0.0114**	-0.00451
		(0.00172)	(0.00173)		(0.00304)	(0.00291)		(0.00423)	(0.00389)
Patient HHI			8.418***			21.45***			27.89***
			(0.613)			(1.521)			(2.077)
No Facility	4.787***	5.197***	13.12***	13.84***	15.45***	35.59***	19.72***	21.81***	47.90***
	(0.216)	(0.393)	(0.626)	(0.557)	(1.078)	(1.585)	(0.750)	(1.300)	(2.211)
Patient per Station		0.499***	0.371**		1.576***	1.234***		2.319***	1.823***
		(0.141)	(0.113)		(0.413)	(0.341)		(0.477)	(0.403)
Constant	2.320***	0.937+	-6.020***	5.923***	3.271*	-14.59***	8.748***	5.546***	-17.84***
	(0.0312)	(0.551)	(0.676)	(0.0836)	(1.447)	(1.558)	(0.119)	(1.664)	(2.091)
Observations	126,784	126,784	126,784	108,672	108,672	108,672	90,560	90,560	90,560
Dep. Var. Mean	2.63	2.63	2.63	7.07	7.07	7.07	10.75	10.75	10.75
Year and HSA FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Chain-type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample	year<2019	year<2019	year<2019	year<2017	year<2017	year<2017	year<2015	year<2015	year<2015

SEs clustered by HSA.

+ $p < .1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Each observation is an HSA-Chain Type-Year, 2005–2019; chain types are DaVita, Fresenius, other chains, and independent. The panel is balanced and filled in with zeros. Standard errors clustered by HSA. Dependent variables are indicators of the HSA-chain type-year having entry in the next 1, 3, and 5 years, multiplied by 100, so the coefficients can be interpreted as the percentage point change in the probability of each event happening as the independent variable increases by one unit. "Rival" is defined as rival chain types.

5 Model: Preliminary & Incomplete

The reduced-form evidence in Section 4 establishes three facts: joint ventures increase patient loads through physician steering, they steal patients from rival facilities, and they deter rival entry. We now develop a dynamic structural model of market structure to quantify the aggregate equilibrium effects of these mechanisms and to evaluate three counterfactual policies that would ban JVs.

Between 2005 and 2019, the combined market share of DaVita and Fresenius grew from 59% to 77% of all freestanding dialysis facilities, and the share of the U.S. population residing in an HSA served exclusively by one or both of these chains increased from 22% to nearly one-third (Xia et al., 2025). Markets with only a single large chain have substantially higher

commercial prices for dialysis, roughly $500 per session more than competitive markets. Understanding how JVs contribute to this consolidation, and whether banning them would lead to the entry of more independent facilities, requires a model that captures the strategic interaction between dominant chains and the competitive fringe they have displaced over the past thirty years.

Our model captures the key features of competition in dialysis: two dominant national chains making strategic entry, exit, and acquisition decisions, a competitive fringe of smaller chains and independent facilities, and the steering effect of JVs.

5.1 Model Overview

We model competition in dialysis as a dynamic entry and exit game played across geographically distinct markets, defined as Health Service Areas (HSAs). In each period t, two strategic players, DaVita (DA) and Fresenius (FR), simultaneously choose actions in every market. A competitive fringe of Other Chain facilities and Independent facilities evolve according to estimated reduced-form entry and exit processes.

A market is characterized by the state vector

$$s = (n_{DA}, k_{DA}, n_{FR}, k_{FR}, n_{OC}, k_{OC}, n_I, n_{PI}, Q, \text{CON}), \tag{2}$$

where n_j denotes the number of facilities operated by type $j \in \{DA, FR, OC, I\}$, $k_j \leq n_j$ counts the number of JV facilities among them, $n_{PI} \leq n_I$ counts physician-owned independents, Q is the total patient count discretized into bins, and $\text{CON} \in \{0, 1\}$ indicates whether the state has a Certificate of Need law restricting entry.

Each strategic player chooses an action triple (a^E, a^X, a^A) per market-year. Entry choices are $a^E \in \{0, 1, 2\}$, corresponding to no entry, non-JV entry, or JV entry. Exit choices are $a^X \in \{0, 1\}$, corresponding to no exit or closing one facility. Acquisition choices are $a^A \in \{0, 1, 2\}$, corresponding to no acquisition, acquiring a fringe facility as non-JV, or acquiring as JV. This yields $3 \times 2 \times 3 = 18$ action combinations per player, subject to feasibility constraints that depend on the current state (i.e., a player cannot exit if it has no facilities, cannot acquire if no fringe facilities exist, and cannot enter or acquire beyond the state space cap; in CON states, entry incurs an additional cost that increases with market saturation, reflecting the regulatory burden of demonstrating need).[6]

[6]We approximate total market stations as 16 times the number of facilities. In CON states, when the implied patients-per-station ratio falls below 4, entrants face an incremental cost proportional to the shortfall. This soft penalty allows the model to assign positive, albeit low, entry probability in saturated CON markets, consistent with the data, while making entry costly enough to deter it in most cases.

Actions are subject to idiosyncratic private information shocks drawn from a type I extreme value distribution. Each player maximizes the expected present discounted value of profits, with discount factor $\beta = 0.95$. We solve for a Markov Perfect Nash Equilibrium (MPNE) in which each player's strategy is a best response to the other's, conditional on the state.

5.2 Revenue and Costs

Revenue Dialysis facilities receive per-treatment payments from two sources: Medicare and employer group health plans (EGHPs). We normalize Medicare reimbursement to 1 and express all monetary values in patient-year units. Private insurers pay substantially more than Medicare: using data on commercial dialysis prices from League et al. (2022a), the national average EGHP-to-Medicare price ratio is approximately 5.5, rising from 4.4 in 2005 to 6.5 in 2017. We denote the share of patients in a market of size Q that are privately insured as ϕ_Q, and calibrate this share from data.

Average revenue per patient at a non-JV facility of chain type j is therefore

$$r_j = (1 - \phi_Q) + \phi_Q \cdot p_j, \tag{3}$$

where p_j is ratio of the EGHP price to Medicare for chain type j. For the two large chains *DA* and *FR*, $p_j = 5.5$; for Other Chains, $p_j = 4.0$; and for Independents, $p_j = 2.0$, reflecting their weaker bargaining position with commercial insurers (Xia et al., 2025).

JV steering The reduced-form evidence in Section 4 shows that JV facilities attract more patients, particularly those with private insurance. We model this through two channels. First, physician steering increases total patient volume at JV facilities, estimated in the first-stage allocation model in Section 5.3. Second, JV facilities have a roughly 15% higher share of commercially insured patients than non-JV facilities of the same chain type, reflecting physicians' tendency to steer their privately insured patients toward facilities in which they hold an ownership stake. We calibrate this EGHP share premium from the data as a proportional shift: $\phi_Q^{JV} = \phi_Q \times (1 + \delta_\phi)$, where $\delta_\phi = 0.154$. This mechanism, operating through both patient volume and payer mix, is the central channel through which JVs affect revenues and ultimately market outcomes.

JV profit sharing Physician owners typically receive 49% of facility-level profits at a JV, an arrangement documented in DaVita and Fresenius' SEC filings and consistent with the

industry practice described in Berns et al. (2018) and Glickman et al. (2020). For a JV facility, the chain retains a share $(1 - \alpha)$ of gross operating profit, where $\alpha = 0.49$.

Costs Facilities incur a variable treatment cost c_{var} per patient-year and a clinical fixed cost FC that covers rent, utilities, and minimum staffing. In addition, each facility operated by a large chain bears a corporate overhead cost FC_{OH} reflecting general and administrative expenses, compliance, and IT infrastructure. The total per-facility fixed cost for a chain facility is $\text{FC}_{\text{chain}} + \text{FC}_{\text{OH}}$, while fringe facilities pay $\text{FC}_{\text{fringe}}$.

MedPAC discipline We discipline the cost structure using external data from the Medicare Payment Advisory Commission. MedPAC reports that the marginal profit on an additional dialysis treatment is approximately 21% of average revenue, while the aggregate Medicare margin is approximately 2.5% (Medicare Payment Advisory Commission, 2021, 2022). The gap between these two figures, high marginal profitability but low aggregate margins, pins down the magnitude of fixed costs, including the corporate overhead that large chains extract from their facilities. We incorporate these moments as an auxiliary penalty in the estimation objective.

Entry, acquisition, and exit costs New entry requires a one-time sunk cost κ_E, reflecting construction and equipment expenses, which is approximately \$1.5–2 million in practice. Forming a JV incurs an additional setup cost κ_J. Acquiring an existing fringe facility costs κ_A, which includes the purchase price for the facility as well its patients, which the model allows to differ from entry costs. Upon exit, a chain recovers a scrap value ς.

Ramp-up New facilities take several years to reach their steady-state patient load. We calibrate the ramp-up profile from the 3,572 entry events in our data by computing the ratio of mean patients at each facility age $t \in \{0, \ldots, 5\}$ to the mean patient count across all facilities aged six years or older ($\bar{q}_{6+} = 80.4$). For non-JV entrants, the ramp-up fractions are $[0.17, 0.45, 0.57, 0.65, 0.71, 0.75]$: a new facility treats only 17% of the steady-state patient load in its first year of operation, reaching 71% by year five and approximate parity by year seven. JV entrants ramp up faster, with fractions $[0.17, 0.52, 0.69, 0.80, 0.86, 0.93]$, consistent with physician referral networks providing an initial patient base; JV facilities reach 93% of steady state by year five. We incorporate the present value of forgone profits during ramp-up, discounted at rate β, as a cost of entry. Acquisitions face a milder ramp-up penalty of 50% of the entry penalty, as the acquirer inherits the existing patient base.

5.3 Patient Allocation

To determine how patients are distributed across facilities within a market, we estimate a first-stage allocation model

$$\ln q_i = \alpha_0 + \alpha_j + \delta \cdot \mathrm{JV}_i + \gamma_Q \ln Q_m + \gamma_{\text{own}} \ln n_{\text{own}} + \gamma_{\text{rival}} \ln(1 + n_{\text{rival}}) + \gamma_{\text{rs}} \cdot \mathrm{RS}_m + \mathbf{X}_t' \boldsymbol{\psi} + \varepsilon_i, \tag{4}$$

where q_i is the number of patients at facility i, α_j is a chain-type fixed effect, JV_i indicates JV status, Q_m is total market demand, n_{own} is the number of own-chain facilities in the market, n_{rival} is the number of rival facilities, RS_m is the fraction of rival facilities with steering advantages (i.e., JV status for chains, physician ownership for independents), and $\mathbf{X}_t$ includes year effects.

The key coefficient δ measures the proportional increase in patients from JV status. The own-chain coefficient γ_{own} captures within-chain cannibalization, while γ_{rival} captures competition from rivals.

JV status is endogenous: facilities that become JVs may be located in markets with unobservably high demand or other attributes that make them well-suited to physician ownership. We instrument for JV status using a leave-one-out national JV share, constructed from each chain's JV propensity in all markets except the focal one. The identifying assumption is that a national chain's corporate strategy for forming JVs is orthogonal to local demand shocks, conditional on market observables. This instrument, interacted with CON law status, provides two excluded instruments for the single endogenous variable. Estimates from this first-stage regression are taken as data in the dynamic model, which uses the allocation function to predict per-facility patient counts as a function of the market state.

5.4 Fringe Entry and Exit

Other Chains and Independent facilities are modeled as a competitive fringe. Rather than solving for their optimal dynamic strategies, we estimate reduced-form logit models for entry and exit as functions of the market state:

$$\Pr(\text{entry}_{jm,t+1} = 1 \mid s_{mt}) = \Lambda(\mathbf{x}_{jmt}' \boldsymbol{\beta}_j^E), \tag{5}$$

$$\Pr(\text{exit}_{imt} = 1 \mid s_{mt}) = \Lambda(\mathbf{x}_{imt}' \boldsymbol{\beta}_j^X), \tag{6}$$

where $\Lambda(\cdot)$ is the logistic function, $j \in \{OC, I\}$, and the regressors $\mathbf{x}$ include log market size, chain presence variables (n_{DA}, k_{DA}, n_{FR}, k_{FR}), the count of own-type facilities, CON status, and year effects.

We define exit as true facility closure, excluding acquisitions by chains. Acquisitions are modeled as strategic actions of *DA* and *FR*, so counting them as fringe exits would double-count these transitions. This distinction matters quantitatively: including acquisitions as exits inflates the apparent exit rate from approximately 2% per year to over 12%.

For Other Chain entrants, we separately estimate the probability of entering as a JV, conditional on entry, using a logit on market characteristics. Under the JV ban counterfactual, this probability is set to zero.

5.5 State Space and Transitions

The full state vector in (2) has ten dimensions. We discretize market size into seven bins using facility-weighted quantiles of the patient count distribution, where each facility-year observation contributes its market's patient count to the quantile calculation. This allocates bin resolution to the range of market sizes where facilities actually operate and where we observe entry, exit, and acquisition decisions. With unweighted quantiles, by contrast, the majority of bins would cover small rural markets with few facilities and little observable chain activity, while compressing the medium-to-large markets that generate most of the identifying variation into a single bin. With caps of $n_{DA} \leq 4$, $n_{FR} \leq 4$, $n_{OC} \leq 3$, and $n_I \leq 5$, and the JV counts bounded by facility counts, the state space contains approximately 661,500 states. The independent cap is set higher than the chain caps to accommodate the JV conversion counterfactual described in Section 5.8, where dissolved JV facilities become physician-owned independents.

Market demand evolves stochastically according to a transition matrix $\mathbf{P}_Q$, where entry (q, q') gives the probability of moving from size bin q to size bin q' in one period. We estimate this matrix from year-over-year transitions in the data. Dialysis demand has grown at approximately 4.2% per year over our sample period, driven by population aging and rising diabetes prevalence (United States Renal Data System, 2020). The estimated transition matrix is diagonally dominant, with the majority of market-years remaining in the same bin, but annual demand growth generates meaningful cross-bin transitions. These transitions accumulate over the model's ten-year counterfactual horizon and ensure that firms' forward-looking entry decisions account for the possibility of moving to a larger or smaller demand bin.

CON status is time-invariant over our sample period. Transitions in the competitive structure, facility counts and JV counts, are determined jointly by the strategic players' actions and the fringe entry/exit realizations, as described in (10).

5.6 Flow Payoffs

The per-period payoff to strategic player $j \in \{DA, FR\}$ in state s when taking action $a = (a^E, a^X, a^A)$ is

$$\pi_j(a,s) = \underbrace{\sum_{f \in \mathcal{F}_j(s)} \Pi_f(s)}_{\text{operating profit from existing facilities}} \underbrace{- \kappa_E \cdot \mathbf{1}(a^E > 0) - \kappa_J \cdot \mathbf{1}(a^E = 2)}_{\text{entry costs}}$$
$$\underbrace{- \kappa_A \cdot \mathbf{1}(a^A > 0) - \kappa_J \cdot \mathbf{1}(a^A = 2)}_{\text{acquisition costs}} + \underbrace{\varsigma \cdot \mathbf{1}(a^X = 1)}_{\text{scrap value}} - \underbrace{R(a,s)}_{\text{ramp-up penalty}}, \tag{7}$$

where $\mathcal{F}_j(s)$ is the set of chain j's facilities and $R(a,s)$ is the present value of forgone profits during the new facility's ramp-up period.

Operating profit at a single facility is

$$\Pi_f(s) = \begin{cases} (r_j - c_{\text{var}}) \cdot q_f(s) - \text{FC}_{\text{chain}} - \text{FC}_{\text{OH}} & \text{if non-JV,} \\ (1-\alpha)\left[(r_j^{JV} - c_{\text{var}}) \cdot q_f(s) - \text{FC}_{\text{chain}} - \text{FC}_{\text{OH}}\right] & \text{if JV,} \end{cases} \tag{8}$$

where $q_f(s)$ is the patient allocation from (4), r_j^{JV} reflects the higher EGHP share from steering, and $\alpha = 0.49$ is the physician's profit share. The chain's payoff from a JV facility thus reflects two offsetting forces: JVs attract more patients — and especially more lucrative EGHP patients — but the chain retains only 51% of the resulting profit. This tradeoff shapes the chain's choice between JV and non-JV entry.

Although the EGHP-to-Medicare price ratio varies substantially over time, we assume the national average premium of 5.5. Geographic and temporal variation in commercial prices enters the model through two channels: the market-varying EGHP patient share ϕ_Q, which differs across demand bins, and the first-stage patient allocation, which captures how facility counts and JV status affect the distribution of patients.

5.7 Equilibrium and Estimation

Equilibrium We solve for the MPNE using value function iteration (VFI). Player j's value function satisfies

$$V_j(s) = \ln\left(\sum_{a \in \mathcal{A}_j(s)} \exp\left[v_j(a,s)\right]\right) + \gamma, \tag{9}$$

where γ is Euler's constant from the type I extreme value distribution of private information shocks, $\mathcal{A}_j(s)$ is the set of feasible actions, and the choice-specific value function is

$$v_j(a,s) = \pi_j(a,s) + \beta \sum_{a_{-j}} \sigma_{-j}(a_{-j} \mid s) \sum_{Q'} P_Q(Q' \mid Q) \cdot V_j(s'(a, a_{-j}, Q'))\,. \tag{10}$$

Here, $\sigma_{-j}(a_{-j} \mid s)$ is the opponent's equilibrium choice probability, $P_Q(Q' \mid Q)$ is the market size transition probability, and $s'(a, a_{-j}, Q')$ is the next-period state given both players' actions, the new demand level, and the expected fringe transitions. We integrate over the opponent's mixed strategy and stochastic demand, but for computational tractability, we substitute the expected fringe entry and exit counts rounded to integers rather than integrating over the full combinatorial distribution of fringe outcomes. This approximation follows the approach in Benkard et al. (2015), who compute the expected fringe state conditional on the dominant firms' actions rather than integrating over the full distribution of fringe outcomes. It reduces the per-state transition from a distribution over many possible fringe realizations to a single deterministic successor for each (a_j, a_{-j}, Q') triple.

Equilibrium choice probabilities follow the logit form

$$\sigma_j(a \mid s) = \frac{\exp\left[v_j(a,s)\right]}{\sum_{a' \in \mathcal{A}_j(s)} \exp\left[v_j(a',s)\right]}. \tag{11}$$

We iterate on (9)–(11) using damped updates to ensure convergence in the simultaneous-move game: $V_j^{(n+1)} = \lambda V_j^{\text{new}} + (1-\lambda) V_j^{(n)}$, with an adaptive damping parameter λ that decreases when convergence stalls. The algorithm converges when $\max_s |V_j^{(n+1)}(s) - V_j^{(n)}(s)| < \tau$ for both players, where $\tau = 3.0$, which is approximately 2% of the typical value function level.

Estimation We estimate the structural parameters using a nested fixed point (NFXP) approach (Aguirregabiria and Mira, 2007). The outer loop maximizes the log-likelihood of observed actions over the structural parameter vector θ; the inner loop solves the dynamic game for each candidate θ to obtain the equilibrium choice probabilities. The log-likelihood is

$$\mathcal{L}(\theta) = \sum_m \sum_t \left[\ln \sigma_{DA}(a^{\text{obs}}_{DA,mt} \mid s_{mt}; \theta) + \ln \sigma_{FR}(a^{\text{obs}}_{FR,mt} \mid s_{mt}; \theta)\right], \tag{12}$$

where $a^{\text{obs}}_{j,mt}$ is the observed action of player j in market m at time t.

We augment the log-likelihood with a penalty that disciplines the cost structure using

the MedPAC moments described in Section 5.2:

$$\mathcal{P}(\theta) = \lambda_{\text{MP}} \left[\left(\frac{r - c_{\text{var}}}{r} - 0.21 \right)^2 + \left(1 - c_{\text{var}} - \frac{\text{FC}_{\text{chain}} + \text{FC}_{\text{OH}}}{\bar{q}} - 0.025 \right)^2 \right], \tag{13}$$

where r is blended revenue per patient, $\bar{q}$ is the average number of patients per facility, and λ_{MP} is the penalty weight.

We minimize $-\mathcal{L}(\theta) + \mathcal{P}(\theta)$ using the Nelder-Mead simplex algorithm with the discount factor β fixed at 0.95.

This results in eight structural parameters to estimate:

(i) c_{var}: variable treatment cost per patient,
(ii) FC_{chain}: clinical fixed cost per chain facility,
(iii) $\text{FC}_{\text{fringe}}$: clinical fixed cost per fringe facility,
(iv) FC_{OH}: corporate overhead per chain facility,
(v) κ_E: sunk entry cost,
(vi) κ_J: JV setup cost,
(vii) κ_A: acquisition cost,
(viii) ς: scrap value upon exit.

Identification The variable cost c_{var} is identified from cross-sectional variation in EGHP patient shares across market size bins: markets with higher EGHP shares are more profitable per patient, and the rate at which entry responds to this variation identifies the gap between revenue and variable cost. The clinical fixed cost FC_{chain} is separately identified from exit patterns: facilities exit when clinical operating profit falls below zero, while the additional overhead FC_{OH} is identified from the MedPAC penalty (i.e., the gap between high marginal profitability and low aggregate margins). The entry cost κ_E is identified from entry rates given forward-looking profit expectations, while the JV setup cost κ_J is identified from the relative frequency of JV versus non-JV entry, which reflects the chain's revealed preference for paying the additional cost in exchange for the steering advantage. The acquisition cost κ_A is separately identified from the frequency of acquisitions relative to organic entry.

[TABLE: Structural Parameter Estimates Forthcoming]

5.8 Counterfactual: JV Ban

We use the estimated model to evaluate a policy that bans all joint ventures in the dialysis industry, motivated by the regulatory concern that JVs create conflicts of interest

for physicians who steer patients toward facilities in which they hold ownership stakes (Berns et al., 2018; Glickman et al., 2020; Medicare Payment Advisory Commission, 2021). Such a ban would be equivalent to removing the Stark Law exception that currently permits physician investment in dialysis facilities, but a key question is what would happen to existing JV facilities when the ban takes effect. We consider three scenarios of increasing intervention. In all three, we remove JV entry and JV acquisition from the action space, re-solve the dynamic game under the ban, and simulate market structure forward for ten years using Monte Carlo draws from the equilibrium choice probabilities and fringe transition models, averaging over 100 simulation paths.

Scenario 1: Facilities revert to chain ownership Existing JV facilities remain with their parent chain but lose JV status. The chain retains the physical facility and its patient base, but the physician partner's referral incentive disappears. This scenario provides a lower bound on the effect of the ban on independent facility presence, as no new independents are created directly by the dissolution.

Scenario 2: Physicians convert JVs to independent facilities Existing JV facilities are dissolved and converted to a physician-owned independent facility. This reflects the economic logic that the physician's primary contribution to the JV is their patient referral network, which they retain after dissolution. In the data, JV physicians hold exclusive relationships with their chain partner and have strong incentives to continue treating dialysis patients. Converting JVs to independents shifts $k_{DA} + k_{FR} + k_{OC}$ facilities out of chain ownership and into the independent sector, while chains lose the corresponding facility counts. This scenario captures the most likely behavioral response to a ban: physicians who previously profited from JV ownership stakes would seek to maintain their income through independent practice rather than simply ceding their patients to the chain.

Scenario 3: Physician conversion with an acquisition ban Same as Scenario 2, but the chains are additionally prohibited from acquiring fringe facilities. This scenario addresses the concern that chains would respond to a JV ban by acquiring the newly independent facilities, effectively re-consolidating through horizontal integration. An acquisition ban, which could be implemented through enhanced Hart-Scott-Rodino enforcement or through new FTC regulations, prevents this re-consolidation channel and provides an upper bound on the effect of the ban on the entry of independent facilities.

Comparison of the three scenarios reveals how the competitive effects of a JV ban depend critically on the policy's implementation and on complementary enforcement. Because the

model is solved in full equilibrium under each regime, the counterfactual captures not only the direct effect of removing steering but also the indirect effects: without JVs, chains may substitute toward non-JV entry and more aggressive acquisition, fringe providers face different competitive environments, and the resulting changes in market structure feed back into all players' dynamic incentives.

[TABLE: Counterfactual Results Forthcoming]

5.9 Sample Selection and External Validity

The model covers 2,072 HSAs, representing 93% of all markets. The state space caps — $n_{DA} \leq 4$, $n_{FR} \leq 4$, $n_{OC} \leq 3$, $n_I \leq 5$ — exclude 167 large metropolitan markets that contain approximately 40% of all facilities. While this is a meaningful share of facilities, the excluded markets differ systematically from those in the estimation sample in ways that make them less relevant for the policy question at hand.

Large metropolitan markets already sustain a competitive fringe: 53% of excluded markets contain at least one independent facility, compared with 15% of markets in the estimation sample. Conversely, 96% of markets that lack independent facilities are included in our sample. Among included markets, 68.5% are chain-only, containing no independent facilities whatsoever. It is precisely in these smaller, more concentrated markets where the foreclosure channel operates most forcefully and where a JV ban has the greatest potential to facilitate independent entry.

The model is therefore best interpreted as quantifying the effects of JVs on market structure in the segments of the industry where chain dominance is most complete and the competitive fringe is most at risk. The excluded large metropolitan areas, where multiple providers already coexist and independents have established footholds, represent settings where the competitive dynamics differ and where the marginal effect of a JV ban on independent presence is likely smaller.

6 Conclusion

Using a newly constructed dataset on JVs and medical directors in the dialysis industry, we study the effects of these vertical ties on patients and market structure. Our reduced-form analysis shows that JVs result in much larger gains in market share than horizontal acquisitions, with relatively small impacts on provider practices. Entering into a JV increases a facility's patient count by about three times more than a horizontal acquisition does. The

market share gains stem largely from JV owners and medical directors steering patients to facilities where they have a financial relationship. We find no evidence that vertical integration leads to better coordination or quality of care.

Taken together, these findings support the growing concerns expressed by regulators about the competitive effects of physician-chain JVs in the dialysis industry. The FTC's 2024 investigation into non-compete provisions in DaVita and Fresenius medical director contracts reflects a related concern: that chains use contractual restrictions on physician mobility to limit competition from independent providers, reinforcing the referral-steering mechanism we document through JVs. The competitive harm from JVs is compounded by the broader consolidation of the dialysis industry, where nearly one-third of the U.S. population now lives in an area served exclusively by DaVita or Fresenius and commercial prices are substantially higher in concentrated markets (Xia et al., 2025). Our findings suggest that extending the Stark Law's self-referral prohibition to freestanding dialysis facilities, and our future work will model the effects of banning JVs directly, with the reduced-form results above suggesting the effect will likely be an increase in the number of independent facilities across the U.S.

References

Aguirregabiria, Victor and Pedro Mira (2007), "Sequential Estimation of Dynamic Discrete Games." *Econometrica*, 75, 1–53.

Axios (2019), "The U.S. Health Care System Is Full of Monopolies." Axios.

Baker, Laurence C., M. Kate Bundorf, and Daniel P. Kessler (2014), "Vertical Integration: Hospital Ownership of Physician Practices Is Associated with Higher Prices and Spending." *Health Affairs*, 33, 756–763.

Baker, Laurence C., M. Kate Bundorf, and Daniel P. Kessler (2016), "The Effect of Hospital/Physician Integration on Hospital Choice." *Journal of Health Economics*, 50, 1–8.

Benkard, C. Lanier, Przemysław Jeziorski, and Gabriel Y. Weintraub (2015), "Oblivious Equilibrium for Concentrated Industries." *RAND Journal of Economics*, 46, 671–708.

Berns, Jeffrey S., Aaron. Glickman, and Matthew S. McCoy (2018), "Dialysis-Facility Joint-Venture Ownership — Hidden Conflicts of Interest." *New England Journal of Medicine*, 379, 1295–1297.

Callaway, Brantly and Pedro H.C. Sant'Anna (2021), "Difference-in-Differences with Multiple Time Periods." *Journal of Econometrics*, 225, 200–230.

Capps, Cory, David Dranove, and Christopher Ody (2018), "The Effect of Hospital Acquisitions of Physician Practices on Prices and Spending." *Journal of Health Economics*, 59, 139–152.

Centers for Medicare & Medicaid Services (2024), *Medicare Claims Processing Manual: Chapter 8 — Outpatient ESRD Hospital, Independent Facility, and Physician/Supplier Claims*, rev. 12979 edition. Centers for Medicare & Medicaid Services, URL https://www.cms.gov/regulations-and-guidance/guidance/manuals/downloads/clm104c08.pdf. Publication 100-04. Issued November 22, 2024; Effective January 1, 2025; Implementation January 6, 2025.

Cooper, Zack, Stuart V. Craig, Aristotelis Epanomeritakis, Matthew Grennan, Joseph R. Martinez, Fiona Scott Morton, and Ashley Swanson (2025), "Are Hospital Acquisitions of Physician Practices Anticompetitive?" *Working Paper, Yale University*.

Cuellar, Alison Evans and Paul J. Gertler (2006), "Strategic Integration of Hospitals and Physicians." *Journal of Health Economics*, 25, 1–28.

Dafny, Leemore, Mark Duggan, and Subramaniam Ramanarayanan (2012), "Paying a Premium on Your Premium? Consolidation in the US Health Insurance Industry." *American Economic Review*, 102, 1161–1185.

Eliason, Paul J, Benjamin Heebsh, Riley J League, Ryan C McDevitt, and James W Roberts (2026), "The Effect of Bundled Payments on Provider Behavior and Patient Outcomes."

Eliason, Paul J., Benjamin Heebsh, Ryan C. McDevitt, and James W. Roberts (2020), "How Acquisitions Affect Firm Behavior and Performance: Evidence from the Dialysis Industry." *Quarterly Journal of Economics*, 135, 221–267.

Eliason, Paul J., Ryan C. McDevitt, and James W. Roberts (2022), "Physicians as Owners and Agents—A Call for Further Study." *JAMA Internal Medicine*, 182, 1276–1277.

Flanagan, Martin (2025), "Flanagan v. Fresenius Medical Care Holdings, Inc." No. 23-1305. United States Court of Appeals, First Circuit.

Gaynor, Martin, Kate Ho, and Robert J. Town (2015), "The Industrial Organization of Health-Care Markets." *Journal of Economic Literature*, 53, 235–284.

Gaynor, Martin and Robert Town (2012), "The Impact of Hospital Consolidation—Update." Technical report, Robert Wood Johnson Foundation.

Glickman, Aaron, Eugene Lin, and Jeffrey S Berns (2020), "Conflicts of Interest in Dialysis: A Barrier to Policy Reforms." In *Seminars in Dialysis*, volume 33, 83–89, Wiley Online Library.

Grieco, Paul LE and Ryan C McDevitt (2017), "Productivity and Quality in Health Care: Evidence from the Dialysis Industry." *The Review of Economic Studies*, 84, 1071–1105.

Heebsh, Benjamin (2020), "Vertical Integration in Health Care Markets." Working Paper.

Koch, Thomas G., Brett W. Wendling, and Nathan E. Wilson (2017), "How Vertical Integration Affects the Quantity and Cost of Care for Medicare Beneficiaries." *Journal of Health Economics*, 52, 19–32.

League, Riley and Ryan C McDevitt (2026), "The Fiscal Impact of the Medicare Secondary Payer Act for End-Stage Renal Disease." *Journal of the American Society of Nephrology*.

League, Riley J., Paul Eliason, Ryan C. McDevitt, James W. Roberts, and Heather Wong (2022a), "Variability in Prices Paid for Hemodialysis by Employer-Sponsored Insurance in the US From 2012 to 2019." *JAMA Network Open*, 5, e220562.

League, Riley J., Paul J. Eliason, Ryan C. McDevitt, James W. Roberts, and Heather Wong (2022b), "Assessment of Spending for Patients Initiating Dialysis Care." *JAMA Network Open*, 5, e2239131.

Medicare Payment Advisory Commission (2021), "Report to the Congress: Medicare and the Health Care Delivery System." Technical report, MedPAC.

Medicare Payment Advisory Commission (2022), "Report to the Congress: Medicare Payment Policy." Technical report, MedPAC.

Munnich, Elizabeth L., Michael R. Richards, Christopher M. Whaley, and Xiaoxi Zhao (2026), "Raising the Stakes: Physician Facility Investments and Provider Agency." *American Economic Review*, 116, 502–534.

Neprash, Hannah T., Michael E. Chernew, Andrew L. Hicks, Teresa Gibson, and J. Michael McWilliams (2015), "Association of Financial Integration Between Physicians and Hospitals with Commercial Health Care Prices." *JAMA Internal Medicine*, 175, 1932–1939.

O'Hanlon, Claire E., Christopher M. Whaley, and Deborah Freund (2019), "Medical Practice Consolidation and Physician Shared Patient Network Size, Strength, and Stability." *Medical Care*, 57, 680–687.

Pozniak, Ashleigh, Richard A. Hirth, Jane Banaszak-Holl, and John R.C. Wheeler (2010), "The Dialysis Market: Payment, Concentration, and Outcomes." Working Paper.

Ramirez, Edith (2016), "Antitrust Enforcement in Health Care: Paving the Way for the 21st Century." Remarks, FTC Chair.

Ravani, Pietro, Suetonia C. Palmer, Matthew J. Oliver, Robert R. Quinn, et al. (2013), "Associations Between Hemodialysis Access Type and Clinical Outcomes." *Journal of the American Society of Nephrology*, 24, 465–473.

Riley, James B. and Robert J. Pristave (2005), "Dialysis Facility Joint Ventures—Current Structures and Issues." *Nephrology News & Issues*.

Shinkman, Ron (2016), "The Big Business of Dialysis Care." NEJM Catalyst.

Swanson, Ashley (2021), "Physician Investment in Hospitals: Specialization, Selection, and Quality in Cardiac Care." *Journal of Health Economics*, 80, 102519.

United States ex rel. David Barbetta (2009), "First amended complaint, *United States ex rel. Barbetta v. DaVita, Inc.*" No. 1:09-cv-02175-WJM-KMT (D. Colo.), URL https://www.phillipsandcohen.com/wp-content/uploads/US-Barbetta-v-DaVita-First-Amended-Complaint-Exhibits.pdf. Filed July 29, 2009. Paragraph 56 contains the quoted phrase.

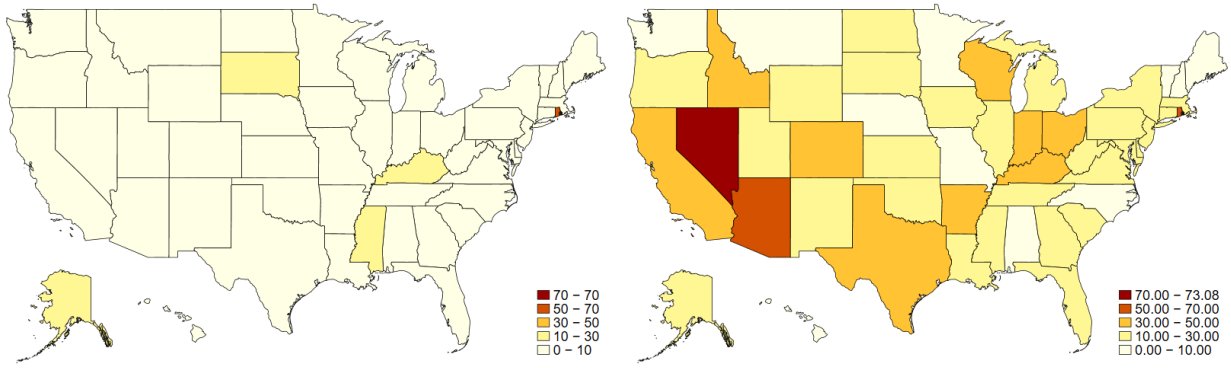
United States Renal Data System (2020), "Annual Data Report: Epidemiology of Kidney Disease in the United States." Technical report, National Institutes of Health, NIDDK.

Wollmann, Thomas G. (2020), "How to Get Away with Merger: Stealth Consolidation and its Effects on US Healthcare." *NBER Working Paper No. 27274*.

Xia, Xuyang, Wanrong Deng, Paul J. Eliason, Riley J. League, Ryan C. McDevitt, James W. Roberts, and Heather Wong (2025), "Financial Ties, Market Structure, Commercial Prices, and Medical Director Compensation in Dialysis." *JAMA Health Forum*, 6, e252659.

A Figures

Appendix Figure A.1: Share of JV Facilities by State

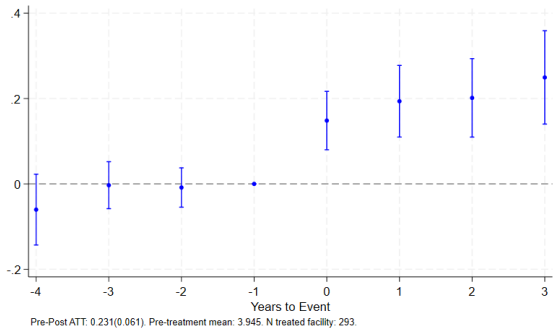


(a) 2005 (b) 2019

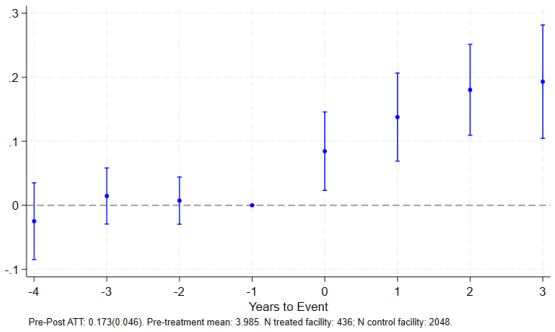
Note: Share of JV facilities by states, from USRDS and PECOS.

Appendix Figure A.2: Alternative Specifications in Dynamic Effect of JV, Log Patient Count

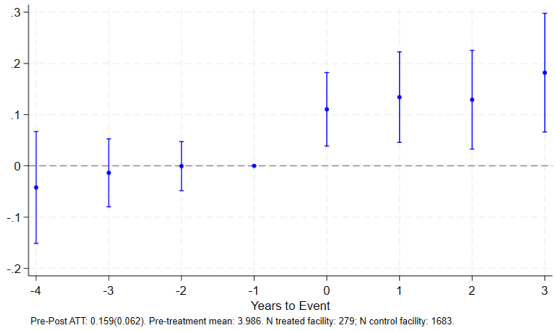
(a) Use Not-Yet-Treated as Control Group



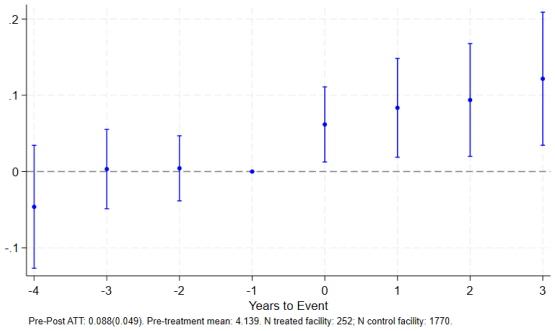
(b) Include Facilities That Switch Chains



(c) With Extra Covariates



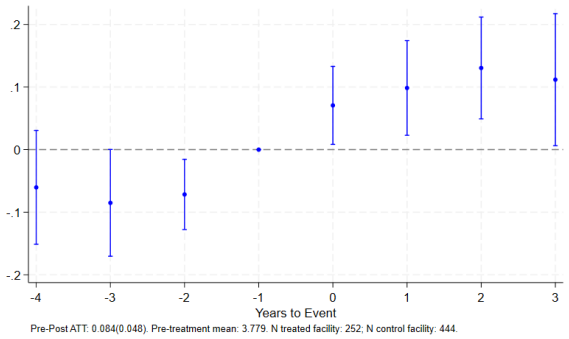
(d) Drop Partial Entry/Exit Years



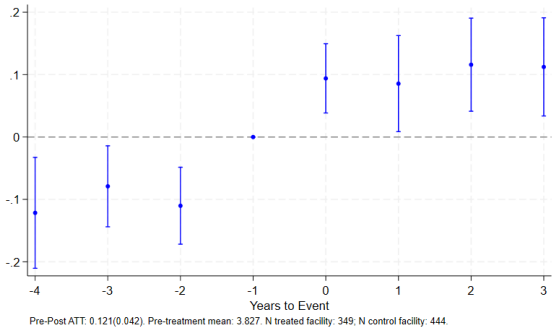
Note: Alternative specifications to Figure 2. Panel (a) uses the same specification and sample restriction as the baseline model, but uses not-yet-treated facilities as the control group. Panel (b) relaxes the sample restriction by including facilities that switch chain affiliations at some point during the sample period. Panel (c) adds more covariates to the outcome model, specifically, a linear function of facility age (since its CMS certification number effective year), the number of dialysis stations, full-time-equivalent (FTE) employees, nurses, and technicians at each facility, and the total number of patients and facilities in the local market (HSA), all from the year before treatment. Panel (d) drops the partial years of facility entry or exit from the baseline sample.

Appendix Figure A.3: Event Study on Other Chain/JV Transitions

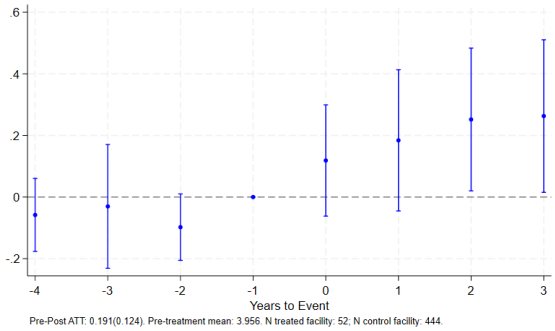
(a) Independent to Non-JV Chain



(b) Independent to JV



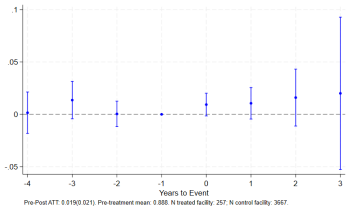
(c) Independent to Ind. Physician-owned



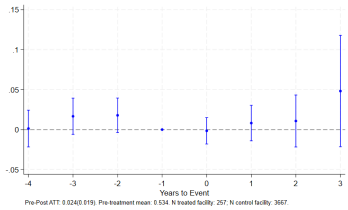
Note: All panels use never-treated samples as the control group, drop always-treated samples, and control for the number of active months in the year to account for partial entry/exit years. The control group of all panels includes facilities that are always non-physician-owned independent facilities.
Panel (a): Treated group includes facilities that once switch from independent to chain, never revert to independent, don't change chain affiliations, and never have a physician owner.
Panel (b): Treated group includes facilities that once switch from (physician-owned or non-physician-owned) independent to JV, never revert back to independent, are never non-JV chain, and don't change chain affiliations.
Panel (c): Treated group includes independent facilities that once switch from non-physician-owned independent to physician-owned independent and are never acquired by a chain. To have sufficient treated samples, we allow the facilities to revert back to non-physician-owned and define the treatment as an absorbing state since the first time having a physician owner.

Appendix Figure A.4: Incident Patient Outcomes

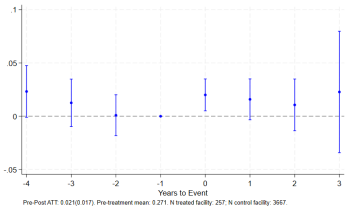
(a) URR Good



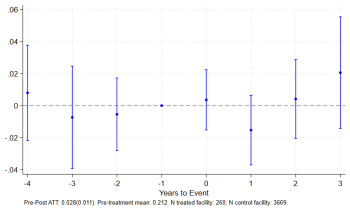
(b) Hgb Good



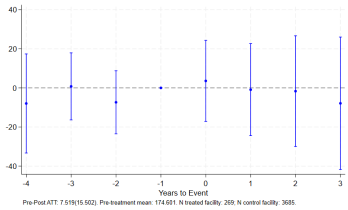
(c) Hgb High



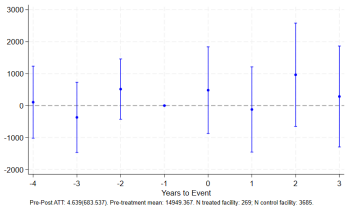
(d) Sept Hospitalization



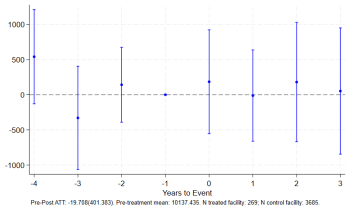
(e) Endovasc Payment



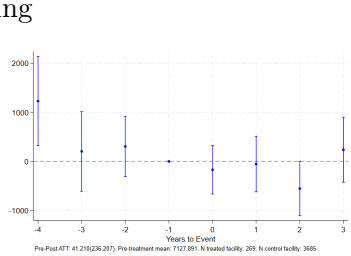
(f) Inpatient Spending



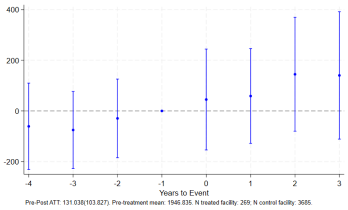
(g) Outpatient Spending



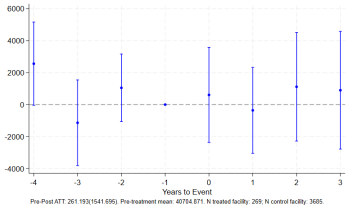
(h) Outpatient Dial Spending



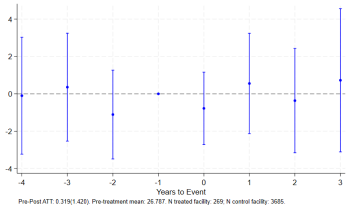
(i) Rx Spending



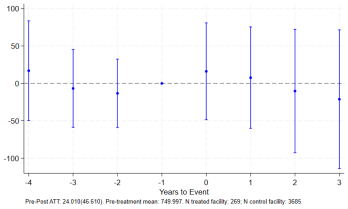
(j) Total Spending



(k) VA Diag Payment

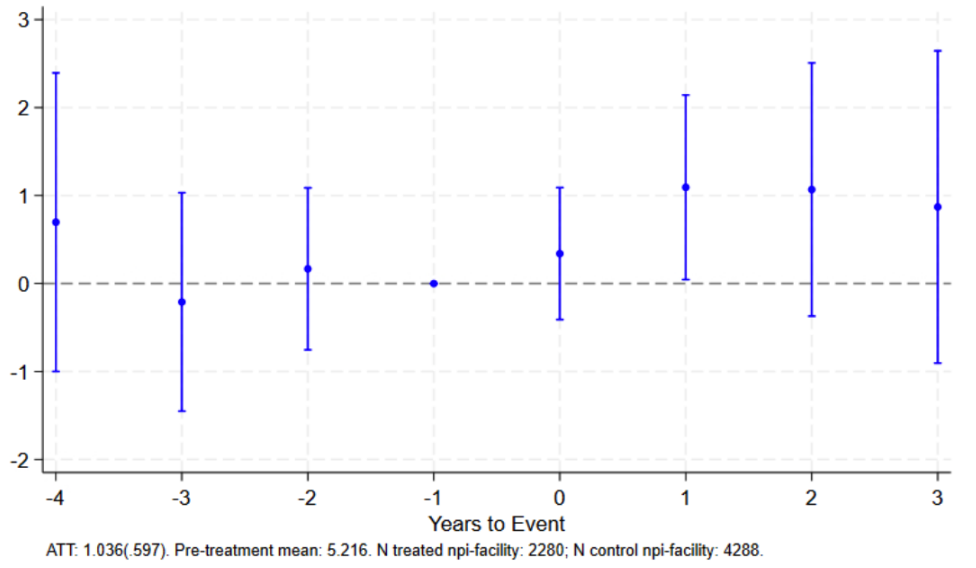


(l) VA Payment



Note: Event study at the incident patient-facility-year level. SEs clustered at HSA level. Only event times -4 to +4 are shown. Pre-post ATT (SE) calculated from all event times is shown in the figure footnote. Outcomes, by panel, include: (a) share of months reporting a urea reduction ratio greater than 0.65, (b) share of months reporting hemoglobin levels between 10 and 12 g/dL, (c) share of months reporting hemoglobin levels greater than 12 g/dL, (d) an indicator for being hospitalized for septiccmia, (e) Medicare spending on endovascular treatments, (f) total Medicare inpatient spending, (g) Medicare outpatient spending excluding dialysis, (h) Medicare spending on outpatient dialysis, (i) Medicare Part D spending, (j) total Medicare spending, (k) Medicare spending on vascular access diagnostics, and (l) total Medicare spending on vascular access. Control for patient characteristics, including indicators for gender, race, cancer, drug use, drinker, smoker, assistance, various chronic conditions (diabetes, hypertension, chronic obstructive pulmonary disease, atherosclerotic heart disease, pulmonary vascular disease, ischemic heart disease and chronic heart disease), insurance status, and the linear and squared terms for BMI age, income ($k), ZIP population share with bachelor and high school degrees, and facility age.

Appendix Figure A.5: Patient Steering Event Study (Independent and Organization Owners), Share of Patients Referred to Facility (%)



Note: SEs clustered at NPI level. Only event times -4 to +4 are shown. Pre-post ATT (SE) calculated from all event times is shown in the figure footnote. Owners include NPIs identified as independent owners in ESRD PECOS or linked to organization owners via physician group PECOS and OpenCorporates. Treated samples are NPI-facilities where the NPI once acts as an owner of the facility, the ownership never reverts, and the NPI never acts as a medical director at the same facility. Control samples are NPI-facilities of NPIs that never act as an owner or medical director at any facilities; we only keep the facility that received the most patient in total, across all years, from the control group NPIs.

B Tables

Appendix Table A.1: Facility Summary Statistics

	2005								2012								2019							
	Independent	Phys-Owned	Chain	JV	DA,Non-JV	DA,JV	FR,Non-JV	FR,JV	Independent	Phys-Owned	Chain	JV	DA,Non-JV	DA,JV	FR,Non-JV	FR,JV	Independent	Phys-Owned	Chain	JV	DA,Non-JV	DA,JV	FR,Non-JV	FR,JV
Averaged Per-Day Measures																								
Patients	67.05	66.57	72.05	63.42	74.22	66.89	71.06	60.69	71.31	67.41	71.93	71.99	71.42	73.34	72.90	70.93	60.65	65.60	68.83	72.47	66.83	70.13	71.94	77.75
HD Sessions	25.96	26.45	28.67	25.09	29.07	26.33	28.89	24.21	28.18	25.88	29.00	27.45	28.27	27.82	29.91	26.90	24.35	26.23	28.27	28.58	27.18	27.03	29.92	30.91
Home Patients	6.86	6.07	5.93	5.70	7.10	5.90	4.30	6.00	8.16	6.91	6.86	8.37	7.81	9.21	5.90	7.86	8.31	8.58	7.82	10.84	7.87	11.80	7.78	11.37
PD Sessions	5.25	5.01	4.95	5.53	6.74	5.84	3.75	5.91	5.81	5.94	6.06	7.75	6.73	8.34	5.35	7.31	7.31	7.79	7.10	10.35	7.36	11.35	6.78	10.59
EGHP Insured Patients	2.86	2.76	3.21	2.82	3.29	2.60	3.21	3.16	3.56	3.17	4.12	4.59	3.92	4.29	4.37	4.80	2.66	2.33	2.94	3.48	2.70	3.21	3.25	3.94
In-Center Sessions per Station	1.41	1.52	1.52	1.36	1.55	1.32	1.52	1.51	1.55	1.40	1.51	1.42	1.52	1.42	1.52	1.39	1.69	1.45	1.49	1.53	1.49	1.48	1.54	1.60
In-Center Sessions per Emp	1.79	1.94	2.26	2.24	2.31	2.20	2.31	1.89	1.87	1.79	2.17	2.02	2.16	2.05	2.21	2.12	1.62	1.70	2.13	2.04	2.14	2.04	2.14	2.05
Yearly Total Measures																								
Transplant	2.76	2.62	2.92	2.50	2.94	2.73	2.81	2.65	2.59	1.81	2.20	2.28	2.25	2.30	2.19	2.33	2.37	2.01	2.44	2.55	2.41	2.57	2.53	2.74
Incident Patient	20.66	22.51	21.21	21.13	21.91	22.40	20.99	15.06	20.10	19.62	17.85	20.11	17.45	19.72	18.47	20.00	17.92	18.57	15.98	18.60	15.04	17.70	17.21	19.78
Death	14.65	16.02	15.18	14.13	15.90	13.39	15.08	14.35	13.91	12.85	11.22	12.13	11.26	11.86	11.25	11.77	11.86	11.77	9.55	10.44	9.06	9.79	10.14	11.10
Switch In	6.58	6.81	6.09	8.21	6.85	9.60	5.98	6.94	6.52	6.19	6.38	6.65	7.36	7.50	5.92	6.39	6.78	5.92	6.37	7.18	6.27	7.87	6.62	7.57
Switch Out	6.38	5.99	6.74	5.35	6.97	5.71	6.71	8.41	7.04	5.46	6.45	6.27	6.84	7.09	6.33	5.84	5.91	5.82	6.39	6.54	6.44	7.04	6.63	7.37
Incident Patients (weighted)																								
1-Year Survival (%)	76.55	74.41	76.38	74.94	76.52	78.16	75.95	77.41	76.98	78.86	80.61	79.89	80.88	80.32	80.26	79.88	76.58	80.42	83.14	82.98	83.61	83.43	82.60	83.09
Pred. 1-Year Survival (%)	75.44	75.76	76.27	75.33	76.40	77.26	76.13	75.81	78.48	78.40	80.67	79.79	80.78	80.11	80.64	80.29	81.75	82.70	82.43	82.88	82.55	82.85	82.19	83.47
1-Year Waitlist (%)	10.55	9.49	9.86	8.62	10.46	9.25	8.77	9.21	11.23	10.10	11.75	10.63	12.16	9.60	11.14	10.77	10.22	8.79	10.42	10.09	10.65	10.25	9.93	9.93
Pred. 1-Year Waitlist (%)	8.92	9.37	9.50	8.96	10.04	9.58	9.03	10.38	10.02	10.87	11.55	11.65	11.88	11.47	11.29	11.50	10.57	10.97	10.40	11.26	10.54	11.36	10.23	11.37
1-Year Transplant (%)	2.63	2.19	2.45	2.12	2.31	1.90	2.37	3.77	2.05	1.44	1.90	1.48	1.92	1.37	1.91	1.82	2.02	1.62	2.01	1.95	2.00	1.93	2.02	2.07
Pred. 1-Year Transplant (%)	2.55	2.58	2.78	2.94	2.95	2.96	2.56	3.46	1.15	1.81	2.17	2.16	2.25	2.02	2.14	2.22	2.24	1.43	2.28	2.47	2.34	2.49	2.30	2.61
Distance (miles)	8.27	7.73	7.52	7.54	7.23	7.61	7.53	5.41	8.00	7.32	7.24	7.50	7.14	7.41	7.23	8.01	8.41	7.87	6.96	7.18	6.63	7.05	7.15	7.61
From Annual Survey and Cost Report																								
Dialysis Stations	16.92	16.51	18.22	17.74	17.91	18.63	18.60	16.94	17.35	16.87	18.20	17.99	17.22	18.16	18.91	17.86	15.92	15.64	17.93	17.32	17.37	16.86	18.33	17.74
Employees (FTE)	14.38	12.70	12.59	11.00	12.41	11.59	12.60	11.18	14.25	12.67	12.76	12.89	12.34	12.64	13.11	12.77	12.58	12.66	12.45	12.69	11.81	11.81	13.18	13.52
Nurses (FTE)	4.39	3.89	3.89	3.41	3.67	3.14	3.92	3.32	5.07	4.23	4.26	4.28	3.98	4.02	4.45	4.59	4.43	4.16	4.16	4.25	3.80	3.83	4.52	4.72
Technicians (FTE)	6.93	6.01	6.25	5.16	6.12	5.96	6.67	5.74	6.15	5.70	6.18	6.17	5.85	6.11	6.55	5.86	5.42	5.88	6.04	6.05	5.68	5.57	6.50	6.50
Nurse per Tech	0.91	0.82	0.78	0.89	0.77	0.66	0.70	0.73	1.04	0.95	0.82	0.82	0.83	0.81	0.79	0.92	1.09	0.88	0.84	0.90	0.80	0.91	0.86	0.94
Emp per Station	0.93	0.83	0.69	0.64	0.69	0.61	0.68	0.72	1.06	0.86	0.72	0.74	0.72	0.71	0.70	0.74	1.23	1.16	0.73	0.81	0.72	0.75	0.76	0.89
With Identified Medical Director (%)	38.86	55.67	43.48	52.63	46.77	47.14	40.88	70.59	78.77	78.50	84.73	84.33	84.50	86.00	84.54	84.00	82.46	92.68	93.67	91.88	93.88	92.08	94.03	93.36
With Identified Medical Director Compensation (%)	39.39	15.60	94.37	66.84	95.81	91.43	96.12	76.47	56.15	31.87	97.86	87.68	98.24	98.86	98.33	92.89	58.12	32.58	98.20	97.74	98.63	98.87	98.15	98.38
Avg. Medical Director Compensation ($)	77,409.46	71,128.90	126,231.73	89,836.57	112,605.83	78,597.13	162,535.24	132,469.03	80,812.41	74,878.12	122,278.55	105,622.36	112,929.99	108,353.81	137,944.96	110,975.55	76,877.18	78,555.70	120,401.05	112,741.86	109,396.41	104,603.65	136,861.05	130,762.97
Per-Procedure Payment (Fistula,$)																								
Share of Pat with Fistula (%)									48.27	52.27	57.01	51.62	56.87	51.70	58.05	57.65	41.41	43.00	50.23	48.49	48.60	46.32	53.02	52.79
Fistula w/o angioplasty, stent, or thrombectomy									408.51	435.13	428.84	424.84	443.14	436.50	424.13	447.72	467.10	529.05	423.22	448.23	431.58	463.45	423.77	424.28
Fistula w/ angi., w/o stent or throm.									1,365.04	1,515.99	1,404.24	1,434.92	1,445.49	1,470.58	1,391.07	1,408.08	768.65	919.56	824.57	933.63	846.77	938.59	818.43	968.55
Fistulas w/ stent									2,584.30	3,116.79	2,691.10	2,776.77	2,842.51	2,934.18	2,619.59	2,674.27	2,573.26	3,005.45	2,651.59	2,965.16	2,737.69	2,976.05	2,614.05	3,031.86
Fistulas w/ throm., w/o stent or angi.									936.57	1,006.32	973.54	960.12	1,047.38	926.07	939.93	1,072.74	758.87	899.00	750.95	838.81	734.77	741.67	776.43	883.04
Fistula w/ angi. and throm, w/o stent.									2,192.27	2,260.99	2,024.08	2,050.60	2,072.50	2,084.34	2,012.39	1,975.05	1,318.38	1,435.59	1,379.15	1,532.87	1,405.31	1,500.01	1,371.73	1,631.43
Fistulas w/ stent and throm.									4,201.59	4,446.07	3,796.28	3,763.52	3,928.04	3,640.49	3,747.95	3,734.81	3,581.23	3,906.89	3,558.73	3,804.52	3,683.92	3,829.44	3,521.34	3,992.38
Any Fistula									1,282.15	1,409.61	1,332.13	1,376.87	1,386.45	1,423.15	1,309.76	1,336.93	837.03	979.26	884.16	988.95	911.75	990.21	877.43	1,016.66
Per-Pat Payment (Fistula Pat,$)																								
Fistula w/o angioplasty, stent, or thrombectomy									487.57	521.80	510.03	500.86	528.09	511.31	503.57	536.90	576.66	688.90	538.41	570.88	549.32	598.28	538.33	540.25
Fistula w/ angi., w/o stent or throm.									2,283.45	2,630.80	2,382.20	2,388.35	2,437.15	2,412.89	2,377.68	2,443.69	1,289.72	1,512.51	1,336.96	1,513.69	1,360.30	1,504.45	1,344.68	1,603.72
Fistulas w/ stent									2,865.62	3,448.06	3,018.12	3,094.69	3,179.09	3,253.94	2,941.98	3,025.11	2,774.75	3,413.24	2,917.41	3,251.19	3,028.59	3,303.52	2,850.94	3,287.44
Fistulas w/ throm., w/o stent or angi.									1,056.90	1,160.90	1,212.75	1,118.04	1,295.02	1,106.11	1,163.01	1,265.72	810.18	1,011.54	853.20	1,006.45	822.93	903.62	895.64	1,081.65
Fistula w/ angi. and throm, w/o stent.									3,071.70	3,269.65	3,135.60	3,108.45	3,241.34	3,233.84	3,107.63	3,000.77	1,899.17	2,148.73	2,168.89	2,381.72	2,189.16	2,282.02	2,172.24	2,576.28
Fistulas w/ stent and throm.									5,175.09	5,381.79	4,463.21	4,368.15	4,721.63	4,220.41	4,313.52	4,138.54	4,276.97	4,964.12	4,249.50	4,559.55	4,438.28	4,548.72	4,180.49	4,818.06
Any Fistula									2,546.20	2,949.68	2,748.98	2,756.82	2,864.13	2,820.22	2,712.47	2,816.23	1,639.78	1,992.17	1,787.18	1,985.73	1,828.50	1,976.18	1,793.69	2,062.53
Shares by Chain																								
DaVita	0.00	0.00	0.39	0.37	1.00	1.00	0.00	0.00	0.00	0.00	0.43	0.42	1.00	1.00	0.00	0.00	0.00	0.00	0.46	0.41	1.00	1.00	0.00	0.00
Fresenius	0.00	0.00	0.37	0.09	0.00	0.00	1.00	1.00	0.00	0.00	0.48	0.27	0.00	0.00	1.00	1.00	0.00	0.00	0.45	0.32	0.00	0.00	1.00	1.00
Other Chain	0.00	0.00	0.24	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.27	0.00	0.00	0.00	0.00
Independent	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Facility Obs	561	282	3,075	190	1,193	70	1,135	17	358	386	3,870	836	1,645	350	1,857	225	382	396	4,788	1,724	2,191	707	2,160	557

Note: Facility-year level summary statistics from USRD, PECOS, and the Healthcare Cost Report Information System (HCRIS). Columns "Phys-Owned" indicate independent facilities with physician owners. Some payment variables are only available after 2012 and are therefore empty in the table.

Appendix Table A.2: Distribution of Chains Owned/Directed Among Owner/Medical Directors, 2019

	Direct at least 1 DaVita Facility	Direct at least 1 Fresenius Facility	Direct at least 1 Other Chain Facility	Direct at least 1 Independent Facility	Own at least 1 DaVita facility	Own at least 1 Fresenius facility	Own at least 1 Other Chain facility	Own at least 1 independent facility
Mean DaVita Facilities	1.39 (1.37 to 1.42)	0.06 (0.05 to 0.07)	0.09 (0.06 to 0.11)	0.17 (0.13 to 0.21)	2.80 (2.65 to 2.94)	0.93 (0.74 to 1.12)	1.09 (0.87 to 1.31)	0.60 (0.48 to 0.73)
Mean Fresenius Facilities	0.07 (0.05 to 0.08)	1.39 (1.36 to 1.42)	0.09 (0.05 to 0.13)	0.09 (0.06 to 0.12)	0.47 (0.36 to 0.57)	4.19 (3.79 to 4.60)	0.49 (0.33 to 0.65)	1.01 (0.79 to 1.24)
Mean Other Chain Facilities	0.03 (0.02 to 0.03)	0.02 (0.01 to 0.03)	1.31 (1.27 to 1.36)	0.03 (0.01 to 0.05)	0.24 (0.20 to 0.27)	0.17 (0.13 to 0.20)	2.00 (1.86 to 2.14)	0.30 (0.19 to 0.42)
Mean Independent Facilities	0.05 (0.03 to 0.06)	0.03 (0.02 to 0.04)	0.03 (0.01 to 0.04)	1.20 (1.15 to 1.24)	0.12 (0.10 to 0.14)	0.23 (0.18 to 0.28)	0.18 (0.14 to 0.22)	1.62 (1.53 to 1.70)

Note: Physicians associated with companies that are linked to more than 50 physicians were not considered owners due to their small ownership stake. Each observation is a physician-month. 95% confidence intervals are in parentheses.

Appendix Table A.3: Patient Load Fixed Effect Regressions

	(1) Patient Count	(2) Patient Count	(3) Log Patient Count	(4) Log Patient Count
Pre Ind -> Phy-Owned Ind	6.804			
	(6.004)			
Post Ind -> Phy-Owned Ind	14.64**	4.993	0.0529	0.0236
	(5.030)	(4.473)	(0.0480)	(0.0651)
Pre Ind -> Non-JV Chain	-2.974			
	(3.189)			
Post Ind -> Non-JV Chain	7.264*	1.135	0.0274	0.128*
	(3.248)	(1.326)	(0.0259)	(0.0588)
Pre Phy-Owned Ind -> JV	-7.177**			
	(2.375)			
Post Phy-Owned Ind -> JV	6.933**	3.164*	0.0464*	0.159**
	(2.449)	(1.366)	(0.0224)	(0.0570)
Pre Ind -> JV	-0.142			
	(11.90)			
Post Ind -> JV	13.10	3.195	0.132	0.171
	(8.626)	(7.029)	(0.0835)	(0.120)
Pre Non-JV Chain -> JV	-1.053			
	(2.042)			
Post Non-JV Chain -> JV	11.20***	6.507***	0.0890***	0.1000***
	(2.306)	(1.174)	(0.0180)	(0.0271)
Num of Active Months	9.142***	5.392***	0.401***	0.424***
	(0.0975)	(0.103)	(0.00372)	(0.00404)
Constant	-38.06***	6.846***	-0.774***	-1.022***
	(0.803)	(1.221)	(0.0440)	(0.0480)
Observations	83,413	83,083	83,048	66,659
Dep. Var. Mean	70.84	71.08	3.97	4.00
Year FE	Yes	Yes	Yes	
Facility FE		Yes	Yes	Yes
HSA-Year and Chain Type-Year FEs				Yes

SEs clustered by facility.

$^{+}$ $p < .1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: All RHS variables are conditional on the facility having the transition. Pre- and Post- are defined based on the first time the transition happens. Facilities can have multiple types of transitions, and the RHS variables are each defined separately. Chain Type includes the following categories: DaVita, Fresenius, Other Chain, and Independent.

Appendix Table A.4: Patient Referral Summary Statistics

	Pre					Post				
	N	Mean	P25	Median	P75	N	Mean	P25	Median	P75
Panel A: *Facility-NPI-Year Level, Number of Referred Patients*										
Owner	3,843	1.48	0	0	2	4,701	2.14	0	1	3
Medical Director	5,806	1.42	0	0	2	7,651	3.18	1	2	5
Neither	794,099	0.45	0	0	1	0				
Panel B: *NPI-Year Level, Number of Referred Patients*										
Owner at Any Facilities	653	5.95	2	5	9	644	6.46	3	5	9
Medical Director at Any Facilities	1,454	4.35	1	3	7	1,647	6.45	2	5	9
Neither	206,932	1.19	0	1	1	0				
Panel C: *NPI-Year Level, Number of Facilities with Referral*										
Owner at Any Facilities	653	2.09	1	2	3	644	2.04	1	2	3
Medical Director at Any Facilities	1,454	1.66	1	1	2	1,647	1.95	1	2	3
Neither	206,932	0.94	0	1	1	0				
Panel D: *NPI-Year Level, Number of Chains with Referral*										
Owner at Any Facilities	653	1.31	1	1	2	644	1.33	1	1	2
Medical Director at Any Facilities	1,454	1.13	1	1	1	1,647	1.24	1	1	2
Neither	206,932	0.81	0	1	1	0				

Note: Summary statistics of patient referrals in Medicare claims from USRD, 2012 – 2019. Samples are NPI-Facility pairs with any referral ever, across all years. We assume an NPI is active for referral from the first to the last year that we observe any referral from the NPI. Pre and Post columns are based on the first time the ownership or medical directorship starts. *Panel A*: Owner row includes NPI-facility pairs where the NPI is ever an owner of the facility. Medical Director row includes NPI-facility pairs where the NPI is ever a medical director of the facility. *Panel B and D*: Owner row includes NPIs who are ever the owner of any facility. Medical Director row includes NPIs who are ever the medical director of any facility. In *Panel D*, each independent facility is defined as a separate chain.

Appendix Table A.5: Referral Physician Patient Steering, Individual Owners from PECOS Only

	(1)	(2)	(3)	(4)	(5)	(6)
	Num Ref	Num Ref	Num Ref Share	Num Ref w/ Pre Neph	Num Ref w/o Pre Neph	Num Ref Private
Is Owner	0.270***	0.263***	1.889**	0.191***	0.0728***	0.0398*
	(0.0492)	(0.0484)	(0.584)	(0.0390)	(0.0219)	(0.0155)
Owner Elsewhere	-0.0139***					
	(0.00309)					
Is Med Dir	0.951***	0.918***	12.53***	0.696***	0.222***	0.108***
	(0.0641)	(0.0649)	(0.796)	(0.0539)	(0.0237)	(0.0179)
Med Dir Elsewhere	-0.000485					
	(0.00252)					
Med Dir Comp (10k)	0.00626	0.00773	0.135*	0.00882*	-0.00110	-0.000527
	(0.00499)	(0.00505)	(0.0554)	(0.00432)	(0.00172)	(0.00146)
Is Owner and Med Dir	0.185+	0.237*	2.293*	0.257**	-0.0201	0.0950**
	(0.105)	(0.103)	(1.057)	(0.0908)	(0.0344)	(0.0296)
Constant	0.153***	0.149***	2.812***	0.114***	0.0345***	0.0261***
	(0.00165)	(0.000972)	(0.0139)	(0.000793)	(0.000385)	(0.000277)
Observations	1957589	1956737	1755059	1956737	1956737	1956737
Pre-Owner DVar Mean	.313	.313	4.54	.248	.065	.0563
Pre-Meddir DVar Mean	1.08	1.07	17.8	.833	.236	.206
Pre-Meddir&Owner DVar Mean	.888	.845	13.8	.643	.202	.213
Fac-NPI FE and Year-Fac FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year-NPI FE		Yes	Yes	Yes	Yes	Yes

SEs clustered by NPI.

$^{+}$ $p < .1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Each observation is an NPI-Fac-Year. SEs clustered at the NPI level. "Num Ref Share" is the share of patients referred by NPI i to facility j among all patients referred by i at t. "Pre Neph" stands for an established nephrologist before dialysis referral. Owners are only individual owners identified from PECOS.

Appendix Table A.6: Entry Summary Table, Conditional on Having Entry

Chain Type	N HSA-Year with Entry	% with 1 Entry	P95	Max
Any Entry				
DaVita	1,241	88.3	2	10
Fresenius	903	92.5	2	8
Other Chains	470	91.1	2	8
Independent	715	89.9	2	8
JV Entry				
DaVita	321	89.4	2	6
Fresenius	126	95.2	1	2
Other Chains	288	93.4	2	4
Independent	0			
Non-JV Entry				
DaVita	956	90.8	2	5
Fresenius	792	93.7	2	8
Other Chains	195	91.3	2	8
Independent	715	89.9	2	8

Note: Summary statistics of entries by chain types from USRDS, 2005 – 2019. Samples are conditional on chain type-market-years with entries.