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Competitive Pressures and Multiple Births in Infertility Treatment

Helen Schneider

Department of Economics, The University of Texas at Austin, Mailcode C3100, Austin

Corresponding author: Helen Schneider, Ph. D., Department of Economics, The University of Texas at Austin, Mailcode C3100, Austin, TX 78712. Phone: (512) 471-1734, Fax: (512) 471-3510, **Email:** h.schneider@eco.utexas.edu

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Abstract

Background: With the increase in fertility problems and delayed childbearing, demand for infertility treatments has been rising. Today, *in vitro fertilization* (IVF) is the most successful infertility treatment but it is costly. To meet rising demand for infertility treatment many markets have seen an increased entry of infertility clinics. Concerns have been raised of the effect of high per-treatment cost and rising competitive pressures on the outcomes of infertility treatments. The objective of this study is to examine the relationship between competitive pressures and prices charged by clinics for in vitro fertilization treatments as well as the effect of prices and competition on multiple gestations.

Method: This is a retrospective analysis of 2012-2014 clinic-level data in the United States. This study collects in vitro fertilization prices and combines the price data with the ART Fertility Clinic Success Rates Reports published by the Centers for Disease Control and Prevention (CDC). The Herfindahl–Hirschman Index (HHI) is a widely-used measure of competition within a market. Regression analysis is used to estimate the relationship between HHI and price variables. The effect of prices and competitive pressures on multiple gestations is estimated.

Results: Multivariate regression results show that competitive pressures do decrease prices charged by IVF clinics (p-value<0.1). IVF refund programs that reimburse couples for multiple failures are more likely to be offered in more concentrated markets (p-value<0.05) and larger clinics (p-value<0.01). Lower prices translate into lower multiple rates for younger women (p-value<0.1). Controlling for prices, competitive pressures decrease multiple rates for younger women (below 35 years of age) but increase multiple rates for older women (above 40 years of age) (p-value<0.1).

Conclusions: Lower IVF prices translate into better quality as measured by the rates of multiples for younger women undergoing infertility treatments. Effect of competitive pressures on quality of care is ambiguous especially after we control for treatment cost. For older women such pressures may lead to more embryo transferred and higher rates of multiples. Further research is needed to identify the relationship between competition and quality of medical care in infertility and other markets.

Keywords: *Infertility, in vitro fertilization, competition, econometrics*

Background

Infertility and in vitro fertilization

About 11 percent of American women 15–44 years of age have difficulty getting pregnant or carrying a pregnancy to term [1]. Today, over 1.7 percent of all infants born in the United States every year are conceived using assisted reproductive technologies (ART) [1]. To meet this increased demand for ART, the number of infertility clinics in the United States has increased from 263 in 1995 when CDC started collecting ART success rate data to 459 in 2014. Today, in vitro fertilization (IVF) is the most successful infertility treatment but it is invasive and costly. IVF involves ovarian stimulation with prescription drugs with close monitoring by the reproductive endocrinologist to prevent overstimulation, ovarian retrieval (an outpatient surgery), fertilizing an egg with sperm outside of a woman's body and then implanting it in her womb (another outpatient hospital procedure). Since IVF is a process, rather than a single procedure, costs include medications, laboratory tests, physician fees, hospital charges, anesthesia, and embryology lab fees. A full IVF cycle is priced at over $10,000 and a frozen embryo transfer at over $3,000 [2]. In addition, many couples have to go through several IVF cycles to achieve a live birth. CDC data indicates that only 32.98% of IVF cycles resulted in a live birth. High costs of IVF combined with relative low probability of success lead to more aggressive treatments and poor quality outcomes since patients' immediate financial interests are best met by maximizing their pregnancy chances on each IVF cycle. Such financial incentives lead to patients transferring more than one embryo so as to limit the number of IVF treatments they undergo despite the health risks and long term costs associated with multiple gestations and births. Although IVF is a medical procedure that treats a medical problem of infertility, most private health insurers exclude it from coverage with only a quarter of insurers covering some infertility benefits [3]. To address costs, some states passed insurance mandates that require employers to cover - or offer to cover- infertility treatments. To date, few Americans have sufficient insurance to cover infertility treatments. While the Affordable Care

Act extended insurance coverage to millions of uninsured Americans, IVF is not considered an "essential health benefit" under the Act and most insurers do not cover it outside of states where it is mandated.

Another factor that can address high costs of IVF is competitive pressures that lead to price competition among clinics. However, the effect of competition on IVF outcomes is ambiguous. While deciding on transferring another embryo, patients and clinics face short term benefits (higher probability of success and thus fewer IVF cycles) and long-term costs (higher probability of prematurity, C-section costs, other risks associated with higher risk pregnancy). On one hand, more competitive markets lead to lower prices which may allow patients to transfer fewer embryos per IVF cycle thus reducing multiple births. On the other hand, IVF clinics also compete for patients by advertising higher pregnancy rates and concerns have been raised that competitive pressures may lead clinics to transfer more embryos that may allow clinics to advertise higher success rates. This can lead to more multiple births.

This study examines the relationship between competitive pressures that infertility clinics face and health outcomes. We concentrate on one dimension of health outcomes: multiple gestations per ART birth. High costs of IVF procedure lead couples to transfer more embryos which leads to more multiple births (twins, triplets and high order multiples) per ART birth and thus poor quality health outcomes.

Health care providers in infertility markets compete along two dimensions: prices and quality. Due to lack of insurance coverage, price competition is more important in infertility settings relative to other areas of medical care that are better insured. This study attempts to use unique features of infertility market to distinguish between price and quality impacts of competitive pressures.

Competition and quality of health outcomes

Outside of infertility markets, the relationship between market competition and health care outcomes is ambiguous. While some studies show that hospital competition decreases mortality rates [4-7] others find higher mortality rates in competitive markets [8-9].

Empirical studies on mergers that result in accumulation of market power are similarly inconsistent. For example, Ho and Hamilton show that mergers increase readmission rates but do not affect mortality rates while Hayford finds that hospital mergers are associated with increased treatment intensity and higher inpatient mortality rates [10,11].

Finally, Mutter, Wong and Goldfarb looked at 12 different dimensions of inpatient quality. They find that the effect of competition is not "unidirectional" with some quality measures showing improvements with greater market competition while others remain the same or even decrease [12].

Infertility treatment markets: The effect of competition

With more IVF clinics entering the market, many hypothesize that under competitive pressures doctors will pursue aggressive treatments so that the IVF clinics can advertise higher success rates. Some industry observers even propose limits on competition [13-15]. Few empirical results that exist however do not support these fears. Steiner measured competition as number of clinics in the area and found that competition did not affect pregnancy rates but decreased high order multiples (triplets and higher) [16]. Hamilton and McManus measured competition with a simple dummy variable (1=monopoly, 0-otherwise). They find that competition does not increase multiple birth rate [17]. Henne and Bundorf (2010) did not find a relationship between the number of competitors an infertility clinic has and embryo transfer decisions [10].

Infertility treatment markets: The effect of insurance mandates

Although previous literature does not exist on the effects of competition on prices of infertility treatments, several studies examined the effect of infertility mandates that make infertility treatments more affordable. Universal insurance mandates are associated with greater utilization of ART and other infertility treatments such as ovulation-inducing drugs and artificial insemination [17, 19-21]. Schmidt finds that infertility mandates significantly increase first birth rates for older women [22]. The effect of insurance mandates on multiple gestations is ambiguous. On one hand, infertility mandates in New Jersey and Connecticut had no effect on embryo transfers and the rate of multiples [21]. On the other hand, a growing literature shows that infertility mandates improve outcomes of infertility treatments by decreasing treatment intensity and decreasing probability of multiple gestations per ART birth [17,19, 21]. However, Buckles estimates that state infertility mandates do not significantly affect multiple birth rates, they do increase triplet and higher-order births by 26% [24].

Previous literature on the cost and affordability of ART in the United States is limited but Chambers et al. using international data found that a decrease in a cost of an IVF cycle leads to fewer embryos transferred and higher use of single-embryo transfers. Affordability was measured as net cost of a standard IVF cycle relative to annual disposable income for thirty high and upper middle income countries [25].

Contribution to previous research

This study contributes to previous research on several fronts. First, we collect data on prices charged by IVF clinics to measure the effect of prices on multiple births. We also estimate the effect of the so-called money back programs that some IVF clinics offer. Second, we calculate Herfindahl–Hirschman Index (HHI) to measure market competition which shows more variance across markets in current data due to entry. Having both competition index and price data allows us to separate the effect of competition on prices from the effect of competition on quality. Finally, we are able to measure the effect of state insurance mandates while controlling for prices and competitive pressures.

Methods

Data sources

We use two waves 2012 and 2014 of ART Fertility Clinic Success Rates Reports. The data is publicly available by Center of Disease

Control and Prevention (CDC). The unit of analysis is a clinic performing ART (no patient level data is available). In this study we use data for non-donor fresh IVF cycles only. Thus, we excluded all cycles where an egg donor was used or frozen embryos were used.

All IVF cycles for each clinic were separated into three age groups since embryo transfer guidelines and IVF success rates vary by maternal age: women below 35 years of age, women between 35 and 40 years of age and women above 40 years of age. We use 2012-2014 ART Fertility Clinic Success Rates Report data to construct the following variables: number of IVF cycles by clinic (this variable captures the volume and the size of each clinic), multiple births by clinic and age group, percent of IVF cycles that underwent PGD (preimplantation genetic diagnosis) to test for genetic abnormalities for each IVF clinic, percent ICSI (intracytoplasmic sperm injection) cycles for each IVF clinic and society for assisted reproductive technologies (SART) membership which requires member compliance with strict embryo transfer guidelines.

Market area characteristics came from publicly available state and MSA-level data. Female labor force participation for years 2012 and 2014 was collected by the Bureau of Labor Statistics (BLS) at the state level. Percentage of educated women variable is based on National Center for Education Statistics report. This data is collected at the state level and captures percent of women with at least a bachelor's degree. MSA-level income per capita data came from the US Census Bureau. Data on state infertility mandates was obtained from the American Society for Reproductive Medicine. We also control for state-to-state differences in health care prices. We use annual average cost of living index for the health sector as reported by the Missouri Economic Research and Information Center (2015).

Competition index

We use Herfindahl–Hirschman Index (HHI) to measure market competition. The index is constructed based on total non-donor fresh IVF cycles performed for each clinic. Increases in the Herfindahl index generally indicate a decrease in competition and an increase of market power, whereas decreases indicate the opposite. The index can vary from zero (perfect competition) to 10000 (Monopoly). We use metropolitan statistical area (MSA) as the relevant market for infertility clinics in our sample.

Price variables

State infertility mandates. Although previous studies used insurance coverage as a main price variable, currently few Americans have sufficient coverage for ART. By 2014 fifteen states passed infertility mandates of which only eight states (Connecticut, Louisiana, Hawaii, Illinois, New Jersey, Massachusetts, Maryland, and Rhode Island) require all insurance plans to cover IVF. In addition, Arkansas, Montana and Ohio and West Virginia require some plans (all HMO's or all non-HMO's) to cover the costs IVF treatments. We use both definitions of the universal mandate to test the sensitivity of our results. It is important to note that even when insurance coverage is provided, the total value of the benefit may be capped at as low as $15,000 or the minimum number of cycles that must be covered may be as low as one [23].

In our definition of mandated infertility benefits, we do not include states like Texas that only require health insurance plants to offer infertility insurance since employers have the right to refuse such coverage. We also exclude states like California that require coverage of all infertility treatments except IVF.

IVF price measures. We supplement our analysis with price data from a health care price transparency website OkCopay. The price variable includes "one cycle of IVF procedure, using your own eggs, without monitoring" (http://www.okcopay.com/). In this study I used prices that included lab fees but not pharmaceutical prices. The data reflects cash prices, which is the charge before insurance.

In addition, many IVF clinics offer money back programs, (sometimes called IVF refund programs or IVF warranty programs) that allow a fixed fee for a number of IVF attempts and if the treatment is not successful, 80%-100% of money is refunded. Thus, couples that are successful on their first or second attempt most likely overpaid in comparison to traditional fee-for-service IVF. But, this "overpayment" can be thought of as an "insurance premium" for money back, in the event the treatment is not successful. Data on refunds by clinics was collected from published sources (http://ivfrefund.com/about-ivf-refund.html) and verified with individual clinics. A dummy variable was created; it takes the value of 1 if a clinic offers a refund and zero otherwise.

Price data is only available for the 33.5% of clinics in the CDC sample while data on discounts is available for all 916 clinics in our sample.

Limited price information is an important limitation of this study since one might worry that the clinics that provide data to the transparency websites are systematically different from those that do not in a way that would boas the results. This is especially important since when price variable is included, all regressions are run on this selected sample of 307 clinics. To alleviate this concern we did look at the clinics with price information and did not find them to be different from clinics without price information. Separately we looked at markets where price data is available and markets where price data is not available and did not find significant differences in market characteristics. These results increase our confidence that lack of data did not bias our empirical results.

Table 1 summarizes descriptive statistics. (Table 1)

Descriptive statistics show that IVF clinics markets vary from unconcentrated (HHI<1500) to monopoly (HHI=10000) although an average clinic is located in a highly concentrated market (mean HHI of 4054). As of 2014, none of the markets can be classified as competitive (HHI< 100). Probability of multiple gestations varied from an average of 14.94% for women over 40 years of age to 29.50% for women under 35 years of age. Average price in our sample was $13,477 with 8.77% of clinics offering IVF refunds.

Empirical analysis

To test the effect of HHI on costs and quality of care, two empirical models are used. First, we estimate the effect of HHI on costs:

Table 1. Descriptive statistics for selected variables

	Mean	SD	Minimum	Maximum
Multiples rate for women aged under 35	29.50	17.99	0	100
Multiples rate for women aged 35-39	24.76	19.29	0	100
Multiples rate for women aged 40 and above	14.94	26.26	0	100
HHI	4054.27	3238.41	216.86	10000
Price	13,476.89	3,248.45	5,500	25,850
IVF refund	0.0877	0.283	0	1
Insurance mandate	0.171	0.377	0	1
Cost of living (health)	107.091	17.43	87.3	145.3
Volume (number of cycles)	336.73	570.27	1	7648
% PGD	5.43	10.68	0	100
% ICSI	70.96	19.48	0	100
SART membership	.835	0.370	0	1
Per capita income	49800.49	9074.61	15,200	81,068
Population, thousands	2,695,066	5,021,092	85.56	2.01e+07
% women with at least bachelor's degree	28.34	4.62	17.4	48.6
Female labor force participation	57.81	3.202	42	69.6
Year = 2014	0.502	0.50	0	1
N N for Price variable	916 307			

$$Cost_i = \beta_0 + \beta_1 HHI_m + \beta_2 COL_s + \beta_3 Mandate_s + \beta_4 Clinic_i + \beta_5 Market_m + \varepsilon_{ims}$$

We use IVF clinic price variable and availability of refunds as our main measures of IVF costs ($Cost_i$) for clinic *i*. Coefficient β_1 captures the effect of competition in market *m*, coefficient β_2 captures cost of living (health component), β_3 captures the effect of state infertility mandates. In *Clinic* we control for characteristics of individual IVF clinics such as proportion of ICSI and PGD procedures performed as well as size of the clinic (measured by the volume of the IVF procedures). Variable $Market_{ms}$ is a vector of controls for variables that vary across MSA's and states that might also affect costs. These include: median family income, population, female labor force participation rate, and percentage of women with at least a bachelor's degree. Economic theory predicts that more competitive markets should have lower prices. This relationship holds true in healthcare markets as well. Baker et al. showed that more competition among physician practices is related to lower prices for office visits [26]. Melnick et al. (1992) observed the same relationship in hospital markets: "greater hospital competition leads to lower prices" [27]. Given economic theory and previous empirical literature, we expect higher prices in more concentrated markets (positive β_1) and more IVF refunds in more competitive markets (negative β_1).

Second model estimates the effect of HHI on multiple gestations. We run the model with and without cost variables to gage the effect of the HHI on price and the effect of the HHI on quality competition. In this study, we concentrate on one important dimension of quality for IVF clinics: the rate of multiple births they produce. Multiple gestations are an important risk factor for preterm birth, with 11% of twins, 36% of triplets, and 67% of quadruplets and higher born very preterm (i.e. less than 32 weeks' gestation), compared with less than 2% of singletons [28]. Preterm birth leads to increased risk for death, long-term neurological disabilities, and extended time in the hospital [29]. A recent study compared outcomes for women undergoing two IVF pregnancies with singletons and women undergoing one IVF twin pregnancy [30]. The neonatal and maternal outcomes were "dramatically" better for women undergoing two singleton pregnancies. IVF twins had higher rates of preterm births, low birth weight, respiratory complications, sepsis, and jaundice. Women delivering twins had higher rates of preeclampsia, preterm premature rupture of the membranes, and cesarean section. The authors proposed to decrease number of embryos transferred by IVF clinics to minimize the risks associated with multiple pregnancies. In our empirical model we use multiple rates per ART birth by maternal age for each clinic as a measure of quality [30].

$$Quality_a = \beta_0 + \beta_1 HHI_m + \beta_2 Cost_i + \beta_3 Mandate_s + \beta_4 Clinic_i + \beta_5 Market_m + \varepsilon_{amsi} \quad (2)$$

where the dependent variable measures quality of health outcomes for age cohort *a* for clinic *i*. Coefficient β_1 captures the effect of market competition, coefficient β_2 captures costs of the procedure (prices charged by individual clinics and discounts offered by individual clinics), β_3 captures the effect of state infertility mandates. Although state infertility mandates directly affect IVF costs we treat this policy variable separately.

Although we control for market characteristics at both MSA and the state level, one major concern is that there are likely to be unobservable characteristics that are correlated with both the independent and dependent variables that are driving the estimated coefficients in (2). Therefore, we also take advantage of the panel nature of the data and run (2) with fixed effects to better control for unobservable differences.

Results

IVF costs

We estimate Equation (1) to describe the effect of HHI on IVF prices and refunds offered. Results are presented in table 2. (Table 2)

Table 2 shows that more concentrated markets tend to have higher prices, as economic theory predicts. At the same time, IVF refund programs are more likely to be offered in more concentrated markets

Table 2. Costs of IVF

	(1)	(2)
Dependent variable	**Price**	**IVF refund**
Estimation method	**OLS**	**Probit**
HHI	0.0321 (0.0174)*	0.384 (0.174)**
Mandate	0.0544 (0.0421)	0.186 (0.280)
Cost of living-health	0.0031 (0.00244)	-0.0122 (0.00759)
West	-0.0226 (0.045)	0.842 (0.287)***
Midwest	-0.112 (0.0498)**	0.251 (0.319)
South	-0.104 (0.0502)**	0.790 (0.287)***
% PGD	0.00248 (0.00129)*	-0.00869 (0.00759)
% ICSI	0.000919 (0.000748)	0.00472 (0.00441)
SART membership	0.0726 (0.0436)*	-0.202 (0.227)
Volume	-0.00176 (0.0145)	0.526 (0.0899)***
Per capita income	-0.0764 (0.189)	0.454 (0.637)
Population, thousands	0.0194 (0.00543)***	0.103 (0.132)
% women with at least bachelor's degree	-0.449 (0.154)***	-0.967 (0.713)
Female labor force participation	0.622 (0.419)	2.011 (1.944)
Year = 2014	0.250 (0.170)	-1.78 (0.197)*
N	303	894
R^2	0.2196	
F	4.00	
Chi-squared		84.43

Notes: All continuous variables are in log form; Robust standard errors are in parentheses.* $p<.10$, ** $p<0.05$, *** $p<0.01$

and in larger clinics. This result is robust to alternative specifications of the model. Health insurance mandates do not significantly affect prices. Other significant variables include regional factors. IVF costs in the northeast are significantly higher relative to Midwest and South. Also, clinics in the South and West are more likely to offer IVF refund relative to Northeast clinics. Prices tend to be higher in more populous areas and lower in areas with more educated women.

Multiple Gestations

The goal of the paper is to examine the effect of determinants of potentially dangerous outcomes from IVF treatments: multiple births. Table 3 presents results of Equation 2 estimates for multiple rates without fixed effects. (Table 3)

Results in Table 3 show that effect of competition on multiple gestations is ambiguous. On one hand, competition decreases multiples through lower prices and through quality competition for women under 35 years of age. Although price variable is not important for women above 35 years of age, younger women are more sensitive with higher prices leading to more multiples for this age group. Without price variables more concentrated markets result in more multiples. Once we control for cost variables, significance of HHI decreases although remains positive and significant at p<0.10.

Table 3. Multiple births

Dependent variable	**Multiple rate, %**		
Age group	**<35 year of age**	**35-40 years of age**	**>40 years of age**
HHI	4.419 (2.51)*	0.253 (2.73)	-5.72 (2.57)**
Price, thousands	8.68 (4.78)*	0.029 (5.23)	-9.67 (6.79)
IVF refund	-1.93 (4.35)	-1.616 (4.73)	-0.632 (4.15)
Mandate	3.63 (3.19)	1.18 (3.47)	-1.58 (3.13)
% PGD	0.0252 (0.101)	-0.206 (0.109)*	0.117 (0.112)
% ICSI	-0.0368 (0.0583)	0.087 (0.067)	0.00438 (0.0608)
SART membership	1.22 (3.35)	1.01 (3.69)	7.17 (3.64)**
Volume	-1.101 (0.993)	-1.78 (1.09)	1.19 (1.11)
Per capita income	-27.65 (12.59)**	-14.89 (13.76)	31.02 (11.96)***
Population, thousands	2.001 (2.009)	1.59 (2.19)	-5.73 (2.12)***
% women with at least bachelor's degree	10.39 (14.-5)	-8.78 (15.72)	-26.77 (14.90)*
Female labor force participation	-38.94 (31.96)	22.36 (35.03)	44.05 (36.13)
West	-3.08 (3.42)	-3.64 (3.73)	-3.14 (3.65)
Midwest	-0.711 (4.53)	-8.57 (4.95)*	-7.01 (4.90)
South	-4.12 (4.01)	-7.62 (4.39)*	2.86 (4.32)
Year = 2014	-15.50 (13.39)	-15.66 (14.54)	22.16 (13.98)
N	294	288	184
R^2	0.217	0.218	0.235
F	2.20***	4.77***	3.65***

Notes: Robust standard errors are in parentheses.* $p<.10$, ** $p<0.05$, *** $p<0.01$; All continuous dependent variables are in the log form

Overall for younger women both price and quality competition is important. For older women (over age of 40) the effect of price and other cost measures is not significant. Thus, for this age group the effect of competition is due to quality competition alone and more concentrated markets actually lead to more multiple gestations. For women between 35 and 40 years of age, regional variables and PGD procedures are more important at determining multiples rates than economic variables.

Table 4 presents equation (2) estimates with individual clinic fixed effects. (Table 4)

Results in table 4 are consistent with results that were observed without fixed effects. Table 4 shows that IVF refund programs significantly decrease multiple gestations for younger women although do not seem to affect multiple rates for women over 35 years of age.

Table 5 below summarizes how HHI coefficient changes with and without price controls. (Table 5)

Table 5 finds that the effect of competitive pressures decreases when we control for prices in magnitude but remains significant for women below 35 years of age. For women over 40 years of age coefficient becomes negative and significant. Therefore, competitive pressures may affect quality differently for women of different age groups.

Overall results in tables 4 and 5 show that effect of competition changes with cost controls and may improve health outcomes for younger women but increase multiples for older women.

This study finds that health insurance mandates lead to fewer multiples (results omitted) but once we control for costs of the IVF, health insurance mandates are not statistically significant.

Discussion

Policy implications

The most important economic issues in the US IVF markets are: 1) barriers to access due to high prices and 2) health outcomes. Our empirical analysis confirms the existing consensus that competition lowers prices and lower prices translate into fewer multiples especially for younger women. Once we control for IVF costs, the effect of competition on multiple gestations is ambiguous and depends on the age of the patients. We also found fewer IVF discounts in more competitive markets. Thus, the overall effect of rising competitive pressures on health outcomes is not necessarily negative as previous literature suggests.

On one hand, competition policy is controversial in health care, compared to its use in other markets due to multiple market failures [31]. On the other hand, nothing about the unique features of health care industry suggests that market power is socially beneficial [32]. Despite expressed concerns that under competitive pressures doctors will be hard pressed to compete for patients by allowing more aggressive IVF treatments to boost clinic success rates, empirical results of this study show that this does not always hold true. At least for younger women, competitive pressures lead to fewer multiples by decreasing costs and through quality competition. Also, competitive pressures may be most helpful at improving access and equity when patients are faced with decreasing insurance funding for fertility treatments [33].

Patients searching for IVF clinics are faced with several factors they have to consider: price per cycle, success rate and multiple rate that clinics report. CDC and many IVF clinics make long-term consequences of IVF publicly available and patients are able to make

Table 4. Multiple births estimates with fixed effects

Dependent variable	**Multiple rate, %**		
Age group	**<35 year of age**	**35-40 years of age**	**>40 years of age**
HHI	0.304 (0.175)*	-4.09 (7.72)	-8.84 (4.65)*
Price, thousands	8.57 (4.71)*	8.05 (18.29)	-16.22 (13.70)
IVF refund	-32.37 (11.08)***	9.79 (14.06)	-6.39 (9.35)
Mandate	4.001 (17.69)	-7.15 (18.47)	-13.22 (14.23)
% PGD	-0.344 (0.584)	0.211 (0.645)	-0.877 0.377)**
% ICSI	-0.168 (0.146)	0.148 (0.163)	0.245 (0.117)*
SART membership	-0.691 (10.48)	1.46 (11.45)	12.79 (9.76)
Volume	-0.172 (2.44)	-0.857 (2.89)	0.514 (1.83)
Per capita income	-69.79 (39.86)*	51.91 (42.83)	56.91 (27.98)*
Population, thousands	-1.03 (5.92)	-4.46 (6.22)	-9.64 (4.68)*
% women with at least bachelor's degree	-9.005 (50.95)	-55.62 (53.44)	-83.48 (46.67)*
Female labor force participation	48.58 (135.61)	54.33 (142.47)	215.21 (159.13)
Year = 2014	8.91 (38.04)	14.94 (40.04)	53.09 (30.09)*
N	291	285	184
R^2	0.145	0.076	0.0733
F	2.26***	3.77***	3.76***

Notes: Robust standard errors are in parentheses.* $p<.10$, ** $p<0.05$, *** $p<0.01$; All continuous dependent variables are in the log form

Table 5. Effect of competition

Dependent variable	**Multiple rate, %**		
Age group	**<35 year of age**	**35-40 years of age**	**>40 years of age**
HHI coefficient *without* price, but with clinic characteristics, market and fixed effects controls	0.481 (0.187)***	4.34 (2.48)*	-4.55 (4.86)
HHI coefficient with price, but with clinic characteristics, market and fixed effects controls (from Table 4)	0.304 (0.175)*	-4.09 (7.72)	-8.84 (4.65)*

comparisons of clinics by the multiples rates that they produce. This may be an important quality dimension that clinics use to attract prospective patients.

Limitations of the study

To separate the effect of competitive pressures on prices from its effect on quality, this study used the best available price data for IVF clinics to capture the cost of one fresh non-donor cycle of IVF procedure, without monitoring and pharmaceuticals. Unfortunately, this data was not available for all clinics. We did our best to verify and supplement the data but at this IVF prices with hospital and embryology lab charges are not attainable for many US clinics. Thus, low sample size is a problem. Our estimates of the effect of HHI on quality for the entire sample (without controlling for prices) show that competition leads to better quality for women under 40 and is not significant for older women. However, such estimates do not isolate the effect of prices from the effect of quality competition. As price data is becoming more available to consumers, future research is necessary to look at different ways in which competitive pressures affect prices and overall patient welfare.

This study uses only two years of available data. Although looking at a change in HHI over a longer time period may yield better results, price data is not available before 2012. As we accumulate price data to aid patients searching for health care providers, the effect of increasing over time competitive pressures that IVF clinics face can be estimated.

We use MSA as our definition of infertility market area. Since IVF is not an emergency procedure, many couples are able to search outside of their MSA area. Medical tourism allows an increasing number of Americans to cross international borders to obtain health care at a lower price and comparable quality. One may consider the entire world to be the market. In this study we assume that medical tourism is limited and most infertile couples search within their MSA.

Conclusions

This study found that lower IVF prices translate into better health outcomes as measured by the rates of multiples for women undergoing infertility treatments. Further research is needed to identify the relationship between competition and prices as well as competition and health care outcomes. With rising demand for infertility treatments, policy makers must consider the effect of ART funding on prices as well as the effect such funding has on quality and patients' welfare in ART markets.

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