Getting Down to Business: Chain Ownership and Fertility Clinic Performance*

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August 2023

ABSTRACT

Chain ownership has been credited with boosting firm performance in the retail and service sectors but criticized for prioritizing profits over the well-being of patients in the healthcare sector. This paper finds that chain organizations improve healthcare outcomes in a setting with relatively minimal market frictions and information asymmetries: the market for In Vitro Fertilization (IVF). After acquisition by a fertility chain, IVF clinic volume increases by 28.2%, and IVF success rates increase by 13.6%. We provide evidence that fertility chains facilitate resource and knowledge transfers needed to enhance clinic quality, benefit underperforming clinics, and expand the IVF market.

JEL Codes: I1, I11, L2, L20, G34

*We are grateful to Morten Bennedsen, Matt Backus, Zack Cooper, Mathijs De Vaan, Mert Demirer, Paul Gertler, Matt Grennan, Atul Gupta, Hans Christian Kongsted, Adam Leive, Sarah Moshary, Adam Sacarny, Brian Silverman, Toby Stuart, Ashley Swanson, and Steve Tadelis for their comments. We thank Giovanni Chiarella, Byron Brannon, and Shayena Shah for their research assistance. Previous draft circulated as “Corporate Ownership and Firm Performance: Evidence from Fertility Clinics.”

1. INTRODUCTION

Over the past several decades, chain organizations have reshaped industries and consumer experiences.[1] For example, by standardizing operations and management, leveraging economies of scale, and generating reputational incentives, chain ownership has been shown to increase firm productivity and product quality in the retail and service sectors (Jin and Leslie 2009; Bloom, Sadun, and Van Reenen 2012; Kosová and Lafontaine 2012; Bernstein and Sheen 2016). Acquisitions by big-box retailers and corporate investors have also contributed to the growth of chain organizations in the healthcare sector. This growth has raised concerns that chain operators will place shareholder financial interests over the health and well-being of patients, supported by recent studies documenting a decline in quality under chain ownership (Eliason et al. 2020; Gupta et al. 2021; Andreyeva et al. 2022). In contrast, using novel data on US fertility clinic chains, this paper provides evidence that chain ownership can improve healthcare outcomes under certain conditions.

Much of the healthcare literature on chain ownership has studied settings with regulated prices and significant information asymmetries between patients and providers. These market and information frictions can contribute to underinvestment in quality and dull the market's ability to discipline corporate entities (Arrow 1963; Dranove and Satterthwaite 1992; Gaynor 2006). However, by 2030, nearly one-third of the US population is projected to receive care through a retail health chain (Ney, Berger, and Fry 2023). These settings more closely resemble the fertility sector – "a virtually free-market branch of medicine" that relies minimally on third-party payers and heavily on consumer choice (Gabriel 1996). For fertility services such as In Vitro Fertilization (IVF), most patients pay upfront and out-of-pocket, which can cost up to $20,000 per cycle. Despite the high cost of IVF, the probability of a live birth is 51.1% for women under 35, falling to 7.6% for women over 40 (CDC 2020). Out of concern that patients were unaware of low IVF success rates, the US Congress passed a law in 1992 that made data on fertility clinic outcomes publicly available.[2] The transparency of IVF prices and quality, among other features, may help explain why the effect of chain ownership could differ across healthcare settings.

To study the impact of chain ownership, we combine hand-collected data on fertility clinic transactions from business intelligence databases with clinic-level data from the Centers for Disease Control (CDC) Fertility Clinic Success Rates Reports. Between 2004 and 2018, the share of clinics in a fertility chain grew from 5% to 20%, with chain clinics now performing over 40% of IVF cycles in the US. Critics caution that chains will treat "fertility medicine as a cash cow," while chains argue they can help clinics "deliver high-quality, convenient care to patients while implementing cost savings,

[1] A chain is a multiunit organization where each unit offers similar services and is controlled by a single business entity and shares in centralized management and standardized business practices.
[2] The Fertility Clinic Success Rate and Certification Act (FCSRCA) of 1992 requires all US clinics that perform IVF to report their outcomes to the CDC. Yearly reports are published with standardized information on IVF success rates and are widely used by patients (Bundorf et al. 2009; Kowitt 2020).

improving processes, and driving growth" (Robbins 2017; Krause 2019). We estimate changes in clinic growth and quality using difference-in-differences methods, which compare clinics before and after chain ownership to a control group of non-chain clinics. We focus on two key outcomes: 1) clinic volume, measured as the number of IVF cycles and transfers, and 2) the success of IVF, measured as the live birth rate per transfer. For patients undergoing IVF, the main goal is to achieve a healthy live birth. Therefore, the live birth rate is the definitive measure of IVF success.

Our results show that after a fertility chain acquires a clinic, IVF cycles increase by 28.2%, IVF transfers increase by 21.4%, and the live birth rate increases by 13.6%. Qualitative data obtained from press releases, marketing materials, and interviews suggest chains help clinics achieve growth by providing financial and managerial resources, such as revenue cycle management and marketing services. These materials also suggest that chains help improve quality by implementing best practices, protocols, and training and facilitating knowledge sharing between clinics through research consortiums and complex case review meetings. We provide empirical evidence that these resource and knowledge transfers drive performance improvements rather than alternative mechanisms such as patient selection.

As evidence of knowledge transfer, we show that only acquired clinics, but not affiliated clinics, improve IVF success rates. As in other chain organizations, some transactions are structured as acquisitions where the fertility chain's parent company owns the clinic's assets, while other transactions are structured as affiliations where a clinic contracts with a fertility chain for management services and access to capital (Lafontaine, Perrigot, and Wilson 2017). In an acquisition, the chain has greater control over clinical processes, whereas, in affiliations, clinic owners retain greater decision-making authority (Grossman and Hart 1986). Greater control is likely more important for facilitating knowledge sharing needed to increase IVF success than for resource sharing needed to fund clinic growth. Consistent with this argument, acquired and affiliated clinics both increase volume, but only acquired clinics increase live birth rates.

We also show that chains update clinic processes and procedures in ways that enhance quality and are consistent with new knowledge leading to improved outcomes. For example, *acquired* clinics achieve the IVF "gold standard": they reduce multiple births, which pose significantly higher risks for patients, and increase singleton births by enough to have a net positive increase in the live birth rate. We find that this quality-enhancing result coincides with acquired clinics reducing the number of embryos placed in the uterus per transfer, suggesting that clinics improve techniques and processes when conducting single embryo transfers (Reimundo et al. 2021; Mizrachi and McQueen 2022).[3] We also find that acquired clinics achieve higher IVF success rates among older patients, whose cases are often more complex. One reason for these improvements is that acquired clinics significantly increase preimplantation genetic testing, which can help

[3] A transfer of multiple embryos at once has a higher initial success rate but has a greater chance of multiple birth. A single embryo transfer has lower initial success rates but less than 1% probability of a multiple birth. Therefore, it is more difficult to increase the live birth rate via single embryo transfers.

physicians choose higher-quality embryos (Maxwell and Grifo 2018; ACOG 2020).

Lastly, we provide evidence consistent with clinics learning from the chain. For example, we find that clinics acquired by higher-quality chains experience larger increases in live birth rates than those acquired by lower-quality chains. Clinics that are initially lower performing also experience larger improvements than initially higher-performing clinics after acquisition by a chain. To rule out concerns that clinics learn via increased volume rather than from the chain, we also show that clinics with minimal increases in volume still significantly increase the live birth rate.

In support of chains providing resources needed to expand clinic operations, we find evidence of market expansion rather than business stealing. For every IVF cycle performed by a chain clinic in a market, there is one additional IVF cycle in that market and no reductions for non-chain clinics.[4] In cross-sectional analyses using hand-collected data from clinic websites, we find that acquired clinics are twice as likely as non-chain clinics to advertise money-back guarantees or multiple-cycle discounts. Such marketing efforts may contribute to market expansion since patients likely view these offers as increasing IVF affordability. As another strategy to illustrate the role of resource transfers, we study how private equity (PE) investment into fertility chains impacts outcomes. At different points during the sample period, eight out of eleven chains receive PE funding, allowing us to separately identify the effect of chain ownership with and without PE funding. Consistent with PE firms easing financial constraints, we find the largest increases in clinic volume occur when a fertility chain receives PE funding.[5]

Overall, these results are consistent with fertility chains providing access to new resources and knowledge needed to increase clinic volume and IVF success rates. However, rather than improving outcomes, clinics could instead select younger or healthier patients. We do not find evidence of patient selection: results are quantitatively similar whether or not we include controls for patient characteristics and infertility diagnosis, and there are no systematic changes in patient characteristics post-transaction that would influence IVF success. Since maternal age is the single most important predictor of IVF success, we also show that the distribution of patients in younger and older age groups is similar before and after a clinic transaction.

Fertility chains could also be better at selecting clinics that would generate performance improvements. While clinic selection is an inherent feature of this setting, we conduct analyses that mitigate concerns that clinic selection explains our results. In event study analyses adjusted for staggered treatment timing, we find no observable pre-trends before a clinic transaction. Results are also quantitatively similar in specifications using *state* × *year* or *market* × *year* fixed effects, which would help account for state or market-level changes that could impact the demand for fertility services. Similarly,

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[4] Market expansion is likely possible because of the large unmet demand for fertility services (Chambers et al. 2009; Greil et al. 2016). However, fertility chains are a relatively recent phenomenon and may eventually drive out less productive or lower quality clinics (Foster, Haltiwanger, and Krizan 2006).

[5] This finding is supported by several studies of PE ownership in the finance literature (see Boucly, Sraer, and Thesmar 2011 and Fracassi, Previtero, and Sheen 2022, among others).

results are robust to excluding markets that became more concentrated because of chain ownership. We also find quantitatively similar results using a matched sample based on pre-transaction clinic characteristics.

This paper contributes to several strands of literature. The first studies the economics of chain organizations (see Kosová and Lafontaine 2012 for a review). Much of this literature has focused on the productivity and competitiveness of large national chains (Foster, Haltiwanger, and Krizan 2006; Jia 2008; Holmes 2011) or franchising decisions (Fan, Kühn, and Lafontaine 2017; Lafontaine, Perrigot, and Wilson 2017) in the retail and service sector. We extend the literature by estimating the causal impact of chain ownership in an understudied healthcare setting. Additionally, by comparing acquired to affiliated clinics, our findings suggest that chain affiliations can facilitate resource transfers necessary to increase volume but may not generate sufficient incentives to invest in quality. The influence of ownership and control complements the differences found between chain-owned and franchised restaurants (Bernstein and Sheen 2016).

Second, this paper contributes to the related literature on the effects of corporate ownership in healthcare and other settings. The corporatization phenomenon in healthcare refers to "corporate investors (e.g., public companies, venture capital/private equity firms, insurance companies, and health systems) acquiring a majority and/or controlling interest" in previously independent organizations (American Medical Association 2019). These corporate entities can create chain organizations (ex. Spring Fertility), help existing chains grow through add-on acquisitions (ex. Gastro Health), or themselves be chains (ex. CVS Health). As a result, most chains are owned by a for-profit corporation, but not all corporate-owned firms are chains.[6]

The positive impact of chain ownership on fertility clinic quality differs considerably from the predominantly negative or null effects on quality found in the recent healthcare literature.[7] For example, Eliason et al. (2020) find that mortality and hospitalization rates increase among dialysis patients after a large corporate chain acquires clinics. Similar results have been found in the nursing home industry (Harrington et al. 2012; Gupta et al. 2021). One explanation for these negative outcomes is that information asymmetries and market frictions prevent healthcare markets from functioning effectively. Specifically, in settings such as dialysis and nursing homes where "Medicare plays an outsize role in subsidizing care and in which patients may find it difficult to observe their facilities' quality, competition may be unlikely to discipline providers' behavior" (Eliason et al. 2020).[8] Reliance on Medicare payments can also lead chain owners to engage in cost-cutting measures that can negatively impact quality.

[6] Most US fertility clinics are for-profit, and there are no non-profit chains.
[7] Andreyeva et al. (2022) document negative effects on hospital readmissions in chain-acquired hospitals. La Forgia (2022) finds reductions in quality after practices are acquired by physician management chains that focus on financial services. A systematic review of the literature on PE ownership (both chain and non-chain organizations) also found mixed to harmful impacts on patients (Borsa et al. 2023).
[8] Additionally, through mergers and acquisitions, nursing home, dialysis clinics and hospital markets have become increasingly more concentrated, potentially further limiting incentives to invest in quality. By contrast, fertility clinics and other retail health settings are still relatively fragmented.

In contrast, the "free market" features of fertility clinics better resemble the consumer-centric model of the retail and service sectors. Such features include price and quality transparency, minimal government intervention, and reliance on consumer choice and self-paying patients.[9] For example, Bundorf et al. (2009) found that the introduction of fertility clinic report cards led consumers to alter their choice of clinics. The salience and transparency of the live birth rate may motivate chain operators to invest in quality to attract patients (Jin and Leslie 2003; Dranove and Jin 2010). The limited role of third-party payers may also lead chains to engage in more price competition to gain market share (Brown 2019; Sinaiko 2019). Using hand-collected data, we find that chain clinics are twice as likely to advertise fertility discounts and money-back guarantees, which may be interpreted as a signal of affordability by patients.

This research offers insights into other consumer-centric healthcare settings embracing the chain business model, such as behavioral and mental health, dermatology, medical spas and plastic surgery, dental care, physical therapy, and urgent care (Jain, Martin, and Murphy 2018). These office-based settings share many similarities to fertility clinics, and may, therefore, be able to achieve similar performance improvements. Additionally, a broader shift towards transparency in healthcare may help align shareholder profit motives with key patient interests (Transparency in Coverage Act 2022). Consistent with this argument, Gandhi et al. (2020) provide evidence that only after CMS introduced a 5-star rating system did PE-backed nursing home chains divert resources toward the evaluated quality measures.

Third, this research contributes to the literature on the industrial organization of healthcare. There is substantial evidence that as markets become less competitive, prices increase and quality worsens or remains unchanged (see Gaynor, Ho, and Town (2015) and Gaynor (2020) for reviews). In support of competition incentivizing quality investment, we show that clinics acquired in more competitive markets have larger increases in the live birth rate. We also find limited evidence that fertility chains increase market concentration, likely because they focus on cross-market acquisitions.

Lastly, this paper contributes to the research on the fertility industry. Much of the literature has focused on how state fertility coverage mandates impact the utilization of fertility services and treatment choices (Schmidt 2007; Henne and Bundorf 2008; Bitler and Schmidt 2012; Hamilton et al. 2018). Despite expansions in coverage, most of the 1 in 5 women struggling with infertility will never have a baby because of barriers to accessing care and low IVF success rates (CDC 2023). While the fertility industry may be "struggling to keep up with demand" (The Economist 2023a), we provide evidence that US fertility chains expand access to IVF and improve IVF success rates. In the long term, these improvements may enable more women to delay motherhood, invest in education and establish their careers, contributing to greater gender equality (Gershoni and Low 2021).

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[9] One misconception is that fertility care is a "one and done" service. However, patients can spend years on their fertility journey and successful patients often return for future births. Therefore, fertility clinics are still "selling to repeat customers desperate to conceive" (The Economist 2023c).

2. THE EMPIRICAL SETTING

2.1 The Fertility Industry

The main providers of infertility services are fertility clinics, which assist couples or individuals who wish to conceive but are unable to naturally. The most effective way to treat infertility is through Assisted Reproductive Technology (ART), where In Vitro Fertilization (IVF) represents over 99% of ART procedures. In the US, the vast majority of fertility clinics are for-profit businesses, and treatment costs are remarkably high.[10] The cumulative cost of IVF is estimated to be between $40,000 and $60,000 because the average patient undergoes multiple IVF cycles (Fertility IQ 2022). These costs are either financed privately by patients or subsidized by insurance companies. However, even with some coverage, patients pay for the majority of services out of pocket (Chambers et al. 2009; McLaughlin et al. 2019).[11]

By the end of the century, it is estimated that 3% of the world's population will have been born via IVF (Faddy, Gosden, and Gosden 2018). This growth is mostly driven by heterosexual couples delaying childbirth and more same-sex couples choosing to have biological children. As a result, "the treatment of infertility has become big business around the world" (Patrizio et al. 2022). The projected demand and high margins of fertility clinics have attracted considerable attention from corporate entities such as PE firms, venture capitalists, management companies, and global health care chains (Borsa and Bruch 2022; Landi 2022; Pringle 2022). In the US, these investments have fueled further growth of existing fertility chains (ex. Reproductive Medical Associates) and helped fund new ones (ex. Spring Fertility). A similar corporatization trend has been well underway in China, India, Australia, and European countries such as Spain and Denmark (Rønning-Andersson 2018; Mellor 2019; Dhanjal 2023).

2.2 The IVF Process

This paper focuses on fertility clinics that provide IVF. While the desired outcome of IVF is straightforward, the process of achieving a live birth is complex. The IVF process consists of several stages that involve over 350 steps performed over 4 to 6 weeks per cycle (McCaffrey, Forman, and Copperman 2022). At a high level, a patient undergoes the five phases of treatment shown in Figure 1. Patients often need several cycles to achieve a live birth, with many patients undergoing at least 3 IVF cycles.

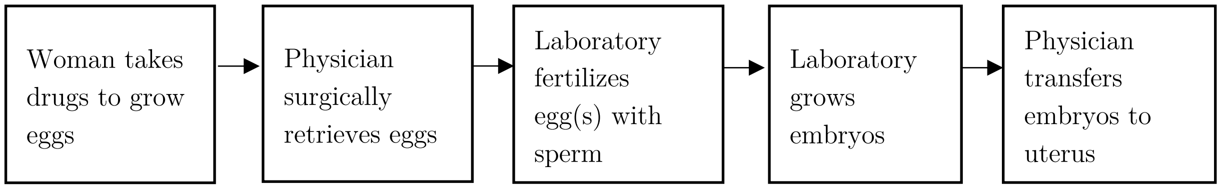
Each step of the IVF process depicted in Figure 1 involves subjective decisions that contribute to variation in fertility outcomes across clinics and physicians (Mizrachi and McQueen 2022; Morin 2022). For example, identifying and grading embryo quality and, therefore, which embryos to transfer to the uterus is considered a subjective

[10] Even for the few clinics that are part of non-profit academic medical center (Patrizio et al. 2022), the fertility clinic itself may be organized as a for-profit subsidiary. See Section 3.1 for details.

[11] Insurance coverage varies widely by state and employer. State coverage mandates do not apply to self-insured companies and often only cover some costs of care. Still, some coverage can considerably reduce the total out-of-pocket costs associated with IVF and influence treatment decisions (Hamilton et al. 2018). For this reason, our primary specification includes *state* × *year* fixed effects.

assessment (Schoolcraft and Meseguer 2017). Similarly, Mizrachi and McQueen (2022) conclude that differences in physician embryo transfer techniques, but not experience, drive much of the variation in the success of an embryo transfer. Several studies have also found that patient mix and clinic volume only explain a small portion of variation in outcomes across clinics, suggesting that clinic-specific factors are important determinants of IVF success (Lintsen et al. 2010; Wilkinson et al. 2021).

Figure 1. The Basic IVF Process of a Single Cycle



Note: Author's illustration adapted from Fertility IQ "What is IVF?"

Differences also exist in the core decision made between a reproductive endocrinologist and a patient on whether to transfer a single embryo or multiple embryos: Transferring multiple embryos increases the success of pregnancy but also results in multiple births in 30% of pregnancies relative to single embryo transfers (Kissin, Boulet, and Jamieson 2016). Multiple births are associated with significant fetal and maternal risks, such as pre-term delivery, low birth weight, and pre-eclampsia. These worse outcomes led the American Society for Reproductive Medicine (ASRM) to issue changes in recommended IVF guidelines to lower multiple birth rates by encouraging single embryo transfers (ASRM 2013, 2017). Therefore, the embryo transfer decision generates a tension between increasing a clinic's live birth rate through multiple embryo transfers and complying with large-scale efforts to reduce multiple births from IVF.

2.3 Organization of Fertility Chains

This paper focuses on fertility clinics that become part of a fertility chain.[12] A fertility chain is a multiunit organization, where each unit is owned or managed by a single for-profit business entity and shares in centralized management and standardized business practices (Figure 2). The unit is the fertility clinic, which typically consists of a main office and satellite office for patient visits and procedures and a laboratory for creating, testing, and storing eggs and embryos.[13]

The fertility chain can grow by acquiring a clinic, affiliating with a clinic, or building a new clinic. In *acquisitions*, the chain's parent company acquires, owns, and directly manages the assets of the fertility clinic. In *affiliations*, the clinic signs a contract

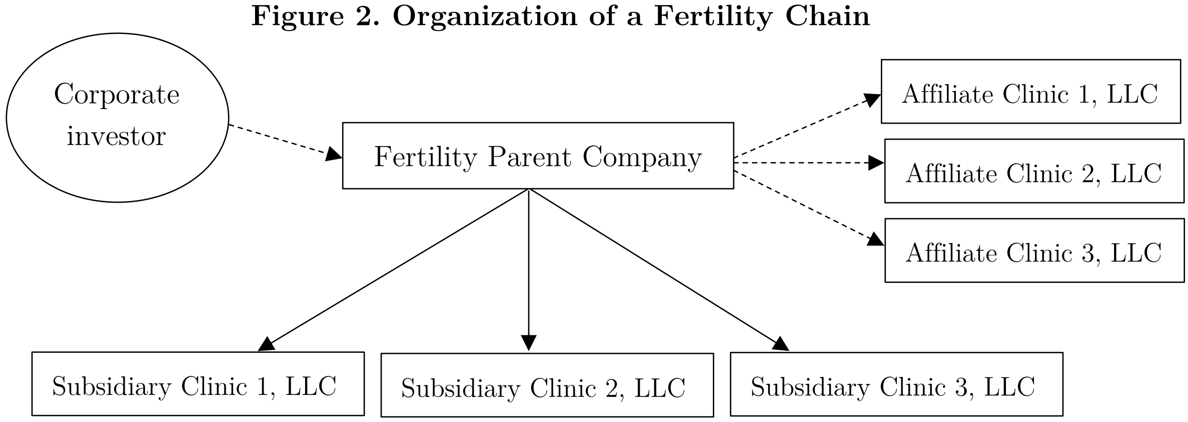
[12] In general, healthcare providers are often reluctant to use business terms such as "chain" and use terms such as "network." Similarly, instead of big box-style rebranding, clinics typically signal chain status through websites and marketing materials.

[13] Like many office-based specialties, fertility clinics often have satellite office locations within a geographic area for patient convenience. The CDC ART data is at the clinic level and not the office level.

with the fertility chain for select management services and capital or financing options. For example, a clinic may affiliate with a chain to receive access to marketing and patient engagement services. The contracts may resemble outsourcing agreements in which the parent company has no ownership stake or may be structured as joint ventures in which the parent company has a partial ownership stake. The commonality of these affiliations is that the clinic owners maintain greater control of clinic operations than in an acquisition. A *de-novo* clinic represents a newly built clinic owned and operated by the chain. Most chains pursue a mix of growth strategies.

Like other chain organizations in the retail and service sector, fertility chains can be privately held or publicly traded corporations.[14] Therefore, the chains can be sold to or receive funding from other corporations or PE firms. To estimate the impact of chain ownership, our primary analysis examines the outcomes of fertility clinics before and after becoming part of chain (i.e., the fertility clinic, not the chain, is the unit of analysis). However, in secondary analyses, we also examine outcomes after a chain receives PE funding (see section 3.1 for more details on fertility chains).

Figure 2. Organization of a Fertility Chain



2.4 Value Proposition of Fertility Chains

Press releases, company websites, news articles, and industry reports provide insights into the strategies and service offerings of fertility chains. For example, most press releases mention that chains promote growth by providing clinics with managerial capabilities and capital and improve quality by updating clinical processes and developing protocols (see Appendix Table B1 for press release text analysis). Below we provide additional qualitative evidence on these resource and knowledge transfers. All sources and documentation of quotes are reported in Appendix Table B2.

Financial Resources and Managerial Capabilities. One reason fertility clinics join fertility chains is to gain access to resources. For example, several chains emphasize

[14] Corporate practice of medicine (CPOM) laws often prohibits non-physician-owned business entities from exerting undue influence on clinical practice. On paper, corporations comply with these laws using complex corporate structures involving a subsidiary management service organization purchasing the non-clinical assets of a clinic. In practice, the corporations still exert significant control over day-to-day clinic operations, generating controversy over the efficacy of CPOM. See Appendix A for details.

providing clinics with long-term "financial stability and growth opportunities" and "strong financial support." These resources can help clinics hire new physicians and build new locations: "[Fertility chain] plans for continued growth through the addition of physicians and satellite offices." Similarly, another chain advertises that they apply "business and operations strategies that expand [clinic] markets and their market share. This may involve the development of new practice locations, embryology laboratories or ambulatory surgery centers, in order to [...] achieve strategic growth objectives." Ultimately, these investments can help increase clinic profitability: one chain advertises that "clinics practices' patient revenues increased 21% from 2007 to 2009."

Marketing materials also highlight that fertility chains provide managerial resources to streamline back-office administration. Since fertility clinics are typically run by physicians focused on clinical medicine and not trained in business practices, clinics may benefit from better management practices. For example, one chain advertises providing "operational and financial management, revenue cycle management, patient marketing and sales, information systems support, and various other services, including patient support." One managerial capability that is particularly highlighted by various chains is marketing, where one chain suggests its clinics should expect "increased patient volume as a result of [the Fertility Chain's] marketing efforts."

Chains also attract patients by offering and heavily marketing new pricing models that help patients finance treatment. For example, one fertility chain has its own subsidiary fertility financing company where "the company's Fertility Loan Specialists will work closely with [the Fertility Chain] to ensure the funds are secured prior to the commencement of [patient] treatment." Similarly, one chain launched "IVF Refund and Multi-Cycle Programs [that] offer patients the assurance that if multiple IVF cycles are necessary, they will not need to expend additional financial resources to receive them."

Clinical Knowledge. A second cited benefit of joining a chain is the ability to share and generate clinical knowledge with other clinics. For instance, a fertility chain advertises that it was "created to break down barriers to idea-sharing and collaborative care." This sentiment is echoed by a fertility clinic citing "access to [...] the most advanced on-going research in the field of reproductive medicine" as a reason for joining a chain. Similarly, one clinic suggests their patients will benefit from "improved access to the best treatment protocols and unique programs for specific conditions, [...] increased access to clinical trials and research initiatives [...] access to an expanded network of [...] experts who will come together to review and assist in complex cases." Multiple physicians echo that chains help standardize clinics' practices via treatment protocols.

Fertility chains also create internal processes to facilitate knowledge sharing and establish best practices within the chain. Many chains create committees with physicians across clinics who meet regularly to discuss clinical research and patient cases and, in some instances, conduct their own research and clinical trials. For example, one chain states that when "research proves that techniques improve conception rates, [Fertility

Chain] incorporates those techniques into their standard care wherever possible." Another chain says that "treatment breakthroughs are quickly applied to multiple centers, thereby furthering the positive impact for patients." Chains also advertise using "proprietary platforms, applications, and data and analytics" to track clinic performance and help clinics improve their clinical processes. Lastly, some chains implement continued medical education and training programs to improve IVF success rates. For example, the CEO of one chain shared: "We'll look at pregnancy per transfer by physician with a blinded letter for each physician. And we'll be able to see how everybody stacks up. And if people fall below a standard deviation, we have that doctor go work with somebody who is above a standard deviation to get retrained."

Fertility chains also advertise strategic goals for the organization that are in line with the latest medical research. For example, many chains advertise increasing single embryo transfers: "Striving for One Embryo-One Baby. [Fertility Chain's] founding philosophy to achieve successful pregnancy one healthy baby at a time." This goal is likely motivated by the ongoing efforts from professional associations to reduce multiple births, leading fertility chains to advertise achieving lower multiple birth rates as both a marketing and reputation tool. Additionally, the chains want to attract employers who offer subsidized fertility benefits to their employees but are sensitive to the much higher costs associated with multiple births.[15] Altogether, the available documentation suggests that when clinics become part of a fertility chain, they receive access to resources and knowledge meant to improve financial and clinical performance.

3. DATA AND DESCRIPTIVE STATISTICS

3.1 Data Description

We construct a panel dataset of fertility clinic transactions to estimate the impact of chain ownership on clinic performance. We combine data from several sources to create a novel dataset of clinics acquired by or affiliated with a fertility chain between 2004 to 2018. See Appendix A for additional details on data construction.

Clinic Characteristics. All clinics that perform Assisted Reproductive Technology (ART) must submit data to the CDC annually under the Fertility Clinic Success Rate and Certification Act (FCSRCA) of 1992.[16] ART includes all fertility treatments in which either eggs or embryos are handled; over 99% of ART is IVF. The CDC then compiles and publishes Fertility Clinic Success Reports (download here: https://www.cdc.gov/art/artdata/index.html), which are meant to inform prospective patients of their probability of achieving a live birth. We will refer to these data as the

[15] A multiple birth can cost up to 20 times more than a singleton birth. Therefore, self-insured employers have an incentive to reduce multiple births to reduce the birth costs they would incur from offering fertility benefits (Lemos et al. 2013). In fact, several fertility benefits management companies advertise only partnering with clinics with low multiple birth rates to attract employers (Winfertility 2022).

[16] To ensure data quality, the medical director of a clinic must verify by signature that the success rates are accurate. Additionally, a random sample of clinics is audited each year.

CDC ART data. While the data are consistent within a year, the variables collected have undergone considerable changes over time, limiting which variables can be studied in a panel framework. After extensive data cleaning, we create a consistent clinic identification number and identify each clinic's patient infertility diagnoses, number of IVF cycles and transfers, and IVF success rates. We also use PDF versions of the CDC ART data to extract information on clinic addresses and laboratories.

Market Characteristics. We define a market as a clinic's Core Based Statistical Area (CBSA), which consists of one or more counties with an urban center of at least 10,000 people plus adjacent counties that are socioeconomically tied to the urban center by commuting.[17] Fertility clinics in the sample are present in 145 out of 927 CBSAs (see Harris et al. (2017) for details on the geographic distribution of fertility clinics).[18] Past research on fertility clinic competition has defined the market for fertility services as a metropolitan statistical area (Bundorf et al. 2009; Hamilton and McManus 2012). However, CBSAs, which include both metropolitan and micropolitan statistical areas, help capture additional clinics located in smaller urban areas. We use data from the US Census Bureau and the Bureau of Labor Statistics to obtain market-level population estimates, the median household income, and the unemployment rate. We also calculate the Herfindahl-Hirschman Index (HHI) based on a clinic's total IVF cycles to measure the competitiveness of the market.

Patient Characteristics. The CDC ART data are aggregated to the clinic level and do not contain patient information beyond infertility diagnoses. For secondary analyses, we use National Center for Health Statistics (NCHS) Vital Statistics Data to account for market-level patient demographics for women who gave birth after receiving any infertility treatment. The NCHS data include a mother's race/ethnicity, educational attainment, insurance, and clinical conditions such as hypertension and diabetes, but are only available from 2009-2018 with an indicator for receiving infertility treatment.

Chain Ownership. We identify clinic transactions through press releases, archived versions of clinic and fertility chain websites, the CDC ART data, and the following business intelligence databases: Irvin Levin, SDC Platinum, and Pitchbook data. These business sources often provide the announced date and the terms of the transaction. Based on their ownership structure, we classify fertility clinics into four main categories:

1) Acquisition: the clinic's assets (offices, lab, or both) are acquired and owned by the chain's corporate parent.

[17] A patient's choice of fertility clinic is not typically related to distance in areas with multiple clinics. Patients are often "willing and able to travel long distances to use the provider of their choice regardless of distance, time, or expense" (Harris et al. 2017).

[18] One fertility clinic in Alaska is not located in a CBSA and was assigned its county-level market characteristics. Clinics in Puerto Rico are excluded from analyses with market-level controls because several variables are unavailable during the sample period.

2) Affiliation: a clinic contracts with a fertility chain for selected management services and capital or financing options, and the corporate parent either has no ownership rights or partial ownership.
3) De-Novo: A new fertility clinic built and opened as part of the chain and is, therefore, owned and managed by the chain's corporate parent.
4) Non-Chain: a clinic that is never acquired by or affiliated with a fertility chain and never receives funding from corporate investors during the sample period.

The control group includes non-chain clinics, and the treatment group includes clinics acquired by or affiliated with a chain. Both non-chain and chain clinics may be hospital-based.[19] This is because even when clinics are part of "nonprofit hospitals or academic institutions, the fertility center itself is often a professionally managed, for-profit, private corporation" (Krawiec 2009). Consequently, most fertility clinics in the US are for-profit, and to our knowledge, there are no nonprofit or for-profit conversions. Additionally, even fertility clinics that are part of academic institutions are considered "lucrative profit centers" (Noah 2003; Jacoby 2009).[20] For these reasons, we include hospital-based clinics in the treatment and control groups. In our empirical analysis, clinic fixed effects account for time-invariant factors associated with being hospital-based, and we show robustness to excluding both chain and non-chain clinics that are part of an academic medical center (AMC).[21]

We identify 11 fertility chains in operation in the US between 2004 and 2018 (see Appendix Table A1 for details on each chain), which match those identified in industry reports and articles studying fertility clinic business models (Dresner Partners 2018; Borsa and Bruch 2022; Patrizio et al. 2022). These chains collectively owned or managed over 20% of fertility clinics in 2018. During the sample period, ten chains were privately held, and one chain was publicly traded. Most of these chains received PE funding between 2004 and 2018: five of the chains were acquired via leveraged buyouts by PE firms, and three chains received growth equity investments through joint venture agreements with PE firms.[22] This means a fertility clinic could be acquired by a chain *before* the chain itself is acquired by a PE firm. Because we are interested in the impact of chain ownership, we define treatment time as the year a clinic first became part of a fertility chain. However, since PE firms often provide additional resources needed for growth and have high-powered incentives to generate profit over a short time span, in secondary analyses, we decompose the effect of chain ownership on fertility clinics into chain ownership with PE funding and chain ownership without PE funding.

[19] There are no hospital-owned fertility chains to date. In other words, a single hospital or academic medical center would *not* own or operate multiple fertility clinics.
[20] For example, even in 1996, the Weill Cornell fertility clinic was considered "a financial powerhouse, generating a $2 million annual surplus for the Cornell Medical College and making possible physicians' salaries up to $1 million, more than the hospital pays its president" (Gabriel 1996).
[21] We identified 49 clinics (12%) as being part of an accredited AMC with a reproductive endocrinology and infertility residency program in 2018, of which 5 are owned or managed by a fertility chain.
[22] One chain is acquired by a PE firm in December 2018, the last month of our sample period. Therefore, we do not include it as PE-funded in descriptions or analyses.

3.2 Outcome Variables

We focus on two outcomes that measure clinic performance: 1) clinic volume and 2) success of IVF. Clinic volume is measured as the total number of IVF cycles and the total number of IVF transfers performed in a year (including donor and non-donor cycles and transfers). A cycle starts with the intent of retrieving an egg for immediate fertilization or to be frozen for future use. A transfer represents the part of an IVF cycle when one or more embryos are transferred into the uterus of a woman with the intent to establish a pregnancy (SART 2021a). Not all cycles become transfers because eggs may not develop, the patient may become ill, or the fertilization of the egg may not be successful, among other reasons (Bedrick et al. 2019). In regression analyses, we log volume variables to better fit the data (Appendix Figure C1).

The success of IVF is measured by the live birth rate. The live birth rate represents the number of live births divided by the number of transfers using fresh or frozen non-donor eggs (i.e., the patient's own eggs).[23] The CDC ART data reports the live birth rate by patient age bins (under 35, 35-37, 38-40, and 41-42). While we present live birth rates separately by age bins, for most analyses, we present a single live birth rate as an age-bin weighted average. We also show results decomposing the live birth rate into the singleton birth rate and the multiple birth rate (i.e., twin births are counted as one live birth). All live birth measures focus on cases where at least one embryo was transferred within 12 months of the start of the cycle; therefore, fertility preservation cycles where patients freeze their eggs or embryos for future use with no intent to become pregnant within 12 months are excluded.

3.3 Descriptive Statistics

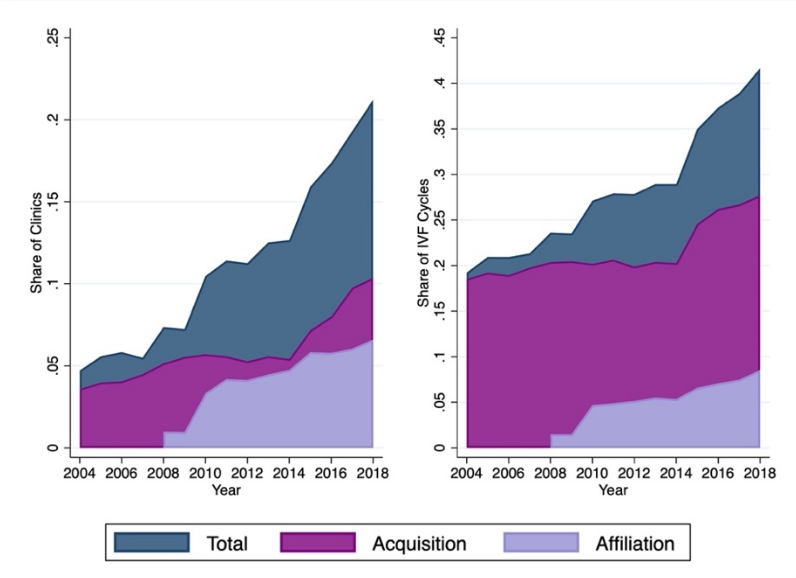
The final analytic sample includes 528 clinics and 6,274 clinic years. To construct this sample, we 1) exclude data reported for patients over the age of 42 because of changes in data availability over the sample period, 2) exclude clinics that perform fewer than 20 cycles a year on average, and 3) exclude clinics that are in the sample for less than 3 years (except for de novo clinics).[24] Figure 3 shows that by 2018, over 20% of clinics are in a fertility chain and perform over 40% of IVF cycles in the US. In total, there are 62 transactions: 33 clinics are structured as acquisitions, and 29 clinics are structured as affiliations. Additionally, 23 clinics are newly built by a chain, 15 clinics are always in a chain, and 428 are never part of a chain (i.e., non-chain clinics). However, in most analyses, we exclude 14 non-chain clinics with multi-year gaps in reporting to the CDC, resulting in 414 non-chain clinics.[25]

[23] An IVF cycle may result in only one or multiple embryos. With multiple viable embryos, one or more embryos may be transferred within a few days of creation, with the remainder frozen for future use. If the fresh embryo transfer is unsuccessful, the frozen embryos can be thawed and transferred subsequently.

[24] We also exclude 17 clinic-years when a clinic has fewer than 10 IVF cycles in their first or last year of data, as this signals a clinic opening or closure and may not accurately reflect a clinic's fertility program.

[25] Multi-year gaps can occur if a clinic pauses IVF cycles to restructure or fails to adhere to FCSRCA reporting requirements. Including these clinics yields slightly larger effect sizes than those in Table 2.

Figure 3. Share of Clinics and IVF Cycles in a Fertility Chain



Note: The left-hand figure shows the share of clinics in a fertility chain each year, and the right-hand figure shows the share of IVF cycles performed by chain clinics. "Total" includes all clinics ever part of a fertility chain, including those always in the chain or that were newly built by the chain.

Table 1 provides additional fertility clinic and market-level characteristics. Prior to a transaction, clinics appear to perform more cycles and transfers and have higher live birth rates than non-chain clinics, suggesting that chains may target better-performing clinics. De novo clinics also provide evidence of the role of chain ownership as they also experience greater volume and IVF success compared to non-chain clinics. Despite differences in these outcomes, patients do not appear to be inherently different across clinics: there are similar distributions of patients under 35 and of patient diagnoses for infertility. Similarly, a mother's reported education, race/ethnicity, insurance type, and health factors are comparable across clinic categories (Appendix Table C1). These statistics confirm that most patients who use infertility treatment are white, privately insured, and highly educated.

In Appendix Table C2, we present the results of a targeting regression to better understand the probability of a clinic acquisition or affiliation based on pre-transaction characteristics. The targeting results suggest chains target clinics that perform more IVF cycles, have a higher live birth rate, and, though marginally significant, target clinics in more competitive markets with larger populations aged 20-49. Additionally, clinics are less likely to be targeted in markets with a greater share of Medicaid patients.

Overall, these descriptive statistics help inform potential identification challenges. While there are differences in the types of clinics selected by fertility chains, there do not appear to be observable differences in the types of patients treated by clinics before the transaction. This pattern is consistent with the homogenous nature of patients treated by fertility clinics. Still, in the empirical analyses that follow, we use several strategies to account for differences between chain and non-chain clinics.

Table 1. Fertility Clinic Summary Statistics, 2004-2018

	Fertility Chain			Non-Chain
	Acquisition Pre-transaction mean	**Affiliation** Pre-transaction mean	**De Novo** Mean of all years	Mean of all years
Clinic Volume				
IVF Cycles	547.36	493.61	491.42	284.17
IVF Transfers	449.40	392.30	363.52	223.19
Log(IVF Cycles)	6.04	5.88	5.82	5.16
Log(IVF Transfers)	5.83	5.66	5.47	4.94
Birth Rates (%)				
Live Birth Rate	41.67	41.80	40.89	36.78
Singleton Birth Rate	30.40	30.86	29.99	26.87
Multiple Birth Rate	11.26	10.97	10.87	9.84
Patient Characteristics (%)				
Share of Patients < 35 (transfers)	51.64	51.88	50.94	51.30
Share of Patients 35-37 (transfers)	24.21	23.23	22.63	23.54
Share of Patients ≥ 38 (transfers)	24.16	24.89	26.43	25.16
Diagnosis, Tubal Factor	11.16	11.17	7.79	12.93
Diagnosis, Ovulatory Dysfunction	11.30	11.67	9.13	12.45
Diagnosis, Diminished Ov. Reserve	24.10	23.34	20.75	21.43
Diagnosis, Endometriosis	7.96	7.74	6.50	8.03
Diagnosis, Uterine Factor	3.79	4.12	1.65	4.04
Diagnosis, Male Factor	25.32	23.70	21.58	26.96
Diagnosis, Other	12.97	12.55	19.11	11.06
Diagnosis, Unknown	10.41	11.36	11.69	9.72
Market Characteristics (CBSA)				
Total Population (Age 20-49)	1,498,221	1,777,190	2,721,922	1,910,081
Population Female (%)	50.23	50.46	50.17	50.29
Unemployment Rate (%)	6.24	5.97	5.65	6.08
Median Household Income ($)	55,362	54,168	62,843	58,475
Market Concentration (HHI)	4,373	3,666	4,023	4,410
Observations				
Number of Clinics	33	29	23	414
Clinic-Years	283	193	138	4948

Notes: All summary statistics are at the clinic-year level. Clinic volume, birth rates, and patient characteristics include adjustment for year effects to account for changes in reporting in the CDC ART data. Market concentration is calculated using a clinic's total IVF cycles. 15 clinics are excluded because they are in a chain before the sample period, and 14 non-chain clinics are excluded because of multi-year reporting gaps. In total, there are 528 clinics and 6,274 clinic years.

4. THE EFFECT OF CHAIN OWNERSHIP

4.1 Empirical Approach

Our empirical strategy aims to identify the causal effects of chain ownership on fertility clinic volume and clinical performance. Our primary strategy utilizes a difference-in-differences (DD) specification to compare changes in outcomes before and after a fertility clinic becomes part of a fertility chain (treated) with concurrent changes for clinics that were never part of a fertility chain (control). De novo clinics and clinics always in a chain are excluded from analyses unless otherwise specified. We estimate extensions of this DD model using an event study framework and a matching estimator, among other analyses, that together provide compelling evidence that chain ownership positively impacts clinic volume and IVF success.

The preferred specification includes clinic fixed effects (θ_c) to adjust for time-invariant clinic characteristics and calendar *state* × *year* fixed effects (θ_{st}) to flexibly allow for time-varying factors that are common to all clinics in a state. We also include a vector of controls ($\boldsymbol{X}_{ct}$) that include an indicator for whether two clinics combined their data reporting to the CDC (i.e., had reported as two separate clinics but then began reporting as a single clinic) and an indicator for the first year a clinic was in the sample to account for partial year reporting when a clinic first enters the data.[26] Each estimation uses cluster-robust standard errors at the clinic level.

Eq. 1: $$Y_{ct} = \beta Post_{ct} + \gamma \boldsymbol{X}_{ct} + \theta_c + \theta_{st} + \epsilon_{ct}$$

Equation 1 is a within-clinic regression, where $Post_{ct}$ is a binary variable equal to one if clinic c is acquired by or affiliated with a fertility chain in year t. The coefficient of interest, β, captures the relationship between becoming part of the chain and Y_{ct}. Since there may be differences in clinic outcomes by ownership structure, we use interactions between $Post_{ct}$ and whether a clinic transaction was structured as an acquisition or affiliation, as seen in Equation 2.

Eq. 2: $$Y_{ct} = \beta_1 (Post \times Acquisition)_{ct} + \beta_2 (Post \times Affiliation)_{ct} + \gamma \boldsymbol{X}_{ct} + \\ + \theta_c + \theta_{st} + \epsilon_{ct}$$

The identifying variation is primarily based on the staggered timing of clinic transactions and the comparison of treatment and control clinics in their overlapping periods. To interpret the β coefficients as the causal effect of the transaction, we must assume that the trends in outcomes of these chain clinics would have been similar to the trends in outcomes of non-chain clinics in the absence of the transaction. The concern with this identification strategy is that the timing of the transaction may be correlated with other contemporaneous factors that impact the outcomes, such as changes in the patient population and the non-random selection of clinics. Additionally, recent literature in econometrics has shown the issue of negative weights that arise from DD with staggered treatment timing because of comparisons not only between treated and control units but between already treated and eventually treated units (see Baker et al. (2022) and Roth et al. (2022) for reviews). We conduct a series of diagnostic and

[26] We identify 10 clinics that combined reporting – this could be the result of a true merger, or the clinics remain separate entities that report under a single clinic. In either case, we take the weighted average of their outcome variables in each year and create an indicator variable equal to 1 post-merger. This is the most conservative approach; magnitudes are slightly larger when not accounting for these mergers.

robustness checks and additional analyses that mitigate concerns of treatment effect heterogeneity and the role of patient and clinic selection.

4.2 Main Effect on Clinic Volume and IVF Success Rates

Table 2 Panel A shows the estimates of the pooled regression from Equation 1 using both *state* × *year* (the preferred specification) and year fixed effects. After a clinic becomes part of a fertility chain, IVF cycles increase by 25.8%, and IVF transfers increase by 21.6%. There are also significant changes to IVF treatment success: The live birth rate increases by 2.6 percentage points (7.0% of the mean). However, pooling together clinics masks the heterogeneity in outcomes by ownership type. Table 2 Panel B reveals that both acquired and affiliated clinics significantly increase clinic volume, but only acquired clinics significantly increase the live birth rate. After an acquisition, the live birth rate increases by 5.1 percentage points (13.6%), and we fail to find evidence of changes in the live birth rate of affiliated clinics.[27]

Table 2. Effect of Chain Ownership on Fertility Clinic Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)
	Log(Cycles)		**Log(Transfers)**		**Live Birth Rate**	
Panel A: Pooled						
Post	0.258***	0.282***	0.216***	0.237***	0.026**	0.018*
	(0.071)	(0.063)	(0.071)	(0.063)	(0.011)	(0.010)
Panel B: Ownership Structure						
Post × Acquisition	0.282***	0.297***	0.214**	0.217**	0.051***	0.043***
	(0.098)	(0.087)	(0.099)	(0.088)	(0.013)	(0.012)
Post × Affiliation	0.238**	0.268***	0.217**	0.253***	0.004	-0.003
	(0.100)	(0.088)	(0.099)	(0.087)	(0.016)	(0.014)
Clinic FE	X	X	X	X	X	X
State × Year FE	X		X		X	
Year FE		X		X		X
Dep. Var. Mean	5.252	5.256	5.035	5.040	0.374	0.375
Clinic-Years	5666	5809	5666	5809	5666	5809
R^2	0.899	0.887	0.898	0.886	0.625	0.579

Notes: Panel A shows the β estimates of Equation 1, and Panel B shows the β_1 and β_2 estimates of Equation 2. The live birth rate is calculated as the number of live births divided by number of transfers. The dependent variable mean captures the predicted mean for control clinics and treatment clinics before the transaction. Standard errors are clustered at the clinic level. Statistical interpretations remain unchanged when using wild bootstrap standard errors to adjust for small sample sizes (Appendix Table D3). Significance levels: *p<0.1, **p<0.05, ***p<0.01

Table 2 shows that effect sizes are similar when accounting for time-invariant

[27] To assess statistical power, Appendix E provides power curves based on simulation analysis. For affiliated clinics, we have 60% and 80% power to detect an effect size of 1.8 pp and 2.4 pp in the live birth rate and 9.5% and 12% in log IVF cycles, respectively. Power curves are similar for acquired clinics.

differences across states rather than within states over time (Columns 2, 4, and 6). Additionally, we find quantitatively similar effects using *CBSA × year* fixed effects, which would account for market-level changes that could impact the demand or provision of fertility services (Appendix Table D1). Accordingly, results are not statistically different when including market-level controls such as the logged values of the CBSA-level population aged 20-49 and median household income (Appendix Table D2).

Using the results in Table 1 and 2 and assuming a profit margin of 37.5% and a price range of $12,000 to $20,000 per IVF cycle, the average clinic makes between $2.36 and $3.94 million in profit per year before chain ownership and $2.97 and $4.96 million per year after chain ownership, just from IVF services. See Appendix Table D4 for more details and discussion of assumptions.

4.3 Treatment Effect Timing

Goodman-Bacon Decomposition. Using a DD research design with multiple periods and treatment times could result in "bad" comparisons between clinics treated earlier and clinics treated later in the sample. The diagnostic test developed by Goodman-Bacon (2021) decomposes treatment effects into multiple, weighted, two-by-two DD estimators.[28] In Appendix Table D5, we show that approximately 90% of the weight is attributable to "good" comparisons of treated to never-treated clinics, and less than 10% is attributable to comparisons between early vs. later treated clinics or to within clinic variation. Furthermore, the small amount of weight placed on within-clinic variation suggests that the inclusion of controls does not drive our results.

Event Study Analyses. Next, we use an event study framework to evaluate whether the treatment and control clinics had differential trends before acquisition or affiliation. The event study is an extension of Equation 2, where instead of aggregating years before and after a transaction, indicators are included for each year relative to the transaction year. In addition to the two-way fixed effects (TWFE) estimates in Figure 4, we show robustness to utilizing the two-stage DD method developed by Gardner (2021) and the weighted group-time estimator developed by Sun and Abraham (2021). Together, these estimators further assuage concerns of treatment effect heterogeneity.

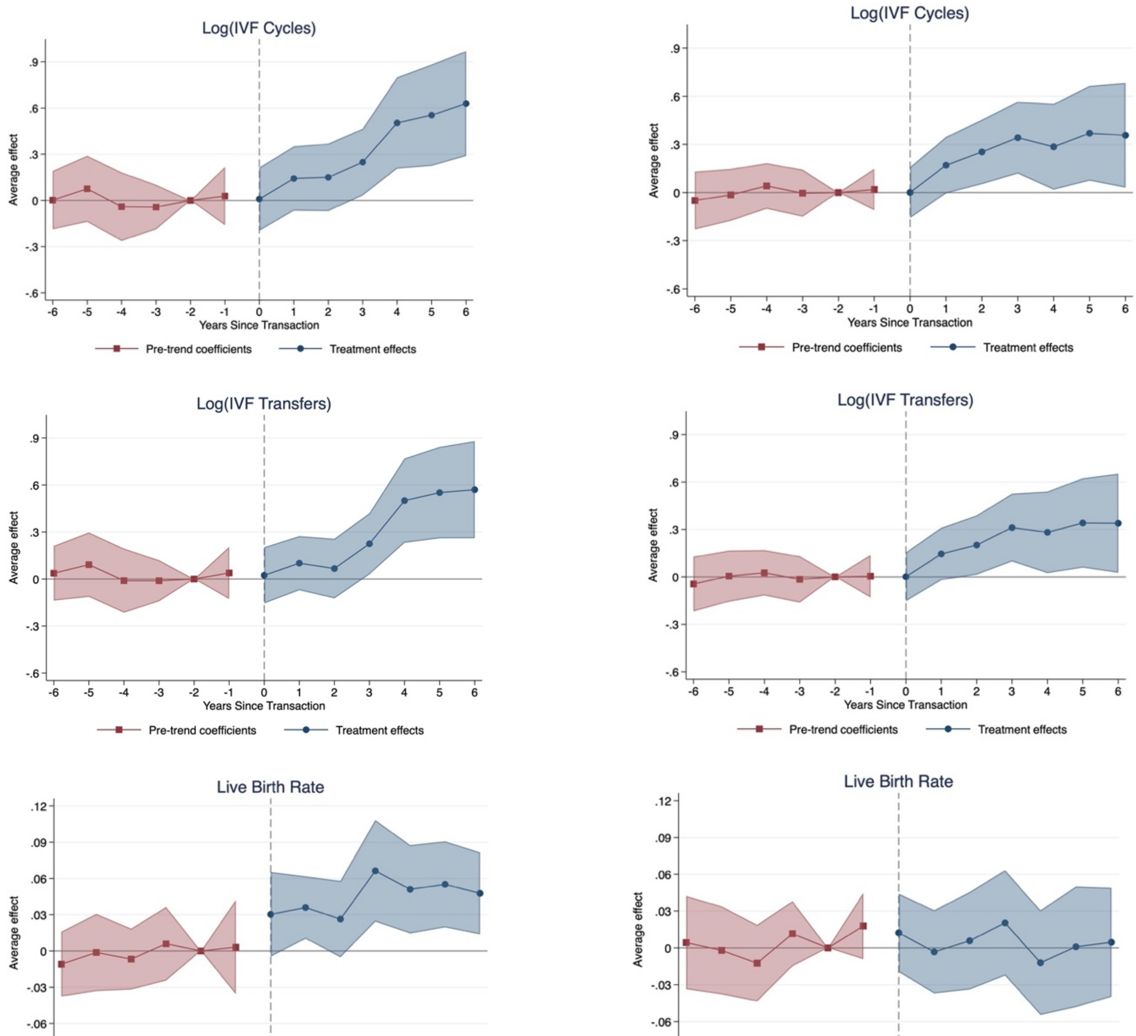
Figure 4 shows event study estimates for the 6 years before and after acquisition or affiliation for IVF cycles, IVF transfers, and the live birth rate (see Appendix Figure D1 for pooled results). We set the reference period to two years before the transaction to rule out possible anticipatory effects. For both ownership structures, there are no significant pre-trends before the transaction for IVF cycles and transfers: F-tests of joint significance show that the pre-transaction years are not statistically different from zero. After transaction, the cycles and transfers start to increase steadily after year 2. This

[28] The Goodman-Bacon decomposition requires a balanced panel, which limits this analysis to clinics with 15 years of data (52% of clinics and 64% of observations). In Appendix Table F6 we show results of our primary specification in Table 2 are quantitatively similar in the balanced panel.

pattern is consistent with the time it would take to expand operations. For example, volume-enhancing changes, such as investments in new office space, hiring and training new staff, and marketing to attract patients, will likely take time.

Figure 4. Event Study Results by Ownership Structure

(a) Acquisition (b) Affiliation



Notes: This figure shows the β_1 and β_2 estimates of Equation 2 interacted with indicators for the year relative to the transaction year. The reference period is two years before the transaction. Bands indicate 95% confidence intervals constructed from clinic-level clustered standard errors. For acquisitions and affiliations, respectively, the p-value from an F-test of joint significance are as follows: 0.574 and 0.734 for log(cycles), 0.754 and 0.781 for log(transfers), and 0.945 and 0.410 for the live birth rate.

With respect to the live birth rate, before acquisition, pre-trends are relatively flat and not statistically different from zero. After acquisition, there is evidence that the live birth rate increases in the year of acquisition and remains above 4 percentage points. Pre-trends are flat, and more precisely estimated using the methods of Gardner (2021) and Sun and Abraham (2021) (Appendix Figures D2 and D3). Post-transaction estimates also show similar increases, lending further credibility to the increase in the live birth rate observed in Figure 4. The event study patterns are suggestive of both immediate and longer-term effects of knowledge sharing in chains for acquired clinics. The immediate change in the live birth rate could result from accessing chain-wide protocols, while the additional increases in the live birth rate observed after year two could result from continued efforts to standardize care and learning from peers. For affiliated clinics, the live birth rate remains close to zero before and after affiliation, particularly when using the alternative DD estimators (Appendix Figures D2 and D3).

Early vs. Late Transactions. One concern related to generalizability of these findings is whether effects were concentrated among early vs. late transactions. As shown in Appendix Table D6, we find similar increases in clinic volume and the live birth rate among clinics acquired before or after 2011.[29]

4.4 The Role of Patient Selection

One identification concern is whether patient characteristics changed after a clinic joined a fertility chain in ways that would influence IVF success rates. For example, if observable patient characteristics changed after acquisition or affiliation, this suggests that patient selection on unobservables could bias the estimates. This selection could result from patients of higher or lower risk selecting certain clinics or from clinics potentially "cherry-picking" patients that would have more successful IVF outcomes, such as younger patients. Below we provide evidence that changes in patient characteristics do not drive changes in the live birth rate.

Similar Patient Age Distributions. The homogenous patient population mitigates concerns about patient differences across clinics. Patients that receive IVF treatment are predominantly white, privately insured, high-income, and highly educated (Chandra, Copen, and Stephen 2014; Galic et al. 2021). Furthermore, the single largest predictor of IVF success is a patient's age (SART 2021b). Predictive models based on pre-treatment patient characteristics find that patient age explains 85% of the total variation in the live birth rate and that patient infertility diagnosis, race/ethnicity, and body mass index are not strongly predictive of IVF success (Xu et al. 2022). In Appendix Figure F1, we show that the distribution of the share of patients in younger and older age groups is similar before and after a clinic transaction in the raw data.[30]

No Systematic Patient Selection. We also do not find evidence that clinics systematically treat patients that could be more or less likely to experience IVF success. Figure 5 presents changes in the share of patients in different age groups and patient

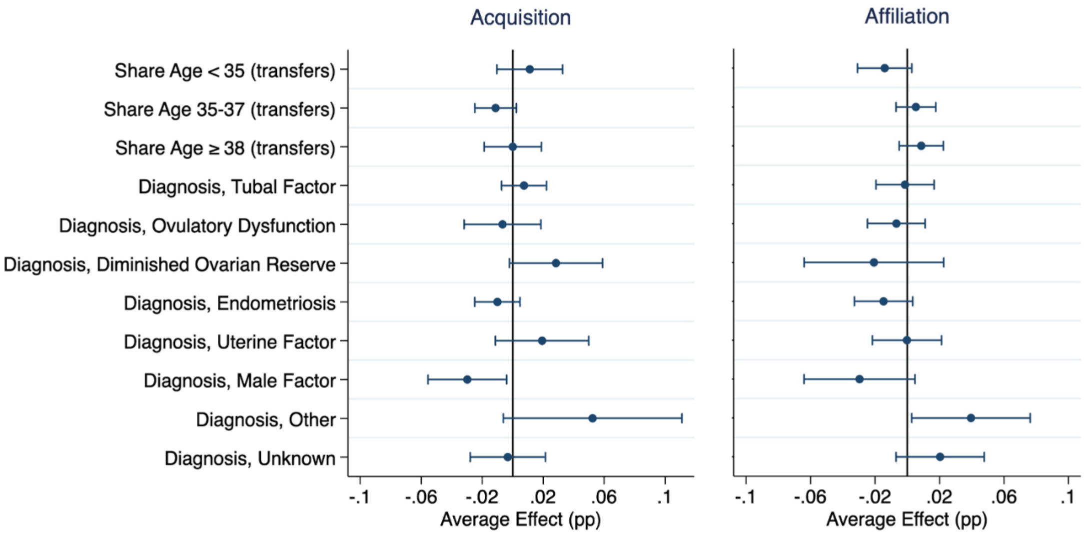
[29] Note that to generate more accurate comparisons between early and late transactions while retaining sufficient observations, we exclude years of data greater than 4 years pre or post transaction.

[30] In Appendix Table H4 (discussed in section 5.1.3), we also show that even clinics with minimal increases in volume (i.e., less likely to experience patient changes) significantly improved the live birth rate.

infertility diagnosis as the outcome variable of Equation 2. For acquired clinics, there is a small reduction in the share of patients aged 35-37 but no change in patients under 35 or 38 and over, which suggests no clear pattern of patient selection based on age. For affiliated clinics, there is a small reduction in the share of patients under 35. However, in Figure 6, we show that 1) increases in clinic volume are similar across all age categories in both acquired and affiliated clinics, 2) acquired clinics increase the live birth rate across all age categories, especially among patients over 38, and 3) affiliated clinics do not increase the live birth rate, even among patients under 35. These results further minimize concerns that outcomes are driven by selection on patient age.

Patient diagnosis patterns are largely similar in acquired and affiliated clinics, and the changes are unlikely to influence IVF success. For example, even though there are significantly lower rates of patients with male factor infertility, there is limited evidence that male factor infertility impacts IVF outcomes (Shamonki et al. 2004; Vaegter et al. 2017). One study found that among the diagnosis categories, a tubal factor diagnosis is associated with the lowest live birth rate, and ovulatory dysfunction is associated with the highest (Vaegter et al. 2017). Figure 5 shows limited evidence of post-transaction changes for these diagnosis categories.

Figure 5. Effect of Chain Ownership on Clinic-Level Patient Characteristics



Notes: This figure displays β_1 and β_2 estimates of Equation 2 using patient characteristics as the outcome variables. Bars are 95% confidence bands. Standard errors are clustered at the clinic level.

Robust to Controls for Patient Characteristics. We find quantitatively similar effects to our primary estimates when including patient diagnoses in Figure 5 as controls, confirming that patient infertility diagnoses have minimal influence on live birth rates (Appendix Table F1 Panel A). We also find quantitatively similar results when including controls for market-level maternal characteristics such as a mother's race, level of education, insurance status, and health factors, for patients who delivered a baby and reported using infertility treatment (Appendix Table F1 Panel B).

Limitations. Overall, these results suggest that changes in patient characteristics do not drive changes in IVF success across clinic types. A limitation of this study is that we can only observe IVF success rates per transfer rather than per patient. This means that the same patient may undergo multiple transfers during the year.[31] Still, this is a commonly used success rate in IVF research and provides the most granular level to estimate success (Awadalla et al. 2021; Cozzolino et al. 2022; Mizrachi and McQueen 2022). Specifically, the occurrence of a transfer requires the creation of a viable embryo and, therefore, precludes patients with failed cycles. This allows for a more "apples to apples" comparison of patients across clinics.

4.5 The Role of Clinic Selection

Selection is an inherent feature of this setting: Fertility chains select the clinics they want in their chain, and clinics select the chain they want to join. Since being part of a fertility chain is not randomly assigned, we cannot unambiguously conclude that chain ownership causes changes in clinic volume and IVF success. For example, chains may acquire clinics that they believe will achieve the best outcomes in the future. Below we provide additional discussion and analysis that helps mitigate but does not eliminate the role of clinic selection in explaining our results.

Robust to Alternative Fixed Effects. The primary specification helps account for potential differences between the treatment and control groups by including clinic fixed effects, which adjust for time-invariant clinic characteristics such as location and reputation. Including *state* × *year* fixed effects accounts for time-varying factors common to all clinics in a state. For example, these fixed effects would account for increases in demand for IVF if changes in state insurance coverage laws increase the affordability of care. However, results are quantitatively similar when only using year fixed effects (Table 2) and *CBSA* × *year* fixed effects (Appendix Table D1).

Limited Evidence of Pre-Trends. As seen in Figure 4 the event studies reveal clear changes in the outcomes before and after the transaction year. There are also no observable pre-trends in the years before the transaction. This suggests that the selection mechanism is unlikely to fully explain the changes observed after chain ownership.

Robust to Using Matched Control Groups. A standard approach to address the endogeneity due to selection is to match treated units with similar characteristics in the pre-transaction period to untreated units. In this setting, clinic volume is the most salient difference between treatment and control clinics: on average, acquired and affiliated clinics appear to perform more IVF cycles and transfers than non-chain clinics before transaction (Table 1). While differences are slightly mitigated by logging the volume

[31] In cross-sectional analysis using new variables reported in 2017 and 2018, we can observe success rates per intended egg retrieval for new patients with no prior ART treatment between their first retrieval and their cumulative retrievals. As seen in Appendix Table F2, the cumulative rates are slightly larger than the first retrieval rates, but both are positive and not statistically different from each other.

outcomes, higher volume clinics may still have different capabilities that more readily manifest in increased volume and IVF success rates in the future.

In Appendix Table F3, we show that the effects of the DD specification in Equation 2 are quantitatively similar for acquired clinics and qualitatively similar for affiliated clinics using matched control groups. Specifically, we use 1-1 coarsened exact matching on a clinic's IVF cycles in the year before the transaction (Appendix Table F3 Panel A). To account for possible spillover effects, we also show that results are robust to repeating the volume-based match excluding non-chain clinics in the same market as chain clinics (Appendix Table F3 Panel B). Lastly, we show robustness to matching on clinic cycles, live birth rate and the share of patients under 35 (Appendix Table F3 Panel C). See Appendix Table F4 for matched sample summary statistics.[32]

However, matching on outcome variables within a DD framework is susceptible to regression to the mean bias (Daw and Hatfield 2018). As an alternative strategy, we limit the control group to non-chain clinics that perform at least 150 cycles a year. This restriction increases the average number of IVF cycles of non-chain clinics from 284 to 426 cycles, which is closer to the pre-transaction volume of acquired and affiliated clinics. The results in Appendix Table F3 Panel D show quantitatively similar results for acquired clinics and qualitatively similar results for affiliated clinics. Together, the matched sample and sample restricted to high-volume clinics suggest that effects are not driven by differential selection of clinics based on size.

Robust to Alternative Samples. We also conduct robustness checks for the years a clinic was in the sample. Clinics open and close during the sample period and so may not be present in the data for all years between 2004 and 2018. For both chain clinics and non-chain clinics, it could take several years for their fertility program to stabilize. We find that effects are quantitatively similar when limiting the sample to clinics present in all 15 years of data (Appendix Table F6 Panel A).

The CDC ART data also includes a flag for whether a clinic self-reported restructuring, defined as a change in at least two of the three key staff positions (practice director, medical director, or laboratory director), or if the clinic was on the verge of closing. Non-chain clinics may experience a restructuring unrelated to joining a chain because of retirement, expansion, general changes in leadership, or impending closure. To ensure these changes are not inadvertently leading to a pseudo-treatment effect, we show that results are quantitatively similar when excluding non-chain clinics that are ever restructured or closed (Appendix Table F6 Panel B).

Lastly, given concerns that clinics that are part of an academic medical center (AMC) may be exposed to different patients, and have different treatment strategies because of resident training, we show results are robust to dropping all chain and non-chain clinics (49 clinics) that are part of an AMC (Appendix Table F6 Panel C).

[32] We collect data on the number of physicians and office locations for the matched sample in 2018 and do not find significant differences in the size of chain and non-chain clinics (Appendix Table F5).

4.6 Additional Robustness

Unique features of the data also warrant additional robustness checks. For example, CDC made a data reporting change in 2018. While data cleaning efforts were made to homogenize data, we show results are robust to dropping the year 2018 (Appendix Table F7 Panel A). In our preferred specification, we assume that once a clinic is treated, it remains treated. However, in some cases, a fertility chain experiences a second acquisition event (i.e., a larger chain acquires a smaller chain). Our results are robust to controlling for the second acquisition event (Appendix Table F7 Panel B). Lastly, we show that results are robust to excluding cases in which it was less clear whether the clinic was an acquisition or an affiliation (Appendix Table F7 Panel C).

4.7 The Role of Market Concentration

By consolidating clinics, chains may impact the competitiveness of fertility markets and, therefore, the behavior of fertility clinics. In particular, more concentrated markets may have less incentive to invest in quality than less concentrated (i.e., more competitive markets) (Matsa 2011). We find that only 3 CBSAs became more concentrated because of chain ownership as measured by an increase in HHI, likely because most acquisitions or affiliations occur across markets. Accordingly, outcomes are quantitatively similar when excluding these markets (Appendix Table G1). We also find that clinics acquired by chains in more competitive markets at baseline increase the live birth rate by 6.4 percentage points, whereas those in less competitive markets only increase the live birth rate by 2.6 percentage points (Appendix Table G2). These results emphasize the importance of competition for quality promotion in healthcare markets.

5. MECHANISMS

The previous analyses find that chain ownership significantly increases clinic volume and IVF success rates and provide evidence that patient and clinic selection do not drive results. In this section, we provide suggestive evidence that the transfer of resources and knowledge following chain ownership most likely explain the changes in clinic volume and IVF success rates. Resource transfers include any transfer of financial resources (e.g., capital) or managerial capabilities (e.g., marketing) from the chain's corporate parent to the target clinic. Knowledge transfers include the sharing of new clinical information. Chains can transfer knowledge through top-down clinical directives (i.e., protocols, monitoring, and mandatory trainings) and by facilitating knowledge sharing among clinics through the creation of research consortiums and case review meetings. While resource and knowledge transfers can work in tandem to improve clinic volume and IVF success rates, resource transfers likely have a greater impact on clinic volume, and knowledge transfers likely have a greater impact on IVF success rates.

The following analyses are collectively intended to show patterns consistent with resource and knowledge transfers leading to improvement in outcomes. First, we discuss and conduct analyses most supportive of knowledge transfers: 1) We argue that increases in live birth rates among acquired clinics, but not affiliated clinics, are consistent with acquisitions better facilitating knowledge transfers because of greater incentive alignment and corporate control, 2) We show that clinics change processes and procedures to enhance quality, consistent with new knowledge leading to improvements in IVF outcomes, and 3) We find that the lowest performing clinics pre-transaction experience the largest performance improvements, as do clinics acquired by higher-quality chains, consistent with clinics learning from other chain clinics. Second, we discuss and conduct analyses most supportive of resource transfers: 1) We find that fertility chains lead to market expansion rather than business stealing from non-chain clinics, suggesting fertility chains provide financial resources needed to expand clinic operations, 2) We provide evidence that chain clinics are more likely to advertise money-back guarantee and multi-cycle IVF discount programs, suggesting fertility chains provide managerial resources needed to attract new patients, and 3) We show that PE investment into fertility *chains* largely drives increases in clinic volume, consistent with PE firms easing financial constraints and facilitating clinic growth.

5.1 Evidence Consistent with Knowledge Transfers

5.1.1 Only Acquired Clinics Increase IVF Success Rates

Differences in ownership structure can shed light on a corporate parent's ability to improve firm performance (Grossman and Hart 1986). Specifically, greater ownership typically confers greater control over the operations of the target firm (Bernstein and Sheen 2016; Demirer and Karaduman 2022). In our setting, marketing materials and press releases suggest that both acquired and affiliated clinics receive access to resources and knowledge in a chain. However, in conversations with chain operators, we learned that they prefer to acquire clinics because of their ability to better control operations. Affiliations typically occur because a clinics' physician owners do not want to relinquish autonomy but still want access to financial resources and management services. Since the clinic owners retain greater decision-making authority and the transactions are more focused on resource transfers, we may expect that affiliations would only impact clinic volume but not IVF success rates.

Furthermore, the interests of affiliated clinics may not be congruent with those of the chain because they seek to maximize their own profits rather than that of the organization.[33] As seen in Table 1, affiliated clinics may believe their IVF success rates are already superior and have less incentive to invest in quality improvement efforts. Affiliated clinics may also seek to benefit from the chain's reputation, which may further reduce incentives to share knowledge or learn from other clinics (Jin and Leslie 2009) Overall, differences in control and incentives of affiliated clinics compared to acquired clinics provide a placebo test for the role of knowledge transfer. Consistent with this

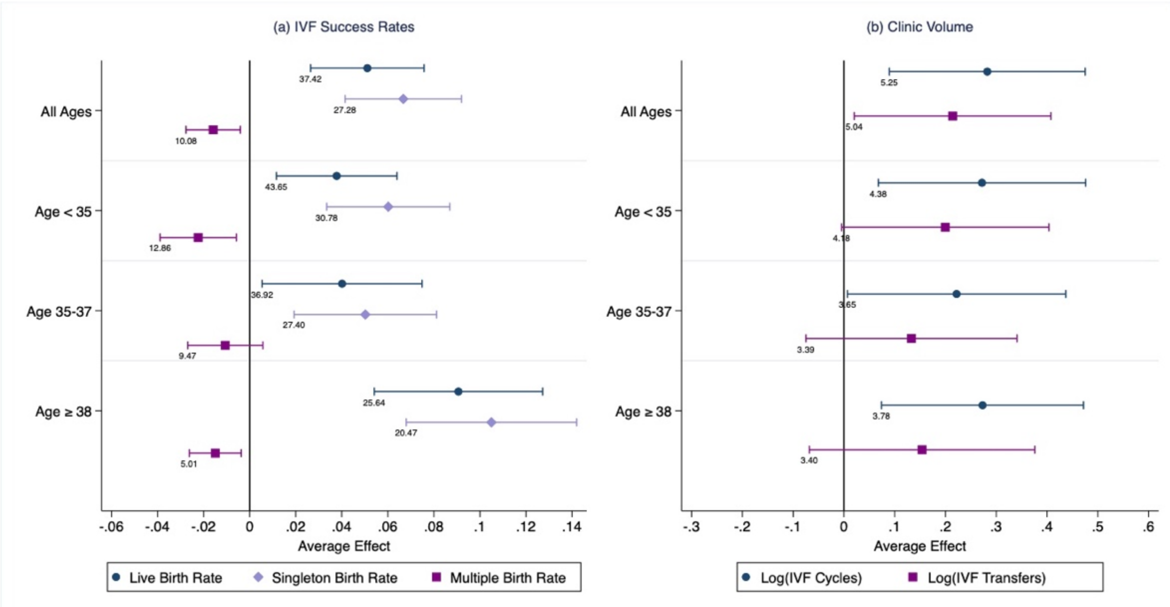
[33] Depending on the terms of the contract, chains may also be reluctant to transfer knowledge to affiliated clinics if they are "free to walk away at any time with the acquired knowledge" (Garicano and Rayo 2017).

argument, we find that both acquisitions and affiliations lead to increases in clinic volume, but only acquisitions lead to increases in the live birth rate (Table 2).

5.1.2 Evidence that Chains Change Procedures and Technology to Increase Quality

Acquired Clinics Increase Singleton Births and Reduce Multiple Births. Improving IVF success rates is a major challenge for fertility clinics. The "gold standard" is to simultaneously decrease multiple births and increase singleton births by enough to have a net positive effect on the live birth rate. Reducing multiple births is quality-enhancing because multiple births have a greater incidence of obstetric and neonatal complications (Kissin, Boulet, and Jamieson 2016). However, transferring multiple embryos (30% probability of a multiple birth) is associated with a greater probability of IVF success than a single embryo transfer (less than 1% probability of a multiple birth). Since the live birth rate is the key metric clinics use to attract patients, this may create an incentive to transfer multiple embryos at once to increase IVF success rates.[34]

Figure 6. The Effect of Chain Ownership on Fertility Clinic Outcomes by Patient Age and Birth Type, Acquired Clinics



Notes: This figure displays β_1 estimates of Equation 2 by patient age category (i.e., only displays results for acquired clinics). The dependent variable mean based on the predicted mean for control clinics and treatment clinics before the transaction is displayed under each 95% confidence bar. Standard errors are clustered at the clinic level. See Appendix Table H1 for the full regression results.

Therefore, transferring multiple embryos allows more room for error in the embryos chosen for transfer, whereas a single embryo transfer requires more precision and expertise to identify the highest quality embryo to transfer (Reimundo et al. 2021).

[34] While some patients may prefer twins, research suggests they may not comprehend the associated risks. Therefore, patient education can be an effective strategy in reducing desire for twins and increasing the use of single embryo transfers (Shenoy et al. 2017; Mendoza et al. 2018; Sunderam et al. 2018)

If the chain were sharing knowledge to improve IVF processes and quality, we would expect increases in the live birth rate to be driven by increases in singleton births large enough to compensate for reductions in multiple births. In Figure 6(a), we graphically present results from Equation 1 by the overall live birth rate, multiple birth rate, and singleton birth rate for acquired clinics. For overall IVF success rates, singleton births increase by 6.7 percentage points, and multiple births decrease by 1.6 percentage points. A similar pattern is observed within each patient age group.

Acquired Clinics Increase Genetic Testing, Reduce Embryos Per Transfer, and Update Laboratories.[35] The increase in the live birth rate driven by singleton births is consistent with new knowledge enabling greater success of single embryo transfers. For example, chains emphasize adopting new procedures that improve embryo selection, such as preimplantation genetic testing (PGT) and intracytoplasmic sperm injection (ICSI): "cutting edge technology enables embryologists and fertility specialists to assess the genetic and chromosomal makeup of an embryo prior to its transfer into a woman's uterus." As shown in Table 3, we find strong evidence that acquired clinics increase the use of PGT but find no changes in ICSI use (potentially because ICSI was introduced in 1991 and experienced rapid adoption). One chain also describes implementing the use of day 5 blastocyst embryos because "this advanced IVF lab technique allows the embryo to mature as far as it can outside the human body, again allowing embryologists and physicians an enhanced ability to select the best single embryo for transfer." While we are unable to measure this outcome, we find that, per transfer, acquired clinics reduce the average number of embryos transferred to the uterus (Table 3). In contrast, no such improvements are seen in affiliated clinics.

Fertility chains can also provide resources to help modernize a clinic's laboratory and implement protocols to standardize laboratory processes. For example, one chain emphasizes that "continuous improvement in laboratory processes and patient care protocols have to lead to increased success rates." While we cannot directly measure whether a clinic changes or makes updates to its laboratory, the CDC ART data publishes the name of the laboratory used by each clinic each year. The name change may indicate a significant overhaul or signal a rebranding with no meaningful changes to the laboratory. In Table 3 Column 4, the outcome variable is zero for all clinics before a name change and 1 after the first time a clinic changes its laboratory name. In Table 3 Column 5, we limit the sample to clinics that only experience 1 name change, as this may best capture a real change. We find that post-transaction, the probability a laboratory changes for acquired clinics increases between 35.7 and 44.3 percentage points. These results provide evidence that fertility chains may update clinic laboratories and facilitate the use of new technology and techniques that enhance the quality of IVF.

[35] See Appendix Table B2 for quote sources in this section. Note that new procedures or techniques are often referred to as technological advancements by fertility specialists.

Table 3. The Effect of Chain Ownership on Procedure and Lab Changes

	(1) PGT Rate	(2) ICSI Rate	(3) Avg. # of Embryos Transferred	(4) Prob. Lab Name Change (Any)	(5) Prob. Lab Name Change (Single)
Post × Acquisition	0.070***	-0.004	-0.286***	0.443***	0.357***
	(0.027)	(0.026)	(0.053)	(0.078)	(0.103)
Post × Affiliation	0.016	0.000	0.075*	0.225***	0.169*
	(0.010)	(0.033)	(0.038)	(0.085)	(0.088)
Dep. Var. Mean	0.058	0.676	2.232	0.124	0.084
Clinic-Years	3863	4888	4890	5666	5210
R^2	0.698	0.766	0.845	0.745	0.700

Notes: This table shows the β_1 and β_2 estimates of Equation 2. The dependent variable mean captures the predicted mean for control clinics and treatment clinics before the transaction. The CDC ART data does not report PGT until 2007 and changes how the data on PGT, ICSI and the number of embryos transferred are collected in 2017 and 2018. Therefore, PGT rate uses data from 2007-2016, and ICSI rate and number of embryos transferred from 2004-2016. Column 4 includes all clinics and column 5 limits the sample to clinics that only had a single change in the lab name during the sample period. Standard errors are clustered at the clinic level. Significance levels: *$p<0.1$, **$p<0.05$, ***$p<0.01$

Acquired Clinics Increase Live Birth Rates for Complex Patients. As an additional strategy to explore the role of knowledge transfer, we consider whether IVF success rates change for patients of different complexity (Stan and Vermeulen 2013). The qualitative materials collected from chain websites suggest physicians within a chain regularly meet to discuss complex patients (Appendix Table B2). One of the most important predictors of IVF success is a patient's age, with patients of older age representing more complex cases. If accessing new or superior knowledge contributes to improved techniques and processes, we would expect the largest improvements for older patients, as they have the most to benefit.

Figure 6 provides empirical support for this argument, where patients aged 38 and older experience increases in the live birth rate at almost double the rates of patients under 35 or patients ages 35-37. The volume of IVF cycles and transfers also increases by the same amount for older patients as other age groups and increases in singleton births drive the increase in the live birth rate. One potential reason for these improvements is the increased use of PGT (Table 3): Studies have found that usage particularly increases the success of single embryo transfers among older women (Maxwell and Grifo 2018; ACOG 2020).

5.1.3 Evidence that Chains Facilitate Learning

Low-Performing Clinics Experience Larger Improvements than High-Performing Clinics. The existence of knowledge transfer assumes physicians receive access to new or superior knowledge or generate knowledge through collaboration after joining a fertility chain. The event studies in Figure 4 suggest both immediate and longer-term effects of acquisitions on the live birth rate, though the wide confidence intervals may indicate differences in effect sizes across clinics. For example, clinics with high birth rates pre-transaction may be less likely to experience positive effects, and those with lower birth rates may have the most to benefit from accessing the knowledge of the chain. Similarly, clinics that already had higher clinic volume may benefit less from resources meant to expand clinic operations.

In Table 4, we divide acquired and affiliated clinics into three terciles based on their pre-transaction IVF cycles, IVF transfers, and the live birth rate, and interact an indicator for each category with the post-transaction indicators in Equation 2. Specifically, all acquired clinics are divided into terciles, and separately, all affiliated clinics are divided into terciles based on their pre-transaction means for each outcome. This strategy allows a clinic to potentially be initially high performing on live birth rate but low performing on clinic volume. Table 4 provides evidence that all acquired clinics experience improvements, but that the largest increases in clinic volume and live birth rates occur among initially lower-performing clinics relative to those that were higher-performing. These results suggest that joining a fertility chain creates a "rising tide lifts all boats" effect, in which all clinics improve, but especially lower performing clinics.

Table 4. The Effect of Chain Ownership on Fertility Clinic Outcomes by Pre-Transaction Clinic Performance

	(1) **Log(Cycles)**	(2) **Log(Transfers)**	(3) **Live Birth Rate**
Post × Acquisition(Low=1)	0.366***	0.287*	0.059***
	(0.140)	(0.146)	(0.022)
Post × Acquisition(Med=1)	0.302	0.209	0.058**
	(0.205)	(0.212)	(0.024)
Post × Acquisition(High=1)	0.133	0.107	0.037***
	(0.105)	(0.099)	(0.009)
Post × Affiliation(Low=1)	0.521***	0.490**	-0.010
	(0.201)	(0.206)	(0.016)
Post × Affiliation(Med=1)	0.232*	0.220*	0.044
	(0.131)	(0.127)	(0.029)
Post × Affiliation(High=1)	-0.035	-0.055	-0.034
	(0.069)	(0.074)	(0.026)
Dep. Var. Mean	5.251	5.034	0.374
Clinic-Years	5666	5666	5666
R^2	0.900	0.899	0.626

Notes: This table displays β_1 and β_2 estimates of Equation 2 with clinics divided into terciles based on their pre-transaction averages for each outcome variable (these categories are mutually exclusive). For example, *Acquisition(Low=1)* is an indicator equal to 1 if an acquired clinic was in the bottom tercile of acquired clinics based on its pre-transaction mean. The dependent variable mean captures the predicted mean for control clinics and treatment clinics before the transaction. Standard errors are clustered at the clinic level. Significance levels: *p<0.1, **p<0.05, ***p<0.01

Clinics Acquired by High-Performing Chains Experience Larger Improvements than Low-Performing Chains. To better understand the fertility chain's role in facilitating improvements in the live birth rate, we conduct additional subsample analyses. If clinics are indeed learning from their chain, we would expect clinics acquired by high-performing chains to experience larger increases in the live birth rate than those acquired by lower-performing chains. To test this, we create an indicator for whether a *fertility chain* is relatively high performing (above median), or low performing (below median) based on the average live birth rate of the clinics in the chain before the first chain transaction occurs. We then interact these high and low-performing chain indicators with the post-transaction indicators in Equation 2. The estimates on these interaction terms are statistically significant and reveal that live birth rates increase by 7.3 percentage points in clinics acquired by high-performing chains, and by 2.8 percentage points in clinics acquired by low-performing chains (Appendix Table H3). These findings suggest that fertility chains with pre-existing superior knowledge can facilitate larger increases in live birth rates.

Improvements in the Live Birth Rate are Not Driven by Volume Increases. Rather than improving by accessing new knowledge, physicians may improve their outcomes by performing more IVF cycles. A study by Wilkinson et al. (2022) did not find a significant association between a clinic's volume and its live birth rates. Similarly, a review by Mizrachi and McQueen (2022) finds no evidence of differences in IVF success rates based on physician experience: Even among fellows, outcomes were stable throughout their training. The authors conclude that because embryo transfer is "performed by a single operator on their own, and thus, after initial training, there is limited opportunity for physicians to compare their technique to other colleagues and improve" (Mizrachi and McQueen 2022, p. 816). Therefore, rather than within-physician learning from increased volume, physicians may be more likely to improve from knowledge sharing within the chain.[36]

The event study results provide insights into the volume-outcome relationship (Figure 4). If improvements among acquired clinics only happened via learning-by-doing from increased volume, we would expect the improvement in the live birth rate to follow a similar trajectory as the increase in clinic volume. Instead, in the first couple of years post-acquisition, there are immediate increases in the live birth rate without commensurate increases in volume. Additionally, affiliated clinics see increases in volume but no changes to the live birth rate. We also re-estimate the terciles in Table 3 Column 1 based on pre-transaction IVF cycles but use live birth rate as the outcome (Appendix Table H4). The estimates of this regression show that acquired clinics in the top tercile of volume (which saw no significant increases in volume) still significantly increase the live birth rate by 4.2 percentage points. Together, these results suggest the volume-outcome relationship does not appear to drive the increase in the live birth rate.

[36] Volume could still be an important mechanism to reinforce a newly learned or adopted procedure. We aim to rule out that volume alone drives changes in the live birth rate.

5.2 Evidence Consistent with Resource Transfers

5.2.1 Chain Clinics Expand IVF Market

The marketing materials of fertility chains place a large emphasis on growth. For example, chains advertise providing clinics with financial resources to fund add-on locations and hire new clinical and administrative staff. Additionally, chains advertise providing clinics with managerial capabilities such as marketing services and patient engagement programs to attract and retain patients throughout their IVF journey. Clinic growth could help increase access to IVF given the unmet demand for fertility services driven by the scarcity of clinics and cost of IVF (Chambers et al. 2009; Greil et al. 2016).

However, rather than expand the market, chain clinics may instead be capturing the market share of non-chain clinics. To study market expansion vs. business stealing, we implement the following instrumental variables approach:[37]

Eq. 3: $$Total\_Chain_{jy} = \gamma Chain\_Clinics_{jy} + \zeta \boldsymbol{X}_{jy} + \theta_j + \theta_y + \nu_{jy}$$

Eq. 4: $$M_{jy} = \delta Total\_Chain_{jy} + \phi \boldsymbol{X}_{jy} + \theta_j + \theta_y + \epsilon_{jy}$$

The first stage in Equation 3 instruments for the total number of IVF cycles ($Total\_Chain_{jy}$) performed by chain clinics in market j in year y using the number of chain clinics ($Chain\_Clinics_{jy}$) in market j in year y. As before, the market is defined as a clinic's CBSA (see Appendix Table H5 for robustness to using commuting zone markets). We control for market (θ_m) and year fixed effects (θ_y), and market-level controls ($\boldsymbol{X}_{jy}$) including median household income and total population aged 20-49. To test whether chain ownership leads to business stealing, we estimate the second stage (Equation 4) using the total IVF cycles performed by non-chain clinics in a market as outcome M_{jy}.[38] If an increase in IVF cycles by chain clinics is the result of business stealing, then we would expect $\delta = -1$. To test whether chain ownership leads to market expansion, we instead use the total number of IVF cycles performed by *all* clinics in a market as outcome M_{jy}. If fertility chain growth is market expanding, then we would expect $\delta = 1$. In other words, for every 1 IVF cycle performed by a chain clinic, there is 1 additional IVF cycle in that market.

As seen in Table 5, we find no support for business stealing and strong evidence in support of market expansion. We observe no reduction in cycles for non-chain clinics (Column 1), and for every additional cycle performed by a chain clinic, there is one additional cycle at the market level (Column 2). These results are consistent with chains providing resources needed to ease clinic capacity constraints and expand the set of

[37] We implement this approach to account for multiple transactions by different clinic chains in the same market and because it provides an intuitive test of market expansion.

[38] By construction, the instrument is strongly predictive of total IVF cycles and live births by chain clinics because as the number of chain clinics in a market increases, so will chain cycles and live births. In other words, the number of chain clinics is assumed to only impact total *market* cycles and live births through the increase in total *chain* cycles and live births.

patients utilizing IVF. Given the large unmet demand for fertility services, chain clinics likely increase access to IVF.[39] There are also similar patterns observed for the number of live births (Columns 3 and 4), providing evidence that the entry of chain clinics does not significantly impact the IVF outcomes of non-chain clinics.

Table 5. Market Expansion Analysis, IV Estimates

	(1)	(2)	(3)	(4)
	Total Market Cycles		**Total Market Live Births**	
	Non-Chain Clinics	All Clinics	Non-Chain Clinics	All Clinics
Total Chain Cycles	-0.021	0.979***		
	(0.152)	(0.152)		
Total Chain Live Births			-0.199	0.801***
			(0.132)	(0.132)
First Stage: F-Stat	83.997	83.997	66.252	66.252
Market-Years	1930	1930	1930	1930

Notes: This table displays the δ estimates of Equation 4. The market is defined as the CBSA of the clinic. *Total Chain Cycles* and *Total Chain Live Births* represent the total number of IVF cycles and live births performed by chain clinics each year in a CBSA, instrumented using the number of chain clinics each year in a CBSA. The first stage F-stat shows the Kleibergen-Paap Wald rk F statistics. We cannot reject that the estimates in Columns 2 and 4 are statistically different from 1 (the p-value from F-tests are 0.892 and 0.134, respectively). The sample includes all clinics in a CBSA that ever had a non-chain clinic. Standard errors are clustered at the market level. Significance levels: *p<0.1, **p<0.05, ***p<0.01

5.2.2 Chain Clinics More Likely to Advertise IVF Financing Options

Fertility clinics often describe investing in quality improvements and marketing programs as strategies to bring new patients into the fertility market. However, the demand effects from quality increases could take time to manifest because of lags in the publication of CDC reports: Data for a given year is typically published 2-3 years later since clinics need to wait 9-10 months to allow for births to occur before the CDC can compile and verify the data. A complimentary and more immediate way to attract patients is through marketing, where one popular strategy is to market IVF financing options meant to increase the affordability of care.

Using the Internet Archive, we collect financial marketing data from clinic websites for our matched sample of clinics in the year 2018. Specifically, we collect information on whether a clinic advertises money-back guarantees, multiple-cycle discount programs, fertility lending options, or other IVF discount programs (data on

[39] An increase in cycles may also be the result of supplier-induced demand: Physicians pressure patients into IVF instead of alternative treatments or into conducting multiple cycles. However, this does not necessarily make patients worse-off. More cycles per patient could be the direct effect of increasing the use of single embryo transfers to reduce multiple births, which can often require multiple rounds of IVF to achieve a live birth. Similarly, alternative treatments such as intrauterine insemination have a higher incidence of multiple birth and can often take longer to achieve pregnancy than IVF.

advertised prices are too idiosyncratic to compare). See Appendix Table H6 for more details on data collection and analysis. Results from a cross-sectional analysis find that clinics acquired by fertility chains are more than twice as likely to advertise money-back guarantees or multiple-cycle discount programs compared to the matched sample of non-chain clinics (79.4% vs. 38.2% of clinics). Additionally, both acquired and affiliated clinics are significantly more likely to advertise fertility lending options. These results can be interpreted as conservative estimates because the clinics in the matched sample are larger and, therefore, have more resources to offer and advertise financing options.

This cross-sectional analysis provides suggestive evidence that chains may attract patients to their clinics by marketing IVF discounts and financing options. While patients may view such offerings as increasing IVF affordability, critics suggest these programs are predatory marketing gimmicks that can lead patients to pay more than they otherwise would. Still, such marketing tactics can help bring in new patients and even signal higher quality (Yu, Ghosh, and Viswanathan 2022).

5.2.3 Private Equity Investment into Chains Increases Clinic Volume

Private equity (PE) firms can enable significant growth among acquired firms by alleviating financial constraints relative to other types of ownership (Eaton, Howell, and Yannelis 2020; Fracassi, Previtero, and Sheen 2022). Therefore, we may expect that the financial resources provided by PE firms would have more salient effects on clinic growth and volume (Braun et al. 2021; Singh et al. 2022). As described in Section 2, eight fertility chains received PE funding during the sample period, creating variation in ownership and timing needed to decompose the effect of PE funding on outcomes.[40]

Appendix Table H7 Panel A shows the results of Equation 2 decomposing the effect between post-transaction years when a clinic was part of a chain with and without PE funding. Specifically, we create a post-transaction indicator equal to 1 when a clinic is part of a chain without PE funding and 0 when the chain has PE funding (*Post_NoPE*), and another post-transaction indicator that is the inverse (*Post_YesPE*). We find large and significant increases in the live birth rate *both* when a clinic is acquired by a chain without PE (5.1 percentage points) and with PE funding (5.2 percentage points). In contrast, almost all the volume effect for acquired clinics occurs because of PE funding (14.5% increase in cycles without PE and 31.3% increase with PE). This result is consistent with clinics accessing knowledge upon first joining the chain but not experiencing significant growth until after PE funding. In other words, PE investment may help facilitate clinic growth but plays less of a role in increasing the live birth rate.[41]

[40] Of these eight chains, three chains enter joint ventures or receive growth equity from PE firms and five chains are acquired via leveraged buyouts by PE firms (in some of these cases, the chain itself is created through the buyout of a flagship clinic with add-on acquisitions). Since we are interested in measuring access to additional financial resources, we treat both types of deals as receiving PE funding.

[41] In Appendix Table H7 Panel B, we use the year the *chain* received PE funding as the year of treatment. These results confirm the role of PE: IVF cycles increase by 16.9 percent, IVF transfers increase by 12.4 percent, and the live birth rate increases by 2.2 percentage points.

6. CONCLUSION

This paper studies how chain ownership impacts firm performance in the fertility industry. By 2018, over 20% of fertility clinics (performing 40% of IVF cycles) were part of a fertility chain. Our results show that both affiliated and acquired clinics increase the volume of IVF cycles and transfers by over 22%, whereas only acquired clinics significantly increase the live birth rate. The 5.1 percentage point increase observed after a clinic acquisition represents a statistically and economically meaningful increase of 13.6% in the live birth rate. We provide compelling qualitative and quantitative evidence that resource and knowledge transfers driven by chain ownership are the most likely explanation for the improvement in clinic performance.

Acquired clinics increase the quality of care by simultaneously reducing multiple births and increasing singleton births and achieve the greatest increase in live births among older patients. These improvements coincide with decreases in the number of embryos transferred and a significant increase in preimplantation genetic testing, which has been found to improve IVF success rates among older patients. These results are consistent with the marketing materials and press releases of fertility chains that argue that by facilitating knowledge sharing, they can improve IVF success rates. We also find that chain clinics increase volume mainly through market expansion rather than business stealing and that PE investment into fertility chains largely drives increases in clinic volume. These results are consistent with access to new resources facilitating clinic growth. Lastly, we do not find evidence that results are driven by changes in patient characteristics that could influence IVF success, differences in the types of clinics selected for acquisition or affiliation, or market-level changes.

This paper provides evidence that chain organizations can improve healthcare outcomes in settings with relatively minimal market frictions and information asymmetries. These are central features of the retail and service sectors but are not yet as common in healthcare. However, because of high-profile acquisitions by retail giants such as Walmart and Walgreens and increasing investments from PE firms, the consumer-centric retail chain model of care has become more prevalent in behavioral and mental health, dermatology, dental care, physical therapy, and urgent care (Jain, Martin, and Murphy 2018; Reed 2023). Like fertility clinics, these are office-based patient-facing settings that can rely more on consumer choice and self-paying patients. Another commonality is an emphasis on convenience and the patient experience. Therefore, even if chain ownership is not quality-enhancing, patients may be willing to pay for convenience and other service amenities (Leive, David, and Candon 2023).

The growth of healthcare chains, particularly those backed by private equity, has become a recent focus of antitrust authorities (Cumming 2022). A key concern, as stated by Deputy Assistant Attorney General Andrew Foreman, is that rather than "function as a maverick or a disruptor in health care markets," investors will "cause the target company to focus solely on short-term financial gain and not on advancing innovation or quality" (Foreman 2022). In contrast, we find that even fertility chains backed by PE firms can help facilitate knowledge sharing among physicians. Previously independent clinics had limited means and incentives to collaborate and learn from each other. Joining a fertility chain helps reduce barriers to collaboration, and a centralized management system allows for the distribution of information and standardization of care. We also find limited evidence that fertility clinic acquisitions or affiliations lead to changes in market concentration. However, the ongoing consolidation of fertility clinics could eventually generate anti-competitive effects.

Ultimately, the findings of this paper are societally important and shed light on the future of the fertility industry. The "the fertility sector is booming" but at the same time, "IVF is failing most women," which has generated increased scrutiny of fertility clinic performance (Walsh 2021; The Economist 2023b). Even though the live birth rate has increased considerably in the past two decades, most patients still have less than a 40% chance of delivering a baby, and rates vary considerably across clinics. New technologies are currently being developed that utilize artificial intelligence to standardize care and improve success rates, raising questions about which clinics and patients will receive access to these technologies (Kesari 2022). More broadly, the striking improvement in IVF success rates within fertility chains highlights the tension between clinical knowledge as a competitive advantage versus a public good that could collectively improve fertility outcomes. Future research must consider implications for equity in access and outcomes.

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APPENDIX

Appendix A. Data Collection and Sample

A.1 CDC ART Data

We downloaded both excel files of the data and PDF files from the CDC directly: https://www.cdc.gov/art/artdata/index.html. The PDF files contain additional information about whether a clinic restructured or failed to report data, as well as address information and laboratory information. For almost each year of data, there are changes in how the CDC reports the data. For this reason, not all variables can be consistently identified over the sample period, and it is necessary to include year fixed effects to account for potential measurement error from year-to-year changes in reporting. Below we describe two additional data issues and our data-cleaning approach.

1) Changes in 2018: In the year 2018, when there were fewer than 4 observations reported for an outcome, the number was obscured by a "star" value (e.g., if there were 3 transfers performed by a clinic, this value would be reported as a "*"). We replace "star" equal to 1 in one dataset (the main dataset used in the analysis) and equal to 4 in another dataset (as a robustness check) and find that results do not differ between these two extremes. Additionally, since our analytic sample excludes clinics with fewer than 20 cycles a year over the sample, this removes most of these missing data cases regardless of the 1 or 4 replacement strategy. Lastly, we show that results are quantitatively similar when excluding the year 2018 altogether (Appendix Table F7).
2) Non-reporting clinic: Every year, the CDC ART data lists clinics that conducted IVF cycles but failed to report their outcomes (approximately 8% of fertility clinics each year). In most cases, this is because a clinic is about to close or is restructuring, which are both indicators provided in the CDC data (these are not mutually exclusive – clinics can close or restructure and still report data to the CDC in the year they are closing or restructuring). In our empirical analyses, we exclude all clinics with less than 3 years of data and with gaps of 2 years or more in reporting to the CDC since these clinics are likely undergoing substantial changes to their IVF program (effect sizes are slightly larger but not statistically different if we include these clinics). This restriction removes most of the clinics with non-reporting years. However, in robustness checks, we also show that results are robust to excluding clinics that ever closed or ever restructured, as well as to limiting the sample to clinics present in all 15 years of data (Appendix Table F6). Altogether, the consistency of results, whether or not we exclude clinics based on reporting criteria, mitigates concerns that reporting bias is affecting our results.

The main variables in the data are constructed as follows:

- IVF Cycles. Total number of cycles using fresh or frozen eggs from both donors or non-donors.
    - From 2004-2016 fresh and frozen cycles were reported separately, so we added them together to create a single consistent variable. In 2017 and 2018, the total

cycles variable included fertility preservation cycles but also reported which percent of cycles were for fertility preservation, so we removed those from the total cycles estimate.
    - In any analysis reported or weighted by age category, we only include non-donor cycles because donor cycles are not reported by age.
- IVF Transfers. Total number of transfers using fresh or frozen eggs from both donors or non-donors.
    - From 2004-2016, fresh and frozen transfers were reported separately, so we added them together to create a single consistent variable.
    - In any analysis reported or weighted by age, we only include non-donor transfers because donor transfers are not reported by age.
- Live Birth Rate. This is the percentage of fresh or frozen embryo transfers from non-donor eggs that resulted in a live birth.
    - In most analyses, the live birth rate is a weighted average of four patient age categories: under 35, 35-37, 38-40, and 41-42. In analyses by age group, we take the weighted average of patients aged 38-40 and 41-42 to have a more proportional number of patients in each group (under 35, 35-37, and over 38).

A.2 Clinic Classification

Clinic Transaction Year. We define the transaction year as the year the clinic became part of a fertility chain. Some chains are newly created during the sample period, in which case the transaction year is the first year the chain was formed.

Chain Ownership. Clinics can become part of a chain in the following three ways:
1) Acquisition: An acquisition refers to an event where assets of the clinic (office, lab, or both) are acquired, owned, and managed by the parent company of the fertility chain. To comply with corporate practice of medicine laws, which prohibit non-physician-owned business entities from practicing medicine, these acquisitions typically follow what is referred to as a "friendly PC" model.[1] In this model, the chain has a subsidiary management company that acquires the seller's assets, and the selling physician serves as the owner of a separate professional corporation (PC). A long-term management service agreement is then signed between the friendly PC and the management company for the company to manage the operations of the clinic. These agreements may include restrictive covenants and non-compete agreements (for example, physicians often enter 5-year employment agreements and are restricted from opening a geographically proximate

[1] A more comprehensive legal description can be found here: https://www.chapman.com/publication-Health-Care-Management-Service-Organizations. CPOM has been heavily criticized for not being effective given the legal workarounds and lack of state enforcement. There have also been several high-profile lawsuits by physicians again PE-backed firms for "profound and pervasive direct and indirect control over the physicians' practice of medicine" (See https://www.lifesciencesperspectives.com/2022/01/26/california-physicians-allege-pe-backed-provider-violates-corporate-practice-law/). Note that CPOM would only apply to cases where a clinic is acquired by a publicly traded or PE-backed firm and not when a clinic is acquired by another clinic in a chain (before the chain received external investment). Clinic to clinic acquisitions are sometimes referred to as mergers in press releases, but usually the clinics remain physically separate entities that are part of the same chain.

competitor clinic), productivity thresholds, and capital commitments to fund clinic growth. The parent company, therefore, exerts control over clinic operations.
2) Affiliation: An affiliation refers to any interorganizational partnership, alliance, venture, or collaboration between a clinic and a fertility chain where the clinic contracts with the chain for selected management services and capital or financing options. For example, a clinic may contract with a chain to receive access to marketing and patient engagement services. These affiliations may resemble outsourcing agreements in which the parent company has no ownership stake or may be structured as joint ventures in which the parent company has a partial ownership stake. While affiliations cover a diverse set of arrangements, the common feature is that clinic owners maintain greater control of clinic operations.
3) De novo: De novo growth refers to a new fertility clinic built and opened as part of the chain and is, therefore, owned and managed by the chain.

Data Collection Process. Below we explain how we determine which clinics are part of a fertility chain and their ownership structure.

Create List of Fertility Chains: We used documents published by consultants and legal firms outlining fertility clinic mergers and acquisitions (for example, www.dresnerpartners.com%2Face-files%2FFertility_June_2018.pdf) and used business intelligence databases such as Irvin Levin, SDC Platinum, and Pitchbook to identify fertility chains that existed during the sample period (some chains no longer exist by name because they were acquired by other chains). In addition, since many times the name of a clinic includes the name of the chain, we were able to use CDC Fertility Clinic Success Reports (referred to as the CDC ART data) to identify chains. A recent publication by reproductive endocrinologists also helped confirm the identification of chains (Patrizio et al. 2022). Details on the specific chains are provided in Section A.3.

Identify Clinics in Fertility Chains: We focused on one chain at a time to identify clinics in that chain. In addition to the business intelligence databases, we used archived and current versions of chain websites and clinic websites, the EDGAR database for SEC filings for those that are part of a publicly traded company, searched for press releases using the name of the chain, and searched for whether the name of the clinic or the clinic's laboratory included the name of the fertility chain in the CDC ART data. We then manually searched for each clinic in the data to ensure we did not miss any clinics through the above process and ensure that none of our non-chain clinics were under chain or corporate ownership. Specifically, we used www.google.com to search the name of the clinic in combination with any of the following terms: "management company", "private equity", "acquired", "acquisition", "merger", "partnership", "alliance" and "affiliation."

1) **Clinic Transaction Year.** The year of transaction was recorded as the year of the announcement date via a press release or PitchBook or the date provided in an SEC filing. If this was not available, we used the date the clinic appeared on a chain website using the Internet Archive (www.archive.org). However, if the CDC reports showed a clinic change names in a year different than the sources above, we used the ART data year and noted this choice. The CDC reports signal a change in ownership through a change in the clinic's name to include the chain name and provide an indicator for

whether a clinic is restructured, which often coincides with an acquisition or affiliation. In all cases, if there was a discrepancy, the changes occur in the CDC ART data the year before the announced date in a press release, especially if the press release is from early in the year. For example, if a press release is from January 1, 2017, but the clinic changed its name to a chain name in 2016, then we record the year of transaction as 2016.

2) Clinic Ownership Structure. In addition to collecting data on the transaction year, we also classify clinics into the previously described ownership structures.

a) When available, we use the description of the financial terms of the transaction as provided in the business intelligence databases or the SEC filings to determine whether a clinic was an acquisition or affiliation.

i. Note that contracts for acquisitions and affiliations are complex. Acquisitions are easier to identify because of legal filing requirements and recording in business intelligence databases. The exact type of affiliation, and particularly the terms of an affiliation, are not possible to determine unless the information has been explicitly reported. For this reason, affiliations include a variety of different arrangements, from contracts for services to joint venture agreements. Our assumption is that a fertility chain exerts greater control over clinical operations in an acquisition than in an affiliation.

b) If this information was not available, we used press releases and information provided on chain websites in combination with state corporate filing data to deduce the nature of the transaction. For example, a press release using the term "partnership" could reflect either an acquisition or affiliation. We, therefore, search for the clinic's corporate filing records (using OpenCorporates.com or state corporate filing websites) to see if a clinic filed to become a subsidiary of a chain (likely signals an acquisition) or remained an independent legal entity (likely signals an affiliation). However, this is not always the case, and depending on the state, corporate filing details may not be available.

i. From the chain websites, we were also able to deduce their typical organizational model. For example, one chain's internal marketing materials emphasize that all their member clinics follow a joint venture model where physicians retain majority control. Another chain's website lists the clinics it owns separately from affiliate clinics. In combination with the steps above, we were able to make an informed decision about a clinic's classification based on the chain's strategy.

ii. Additionally, if there is evidence of a merger – the clinic's operations or reporting were merged with another clinic in the chain – then we used this as evidence of an acquisition (i.e., these are not mergers of equal – one clinic acquires another clinic and then "merges" their data reporting). In the ART data, merged clinics typically stop reporting outcomes under their own name and start reporting under the clinic that acquired them. We record, combine and control for these mergers in the analysis.

c) Each clinic's classification is recorded/checked by 4 different individuals (two Research Assistants with experience working in finance and the two authors of the paper), and cases that are not clear are discussed. If consensus cannot be reached, we provide the most likely classification given the nature of the chain and the classification of other clinics in the chain. These clinics are also flagged to be removed during robustness checks. Any measurement error in the classification is not likely to be systematic and instead would introduce noise rather than bias into the estimates.

We also follow the additional rules:

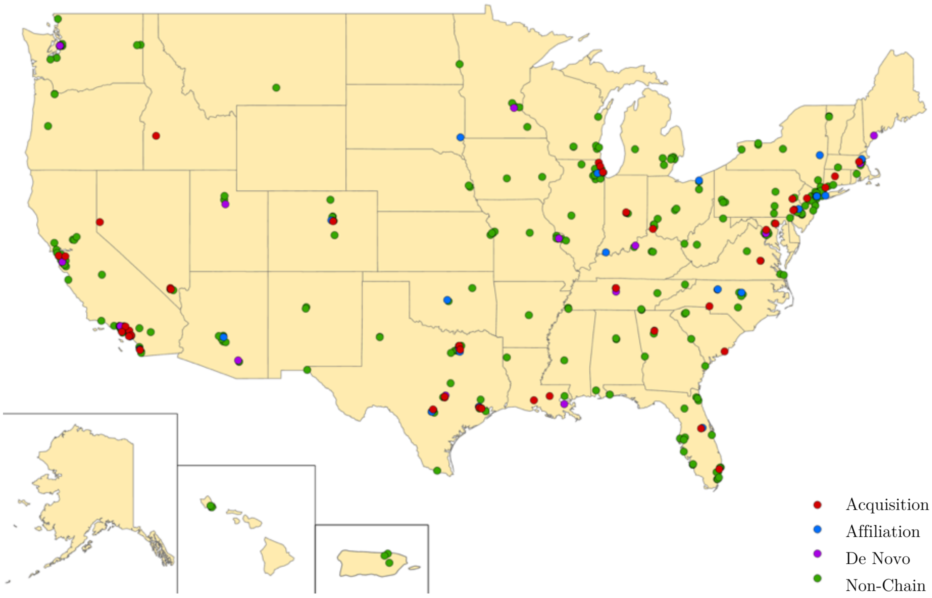
a) When a clinic is a "founding" clinic of a chain, it is always recorded as an acquisition since this is the central clinic owned by the parent company.
    i. For chains that were newly formed, the date of transaction for a founding clinic is the date the chain formed.
    ii. For founding clinics that started as a single independent practice that then began acquiring or affiliating with other clinics before external investment, their date of transaction is their date of founding. In other words, these clinics are always considered as treated in the sample because there is no official chain creation date. For any clinics acquired or affiliated with that clinic in the future, we use the date they joined the founding clinic's chain.

b) If a clinic had multiple transactions (i.e., the chain was acquired by another chain or company), we only record the date of the first transaction under the assumption that the clinic has already received treatment. However, in robustness checks, we control for the second transaction. If a clinic leaves a chain, the post-transaction indicator turns to zero. Results are robust to dropping the years after a clinic left a chain.

A.3 Fertility Clinic Chains

We identify 11 fertility chains active from 2004 to 2018. Information about each chain is provided in Table A1 below, and a map of the distribution of chain clinics is provided in Figure A1. As seen in Table A1, the fertility chains were acquired by a variety of firms, including PE firms and international healthcare chains by the end of the sample period. In total, 9 of the chains received PE funding during the sample period. However, since one chain was not acquired until December 2018, the last month in our sample, we do not include it as a PE-backed chain. Also note that some chains were established via a joint venture or buyout by a PE firm, while other chains existed before buyout.

Figure A1. Location of US Fertility Clinics, 2018



Note: Locations are based on the coordinates of the address provided by the clinic to the CDC in the Fertility Clinic Success Reports. "De Novo" refers to a newly built clinic that is part of a chain.

Table A1. Characteristics of Fertility Chains

Chain Name	Year Founded	Deal Mon/Year	Investing/ Acquiring Firm	Deal Type	Additional Details
Boston IVF	1986	Dec 2018	NMC Health (Publicly traded international health care chain)	Acquisition (NMC owns 70% of the company)	Growth initially focused on New England but now has a national presence.
Huntington Reproductive Center (HRC) Fertility	1988	Dec 2018	Jinxin Fertility (formerly PE-backed international fertility chain)	Acquisition (Details not disclosed)	Started with two founding partners that expanded through Southern California. Jinxin was taken public in 2019.
Reproductive Medicine Associates of New Jersey (RMANJ)	1999	Feb 2017	The Valencian Infertility Institute (Privately held international fertility chain)	Acquisition (IVI owns 70% of the company)	The merger with IVI led to rebranding to the "RMA Chain" to capture its national presence.

InVitro Sciences (IVS)	1998	Aug 2017	Sverica Capital Management (PE firm)	Acquisition (Buyout/LBO 100%)	IVS was a subsidiary of the practice management company Women's Health USA – was spun out by Sverica in 2019 and rebranded as First Fertility.
Prelude Fertility Network	2016	Oct 2016	Lee Equity Partners (PE firm)	Joint Venture ($200 million growth equity)	Started as a joint venture with Lee Equity in 2016. Prelude went on to acquire Vivere Health in 2017 and was acquired by Inception Fertility in 2019.
Inception Fertility	2015	Mar 2016	Lee Equity Partners (PE firm)	Growth Equity (Details not disclosed)	Acquired by WayPoint Capital Partners in Jan 2018 in a buyout/LBO.
Colorado Center for Reproductive Medicine (CCRM)	2015*	Aug 2015	TA Associates (PE firm)	Acquisition (Buyout/LBO 100%)	*CCRM's first clinic was founded in 1987. The chain did not exist until 2015. In 2021 was acquired by Unified Women's Healthcare.
Ovation Fertility	2015	Jun 2015	MTS Health Investors (PE firm, name has changed to WindRose)	Acquisition (Buyout/LBO 100%)	Focuses more on lab management than clinics, though provides both services. Sold to Morgan Stanley Capital Partners in 2019.
Sher Institute for Reproductive Medicine (SIRM)	1982	Jan 2015	Integramed (backed by PE firm Sagard Capital Partners)	Acquisition (Buyout/LBO 100%)	First private IVF practice. Bi-coastal growth focus. Many locations closed or rebranded post buyout.
Integramed	1985	Sept 2012	Sagard Capital Partners (PE firm)	Acquisition (Buyout/LBO 96.30%)	Integramed owned Shady Grove Fertility until Shady Grove was acquired by Amulet Partners to form a new chain called US fertility. Integramed declared bankruptcy in 2020.
Vivere Health	2010	May 2010	LLR Partners (PE firm)	Joint Venture ($23 million growth equity)	LLR partners initially acquired a flagship clinic and invested to create the platform. Acquired by Prelude in 2017.

Appendix B. Qualitative Data

This appendix provides a text analyses of press releases from fertility clinic transactions (Table B1) and quotes compiled from fertility clinic and chain press releases, websites, and marketing materials to understand the stated purpose of the fertility chains and the reasons clinics would join a chain (Table B2). When possible, we use archived websites to reflect the materials during the sample period and use quotes from all the chains in the sample. See the endnotes of the appendix for links to the sources.

We also conducted unstructured interviews with reproductive endocrinologists, corporate investors in fertility clinics, and fertility chain operators. We received IRB approval to conduct interviews with clinicians from The Committee for Protection of Human Subjects (CPHS) of the University of California Berkeley. Information from interviews was used on background, and no direct quotes are provided from these interviews.

Table B1. Press Release Text Analysis

Concept	Identification	Number of Deals	Percentage
Expansion/Growth	(mentioning "growth" or "expand")	27	75%
Knowledge	(mentioning any of the below)	29	81%
	"knowledge"	7	19%
	"research"	20	56%
	"standard"	14	39%
	"protocols"	5	14%
	"process"	4	11%
Resources	(mentioning any of the below)	29	81%
	"resources"	14	39%
	"financial"	19	53%
	"capital"	8	22%
	"management"	11	31%
	"marketing"	10	28%
	"technology"	17	47%

Notes: We find informative press releases on 36 transactions. Many times, a single press release serves to announce multiple transactions, resulting in fewer press releases than transactions.

Table B2. Selected Quotes from Archival Material Reflecting Fertility Clinic Motives for Chain Affiliation or Acquisition

	Examples	
Resource transfer	Financial Resources and Growth Strategies	"We […] develop new practices or strengthen existing ones by applying business and operations strategies that expand their markets and their market share. This may involve the development of new practice locations, embryology laboratories or ambulatory surgery centers, in order to strengthen the performance of a practice and achieve strategic growth objectives."[1]
		"Our partner practices' patient revenues increased 21% from 2007 to 2009. Customers that chose partner relationships with us gain access to capital and best-in-class business and clinical services. The combination of expertise and economies of scale offers them a unique formula for profitable growth."[2]
		"Joining us allows you to continue improving people's lives by helping them make the family of their dreams while enjoying the financial stability and growth opportunities you're looking for in the long term."[3]
		"Strong financial support from a leading New York–based private equity firm. For REs, [Fertility Chain] provides higher success rates, access to the first multi-center network of fertility centers offering cryogenic egg vitrification, world-class marketing and lead generation, more patients, new revenue streams, and strong financial support."[4]
		"[Fertility Chain] partners to offer strategic opportunities for independent practices, including: implementing creative growth strategies supporting streamlined operational costs, payer alignment, merger and acquisition plans, marketing, and risk management services."[5]
		"Internationally recognized for its extensive clinical experience, advanced technologies, and groundbreaking research within the field of reproductive endocrinology [Fertility Chain] will reinvest in and enhance every aspect of clinical care."[6]
		"Joining […] [Fertility Chain] will enable our patients and patients throughout Dallas-Fort Worth access to its leading fertility services, innovative technology and cutting-edge labs"[7]
		"[Fertility Chain] plans for continued growth through the addition of physicians and satellite offices"[8]
	Managerial Capabilities	"We feel very strongly about the benefits that the full complement of management support, patient sales and marketing, electronic patient information systems, and one-of-a-kind [the clinic's] IVF programs will bring to our faculty, students and patients."[9]
		"[The clinic] will receive [Fertility Chain's] full complement of support services, including operational and financial management, revenue cycle management, patient marketing and sales, information systems support, and various other services, including patient support […]."[10]

		“[Fertility Chain’s] primary focus is to improve quality outcomes by enabling the strategic expansion of growing fertility practices by providing capital and operational support including marketing services, pharmacy services and back office services.”[11] “Under the agreement, the newly formed LLC will receive [the Fertility Chain’s] full complement of support services, including operational and financial management, revenue cycle management, patient marketing and sales, information systems support, and various other services, including patient support”[12] “Increased patient volume as a result of [Fertility Chain’s] marketing efforts to educate men and women in their 20s and 30s about the benefits of preserving their fertility at its peak, as well as to target potential gamete donors.[13] “At [Fertility Chain], we make the following commitments to our patients: […] • Offer transparent pricing with no out-of-network fees or hidden costs • Use the most advanced technology to increase the odds of a successful pregnancy • Simplify the treatment process, meeting critical timelines, avoiding missed medications, and reducing travel time • Streamline communications between you and your clinicians, eliminating the frustration of missed calls • Use advanced digital technologies to help you easily manage all aspects of your fertility journey • Clearly explain the fertility treatment process, empowering you to make decisions that are right for you”[14] “Each loan program is designed to fit your individual circumstances and, once approved, the company’s Fertility Loan Specialists will work closely with [Fertility Chain] to ensure the funds are secured prior to the commencement of your treatment.”[15] “[Fertility Chain] announced the launch of two new programs designed to help ease the financial burdens for fertility patients that may need multiple in vitro fertilization (IVF) cycles. The [Fertility Chain’s] IVF Refund and Multi-Cycle Programs offer patients the assurance that if multiple IVF cycles are necessary, they will not need to expend additional financial resources to receive them.”[16]
Knowledge transfer	Access to Protocols, Best Practices and New Knowledge	“Patients seeking treatment at their fertility center […] will receive improved access to the best treatment protocols and unique programs for specific conditions, new technologies that improve clinical success rates, and increased access to clinical trials and research initiatives, which often offer significant discounts on treatments and medications.”[17] “Partnering with [Fertility Chain] allows us to greatly expand our work with other top-tier centers, and to leverage the strengths of this national network to further revolutionize patient care with new access to proven treatment protocols and an expanded focus on fertility preservation.”[18] “Our collaboration with [Fertility Chain] will give us access to the most advanced research in the field of reproductive medicine, and will further enable us to deliver leading care to our patients”[19]

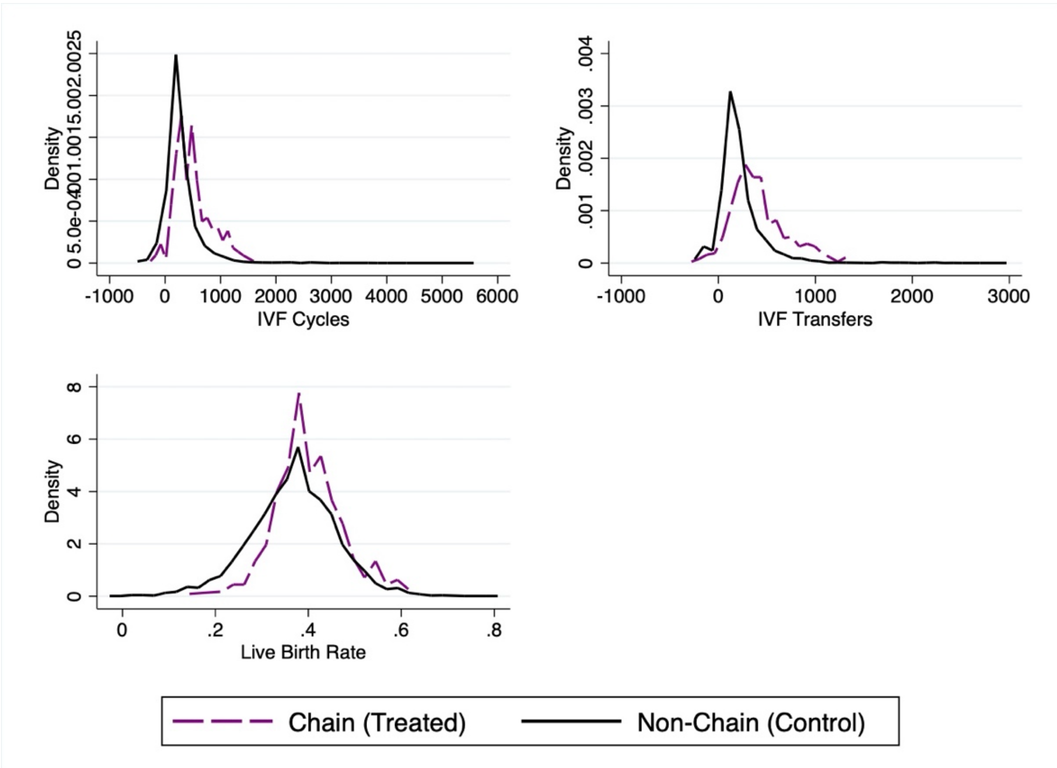
		"[Fertility Chain's] mission is to shift the paradigm of the IVF market by raising the standard of care, streamlining fragmented components into an integrated system, and enhancing the overall patient experience."[20] "Our collaboration with [Fertility Chain] will give us access to the most advanced research in the field of reproductive medicine, and will further enable us to deliver leading care to our patients."[21] "Best Practices Are Standard Care. [Fertility Chain] believes that patients should not have to pay more for best practices. Therefore, when research proves that techniques improve conception rates, [Fertility Chain] incorporates those techniques into their standard care wherever possible."[22] "[Fertility Chain] will give our embryologists access to a broader base of knowledge drawn from all [...] labs [...] and because of [Fertility Chain's] size, we will be able to take advantage of the latest techniques and equipment for services offerings we don't currently provide in house, including long-term storage, egg donation and genetic testing. By bringing these services in house, we can better control our patients' experience."[23]
	Information Sharing Process	"[Fertility Chain] was created to break down barriers to idea-sharing and collaborative care. "At its best, reproductive medicine is a tightly woven community working side by side on research, clinical trials and educational efforts. The [Fertility Chain] umbrella gives us the freedom to explore clinical and laboratory breakthroughs together, and that is exciting news for the future of infertility care."[24] "Patients will also have access to an expanded network of [Fertility Chain] experts who will come together to review and assist in complex cases."[25] "The successes at [Fertility Chain] led to the desire to share these techniques with additional clinics, thereby providing patients increased geographical access to top-quality infertility care. [Fertility Chain] is in a unique position where treatment breakthroughs are quickly applied to multiple centers, thereby furthering the positive impact for patients."[26] "The [Fertility Chain] is also a tech-enabled organization leading the industry in proprietary platforms, applications, and data and analytics. By using these purpose-built applications with other flagship technologies, we are improving patient experience and outcomes. Our proprietary [...] tool keeps our network seamlessly connected when it comes to data and analytics, financial services, staff workflow automation, and hybrid workforce productivity."[27] "We'll look at pregnancy per transfer by physician with a blinded letter for each physician. And we'll be able to see how everybody stacks up. And if people fall below a standard deviation, we have that doctor go work with somebody who is above a standard deviation to get retrained."[28] "Under the terms of the agreement, [Fertility Chain] purchased the assets of [the clinic] and will provide a variety of services, including marketing, treatment programs for women who wish to get pregnant and a sophisticated electronic medical records system."[29] "Collaborative innovation – [Fertility Chain] scientists and physician partners share data and best practices, improving outcomes for patients and partner physician

		practices. Research – [Fertility Chain] is one of America's most prolific producers of IVF research, with collaborative studies continuously under way to advance the state of the art in IVF."[30]
	Single Embryo Transfer Strategy	"Striving for One Embryo-One Baby. [Fertility Chain's] founding philosophy to achieve successful pregnancy one healthy baby at a time. Although advanced embryo culturing has led to favorable pregnancy results using fresh embryo transfers, they often were the result of multiple embryo transfers, resulting in high-risk pregnancies with twins and triplets. Through elective vitrification and the adoption of blastocyst biopsy/PGS, [Fertility Chain] has improved the quality of patient care by transferring fewer embryos, reducing miscarriages and increasing healthy singleton live births."[31] "[Fertility Chain] reported a significant increase in the number of IVF cycles employing pre-implantation genetic testing. This cutting edge technology enables embryologists and fertility specialists to assess the genetic and chromosomal makeup of an embryo prior to its transfer into a woman's uterus. [Fertility Chain] now also performs almost exclusively Day 5 embryo transfers (at the blastocyst stage of development) for those patients who request or need a fresh embryo transfer. This advanced IVF lab technique allows the embryo to mature as far as it can outside the human body, again allowing embryologists and physicians an enhanced ability to select the best single embryo for transfer into the patient's uterus."[32] "The One Healthy Baby at a Time Promise. Reducing Risk for Mom and Baby. By routinely practicing Single Embryo Transfer (SET), [Fertility Chain] has drastically reduced the risk for the mother and child." "`Our rate of single embryo transfer [and subsequently our low multiple pregnancy rate] is higher than the national average, with no difference in the number of embryos transferred in fee for service versus Shared Risk patients,' comments [physician]. With advances in technology, eSET has allowed patients to have a healthy singleton pregnancy while significantly lowering the risks associated with multiple pregnancies without comprising chances of success."[33]

Appendix C. Additional Descriptive Statistics

This appendix provides additional summary statistics of the data and sample. Figure C1 shows the distribution of clinic volume and IVF success rates between chain clinics and non-chain clinics before the transaction, Table C1 provides descriptive statistics based on CBSA-level patient characteristics, and Table C2 provides a targeting regression of the probability that a clinic becomes acquired or affiliated with a chain using characteristics at the CBSA-level (estimation details shown before the table).

Figure C1. Distribution of Clinic Volume and IVF Success Rates for Clinics Before the Chain Transaction and Non-Chain Clinics



Note: This histogram shows the distribution of clinic volume (IVF cycles and IVF transfers) and of IVF success rates (Live Birth Rate) in the pre-transaction period for chain clinics and over the full sample period for non-chain clinics. The regression includes *state* × *year* fixed effects, with robust standard errors clustered at the clinic-level.

Table C1. CBSA-Level Characteristics of Patients Reporting Using Infertility Treatment, 2009-2018

	Fertility Chain			Non-Chain
	Acquisition	**Affiliation**	**De Novo**	
	Pre-transaction mean	Pre-transaction mean	Mean of all years	Mean of all years
Education (%)				
Less than High School	1.06	1.55	1.35	1.37
High School	5.57	6.60	5.85	6.72
Some College	11.39	10.12	10.58	11.06
Associate or Bachelor's Degree	47.57	46.02	45.70	44.61
Graduate Degree	34.41	35.71	36.53	36.24
Race/Ethnicity (%)				
White	71.71	75.27	71.41	71.71
Black	6.02	6.22	4.89	5.69
Hispanic/Latina	9.68	7.83	9.62	9.76
Other Race	12.58	10.67	14.09	12.83
Insurance (%)				
Private	89.97	91.80	90.37	88.99
Medicaid	3.61	4.59	5.65	5.30
Self Pay	3.48	1.89	1.56	2.34
Other	2.94	1.73	2.42	3.37
Clinical Factors				
Body Mass Index	25.27	25.82	25.43	25.74
Pre-Pregnancy Diabetes	0.79	0.81	0.90	1.20
Pre-Pregnancy Hypertension	2.34	2.54	2.09	2.76
Previous Birth	28.72	28.58	30.61	30.10
Observations				
Number of Clinics	23	25	21	400
Clinic-Years	147	79	112	3249

Note: This data is from the NCHS natality data for patients reporting using any infertility treatment to deliver a baby. This reporting flag was only available starting in 2009, therefore, the data represent years 2009-2018. Since the NCHS data are reported at the county level, we created a CBSA-level average using the county data weighted by the population in the county that was female. Clinics that experienced a chain transaction prior to 2009 are removed because they are now always considered part of a chain.

Targeting Regression (Table C2, below). To explore what types of fertility clinics are targeted, we estimate the probability that a clinic is acquired or affiliated with a chain for the years before the transaction:

Appendix Eq. 1: $$Prob(Chain)_{ct} = \alpha_s + \alpha_t + \beta \boldsymbol{X}_{ct} + \epsilon_{ct}$$

Here, *Prob(Chain)* is set to 100 in the year before acquisition or affiliation (and zero otherwise) and all years post-transaction are dropped. We include state and year fixed effects, and $\boldsymbol{X}_{ct}$ is a vector of different clinic and market characteristics. The results are presented in Table 2, where each column groups different combinations of characteristics. Because the listed patient characteristics are only available between 2009-2018, we do not present them in combination with the market-level characteristics. The characteristics most predictive of acquisition or affiliation are total IVF cycles and the live birth rate. At the same time, clinics are much less likely to be targeted in markets with higher proportions of patients on Medicaid or other government insurance. Larger population aged 20-49 and more competitive markets are also somewhat predictive of being targeted, though become insignificant once we simultaneously control for clinic volume and IVF success rates.

Table C2. Probability Clinic Becomes Part of a Fertility Chain, CBSA Level Characteristics

	Mean	(1)	(2)	(3)	(4)	(5)
Clinic Outcomes						
Log(IVF Cycles)	5.220	0.645***			0.627***	
		(0.161)			(0.161)	
Live Birth Rate	37.051	5.500***			5.529***	
		(1.543)			(1.536)	
Market Characteristics (CBSA)						
Log(Total Population)	13.615		0.279*		0.099	
			(0.156)		(0.205)	
Log(Median Household Income)	10.949		0.610		-0.065	
			(1.194)		(1.201)	
Market Concentration						
HHI (tercile = 1)				0.933*	0.553	
				(0.479)	(0.626)	
HHI (tercile = 2)				0.605*	0.303	
				(0.339)	(0.420)	
Patient Characteristics (CBSA)						
Education (reference=Graduate School)						
Less than High School	1.359					8.608
						(13.105)
High School	6.671					-3.772
						(2.434)
Some College	11.056					-4.519*
						(2.651)
Associate or Bachelor's Degree	44.764					-0.539
						(2.037)
Race/Ethnicity (reference=White)						
Black	5.720					5.789*
						(2.958)
Hispanic/Latina	9.717					-2.939
						(2.175)
Other Race	12.772					-4.624*
						(2.621)
Insurance (reference=Private)						
Medicaid	5.214					-5.278**
						(2.474)
Self Pay	2.375					1.456
						(4.153)
Other	3.316					-6.316***
						(1.991)
Clinic-Years		5424	5385	5385	5385	3475
R^2		0.030	0.024	0.024	0.031	0.040
Ymean		1.143	1.151	1.151	1.151	1.324

Note: This table shows the estimates of Appendix Equation 1, which estimates the probability a clinic becomes part of a fertility chain. The dependent variable is an indicator for a clinic transaction in the following year (100 if yes, 0 otherwise). The sample is restricted to non-chain clinics and acquired or affiliated clinics for the years before the transaction.

Appendix D. Robustness and Diagnostic Checks of Main Effects on Clinic Volume and IVF Success Rates

This appendix provides robustness and diagnostic checks to the primary results presented in Table 2 of the manuscript. Table D1 replicates Table 2 using *CBSA × Year* fixed effects, Table D2 replicates Table 2 including market-level controls, Table D3 replicates Table 2 showing p-values derived from wild bootstrap standard errors, Table D4 provides a back of the envelope profit calculation post-chain ownership, Table D5 shows results of the Goodman-Bacon (2021) decomposition and Table D6 decomposes the effect of chain ownership between early and later transactions.

Figure D1 provides event study graphs pooling ownership types using two-way fixed effects (TWFE), Figure D2 provides event study graphs using the two-stage DD estimator of Gardner (2021) by ownership structure, and Figure D3 provides event study graphs using the weighted group-time estimator developed by Sun and Abraham (2021) by ownership structure. By showing event studies using these three different methods, we provide robustness to different types of estimators and approaches recently developed in the difference-in-differences literature. In particular, we choose these methods because they implement different approaches yet adopt simple, intuitive steps and assumptions, minimal programming, and flexibility when implementing DD with an unbalanced panel, multiple treatment groups and interacted fixed effects (Cunningham 2021).

Table D1. Effect of Chain Ownership on Fertility Clinic Outcomes, Including *CBSA × Year* Fixed Effects

	(1)	(2)	(3)
	Log(Cycles)	**Log(Transfers)**	**Live Birth Rate**
Panel A: Pooled			
Post	0.309***	0.283***	0.020
	(0.086)	(0.083)	(0.013)
Panel B: Ownership Structure			
Post × Acquisition	0.395***	0.356***	0.043***
	(0.099)	(0.096)	(0.014)
Post × Affiliation	0.236*	0.220*	0.001
	(0.123)	(0.120)	(0.019)
Dep. Var. Mean	5.287	5.064	0.373
Clinic-Years	4766	4766	4766
R^2	0.908	0.907	0.682

Notes: Panel A shows the estimates of Equation 1, and Panel B shows the estimates of Equation 2, except we include *CBSA × Year* fixed effects instead of *State × Year* fixed effects. Therefore, observations where there is only one clinic in a CBSA-year are dropped from the regression. The live birth rate is weighted by the number of transfers within each patient age category: under age 35, 35-37, 38-40, and 41-42. The dependent variable mean captures the predicted mean for control clinics and treatment clinics before the transaction. Standard errors are clustered at the clinic level. Significance levels: *p<0.1, **p<0.05, ***p<0.01

Table D2. Effect of Chain Ownership on Fertility Clinic Outcomes, Including Market-Level Controls

	(1)	(2)	(3)	(4)	(5)	(6)
	Log(Cycles)		**Log(Transfers)**		**Live Birth Rate**	
Panel A: Pooled						
Post	0.257***	0.275***	0.215***	0.233***	0.025**	0.017*
	(0.071)	(0.063)	(0.071)	(0.063)	(0.011)	(0.010)
Panel B: Ownership Structure						
Post × Acquisition	0.278***	0.289***	0.212**	0.213**	0.050***	0.042***
	(0.099)	(0.086)	(0.099)	(0.088)	(0.013)	(0.012)
Post × Affiliation	0.239**	0.264***	0.217**	0.251***	0.005	-0.003
	(0.100)	(0.089)	(0.099)	(0.088)	(0.016)	(0.014)
Clinic FE	X	X	X	X	X	X
State × Year FE	X		X		X	
Year FE		X		X		X
Dep. Var. Mean	5.258	5.262	5.039	5.046	0.375	0.375
Clinic-Years	5627	5770	5627	5770	5627	5770
R^2	0.898	0.887	0.898	0.885	0.622	0.578

Notes: Panel A shows the estimates of Equation 1, and Panel B shows the estimates of Equation 2. All regressions include the following CBSA-level controls: the log of the total population aged 20-49 and the log of the median household income (the unemployment rate and household income are highly correlated, so we only included household income). These variables are not available for Puerto Rico; therefore, clinics in Puerto Rico are not included in this sample. The live birth rate is weighted by the number of transfers within each patient age category: under age 35, 35-37, 38-40, and 41-42. The dependent variable mean captures the predicted mean for control clinics and treatment clinics before the transaction. Standard errors are clustered at the clinic level. Significance levels: *p<0.1, **p<0.05, ***p<0.01

Table D3. Effect of Chain Ownership on Fertility Clinic Outcomes, Wild Bootstrap Standard Errors

	(1)	(2)	(3)	(4)	(5)	(6)
	Log(Cycles)		**Log(Transfers)**		**Live Birth Rate**	
	b/wild p-val		b/wild p-val		b/wild p-val	
Panel A: Pooled						
Post	0.258***	0.282***	0.216***	0.237***	0.026**	0.018*
	0.000	0.000	0.004	0.000	0.021	0.072
Panel B: Ownership Structure						
Post × Acquisition	0.282**	0.297***	0.214**	0.217**	0.051***	0.043***
	0.011	0.000	0.046	0.017	0.001	0.001
Post × Affiliation	0.238**	0.268***	0.217**	0.253***	0.004	-0.003
	0.015	0.004	0.031	0.004	0.794	0.843
Clinic FE	X	X	X	X	X	X
State × Year FE	X		X		X	
Year FE		X		X		X
Dep. Var. Mean	5.252	5.256	5.035	5.040	0.374	0.375
Clinic-Years	5666	5809	5666	5809	5666	5809
R^2	0.899	0.887	0.898	0.886	0.625	0.579

Notes: Panel A shows the estimates of Equation 1, and Panel B shows the estimates of Equation 2. The live birth rates are weighted by the number of transfers within each patient age category: under age 35, 35-37, 38-40 and 41-42. The dependent variable mean captures the predicted mean for control clinics and treatment clinics before the transaction. Standard errors are clustered at the clinic level. Significance levels: *p<0.1, **p<0.05, ***p<0.01

Back of the Envelope Profit Calculation (Table D4 below). An assumption of our paper is that increases in clinic volume driven by chain ownership would lead to an increase in profit. There is no publicly available data on clinic financials. Therefore, we provide a back-of-the-envelope calculation on how profits could be affected by chain ownership.

In our difference-in-differences analysis, we find that on average, chain ownership increases the volume of IVF cycles by 25.8%. The price of a single cycle of IVF is often quoted between $12,000 and $20,000. Industry reports often suggest fertility clinics have high profit margins, with one clinic reporting a profit margin of 37.5% in 1996.[2] In 2022, we asked one fertility chain investor what the typical profit margin of a fertility clinic was, and they provided the range of 30-47.5% depending on the clinic's size. They said small clinics sometimes had lower profit margins than this range.

In the simplest example in which there are no changes to a clinic's prices or operating costs, the average clinic makes between $2.36 and $3.94 million in profit per year before chain ownership and $2.97 and $4.96 million per year after chain ownership, just from IVF services. Through chain ownership, there may initially be capital expenditures that increase costs, whereas managerial efficiencies and economies of scale may contribute to lower operating costs in the future. Given the significant increases in volume, it would take large reductions in prices and increases in costs for clinics to not experience an increase in profits post-chain ownership.

Anecdotally, one fertility chain advertises that "clinics practices' patient revenues increased 21% from 2007 to 2009," which is consistent with our finding.[3] Other news articles have reported clinics' "generating a $2 million annual surplus" in 1996. The aforementioned investor shared that their chain's most lucrative clinic had an EBITDA of over $9 million. Given that this clinic is likely extremely large, our estimates seem consistent with the average profit of a clinic in a fertility chain.

[2] https://www.nytimes.com/1996/01/07/us/high-tech-pregnancies-test-hope-s-limit.html

[3] https://web.archive.org/web/20110314151145/http:/attainfertilitycenters.com/success/index.html

Table D4. Back of the Envelope Profit Calculation

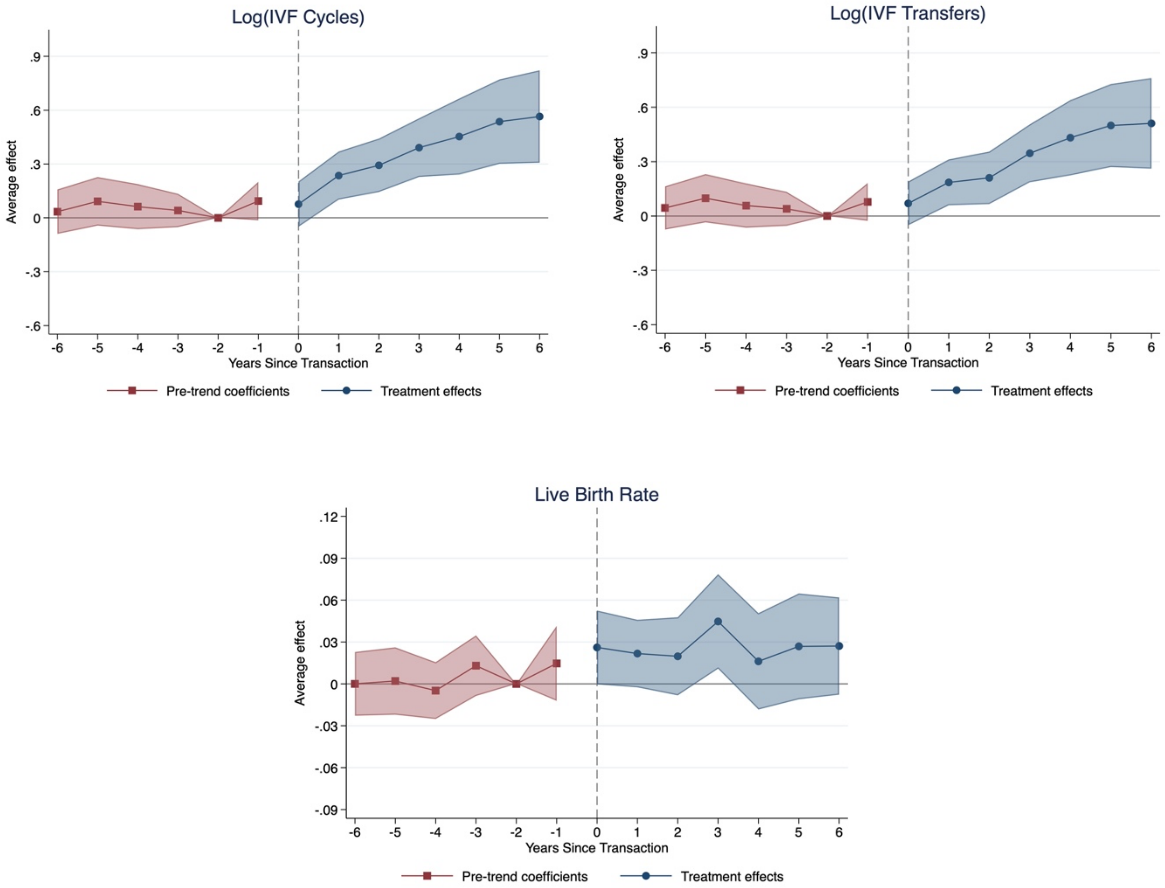
	Before Chain Ownership	After Chain Ownership	Total Difference
$12,000 per IVF Cycle			
Average IVF Cycles	525.56	661.15	
Average Price ($)	12,000	12,000	
Revenue from IVF Cycles ($)	6,306,720	7,933,800	1,627,080
Estimated Profit Margin	37.50%	37.50%	
Estimated Profit ($)	2,365,020	2,975,175	610,155
$20,000 per IVF Cycle			
Average IVF Cycles	525.56	661.15	
Average Price ($)	20,000	20,000	
Revenue from IVF Cycles ($)	10,511,200	13,223,000	2,711,800
Estimated Profit Margin	37.50%	37.50%	
Estimated Profit ($)	3,941,700	4,958,625	1,016,925

Table D5. Goodman-Bacon Decomposition of Treatment Effects

		(1)	(2)	(3)
	Weight	**Log(Cycles)**	**Log(Transfers)**	**Live Birth Rate**
Panel A: Pooled				
Post		0.245***	0.205***	0.019*
		(0.072)	(0.072)	(0.011)
Timing groups	0.093	0.113	0.109	-0.006
Never_v_timing	0.881	0.278	0.229	0.021
Within	0.026	-0.399	-0.254	0.026
Panel B: Ownership Structure				
Post × Acquisition		0.267***	0.197**	0.041***
		(0.096)	(0.099)	(0.012)
Timing groups	0.052	0.129	0.125	0.009
Never_v_timing	0.907	0.294	0.212	0.042
Within	0.041	-0.146	-0.048	0.053
Post × Affiliation		0.223**	0.213**	-0.002
		(0.104)	(0.102)	(0.016)
Timing groups	0.029	0.115	0.111	-0.009
Never_v_timing	0.966	0.216	0.208	-0.004
Within	0.005	2.368	1.991	0.474

Notes: Panel A shows the estimates of the Goodman-Bacon decomposition when pooling together both ownership structures, and Panel B shows the decomposition by ownership structure. The decomposition requires a balanced panel, in this setting, that represents 246 clinics and 3690 clinic-years that had 15 years of data. Standard errors are clustered at the clinic level. Significance levels: *p<0.1, **p<0.05, ***p<0.01

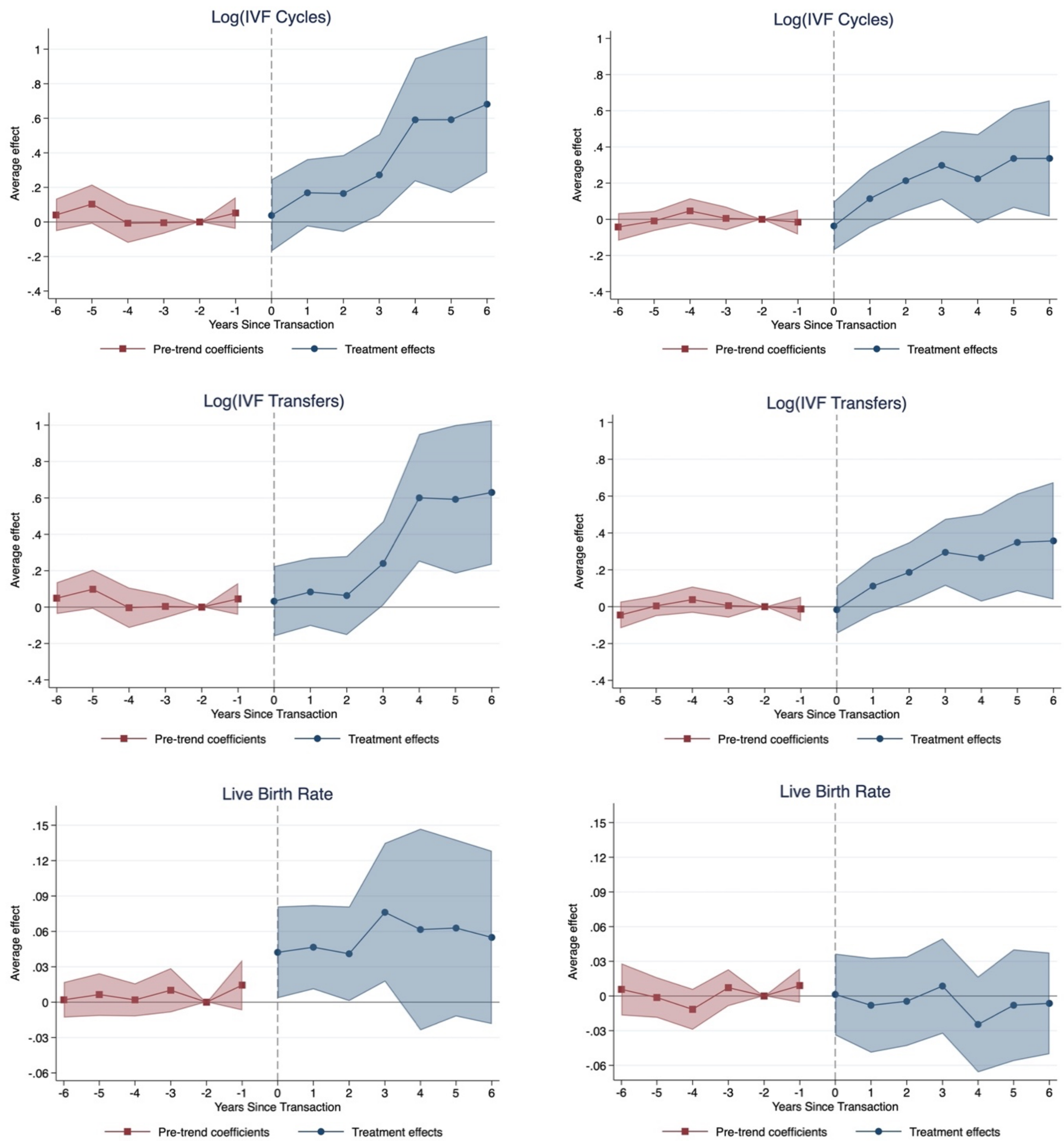
Figure D1. Pooled Event Study Results, TWFE



Notes: This figure shows the β estimates of Equation 1 interacted with indicators for the year relative to the transaction year. The reference period is two years before the transaction. Bands indicate 95% confidence intervals constructed from clinic-level clustered standard errors.

Figure D2. Event Study Results by Ownership Structure, Gardner (2021)

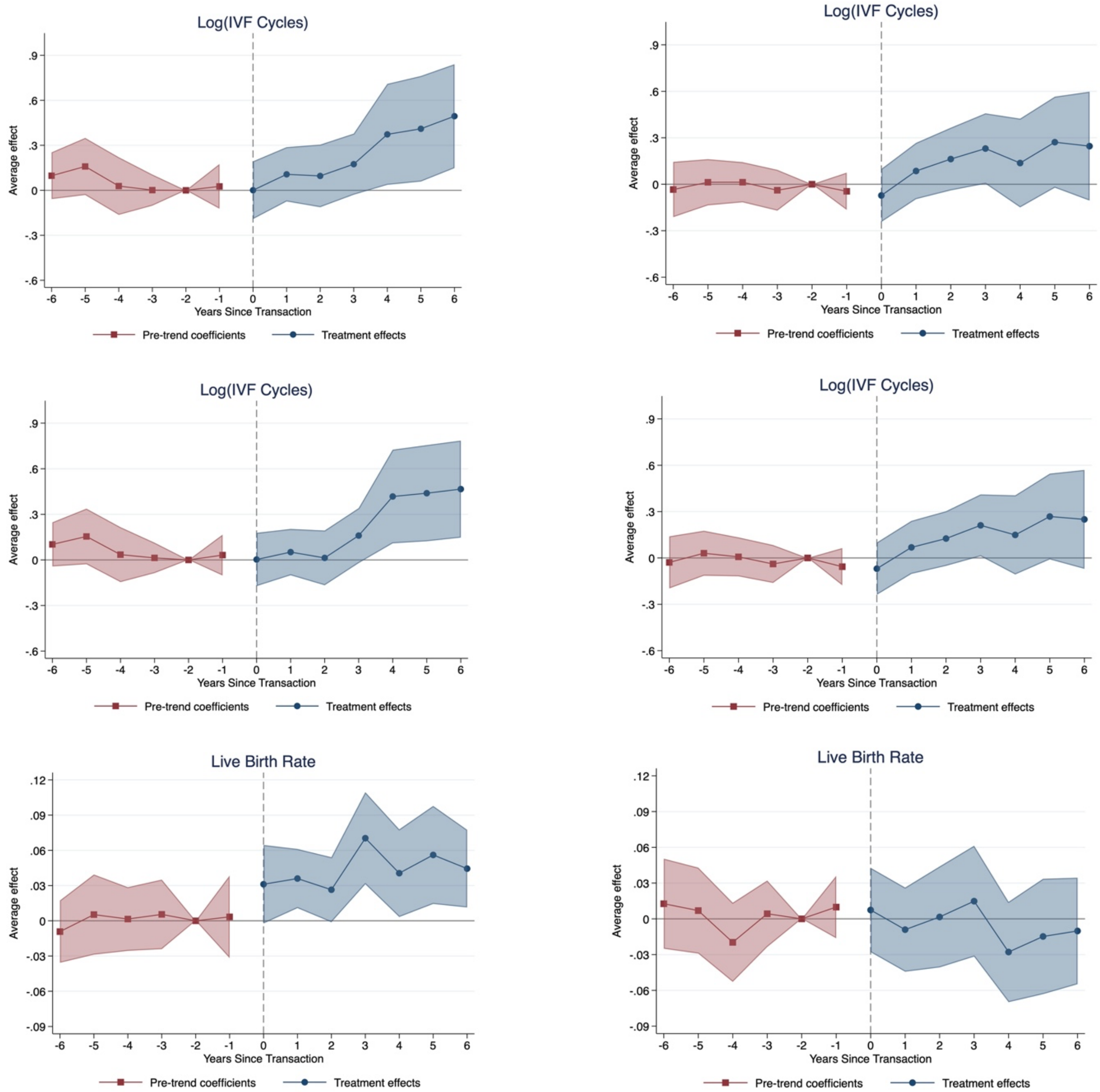
(a) Acquisition (b) Affiliation



Notes: This figure shows the β_1 and β_2 estimates of Equation 2 interacted with indicators for the year relative to the transaction year. The reference period is two years before the transaction. Bands indicate 95% confidence intervals constructed from clinic-level clustered standard errors. These event studies were created using the user written Stata command *did2s* by Butts (2021) based on Gardner (2021).

Figure D3. Event Study Results by Ownership Structure, Sun and Abraham (2021)

(a) Acquisition (b) Affiliation



Notes: This figure shows the β_1 and β_2 estimates of Equation 2 interacted with indicators for the year relative to the transaction year. The reference period is two years before the transaction. Bands indicate 95% confidence intervals constructed from clinic-level clustered standard errors. These event studies were created using the user written Stata command *eventstudyinteract* by Sun (2021).

Table D6. Effect of Chain Ownership on Fertility Clinic Outcomes, Early Vs. Late Transactions

	(1) Log(Cycles)	(2) Log(Transfers)	(3) Live Birth Rate
Post × Acquisition (Early=1)	0.329*	0.337**	0.035
	(0.172)	(0.163)	(0.022)
Post × Acquisition (Late=1)	0.181**	0.094	0.026**
	(0.074)	(0.069)	(0.010)
Post × Affiliation (Early=1)	0.197**	0.220**	0.003
	(0.100)	(0.095)	(0.017)
Post × Affiliation (Late=1)	0.142*	0.049	-0.011
	(0.085)	(0.076)	(0.021)
Dep. Var. Mean	5.199	4.981	0.373
Clinic-Years	5282	5282	5282
R^2	0.899	0.899	0.627

Notes: This table provides an extension of Equation 2 where the post-transaction indicators are interacted with an indicator for whether the clinic is acquired by or affiliates with a fertility chain before 2011 (Early=1) or after (and including) 2011 (Late=1). We exclude observations greater than 4 years pre or post transaction to allow for more accurate comparisons while limiting data loss. However, the event windows are still different for the early and late transactions. For example, a clinic acquired in 2016 would have 4 years of pre-period data and three years of post-period data (including 2016). The dependent variable mean captures the predicted mean for control clinics and treatment clinics before the transaction. Standard errors are clustered at the clinic level. Significance levels: *$p<0.1$, **$p<0.05$, ***$p<0.01$

Appendix E. Power Calculations

This appendix provides power curves based on simulation analysis to assess to what extent we are powered to detect different effect sizes. For both clinic volume and IVF success rates, we simulate power to assess our ability to statistically reject the null hypothesis that $\beta_1 = 0$ and $\beta_2 = 0$ in Equation 2. We calculate power for a range of values, allowing for a type I error rate of 5%. We implement this procedure in three steps:

1) Calculate the parameters of Equation 2 (shown below as a reminder) for the control variables and fixed effects using only data from non-chain clinics and chain clinics before transaction.

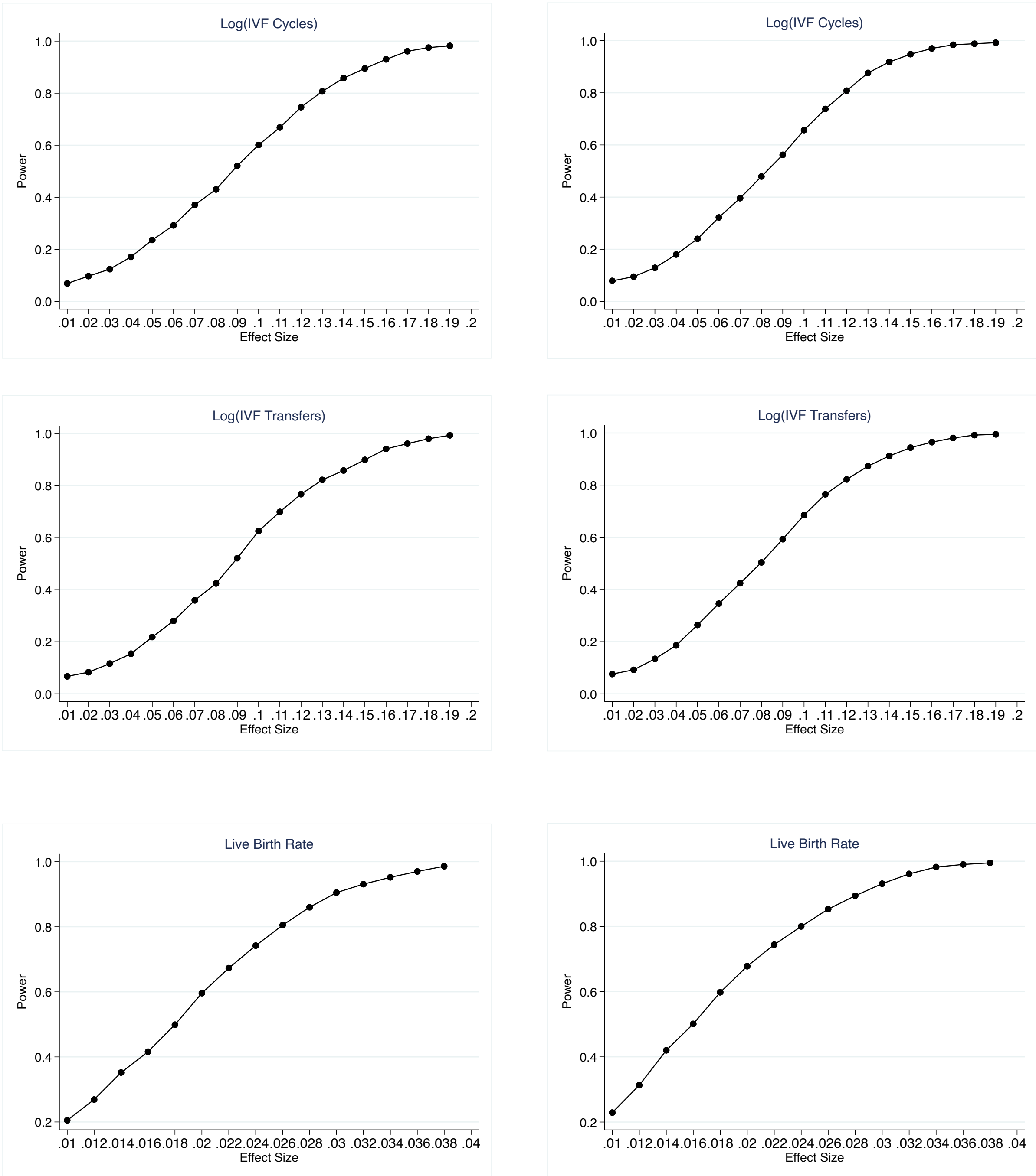
Eq. 2: $$Y_{ct} = \beta_1(Post \times Acquisition)_{ct} + \beta_2(Post \times Affiliation)_{ct} + \gamma\boldsymbol{X}_{ct} + \theta_c + \theta_{st} + \epsilon_{ct}$$

2) For each clinic, simulate outcomes based on the proposed true effect size of β_1 and β_2 and a random error, drawn from a normal distribution with mean zero and standard deviation calculated from the residuals from step 1. Repeat this process 1000 times to construct 1000 simulated samples.
3) Estimate Equation 2, clustering standard errors at the clinic level, in each of the 1000 simulated samples, and record the percentage of cases in which the *p-value* when testing $\beta_1 = 0$ and $\beta_2 = 0$ is below 0.05.

As seen in Figure E1, the simulations suggest the difference-in-differences regressions are well powered. For example, at 80% power, we can detect a 13% and 12% change in total cycles for acquired and affiliated clinics respectively, which is roughly half of the observed increase seen in most analyses. For the live birth rate, at 80% power we can detect a 2.6 pp and 2.4 pp change for acquired and affiliated clinics, respectively. While these are meaningful effect sizes, acquired clinic effect sizes are more than 1pp above this value in all regressions and affiliated clinic effect sizes are often close to zero.

Figure E1. Power Curve for Fertility Clinic Outcomes by Ownership Structure

(a) Acquisition (b) Affiliation

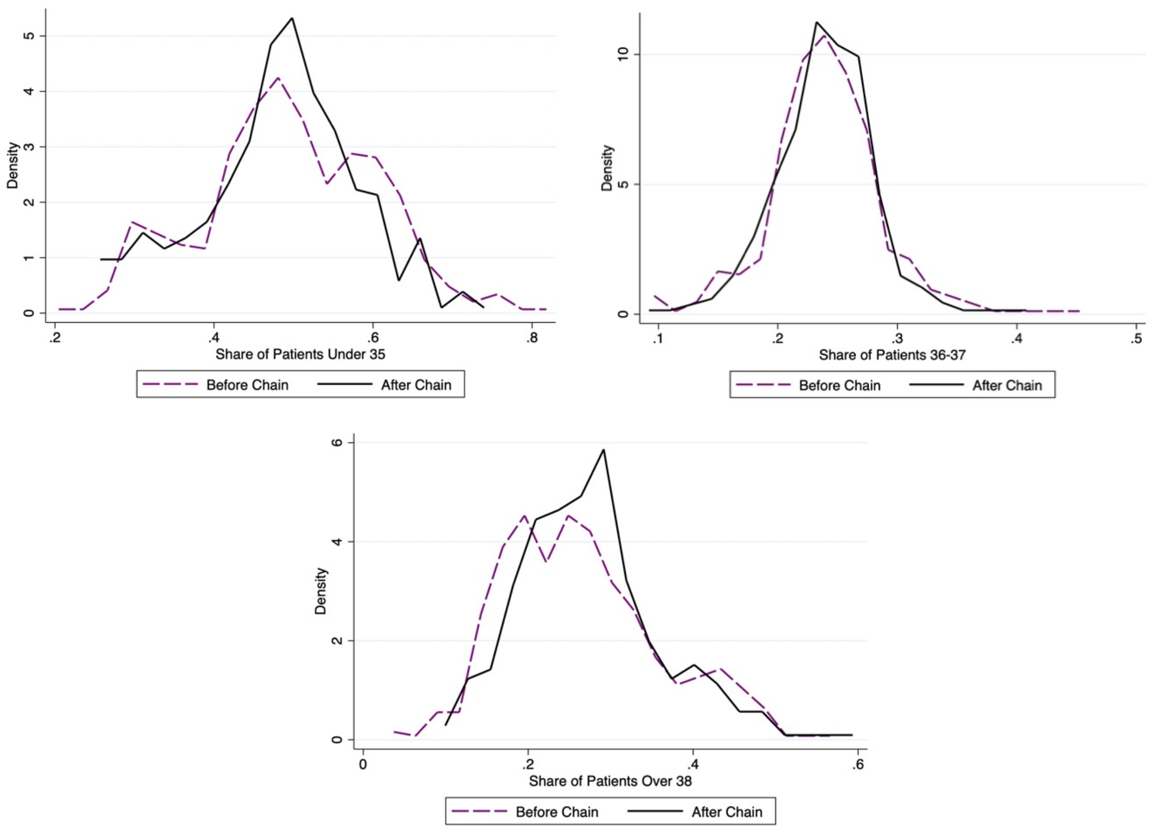


Notes: Figures plot power against hypothesized effect sizes assuming a type I error rate of 0.05. For the singleton birth rate, at 80% power we can detect a 2.2 pp and 2.0 pp change for acquired and affiliated clinics, respectively. For the multiple birth rate, at 80% we can detect a 1.5 pp and 1.3 pp change for acquired and affiliated clinics, respectively. Output for these additional outcome variables available upon request.

Appendix F. Assessing the Role of Patient and Clinic Selection

This appendix provides robustness checks to the main DD that mitigate concerns of patient selection and the non-random selection of clinics into fertility chains. Figure F1 shows the distribution of patients in different age bins before and after chain ownership in the raw data. Table F1 shows results of the live birth rate, singleton birth rate, and multiple birth rate using different patient controls and weights, Table F2 shows cross-sectional analysis using new variables available in 2017 and 2018 for first-time patients using IVF, Table F3 shows results using different matched control groups, Table F4 shows the summary statistics for the matched samples, Table F5 shows the association between chain ownership and clinics size in 2018 for the matched sample, Table F6 shows results using alternative samples, Table F7 shows additional robustness that account for unique features of the data.

Figure F1. Distribution of Share of Patients by Age Bin Before and After Transaction, Unadjusted Data



Notes: This figure shows histograms of the share of patient in each age bin (as a fraction total IVF cycles) before and after chain ownership using the raw data.

Table F1. Effect of Chain Ownership on Fertility Clinic Outcomes, Patient Robustness

	(1) Live Birth Rate	(2) Singleton Birth Rate	(3) Multiple Birth Rate
Panel A: Including Clinic-Level Patient Diagnosis as Controls (2004-2018)			
Post × Acquisition	0.052***	0.067***	-0.015**
	(0.012)	(0.012)	(0.006)
Post × Affiliation	0.007	0.011	-0.005
	(0.016)	(0.014)	(0.006)
Dep. Var. Mean	0.374	0.273	0.101
Clinic-Years	5666	5666	5666
R^2	0.626	0.620	0.512
Panel B: Including CBSA-Level Patient Characteristics as Controls (2009-2018)			
Post × Acquisition	0.036***	0.064***	-0.028***
	(0.012)	(0.013)	(0.006)
Post × Affiliation	0.013	0.020	-0.007
	(0.014)	(0.014)	(0.008)
Dep. Var. Mean	0.389	0.293	0.096
Clinic-Years	3742	3742	3742
R^2	0.656	0.642	0.550
Panel C: Main DD Estimation Weighted by Clinic IVF Cycles (2004-2018)			
Post × Acquisition	0.030***	0.039***	-0.009*
	(0.011)	(0.013)	(0.005)
Post × Affiliation	0.003	0.007	-0.004
	(0.016)	(0.016)	(0.005)
Dep. Var. Mean	0.390	0.295	0.095
Clinic-Years	5666	5666	5666
R^2	0.752	0.776	0.685

Notes: This table shows the estimates of Equation 2 including different sets of patient controls. In Panel B, the sample excludes years before 2009 because the NCHS data did not report whether a patient used infertility treatment until 2009, and, therefore, includes a smaller sample of chain clinics. For the same sample period (2009-2018) without including vital statistics controls, the b/se for the live birth rate in acquired and affiliated clinics are .035 (.012) and .004 (.015), respectively. We also find nearly identical results when using county-level patients characteristics as controls (available upon request). The dependent variable mean captures the predicted mean for control clinics and treatment clinics before the transaction. Standard errors are clustered at the clinic level. Significance levels: *p<0.1, **p< 0.05, ***p<0.01

Table F2. Association between Chain Ownership and Live Birth Rates for First Time IVF Patients, Years 2017 and 2018

	(1)	(2)
	Live Birth Rate (First Intended Retrieval)	**Live Birth Rate (All Intended Retrievals)**
Acquisition=1	0.088***	0.093***
	(0.017)	(0.016)
Affiliation=1	0.057***	0.069***
	(0.015)	(0.017)
Dep. Var. Mean	0.370	0.429
Clinic-Years	759	759
R^2	0.263	0.238

Notes: This table shows an adaptation of Equation 2 without clinic fixed effects using data only available in 2017 and 2018. Rather than post-transaction indicators, "*Acquisition=1*" is equal to 1 for acquired clinics and zero otherwise and "*Affiliation=1*" is equal to 1 for affiliated clinics and zero otherwise. The dependent variable mean captures the predicted mean for control clinics and treatment clinics in 2017 and 2018. Standard errors are clustered at the clinic level. Significance levels: *p<0.1, **p<0.05, ***p<0.01

Table F3. Effect of Chain Ownership on Fertility Clinic Outcomes, Matched Sample and Volume Restricted Sample

	(1) Log(Cycles)	(2) Log(Transfers)	(3) Live Birth Rate
Panel A: Matched Sample (Cycles Only)			
Post × Acquisition	0.288**	0.264**	0.040***
	(0.119)	(0.114)	(0.015)
Post × Affiliation	0.202*	0.177*	-0.023
	(0.110)	(0.104)	(0.018)
Dep. Var. Mean	5.719	5.498	0.398
Clinic-Years	1514	1514	1514
R2	0.924	0.926	0.727
Panel B: Matched Sample Excluding Clinics in Same Market (Cycles Only)			
Post × Acquisition	0.206*	0.172*	0.040***
	(0.105)	(0.102)	(0.014)
Post × Affiliation	0.149	0.130	-0.007
	(0.131)	(0.125)	(0.020)
Dep. Var. Mean	5.804	5.593	0.397
Clinic-Years	1436	1436	1436
R2	0.926	0.928	0.763
Panel C: Matched Sample (Cycles, Live Birth Rate, Share of Patients<35)			
Post × Acquisition	0.341***	0.300***	0.050***
	(0.120)	(0.106)	(0.016)
Post × Affiliation	0.166	0.152	-0.009
	(0.123)	(0.121)	(0.019)
Dep. Var. Mean	5.567	5.355	0.395
Clinic-Years	1314	1314	1314
R2	0.912	0.917	0.686
Panel D: Clinics with at Least 150 Cycles a Year			
Post × Acquisition	0.202**	0.174*	0.038***
	(0.094)	(0.093)	(0.013)
Post × Affiliation	0.158	0.151	-0.002
	(0.105)	(0.103)	(0.016)
Dep. Var. Mean	5.805	5.577	0.387
Clinic-Years	3541	3541	3541
R2	0.840	0.840	0.723

Notes: This table shows the estimates of Equation 2 using matched control groups. Panel A includes non-chain clinics matched based on 1-1 coarsened exact matching on a clinic's IVF cycles in the year before transaction (62 treated and 62 control clinics), Panel B repeats the match process but excludes non-chain (control) clinics in the same CBSA as a treated clinic from the match (61 treated and 61 control), and Panel C uses the full sample but matches on IVF cycles, the live birth rate, and the share of patients under 35 (55 treated and 55 control clinics), and Panel D includes a sample of non-chain clinics that perform at least 150 cycles per year over the sample period The dependent variable mean captures the predicted mean for control clinics and treatment clinics before the transaction. Standard errors are clustered at the clinic level. Significance levels: *$p<0.1$, **$p<0.05$, ***$p<0.01$

Table F4. Fertility Clinic Summary Statistics: Matched Sample, 2004-2018

	Matched (IVF Cycles)			Matched (IVF Cycles, Live Birth Rate, Share Under 35)		
	Fertility Chain		**Non-Chain**	**Fertility Chain**		**Non-Chain**
	Acquisition	**Affiliation**		**Acquisition**	**Affiliation**	
	Pre-transaction mean	Pre-transaction mean	Mean of all years	Pre-transaction mean	Pre-transaction mean	Mean of all years
Clinic Volume						
IVF Cycles	563.81	515.43	440.56	487.01	482.00	333.79
IVF Transfers	453.57	401.08	347.91	388.09	376.40	260.75
Log(IVF Cycles)	6.05	5.90	5.56	5.91	5.84	5.38
Log(IVF Transfers)	5.83	5.67	5.34	5.69	5.62	5.17
Birth Rates (%)						
Live Birth Rate	41.80	41.98	37.74	41.13	41.95	38.17
Singleton Birth Rate	30.68	31.21	27.48	30.09	31.17	27.51
Multiple Birth Rate	11.10	10.79	10.19	11.01	10.79	10.60
Patient Characteristics (%)						
Share of Patients $<$ 35 (transfers)	51.79	52.06	49.54	53.27	52.16	52.54
Share of Patients 35-37 (transfers)	24.17	23.17	23.87	23.78	23.04	23.70
Share of Patients $\geq$ 38 (transfers)	24.05	24.77	26.58	22.94	24.80	23.76
Diagnosis, Tubal Factor	10.94	10.72	11.75	11.56	10.74	13.24
Diagnosis, Ovulatory Dysfunction	11.14	11.28	10.94	11.58	11.56	11.88
Diagnosis, Diminished Ovarian	23.90	23.24	23.21	22.50	23.82	20.09
Diagnosis, Endometriosis	7.80	7.32	7.03	7.91	7.77	9.75
Diagnosis, Uterine Factor	3.74	4.06	3.88	3.71	4.15	3.86
Diagnosis, Male Factor	24.89	22.77	24.96	25.51	22.89	27.89
Diagnosis, Other	13.18	12.81	12.68	11.99	12.59	10.82
Diagnosis, Unknown	10.44	11.46	11.73	11.00	10.94	9.78
Observations						
Number of Clinics	33	29	62	29	26	55
Clinic-Years	283	193	849	237	180	744

Notes: All summary statistics are at the clinic-year level. Clinic volume, birth rates, and patient characteristics include adjustment for year effects to account for changes in reporting in the CDC ART data (therefore, there will be differences between these statistics and those reported in Table 1). The samples are constructed using 1-1 coarsened exact matching on a clinic's IVF cycles in the year before transaction or using a clinic's IVF cycles, live birth rates and share of patients under 35 years of age in the year before transaction. In the latter matched sample, not all treated clinics were matched to a control clinic.

Cross-Sectional Analysis of Clinic Size (Table F5 below). For the year 2018 (the last year in our sample), we collect information on whether a clinic advertises IVF financing options (Appendix Table H6) for the sample of clinics matched on pre-transaction IVF cycles (62 treated and 62 control clinics).[4] In addition, we collect information on the number of physicians and number of locations listed on fertility clinic websites in 2018. For the physician count, we include medical doctors with an MD or DO and for the location count, we include all office and satellite locations where in-person fertility visits are provided, and therefore, exclude laboratory locations.

In Table F5 we show the results from estimating Appendix Equation 2 with and without state (α_s) and year (α_t) fixed effects:

$$\text{Appendix Eq. 2:} \quad Y\_Number_{ct} = \alpha_s + \alpha_t + \beta_1 Acquisition_c + \beta_2 Affiliation_c + \epsilon_{ct}$$

The dependent variable Y_Number_{ct} represents either the number of physicians or the number of locations. The independent variables $Acquisition_c$ and $Affiliation_c$ are binary variables equal to 1 if the clinic was acquired by a fertility chain or affiliated with a fertility chain, respectively. While we make efforts to collect data only from the year 2018 but in some instances, the Internet Archive does not have a webpage in the year 2018 for a clinic. In those cases, we assume that if the information was the same in any year before and any year after 2018, then the information would be the same in 2018. If there was only information available in a single year, we record data from the closest year to 2018. As robustness, we include year and state fixed effects.

Table F5. Association Between Chain Ownership and Clinic Size

	(1)	(2)	(3)	(4)
	Number of Physicians		**Number of Locations**	
Acquired=1	0.316	-0.033	0.551	0.262
	(0.659)	(0.968)	(0.530)	(0.684)
Affiliation=1	-0.238	-0.781	0.242	0.012
	(0.662)	(0.785)	(0.521)	(0.653)
Constant	4.273***	4.554***	2.655***	2.856***
	(0.425)	(0.556)	(0.271)	(0.383)
Year FE		X		X
State FE		X		X
Clinic-Years	118	102	118	102
R^2	0.005	0.301	0.010	0.213

Notes: This table displays the β estimates of Appendix Equation 2. The constant represents the mean of the dependent variable for control clinics. Standard errors are clustered at the clinic level. Significance levels: *p<0.1, **p<0.05, ***p<0.01

[4] We were unable to find websites or sufficient website data for 6 control clinics. These were typically hospital-based where the Internet Archive did not save the fertility specific web page embedded within the hospitals' website.

Table F6. Effect of Chain Ownership on Fertility Clinic Outcomes, Alternative Clinic Samples

	(1) Log(Cycles)	(2) Log(Transfers)	(3) Live Birth Rate
Panel A: Balanced Panel (15 Years)			
Post × Acquisition	0.309***	0.254**	0.051***
	(0.111)	(0.112)	(0.013)
Post × Affiliation	0.211*	0.190	0.013
	(0.122)	(0.120)	(0.019)
Dep. Var. Mean	5.550	5.340	0.375
Clinic-Years	3570	3570	3570
R^2	0.905	0.906	0.634
Panel B: Excluding Non-Chain Clinics that Restructured or Closed			
Post × Acquisition	0.251**	0.190*	0.045***
	(0.105)	(0.103)	(0.013)
Post × Affiliation	0.200*	0.181*	0.003
	(0.104)	(0.103)	(0.016)
Dep. Var. Mean	5.364	5.141	0.381
Clinic-Years	4124	4124	4124
R^2	0.906	0.908	0.631
Panel C: Excluding all Academic Medical Center Fertility Clinics			
Post × Acquisition	0.316***	0.242**	0.058***
	(0.099)	(0.099)	(0.013)
Post × Affiliation	0.287**	0.261**	0.004
	(0.112)	(0.110)	(0.018)
Dep. Var. Mean	5.167	4.952	0.374
Clinic-Years	4984	4984	4984
R^2	0.889	0.888	0.626

Notes: This table shows the estimates of Equation 2 for different samples. Panel A includes clinic present in all years of data from 2004 to 2015, Panel B excludes non-chain clinics that ever restructured or closed, and Panel C excludes any clinic that is part of an academic medical center. The dependent variable mean captures the predicted mean for control clinics and treatment clinics before the transaction. Standard errors are clustered at the clinic level. Significance levels: *$p<0.1$, **$p<0.05$, ***$p<0.01$

Table F7. Effect of Chain Ownership on Fertility Clinic Outcomes, Additional Robustness

	(1) Log(Cycles)	(2) Log(Transfers)	(3) Live Birth Rate
Panel A: Excluding the Year 2018			
Post × Acquisition	0.281***	0.237**	0.045***
	(0.105)	(0.105)	(0.014)
Post × Affiliation	0.211**	0.197**	-0.004
	(0.101)	(0.098)	(0.017)
Dep. Var. Mean	5.222	5.036	0.372
Clinic-Years	5287	5287	5287
R^2	0.903	0.904	0.645
Panel B: Controlling for a Second Acquisition			
Post × Acquisition	0.266***	0.200**	0.050***
	(0.095)	(0.094)	(0.013)
Post × Affiliation	0.233**	0.212**	0.004
	(0.100)	(0.099)	(0.016)
Dep. Var. Mean	5.252	5.035	0.374
Clinic-Years	5666	5666	5666
R^2	0.899	0.898	0.625
Panel C: Removing Clinics with Uncertain Classification			
Post × Acquisition	0.292***	0.221**	0.047***
	(0.103)	(0.104)	(0.012)
Post × Affiliation	0.254**	0.233**	0.011
	(0.115)	(0.114)	(0.018)
Dep. Var. Mean	5576	5576	5576
Clinic-Years	0.900	0.899	0.623
R^2	5.249	5.032	0.374

Notes: This table shows the estimates of Equation 2 for different samples and use of alternative control variables. Panel A includes an additional indicator for whether a clinic experienced a second acquisition event (1 for the second acquisition, 0 otherwise); Panel B removes the year 2018 to assess robustness to changes in data reporting in that year; and Panel C removes clinics for which there was potential uncertainty in clinic ownership and removes chains that did not receive external funding until 2018. The dependent variable mean captures the predicted mean for control clinics and treatment clinics before the transaction. Standard errors are clustered at the clinic level. Significance levels: *$p<0.1$, **$p<0.05$, ***$p<0.01$

Appendix G. Assessing the Role of Market Concentration

This appendix focuses on analyses related to market concentration. Table G1 assesses robustness to changes in market concentration and Table G2 shows how effects differ by baseline levels of market concentration.

Market Concentration Analysis (Table G1, below). Like many healthcare markets, US fertility markets are highly concentrated. One reason is that reproductive endocrinology is a relatively new field of medicine having started in the 1970s, with the first IVF baby born in the US in 1981. While there has been much progress and growth, in 2014, for example, only 442 fertility clinics provided IVF services in the US, and the average HHI was 4342. However, as seen in the table below (data from 2014), 28% of clinics are in CBSAs with 1-2 clinics, whereas 51% are in CBSAs with 6 or more clinics. The HHI is calculated using the share of total IVF cycles by year for each parent organization (the parent is the corporate parent of the chain for chain clinics and the clinic itself for non-chain clinics) in a CBSA. By comparison, the mean HHI for hospitals at the MSA-level was around 5500 for hospitals and 3300 for specialist physicians in 2014 (Fulton 2017).

Number of Clinics	% of Clinics in CBSA	HHI
1-2	28.02	8578
3-5	20.96	4156
6-9	17.31	2720
10+	33.71	1770

As mentioned in the manuscript, fertility chains are more likely to target clinics in more competitive markets, and most chain transactions occur across markets rather than within markets. To confirm this, we calculate the number of markets where an acquisition or an affiliation increased the number of clinics belonging to the same chain. For example, if there were three non-chain clinics in a CBSA before an acquisition, and one clinic was acquired, then there would be no consolidation at the chain level in that market. However, if a second clinic in that CBSA was acquired by the same chain, then that CBSA would become more consolidated as the result of the acquisition. We identify 5 CBSAs (out of 147) where an acquisition or affiliation led to chain-level consolidation (the 5 CBSAs include Boston-Cambridge-Newton, Chicago-Naperville-Elgin, Dallas-Fort Worth-Arlington, Los Angeles-Long Beach-Anaheim and New York-Newark-Jersey City).

We then calculate whether a market became more *concentrated* because of an affiliation or an acquisition. Defining a market as a CBSA, we locate market years where an acquisition or affiliation occurs in the following year. Next, we calculate a counterfactual HHI based on a chain's pre-transaction shares but post-transaction ownership within a market. This counterfactual HHI represents the post-transaction change in HHI only driven by the clinic acquisition or affiliation in that market. Using this methodology, we identify 3 CBSAs as having transactions that induce increases in HHI. In Appendix Table G1, we provide evidence that results are robust to excluding these markets, suggesting that the impact of chain ownership on fertility clinic outcomes is not driven by changes in market concentration. Furthermore, as seen in Appendix Table D1, results are also robust to the inclusion of *CBSA* × *year* fixed effects, which would help account for market-level changes.

Table G1. Effect of Chain Ownership on Fertility Clinic Outcomes, Robustness to Changes in Market Concentration

	(1)	(2)	(3)
	Log(Cycles)	**Log(Transfers)**	**Live Birth Rate**
Panel A: Exclude Markets Where Chain Transaction Increased HHI			
Post × Acquisition	0.261***	0.186*	0.051***
	(0.095)	(0.096)	(0.012)
Post × Affiliation	0.239**	0.211**	0.001
	(0.099)	(0.098)	(0.015)
Dep. Var. Mean	5.267	5.044	0.376
Clinic-Years	5271	5271	5271
R2	0.905	0.905	0.635
Panel B: Exclude Markets With Any Chain-Level Consolidation			
Post × Acquisition	0.272**	0.191	0.040***
	(0.119)	(0.117)	(0.013)
Post × Affiliation	0.118	0.106	0.003
	(0.082)	(0.084)	(0.021)
Dep. Var. Mean	5.233	5.015	0.379
Clinic-Years	4091	4091	4091
R2	0.907	0.907	0.627

Notes: This table shows the estimates of Equation 2 run on samples excluding different markets. Panel A excludes data from 3 CBSAs where a clinic transaction increased the HHI in that market. Panel B excludes data from 5 CBSAs where a clinic transaction increased the number of clinics under the same ownership in the same market. The dependent variable mean captures the predicted mean for control clinics and treatment clinics before the transaction. Standard errors are clustered at the clinic level. Significance levels: *p<0.1, **p<0.05, ***p<0.01

Table G2. Effect of Chain Ownership on Fertility Clinic Outcomes by Baseline Levels of Market Concentration

	(1) Log(Cycles)	(2) Log(Transfers)	(3) Live Birth Rate
Post × Acquisition(HHI_Above=1)	0.257**	0.143	0.026**
	(0.115)	(0.114)	(0.013)
Post × Acquisition(HHI_Below=1)	0.291**	0.244*	0.064***
	(0.129)	(0.131)	(0.016)
Post × Affiliation(HHI_Above=1)	0.330	0.333	-0.012
	(0.209)	(0.203)	(0.019)
Post × Affiliation(HHI_Below=1)	0.184*	0.150	0.015
	(0.096)	(0.098)	(0.022)
Dep. Var. Mean	5.252	5.035	0.374
Clinic-Years	5666	5666	5666
R^2	0.899	0.898	0.625

Notes: This table shows the estimates of Equation 2 interacted with a binary indicator for whether a clinic was in a market with below or above median HHI (calculated using the HHI of the CBSA for the first year the clinic is in the sample). Specifically, HHI_Above means the market is more concentrated and therefore, less competitive (mean HHI of 6824) and HHI_Below means the market is less concentrated and therefore, more competitive (mean HHI of 1925). The dependent variable mean captures the predicted mean for control clinics and treatment clinics before the transaction. Standard errors are clustered at the clinic level. Significance levels: *p<0.1, **p<0.05, ***p<0.01

Appendix H. Mechanisms

This appendix uses alternative specifications and outcomes to explore underlying mechanisms driving the observed changes in fertility clinic volume and IVF success rates. Table H1 shows improvements in outcomes for patients of different ages as well as decomposes the live birth rate into multiple and singleton births, Table H2 shows clinic improvements in the live birth rate relative to the average of their fertility chain, Table H3 shows changes in the live birth rate by whether the fertility chain has below or above average live birth rates before the first chain transaction, Table H4 shows changes in the live birth rate by terciles of a clinic's pre-transaction clinic volume, Table H5 shows whether clinics engage in market expansion or business stealing using commuting zones as markets, Table H6 shows the association between chain ownership and advertising fertility financing options and Table H7 explores the role of private equity investment into fertility chains.

Table H1. Effect of Chain Ownership on Fertility Clinic IVF Success Rates by Patient Age Category

	(1) Log(Cycles)	(2) Log(Transfers)	(3) Live Birth Rate	(4) Singleton Birth Rate	(5) Multiple Birth Rate
Panel A: Patients All Ages (Weighted)					
Post × Acquisition	0.282***	0.214**	0.051***	0.067***	-0.016***
	(0.098)	(0.099)	(0.013)	(0.013)	(0.006)
Post × Affiliation	0.238**	0.217**	0.004	0.011	-0.007
	(0.100)	(0.099)	(0.016)	(0.014)	(0.006)
Dep. Var. Mean	5.252	5.035	0.374	0.273	0.101
Clinic-Years	5666	5666	5666	5666	5666
R^2	0.899	0.898	0.625	0.618	0.508
Panel B: Patients Under 35					
Post × Acquisition	0.274***	0.202*	0.038***	0.060***	-0.022***
	(0.104)	(0.104)	(0.013)	(0.014)	(0.008)
Post × Affiliation	0.199**	0.176*	-0.003	0.007	-0.010
	(0.094)	(0.091)	(0.016)	(0.015)	(0.008)
Dep. Var. Mean.	4.378	4.180	0.437	0.308	0.129
Clinic-Years	5666	5666	5665	5665	5665
R^2	0.875	0.872	0.521	0.508	0.433
Panel C: Patients 35-37					
Post × Acquisition	0.222**	0.130	0.040**	0.050***	-0.011
	(0.109)	(0.106)	(0.018)	(0.016)	(0.008)
Post × Affiliation	0.265***	0.221**	0.014	0.023	-0.009
	(0.102)	(0.100)	(0.021)	(0.019)	(0.010)
Dep. Var. Mean	3.651	3.388	0.369	0.274	0.095
Clinic-Years	5666	5666	5656	5656	5656
R^2	0.824	0.802	0.405	0.414	0.265
Panel D: Patients 38 and Over					
Post × Acquisition	0.273***	0.153	0.091***	0.105***	-0.015***
	(0.101)	(0.113)	(0.019)	(0.019)	(0.006)
Post × Affiliation	0.263**	0.265**	0.024	0.012	0.010*
	(0.112)	(0.115)	(0.019)	(0.018)	(0.006)
Dep. Var. Mean	3.779	3.402	0.256	0.205	0.050
Clinic-Years	5666	5666	5655	5655	5655
R^2	0.866	0.816	0.417	0.406	0.233

Notes: This table shows the estimates of Equation 2 run for three separate age categories: all patients with results weighted by patient age group (Panel A), patients under the age of 35 (Panel B), patients between the ages of 35 and 37 (Panel C) and patients of age 38 or older (Panel D). Note that because of changes in data reporting the oldest patients included in the sample are 42 years old. The dependent variable mean captures the predicted mean for control clinics and treatment clinics before the transaction. Standard errors are clustered at the clinic level. Significance levels: *p<0.1, **p<0.05, ***p<0.01

Table H2. Effect of Chain Ownership on Fertility Clinic Live Birth Rate Relative to the Fertility Chain Average Live Birth Rate

	Difference in Live Birth Rate Between Clinic and Chain Average
Post × Acquisition(BelowAvg=1)	0.082**
	(0.036)
Post × Acquisition(AboveAvg=1)	0.039***
	(0.015)
Post × Affiliation(BelowAvg=1)	0.034**
	(0.013)
Post × Affiliation(AboveAvg=1)	-0.009
	(0.021)
Dep. Var. Mean	0.050
Clinic-Years	5666
R^2	0.582

Notes: This table provides an extension of Equation 2 where the outcome variable is the difference between a clinic's own live birth rate and the average live birth rate of the clinic's chain (the average excludes a clinic's own live birth rate) for each year of the sample. We decompose the change between clinics above their fertility chain's average live birth rate pre-transaction (i.e., positive-valued difference) and clinics below their fertility chain's average live birth rate pre-transaction (i.e., negative-valued difference). The dependent variable mean captures the predicted mean for control clinics and treatment clinics before the transaction. Standard errors are clustered at the clinic level. Significance levels: *$p<0.1$, **$p<0.05$, ***$p<0.01$

Table H3. The Effect of Chain Ownership on the Live Birth Rate by Fertility Chain Pre-Transaction Live Birth Rates

	Live Birth Rate
Post × Acquisition(ChainBelow=1)	0.028**
	(0.012)
Post × Acquisition(ChainAbove=1)	0.073***
	(0.019)
Post × Affiliation(ChainBelow=1)	-0.006
	(0.021)
Post × Affiliation(ChainAbove=1)	0.029*
	(0.016)
Dep. Var. Mean	0.375
Clinic-Years	5666
R^2	0.625

Notes: This table provides an extension of Equation 2 where the post-transaction indicators are interacted with an indicator for whether the clinic is acquired by or affiliates with a fertility chain with below or above median live birth rates. To calculate each chain's live birth rate, we take the average live birth rate of the clinics that are already in the chain before the first transaction takes place in our sample. However, since some chains are newly created by PE firms during our sample period (i.e., had no clinics already in the chain), for these chains we use the average live birth rate of the flagship clinic(s) first acquired to create the chain in the years before the transaction occurs. Using these pre-transaction chain-level live birth rates, we then divide chains into those with below or above the median live birth rates. The dependent variable mean captures the predicted mean for control clinics and treatment clinics before the transaction. Standard errors are clustered at the clinic level. Significance levels: *$p<0.1$, **$p<0.05$, ***$p<0.01$

Table H4. The Effect of Chain Ownership on the Live Birth Rate by Terciles of Clinic Pre-Transaction IVF Cycles

	Live Birth Rate
Post × Acquisition(Low=1)	0.068***
	(0.021)
Post × Acquisition(Med=1)	0.043*
	(0.024)
Post × Acquisition(High=1)	0.042***
	(0.014)
Post × Affiliation(Low=1)	0.001
	(0.023)
Post × Affiliation(Med=1)	0.006
	(0.036)
Post × Affiliation(High=1)	0.006
	(0.016)
Dep. Var. Mean	0.374
Clinic-Years	5666
R^2	0.625

Notes: This table provides an extension of Equation 2 with clinics divided into terciles based on their pre-transaction average of IVF cycles. For example, *Acquisition(Low=1)* is an indicator equal to 1 if an acquired clinic was in the bottom tercile of acquired clinics based on its pre-transaction average of IVF cycles. The dependent variable mean captures the predicted mean for control clinics and treatment clinics before the transaction. Standard errors are clustered at the clinic level. Significance levels: *p<0.1, **p<0.05, ***p<0.01

Table H5. Market Expansion Analysis, IV Estimates Based on Commuting Zones

	(1)	(2)	(3)	(4)
	Total Market Cycles		**Total Market Live Births**	
	Non-Chain Clinics	All Clinics	Non-Chain Clinics	All Clinics
Total Chain Cycles	-0.010	0.990***		
	(0.186)	(0.186)		
Total Chain Live Births			-0.249*	0.751***
			(0.136)	(0.136)
First Stage: F-Stat	63.467	63.467	62.071	62.071
Market-Years	1876	1876	1876	1876

Notes: This table displays the δ estimates of Equation 4. The market is defined as the commuting zone of the clinic based on ERS 2000 delineations. *Total Chain Cycles* and *Total Chain Live Births* represent the total number of IVF cycles and total number of live births performed by chain clinics each year in a commuting zone, instrumented using the number of chain clinics each year in a commuting zone. The first stage F-stat shows the Kleibergen-Paap Wald rk F statistics. The sample includes all clinics (including clinics always in a chain and newly opened by a chain) in a commuting zone that ever had a non-chain clinic. Standard errors are clustered at the market level. Significance levels: *$p<0.1$, **$p<0.05$, ***$p<0.01$

Advertised Fertility Financing Options Analysis (Table H6, below). The cost of IVF is often cited as a barrier to take-up. As a strategy to attract new patients and ostensibly make care more affordable, many fertility clinics advertise financing options or IVF discount programs. To examine whether chain clinics are more likely than non-chain clinics to provide and advertise IVF financing options, we hand-collect data from clinic websites using the Internet Archive (https://archive.org/). We collect a cross-section of data for the year 2018 (the last year in our sample) for clinics in our matched sample (62 treated and 62 control clinics).[5] This sample is matched on pre-transaction clinic volume and, therefore, represents the largest non-chain fertility clinics in our sample. For this reason, our estimates are likely to be conservative as the larger clinics in the control group may have more resources to offer and advertise financing options than smaller clinics.

We collect information on whether a clinic advertised any of the programs listed below (a clinic could offer none or all these options).[6]

1) **Money-Back Guarantees** (also called shared risk or refund programs): A patient typically pays a large, all-inclusive upfront sum for 2-3 cycles before starting treatment. If their cycles are unsuccessful, then they are refunded between 50-80% of the original amount. These programs can be provided directly by the clinic or in collaboration with a fertility benefits manager (examples include WinFertility and ARC Fertility).
2) **Multiple-Cycle Discount Plans:** There is no refund, and instead, a patient typically pays a reduced price for multiple cycles or, if they pay for two cycles, then they receive a third cycle free. These programs can be provided directly by the clinic or in collaboration with a fertility benefits manager (examples include WinFertility and ARC Fertility).
3) **Lending Program:** Fertility clinics often partner with fertility-specific lenders that provide loans and payment plans for patients (examples include Lending Club and CapExMD).
4) **IVF Discounts:** Fertility clinics can also advertise cash discounts, price matching, sliding scale payments, or grants to help patients cover IVF treatment. We excluded medication discounts because many patients can independently seek medication discounts, and medications are more likely to be covered by insurers.

In Table H6 we show the results from estimating Appendix Equation 3 with and without state (α_s) and year (α_t) fixed effects:

Appendix Eq. 3: $$Prob(Advertise)_{ct} = \alpha_s + \alpha_t + \beta_1 Acquisition_c + \beta_2 Affiliation_c + \epsilon_{ct}$$

[5] We were unable to find websites or sufficient website data for 6 control clinics. These were typically hospital-based clinics where the Internet Archive did not save the fertility specific web page embedded within the hospital's website.

[6] Initially, we also sought to collect data on advertised prices. However, clinics vary considerably in what they include in the advertised price of IVF and often do not provide detailed information. For example, one clinic may say they provide an all-inclusive price of $12,000 and another clinic will say they offer "low-cost IVF" at $4500. Most clinics ask patients to call for more price information.

The dependent variable $Prob(Advertise)_{ct}$ is a binary variable equal to 1 if the fertility clinic advertises 1) A money back guarantee or multiple cycle discount program (these are typically offered together), 2) a partnership with a lender, or 3) IVF-specific discounts. The independent variables $Acquisition_c$ and $Affiliation_c$ are binary variables equal to 1 if the clinic was acquired by a fertility chain or affiliated with a fertility chain, respectively. While we make efforts to collect data only from the year 2018, in some instances, the Internet Archive does not have a webpage in the year 2018 for a clinic. In those cases, we assume that if the information was the same in any year before and any year after 2018, then the information would be the same in 2018. If there was only information available in a single year, we record data from the closest year to 2018. As robustness, we include year fixed effects to account for any differences in the year the data was collected.

Table H6. Association Between Chain Ownership and Advertising Fertility Financing Options

	(1)	(2)	(3)	(4)	(5)	(6)
	Money Back Guarantee or Multi Cycle Discount		**Lending Program**		**Other IVF Discount Program**	
Acquisition=1	0.412***	0.402***	0.330***	0.298***	0.003	-0.010
	(0.097)	(0.121)	(0.083)	(0.111)	(0.101)	(0.124)
Affiliation=1	0.170	0.180	0.280***	0.322***	-0.084	-0.069
	(0.115)	(0.136)	(0.094)	(0.121)	(0.098)	(0.121)
Constant	0.382***	0.394***	0.582***	0.606***	0.291***	0.292***
	(0.066)	(0.069)	(0.067)	(0.080)	(0.062)	(0.075)
Year FE		X		X		X
State FE		X		X		X
Clinic-Years	118	103	118	103	118	103
R^2	0.122	0.393	0.125	0.342	0.007	0.276

Notes: This table displays the β estimates of Appendix Equation 3. The constant represents the mean of the dependent variable for control clinics. Standard errors are clustered at the clinic level. Significance levels: *p<0.1, **p<0.05, ***p<0.01

Table H7. Effect of Private Equity Funding on Fertility Clinic Outcomes

	(1) Log(Cycles)	(2) Log(Transfers)	(3) Live Birth Rate
Panel A: Private Equity Decomposition			
Post_NoPE × Acquisition	0.144	0.165	0.051***
	(0.160)	(0.143)	(0.019)
Post_YesPE × Acquisition	0.313***	0.224**	0.052***
	(0.103)	(0.104)	(0.012)
Post_NoPE × Affiliation	0.225**	0.218**	-0.009
	(0.102)	(0.098)	(0.019)
Post_YesPE × Affiliation	0.258**	0.217*	0.021
	(0.115)	(0.118)	(0.015)
Dep. Var. Mean	5.253	5.035	0.374
Clinic-Years	5666	5666	5666
R^2	0.899	0.898	0.625
Panel B: Effect of Private Equity Funding			
Post_PE	0.169***	0.124**	0.022***
	(0.054)	(0.053)	(0.008)
Dep. Var. Mean	5.325	5.103	0.375
Clinic-Years	6134	6134	6134
R^2	0.909	0.909	0.630

Notes: This table shows the estimates of Equation 2 with treatment times based on private equity investment into a chain. In Panel A, *Post_NoPE* is a post-transaction indicator equal to 1 for the years a clinic is in a chain without PE funding and 0 for the years the clinic is in the chain with PE funding. *Post_YesPE* is a post-transaction indicator equal to 1 for the years a clinic is in the chain with PE funding and 0 for the years the clinic is in the chain without PE funding (these are mutually exclusive). In Panel B, *Post_PE* is an indicator equal to 1 when a chain receives PE funding and zero prior to PE funding. Panel B includes that full sample of clinics. The dependent variable mean captures the predicted mean for control clinics and treatment clinics before the transaction (Panel A) or before PE investment (Panel B). Standard errors are clustered at the clinic level. Significance levels: *$p<0.1$, **$p<0.05$, ***$p<0.01$

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