Money-Back Guarantees and Service Quality: The Marketing of In-Vitro Fertilization Services

Shan Yu
Assistant Professor of Marketing
Lally School of Management | Rensselaer Polytechnic Institute
Pittsburgh Building 2202, 110 8th street, Troy, NY 12180
518.276.6834 | yus6@rpi.edu

Mrinal Ghosh
Eller Professor of Marketing
Eller College of Management | University of Arizona
1130 E. Helen St., McClelland Hall 320, Tucson, Arizona 85721-0108
520.626.7353 | mghosh@email.arizona.edu

and

Madhu Viswanathan
Assistant Professor of Marketing
Eller College of Management | University of Arizona
1130 E. Helen St., McClelland Hall 320, Tucson, Arizona 85721-0108
520.621.2885 | madhu@email.arizona.edu

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Abstract

Marketing practices like Money-Back Guarantees (MBG) are prevalent in many expert service markets but are often decried for taking advantage of poorly informed consumers. In this research, conducted in the market for In-Vitro Fertilization services, we empirically test two contrasting views of MBG practices – the "light" theories, like signaling and insurance which advocate the positive impact of marketing practices and the "dark" theories, like firm sorting and aggressive treatment that postulate the negative impact of such practices. Our analysis is conducted on a large and unique longitudinal dataset that includes clinic-level treatment and outcome statistics for almost all IVF clinics in the U.S., fertility clinic characteristics, and information on state-level insurance mandates and demographic characteristics. Using an instrument variable approach to account for the endogeneity of MBG decisions made by fertility clinics, we find more support for the "light" and positive impact of marketing practice. Our results suggest that MBGs can work as signals of quality despite the incentives for clinics to engage in opportunistic behaviors.

Keywords: Money-Back Guarantees, Signaling, Expert Services, Health Care Marketing, In-Vitro Fertilization

INTRODUCTION

Popular marketing practices like Money Back Guarantees (MBG) are becoming increasingly prevalent in many "expert" service sectors such as healthcare, legal services, consumer financial services, automotive repairs, and even wedding planning. Similar kinds of "penalty for non-performance" arrangements are also observed in a variety of business service sectors including engineering services, management consulting, advertising agency contracts, and turn-key project management. These expert service markets are typically characterized by customized offerings and significant differences between the service provider and the consumer in knowledge and expertise. Despite their growing popularity, there is considerable ambivalence among both academicians and practitioners on the role such MBG or penalty for non-performance practices play in these market sectors.

Consider the practice of MBG in an important health-care sector that is the focus of this study – the market for In-Vitro Fertilization (IVF) services. In this market, infertility clinics offer a variety of treatment services to customers/patients who have difficulty conceiving naturally to deliver a live baby. In-Vitro Fertilization (IVF) is the most prevalent of these treatment services. The service is expensive (costing almost $15,000 per cycle), physically challenging (with drawn-out and invasive treatment cycle including hormonal stimulation, egg retrieval and embryo implantation, ultrasound monitoring, etc. with potentially adverse consequences for the would-be mother's health), and emotionally stressful (average success rate of producing a live baby is around 30% for each cycle) for consumers. Furthermore, the service offering itself is highly customized and the treatment protocol is designed after taking into account the patients' health and diagnosis and other patient characteristics. As a consequence of this customization, and given the expertise and knowledge required of the practicing infertility

experts and physicians, there is significant information asymmetry between the service provider (physician/IVF clinic) and the customer/patient on what is the appropriate course of action for that given customer/patient.

Many IVF clinics (approximately 36% in the U.S.) offer consumers MBG along with the traditional *a la carte* payment scheme. If a consumer opts for a MBG program, they pay up front a lump sum amount that covers a certain number of cycles. They then undergo treatment for those covered cycles until they get a live baby. However, if no live baby is delivered after the said number of cycles, patients get a full or partial refund of the payment. Given the nature of this market, however, these programs have been widely denounced as being "marketing gimmicks" that are unethical, deceptive and harmful to consumer welfare. According to this "dark" side view, clinics offering MBG have the *incentive* to deliver a live baby and avoid paying the penalty for non-performance and hence might deliberately (a) *sort* (and treat) either only high fertility patients and/or inducing unsuspecting fertile couples to unnecessarily undergo IVF treatments (Scott and Silverberg 1998) or (b) undertake overly aggressive treatments like transferring more than necessary number of embryos to the woman patient's uterus thereby raising the risks of multiple births (Murray 1998). This negative view of MBG stands in contrast to the "light" side rationale that market-based practices like MBG could be beneficial and enhance consumer welfare. Accordingly, MBG could serve either as (a) *signals* of clinic quality that help less informed consumers distinguish between high-quality and low-quality firms (e.g., Spence 1977, Moorthy and Srinivasan 1995, Kirmani and Rao 2000), or as b) an *insurance* to consumers because they alleviate their financial burden (e.g., Heal 1976, 1977).

Our goal in this paper is to shed more light on the role of MBG practice in this important healthcare sector by asking whether *MBG could be beneficial to consumers (by enabling them to distinguish between different types of clinics or by acting as risk-sharing mechanisms protecting them against financial uncertainty) or are they just "marketing gimmicks" that are harmful to customers (by enabling the clinics to benefit themselves but at a cost to the consumers)*? In particular, we seek to systematically investigate whether MBG clinics are actually "higher quality" clinics who make better input decisions and secure better outcomes for the patients or are they unethical programs meant to attract unwary patients and secure outcomes either through risky, aggressive over-treatment or through sorting out the more fertile patients. These contrasting viewpoints have different assumptions about clinic and consumer behavior and hence have different implications on the role of MBGs in both clinic and patient behavior and outcomes.

To address our goal, we had to tackle three challenges. First, we needed comprehensive data on clinic characteristics and MBG practice that is not easily accessible and available. We compile a unique, comprehensive, and longitudinal dataset that draws from four different sources. These include: (a) clinic-level treatment and outcome statistics and aggregate patient/clinic characteristics obtained from the *Center for Disease Control and Prevention* (CDC) for the entire sampling frame of IVF clinics in the U.S., (b) archival data on clinic's MBG policies and prices obtained from each clinic's website and Internet Archive collected over a period of 3 years, (c) state-level insurance coverage mandate information obtained from *Resolve: The National Infertility Association*, and (d) demographic data from the U.S. Census Bureau and medical wage index obtained from the *Centers for Medicare & Medicaid Services (CMS)*.

Second, a single individual measure of performance is neither a sufficient nor an accurate measure of clinic quality. For instance, clinics can secure a higher live birth rate by strategically sorting and treating the more fertile patients or undertaking aggressive risky procedures that jeopardize the short- and long-term health of both the would-be mothers and the newborns. Thus using only live birth success rates to infer clinic quality would be misleading as clinics could adopt unethical procedures and guarantee successful live birth outcomes. To address this problem, we take a comprehensive look and also investigate other key aspects of the clinic's role in affecting treatment outcomes, including (a) the clinic-level quality/fertility of the patients that the clinic performs IVF services on, (b) the inputs decisions made by the clinic in terms of the number of embryos transferred, and (c) the potential riskiness of the outcomes in terms of live birth rates for multiples.

Finally, given the significant information asymmetry in this market, it is important to control for both observed and unobserved measures of patient quality/fertility. To this end, we construct a unique measure of observed patient quality/fertility for each clinic using national health records on the difficulty of successfully treating various medical diagnoses to obtain a live baby. In addition, we control for unobserved quality using standard IV estimation techniques. We analyze the data using standard Probit/OLS estimations as well as full information maximum likelihood (FIML) estimations with instrument variables to account for the endogeneity of MBG.

Our results provide robust evidence that in the IVF market, the use of MBG practices support the "light" side rather than "dark" side theories. In particular, we find that compared to non-MBG clinics, clinics offering MBG programs, achieve *higher* success rate (i.e., higher live birth rate), use *less* aggressive treatments (i.e., fewer number of embryos per transfer), and

impose *lower* multiple birth risk (i.e., lower chance of triplets or more births) in spite of *not having more fertile patients*. Our results also suggest that consumers view MBGs as risk-sharing mechanisms. Taken together, these results are consistent with the signaling and insurance role that marketing practices like MBG play in markets with significant information asymmetry. As such they seem to facilitate better decision making on the part of the consumers/patients and enhance social welfare.

Our research makes several contributions to both practice and theory. Substantively, our work sheds light on a controversial marketing practice in an important healthcare market. In contrast to the existing literature (Murray 1998; Scott and Silverberg 1998; Schmittlein and Morrison 2003; Dukes and Tyagi, 2009), our results support the argument that clinics offering MBG provide better results and lower-risk outcomes without either strategically sorting the more fertile patients or taking undue risks. We contend that these clinics tend to be the ones to have developed a repository of skills, expertise, and experience that makes them confident in offering MBG programs. By showing that IVF clinics that offer MBG are not any more opportunistic than clinics that do not offer MBGs, our study provides the first empirical evidence and policy guidance on this controversial practice in the healthcare market.

Theoretically, we enrich the literature on signaling theory by providing empirical support for MBG as signals in an important and unique expert service market. Although empirical studies have shed light on the signaling role of various other marketing tools, evidence on the role of MBG is scarce. Finally, our study contributes to our understanding of substantive marketing practices like MBGs and their role. By doing so, we add to the small but growing body of work that focuses on the role of marketing practices in enhancing social welfare and satisfying consumer needs (e.g., Anderson-Macdonald 2014; Viswanathan et al 2010).

The remainder of this article is organized as follows. We begin with providing a brief description of the IVF market and its relevant features and then review the literature on MBGs to derive the testable implications in the IVF market. We then describe our unique dataset, provide key model-free evidence, and discuss our estimation approach and results. We conclude with implications for theory and practice.

THE MARKET FOR IN-VITRO FERTILIZATION

Infertility and Features of IVF Market and Treatment

Infertility is a significant public health problem (Mascarenhas et al. 2012) with about 12.4% of couples of reproductive age[1] being estimated to be infertile[2] worldwide as of 2010. Infertility treatments, for people who choose to opt for it, include ovulatory drugs (e.g., Clomiphene), surgery, intrauterine insemination and host of techniques broadly classified under the umbrella of assisted reproductive technologies (ART). Among these, the most technologically advanced and popular treatment is *In-Vitro Fertilization* (IVF). In IVF treatments, the egg(s) is (are) fertilized outside the body (therein *in-vitro*) and then the embryo(s) is (are) placed into the woman's uterus. About 1% of the babies born in the United States every year are the result of successful IVF treatments provided by about 450 ART clinics (ASRM 2010). It is expected that by the year 2020, the global market for IVF would be about $22 Billion (Shields and Rohini 2014).

IVF treatments extract considerable physical, emotional, and financial toll on patients. Physically, patients/couples seeking IVF treatment go through a tedious procedure (see Figure 1). Briefly, the IVF treatment procedure can be divided into two phases – a retrieval phase and an implantation phase. In the retrieval phase, the would-be mother takes birth control pills for a

[1] That is, 12.4% of couples aged 15-44 in the world (Mascarenhas et al. 2012).

[2] Infertility is defined as an inability to become pregnant after 12 months of attempts to procreate without contraception (Stephen and Chandra 2000).

few days (as per a clinics' protocol) and is then injected daily with synthetic hormone medications to simulate egg development. After close ultrasound monitoring and based on the ovarian response, eggs are retrieved on an outpatient basis once the follicles are mature. An embryologist then fertilizes the eggs outside the female body with healthy sperm[3] and cultures the fertilized eggs for between 2 to 6 days in the laboratory. Based on the quality of the embryos, patient age, severity of the patient infertility diagnosis, and results of previous infertility treatment, the physician then recommends the number of embryos to transfer. After agreeing with the patients on the number, the embryos are transferred into the patient's uterus.

- Insert Figure 1 about here -

It is pertinent to note a few things here. One, increasing the number of embryos increases the success rate but also increases the chance of multiple births, which can have adverse health consequences for both would-be mothers and babies. For instance, women with multiple gestations are more likely to suffer from hyper-stimulation, hypertension, diabetes, prolonged bed rest, pre-term delivery, caesarean section surgeries, and postpartum hemorrhage. Likewise, babies born under multiple gestations are more likely to be premature, have lower birth weight, higher hospitalization and mortality rate, and potentially adverse long-term developmental issues such as intellectual, learning, emotional and behavioral problems throughout life. Infant mortalities are also higher under multiple gestations. As a consequence, multiple births are associated with long-term financial and social cost for both the families and the society.

Emotionally, an IVF treatment requires patients to have high fortitude because the process may feel like a "roller coaster ride" with expectations reaching their zenith during the treatment but

[3] If there is male-factor infertility, embryologists may use Intracytoplasmic Sperm Injection (ICSI) to increase fertilization rate by selecting a single healthy sperm and injecting it directly into the center of each egg.

reaching the nadir when it fails. Given that the chance of getting a live birth per cycle is only 30% as of 2012, each IVF treatments is really a gamble even in the best-case scenario.

Financially, IVF treatments are very expensive with an average total cost per cycle around $14,500[4] in the U.S. Given a median household income of $53,000, the cost of undergoing an IVF treatment is financially intimidating. Furthermore, insurance coverage for infertility treatments like IVF is extremely limited. Without a federal law, only 8 states in the U.S. have enacted mandate that requires insurance coverage for IVF treatments (see Appendix A); however, even then, there is not only a lifetime cap on the amount but also no coverage for medications which cost around $3,000 per cycle and non-standard procedures. Consumers might find price comparison valuable under this setting; however, it is difficult to compare prices because only a small proportion of IVF clinics list price information on their website (about 35% as of 2012) and these posted prices cover different bundles of procedures and medications. Hawkins (2013) listed three reasons to explain this phenomena: a) doctors have a general aversion for discussing prices with patients, b) it is usually difficult to predict the accurate cost of treatment before the doctors see the patients because each patient needs customized treatment whose costs cannot be determined ex ante (e.g., doctors choose the more costly ICSI procedure to fertilize the embryos only after assessing the quality of the eggs and the sperms), and c) clinics want to steer patients' attention away from the high price that potentially deters them from seeking treatment.

Information Asymmetry in the IVF Market

Apart from limited pricing information, patients also do not have sufficient information about the quality of the clinics. Only 55% of clinics publicly display information their success

[4] Average cost of fresh embryo cycle is $8185, medication $3000~$5000, for additional ICSI $1544, and for PGD $3550. Source: http://www.resolve.org/family-building-options/making-treatment-affordable/the-costs-of-infertility-treatment.html

rates. In addition, the marketing on the website is usually filled with images of babies and words like "dream" and "miracle", suggesting the clinics' tendency to frame their relationship with patients as non-commercial (Hawkins 2013). The Center for Disease Control (CDC) and the Society for Assisted Reproductive Technology (SART)[5] make the success rates for all the clinics available; however, it is difficult to accurately compare clinic quality based on this nominal information. For instance, as suggested earlier, the treatment protocol is customized because of heterogeneity in the patient characteristics and a clinic could boost its success rate by sorting higher quality patients or using more aggressive treatments. As a testament to this noisy signal, SART explicitly prohibits member clinics from using its data to rank or compare clinics and their practices in their advertising. Finally, due to the sensitive and personalized nature of the health problem, consumers, in general, are wary of using traditional word-of-mouth networks because it is very difficult to judge clinic quality based on another consumer's experience or even one's own. Indeed, it is difficult for consumers to assess the accuracy of diagnosis and the appropriateness of treatment even after the treatment, even if it successfully delivers a live baby, because they have inferior knowledge about the procedures and their effectiveness for patients with different diagnosis and fertility levels, compared to the physicians. All these factors make information asymmetry a significant problem in the IVF context.

Money-Back Guarantees in the IVF Market

About 36% of IVF clinics in the U.S. offer money-back guarantees (MBGs) to supplement the traditional *a la carte* payment scheme. If consumers choose a MBG program, they pay a lump sum amount (e.g., $25,000) up front that covers up to say, three cycles. They

[5] SART is an organization dedicated to establishing and enforcing standards for fertility treatments like IVF. SART members agree to follow a set of standards and guidelines. Failure to follow these rules can result in SART membership being revoked.

then go through the stated number of covered cycles until they get a live baby. However, if no live baby is achieved after all the possible attempts, patients get a full or partial refund.

In practice, MBG programs vary across clinics in several aspects. First, such programs are marketed under a variety of names such as "Shared Risk Program", "Refund Guarantee Package", "Three-cycle Plus™", or "Affordable Treatment Plan". Second, some clinics provide MBGs using their own financial resource while others use third party underwriters. Third, the criteria for returning the money back is usually the birth of a live baby (though some clinics offer it just on pregnancy too) and the refund ranges from 70% to 100% of their original payment, *excluding* medications. Fourth, clinics specify various criteria such as age (usually less than 40 years), body mass index, number of previous IVF cycles that failed to result in a pregnancy or live birth, and requirement for using pre-implantation genetic diagnosis (PGD) for offering the MBG option to the patients.

MBG in the IVF market have several unique features compared to MBG for say durable goods. First, unlike durable products, IVF treatments retain no salvage value when the clinic is obligated to pay the patient in case of no live birth. Thus the cost of MBG is very high for IVF clinics especially considering the low success rate (30% on average) and high treatment cost (e.g., $8,000[6]). Second, the outcome of IVF treatment is not only influenced by clinic quality (e.g., doctor expertise, experience or IVF process management), but also by patient quality (e.g., age, diagnosis), treatment aggressiveness (e.g., medicine dosage, number of embryos to transfer) and luck. Third, in this market, patients are heterogeneous in their innate fertility while doctors

[6] In 1988, a clinic's average cost per IVF cycle was estimated to be $5,000 (Wagner and St. Chlair 1989). With a 2% annual nominal cost increase, the average cost per IVF cycle may increase to $8,000 in 2012.

have superior knowledge regarding patients' diagnosis and determine what treatment is appropriate for the patients.

The IVF market is an appropriate context for identifying the signaling role of MBGs. First, both price and advertising are not appropriate signaling tools in this context. As noted earlier, the actual realized price is based on the treatment protocol used for a particular patient; hence, clinics are reluctant to post treatment prices. Likewise, industry level regulations prevent clinics from using outcome-level data to compare across clinics. Second, consumer-side moral hazard is unlikely to exist in this context. In other words, consumers (patients) who go through the IVF treatment do so because they sincerely want a live baby and are unlikely to misuse the service or abuse the contract terms. Patients always try their best to cooperate with the doctors to get a live baby rather than try to scheme to get their money back. Finally, it is important to note that even under a fully-refunded MBG, the patient still bears the cost of medications as well as faces emotional and physical costs throughout the process.

In essence, the market for IVF services captures many of the characteristics of non-traditional expert service markets such as low salvage value, uncertain outcomes, customized service, and providers' superior knowledge. Moreover, practices in this industry have important public health consequences. Finally, other confounding factors like consumer-side moral hazard as well as price and advertising as signals are not present in this context due to the nature of regulations and industry practices.

LITERATURE REVIEW

Our study relates to multiple streams of literatures in marketing, economics, public policy, and health care. We briefly review the literature here and then draw the testable implications of these literatures in our IVF context.

"Light" theories of MBG

The Signaling Role of MBG: There is an extensive literature in marketing and economics on signaling theory (see Kirmani and Rao 2000 for a comprehensive review). The theory deals with addressing issues that occur due to hidden information in markets characterized by asymmetric information (Akerlof 1970) and how certain costly firm actions can act as signals to alleviate these issues. Examples of such signals include uninformative advertising (Archibald, Haulman and Moody 1983; Horstmann and MacDonald 2003; Milgrom and Roberts 1986), umbrella branding (Erdem 1998; Wernerfelt 1988), brand alliance (Chu and Chu 1994; Rao, Qu and Ruekert 1999), slotting allowances (Desai 2000), charitable donation (Elfenbein, Fisman and McManus 2012), accreditation (Xiao 2010), warranties (Spence 1977; Soberman 2003) and MBGs (Moorthy and Srinivasan 1995; Shieh 1996). Moorthy and Srinivasan (1995) show that when consumers are homogeneous, an MBG is an important signal because price alone is not sufficient to signal quality. However, when consumers are heterogeneous, an MBG can be a useful supplement to price as a quality signal and may be a superior signal than uninformative advertising. Furthermore, Shieh (1996) shows that MBG and price together efficiently signal product quality of a monopoly seller, while the provision of MBG allows the seller to signal with its full-information price. However, empirical work on the signaling role of MBG is non-existent. In a closely related literature on warranties, empirical studies have found no general correlation between quality and warranties (e.g., Gerner and Bryant 1981; Chu and Chintagunta 2011) although theoretical model predicts that high quality should be associated with a longer warranty (e.g., Spence 1977). To explain this controversy, researchers argue that warranties will no longer be associated with high quality when the monopolist charges higher price (Grossman

1981), when buyer moral hazard affects product performance (Lutz 1989), and when a new entrant competes with an established product (Balachander 2001).

The Insurance Role of MBG: Under MBG, firms are obliged to return the promised amount in the event of failure. Hence, by its very nature, MBG act as a risk-sharing device between the firm and the consumer (Heal 1976, 1977; Chu and Chintagunta 2011) and provide insurance to risk-averse consumers. A direct implication of the insurance role on provision of MBG is that riskier patients (i.e. those with lower fertility) will prefer MBG clinics over non-MBG clinics.

It is important to note that empirically, both signaling and the insurance role of MBG can co-exist and one could distinguish between the two by examining the impact on firm and consumer behavior. While the insurance theory implies that MBG will affect the distribution of patients choosing MBG and subsequently the firm outcome, the signaling role implies that MBG will be related to firm outcomes independent of the patient profile. In other words, the insurance role predicts that MBG clinics will get lower quality patients while the signaling role predicts that holding patient quality constant, MBG clinics will be the better quality clinics in terms of their outcomes and decisions.

"Dark" theories of MBG

The Sorting Effect of MBG: While there are no studies examining the sorting role of MBG, there are numerous studies examining the role of sorting in warranties (Kubo 1986; Matthews and Moore 1987; Padmanabhan and Rao 1993). The implications can be easily extended to MBGs. The key focus of the sorting theories in warranties is on designing different contracts to screen consumers based on "type" by allowing consumer self-selection. In our context, clinics could offer MBG contracts only to customers who pass the pre-screening test

based on certain characteristics (i.e., age, medical history, etc.). Such pre-screening could reveal the quality of the patient so that clinics offer or design MBG only to the more fertile patients. It is precisely this concern that Scott and Silverberg (1998) and Schmittlein and Morrison (2003) raise when they suggest that MBG clinics have the incentive to prescreen and select only higher fertility patients. Similar to the insurance role of MBG, the underlying assumption is that patients are heterogeneous and differ in their level of fertility or other dimensions that are private and not observable to the firm. A key implication of the sorting role of MBG is that MBG clinics are more likely to choose more fertile patients than non-MBG clinics.

Note that similar to the insurance role of MBG, the sorting role of MBG can coexist with the signaling role. The sorting behavior by clinics can also be distinguished in a similar manner, i.e., the sorting role affects the distribution of consumer types and subsequently firm outcomes while the signaling role predicts firm outcomes is independent of consumer types.

The Incentive Effect of MBG: A related concern about MBG practices, especially in expert service markets like IVF services, is that firms offering MBG might undertake undesirable behavior ex post (i.e. after they offer MBG) so as to avoid paying back customers in case of non-performance. This concern is moot in product markets where the same product is sold to different customers. In contrast, this concern is material in expert-service markets where customers are heterogeneous and the service is customized because clinics can strategically choose the treatment protocol. For instance, to avoid paying back patients, clinics offering MBG might be overly aggressive, use higher dosage of hormone medicine, and implant more embryos than necessary. This increases the likelihood of a live birth; however, it also increases the likelihood of multiple births that are likely to have adverse short- and long-term consequences for the babies, the would-be mothers, and the family (Murray 1998). A key implication of this

incentive role is that MBG clinics are likely to transfer more number of embryos on average than non-MBG clinics.

IVF and MBG

In the context of the IVF market, Schmittlein and Morrison (2003) have focused on studying the profitability of clinics offering MBG. Using a model of clinic behavior and based on (a) assumed price and cost[7] and (b) observed success rates for IVF treatments, they conclude that clinics cannot be profitable if they offer MBG. Based on this analysis, they suggest that MBG programs can only be profitable for IVF clinics if they are successful in luring more fertile patients – those who don't necessarily need IVF treatment – to undergo IVF. This elevates the success rates and prevents clinics from paying the patients back. Dukes and Tyagi (2009) offer an alternative explanation for Schmittlein and Morrison's (2003) finding. Specifically, they analytically show that MBG and *a la carte* pricing can be used to segment customers such that clinics offering MBG could raise the prices of *a la carte* menu and hence become profitable. Thus clinics offering MBGs can be profitable without having to resort to misleading tactics.

Another study, which while not directly related to MBG but nevertheless important in understanding the role of such practices in the IVF market is by Hamilton and McManus (2012) who study the effects of state-level insurance mandates on patient access to IVF and treatment outcome. They find that insurance mandates lead to increase in IVF usage, decrease in live birth rate, and decrease in treatment aggressiveness and multiple birth risks. They use these results to suggest that insurance mandates, by reducing financial pressure, lead to market expansion and are welfare enhancing because they draw less fertile patients into the market.

[7] They assume the price for 3-cycle MBG program is $15,000 and for single-cycle IVF is $7,500; the cost per cycle is $6,000; average success rate is 0.22 based on 1996's data.

Literature Summary

The preceding discussion highlights several streams of literature that are relevant to the use of MBG in the IVF market. Two key elements merit emphasis. First, there is limited empirical work on role of MBG, especially in non-traditional contexts. Given how marketing practices are omnipresent, it is important to establish the role of marketing in diverse contexts. Second, past studies examining the role of MBG in the IVF context do not distinguish between the various mechanisms (sorting, incentives, insurance and signaling) surrounding MBGs nor do they disentangle the relationship between patient and firm behavior. This is relevant to determine the nature of MBG in this market. Our study addresses these issues.

Testable Implications

Based on the literature review, our study tests the following hypothesis to distinguish between the "dark" and "light" theories of MBG. One of the key challenges in the IVF (and other healthcare service) markets is that the overall distribution of patient quality for a clinic and consequently the clinic's overall treatment protocol and treatment outcomes are affected by both patient and firm behavior. A natural question then is to examine whether MBG clinics differ from non-MBG clinics on the type of patients they attract. Using a simple model (see Appendix C) similar to Schmittlein and Morisson (2003) and Hamilton and McManus (2012) we arrive at the following testable hypotheses

> *Proposition 1 (Patient Sorting)*: All else equal, if patients could select clinics based on clinics' MBG provision, MBG clinics would have patients with lower fertility as compared to non-MBG clinics.

From the clinic point of view, both MBG and non-MBG clinics have an incentive to sort and get higher fertility patients albeit for different motivations. Both MBG and non-MBG clinics would like to enhance their success rate information disclosed to SART and CDC by sorting high

fertility patients. However, MBG clinics have an additional incentive to sort high quality patients, especially if they are using MBG primarily to lure patients. Similarly, non-MBG clinics would also have an additional incentive to sort patients if they are of lower quality than MBG clinics and want to boost their treatment outcome figures disclosed to the public. What this implies empirically is that one can only distinguish between relative sorting behavior, i.e., are MBG clinics sorting more or less compared to non-MBG clinics.

Proposition 2 (Clinic Sorting): All else equal, if MBG (non-MBG) clinics are more likely to sort patients than non-MBG (MBG) clinics, MBG (non-MBG) clinics would have patients with higher fertility as compared to non-MBG (MBG) clinics.

With respect to the clinic treatment and outcomes, after controlling for patient fertility, we test the following proposition:

Proposition 3 (Signaling): After controlling for patient fertility, compared to non-MBG clinics, MBG clinics would use less aggressive treatment procedures, have higher treatment success rates, and impose lower long-term risks.

Proposition 4 (Incentive): After controlling for patient fertility, compared to non-MBG clinics, MBG clinics would use more aggressive treatment and impose higher long-term risks.

DATA

We compiled a unique dataset from four different sources for the years 2010 to 2012. Tables 1 and 2 provide the summary statistics. In the following sub-sections, we discuss the features of each subset of data and key variables.

- Insert Table 1 and Table 2 about here -

Clinic Treatment Statistics

We obtained data containing clinic-level treatment and outcome statistics from the *Centers for Disease Control and Prevention* (CDC). The dataset includes information on treatment input (e.g., number of embryos per transfer), treatment outputs (e.g., percentage of cycles resulting in live births and multiple births; etc.) for five different age groups, clinic characteristics (e.g., number of cycles; service availability for single women and gestational carrier; usage rate for ICSI and PGD; SART membership; accredited laboratories; etc.), and patient characteristics for a given clinic (e.g., proportion of patients with specific diagnosis).

The reporting of treatment statistics by different age groups allows us to compare the key variables within an individual age group. This is important because female fertility decreases rapidly after the age of 35 (CDC 2012). In addition, our analysis focuses on fresh, non-donor egg treatments, which account for about 63% of all IVF cycles intending for embryos transfer (vs. cryopreservation)[8]. Table 2 shows that on average, clinics conduct 249 separate IVF cycles annually, transfer 2.25 embryos per cycle, achieve a live birth rate per cycle of 30.39%, and have a multiple birth (triplet or more) rate per cycle of 2.46%.

MBG, Price, and Number of Doctors and Embryologists

We supplemented the main dataset with additional information on MBG practices, price, and number of doctors and embryologists obtained from each clinic's website and Internet Archive (archival.org). About 75% of the clinics in the U.S. have their own websites, leaving us a dataset with 984 clinic-year data combinations. We collected data on whether a clinic provides MBG, the criteria for offering MBG (live birth vs. pregnancy), percentage of MBG refund (70%

[8] In year 2012, 456 IVF clinics reported operation of 157,662 cycles intending for embryo transfer, including 99,665 fresh non-donor cycles, 38,150 frozen non-donor cycles, 10,954 fresh donor cycles, and 8,893 frozen donor cycles.

or 100%), the number of doctors (i.e., endocrinologists and urologists) and embryologists (i.e., lab director and entry-level embryologists) employed at each clinic, the regular IVF price and the MBG price. The reported price information varies considerably depending on the procedures that are covered. For instance, some of the clinics report a price that covered some non-standard procedures like prescreening, monitoring, medications, ICSI, PGD, assisted hatching (AH), anesthesia, and embryo cryopreservation while others don't. To facilitate comparison across clinics, we standardized the price by deducting the average cost of these procedures whenever they were included as part of the price. On average, about 36% of clinics offer MBGs, 35% provide price information on their websites, and clinics have 2.9 doctors and 1.4 embryologists.

Competition, Demographics and Medical Wage Index

To measure competition, we used the U.S. metropolitan statistical areas (MSAs) as geographic boundaries for local markets for IVF services. Our choice of MSAs as geographic boundaries is motivated by two reasons. First, IVF treatments require frequent clinic visits and extra physical care that discourages most couples from traveling farther than their metropolitan area to seek treatment. Second, only four clinics (with 12 clinic-year combinations) operate outside an MSA (we use micropolitan area in those cases). We have 150 MSAs (approximately 40% of all U.S. MSAs) that have at least one IVF clinic in 2012. In general, local markets for IVF treatments vary substantially in terms of number of clinics serving the market (M = 9; SD = 10.36). In 2012, about 15% of MSAs having IVF clinics are served by a single clinic while 50% of markets have six or more clinics. The Los Angeles area, for example, has 35 IVF clinics operating within it. We also secured data on demographic characteristics like MSA population and state income from the *U.S. Census Bureau*. We also collected data on the medical wage

index (by metropolitan and micropolitan areas) from the *Centers for Medicare & Medicaid Services* (CMS)[9] to construct an instrumental variable that captures the clinic's financial scale.

Insurance Mandate

We obtained state-level insurance mandate information from *Resolve: The National Infertility Association* and follow the categorization used by Hamilton and McManus (2012), Schmidt (2007), and Jain et al (2002). Infertility insurance mandates vary widely in their comprehensiveness (e.g., cover vs. not cover IVF treatment, cover vs. offer coverage for fertility treatment), reimbursement lifetime cap, and eligibility requirements. Only eight states have enacted insurance mandates requiring insurers to cover IVF treatments and three of them have strict restrictions (e.g., patients cannot use donor sperm; HMOs are exempted, etc.). In addition, seven states have mandates requiring coverage for some infertility treatments but have no bearing on the coverage for IVF. The remaining 35 states and the District of Columbia do not have any infertility mandate. For brevity, we construct a dummy variable InsMandate_{it} to distinguish the eight states that offer coverage for IVF from the other 42 states. On average, about 17% of clinic-year observations operate in states under InsMandate_{it} (see Appendix A).

Key Variables

Appendix B provides a summary of our measures. We focus attention on the key variables below. Hereafter, we use subscript *it* for variables on clinic level and *ijt* for variables on a disaggregated age level, where *i* is for clinic, *j* for age group, and *t* for year.

Treatment Aggressiveness ($EmbryoNum_{ijt/it,}$). We used the average number of embryos per transfer for separate age groups to measure treatment aggressiveness $EmbryoNum_{ijt}$. To

[9] Based on hospital wage costs, CMS annually renews the hospital wage index by dividing the average hourly wage of each core based statistical area (CBSA) by the national average hourly wage. CBSA refers collectively to both metropolitan and micropolitan areas.

conduct clinic level analysis, we calculated clinic-level measure $EmbryoNum_{it}$ by dividing total number of embryos transferred by total number of cycles for all age groups in a clinic.

Treatment Outcomes ($LvBirRate_{ijt/it}$, $MultBirRate_{ijt/it}$, $CycleNum_{ijt/it}$). We used average live births per 100 cycles to measure the short-term success rate. Then we used average rate of obtaining triplets or more births per 100 cycles to measure multiple birth risk or long-term outcomes. We did not include twins in calculating multiple birth risk because having twins is often considered socially desirable.

MBG (MBG_{it}). A dummy variable indicates whether a clinic provides MBG program.

Patient Fertility ($PatFert_{it}$). Infertility diagnoses are consistently associated with a prognosis for a successful pregnancy after IVF. Some diagnoses are more difficult to treat than others. For example, diminished ovarian reserve is associated with the lowest live birth rate of 17.1% while ovulatory dysfunction has the highest live birth rate of 37.5%. We constructed a patient fertility variable for each clinic by weighing each diagnosis' national live birth rate, that we obtained from the CDC, with the proportion of patients having that diagnosis in that clinic. Higher value in $\mathrm{PatFert}_{\mathrm{it}}$ indicates higher patient fertility. Since a patient might have multiple primary diagnoses, the sum of over 10 diagnoses ($\mathrm{PatFert}_{\mathrm{it}}$) could be higher than 1 for a clinic. It is worth noting that patient (women) age is also highly related to patient fertility (CDC 2012). However, as the CDC organizes and provides data by different age groups, our comparison on treatment input and outputs between MBG and non-MBG clinics on both clinic level and individual age group level can alleviate this concern.

Clinic Characteristics (X_{it} and X_{ijt}*).* We used the total number of doctors employed by the clinic as a measure for clinic scale. Clinic capability was indexed by (a) whether the clinic had an embryologist on its staff and (b) the average live birth rate across all age groups for all the years

of the clinic's existence. In addition, we measured clinic experience with the total number of cycles completed over all previous years as well as the total number of years the clinic has operated in the market. To measure the clinic service scope, we constructed dummy variables that captures whether the clinic offered surrogate service. We also constructed a SART membership dummy to measure whether the clinic has industry accreditation. To make regular price and MBG price comparable, we constructed the price variable as the minimum of the regular single-cycle price and MBG price divided by number of covered cycles. This is because the price for MBG program is a lump sum amount covering multiple cycles. Since a majority of the clinics (65%) do not provide price information on their websites, we also constructed a No Price dummy variable, which equals to one when there is no price information and equals to zero when there is price information. Finally, to account for variation across age groups, we changed the clinic level previous live birth rate to age-group level previous live birth rate in X_{ijt}.

Environmental and Demographic Characteristics and Year Dummy (E_{it}). We captured environmental characteristics such as the type of insurance mandate prevailing in that particular MSA, number of competitors in the MSA, and the number of MBG competitors in the MSA. In addition, we captured demographic characteristics such as average state income and MSA population. We controlled for time variation with year fixed effects.

MODEL FRAMEWORK

Our research question aims to identify whether clinics that offer MBGs are beneficial to consumers (the signaling, insurance argument) or are utilizing MBGs to lure and sort out higher fertility patients and/or offer them unnecessary and risky service. This is difficult to test in service sectors because objective, unambiguous, and complete measures of service quality are difficult to obtain. In traditional markets, an acceptable compromise is to use consumer perceived quality, such as product reliability in Consumer Reports (e.g., Chu and Chintagunta

2011), as a measure of quality. In the market for IVF as well as other expert service markets, service outcomes such as success rate or mortality rate seem to be appealing measures for service quality. However, the credence goods nature of such services makes it difficult for consumers to accurately judge the service (treatment) appropriateness even if the service outcome is observed (Emons 1997, Dulleck and Kerschbamer 2006). For instance, if a patient does not secure a good outcome after a medical treatment, it is unclear whether the outcome is a result of not being properly treated (i.e. a poor quality physician), the patient condition being more adverse to treatment, or simply because of the uncertain nature of the diagnosis and the illness.

Hence, to distinguish between the "dark" and "light" viewpoints in our context, one will have to examine how MBG offering is related to patient fertility, as well as treatment input decisions and treatment outcomes. Our approach essentially involves identifying a set of results across key variables that shed light on whether MBG act as signals of quality, serve as risk-sharing mechanisms or are just marketing gimmicks to lure patients.

Model-Free Evidence

We start by providing model-free analyses (2-sample t-tests) to investigate whether there are differences between MBG and non-MBG clinics.

Figure 2 as well as the last columns in Tables 1 and 2 show the results for these model-free analyses. In general, the results indicate that compared to non-MBG clinics, MBG clinics are more likely to a) provide peripheral service, have SART membership, and obtain lab accreditation, b) have longer industry experience and more numbers of doctors and embryologists, c) accept slightly lower fertility patients (independent of age), d) operate more number of cycles, e) use less aggressive treatment, f) secure higher success rate, and g) impose lower multiple birth risks. All of these measures are observable, albeit incomplete, measures of clinic characteristics, patient fertility, and treatment input and outputs. Overall the model-free

analyses seem to support the "light" theories that MBG clinics are of higher quality than non-MBG clinics and attract patients from the lower end of the fertility distribution. However as mentioned earlier, to distinguish between the different theories, we will have to control for patient fertility. We do so in the subsequent analysis.

- Insert Figure 2 about here -

Model Specification

We now empirically and formally examine the relationships between MBG offering and patient fertility, treatment inputs (number of embryos) and treatment outputs (short-term live birth rate and long-term multiple birth rates) by controlling for a variety of factors.

Patient Fertility and Treatment Inputs. To examine whether MBG clinics and non-MBG clinics differ in patient fertility and treatment aggressiveness, we first estimate equations 7 and 8 using an ordinary least squares (OLS) and Poisson regression approach respectively:

$$\text{PatFert}_{it} = \beta_0 + X_{it}\beta_1 + E_{it}\beta_3 + \beta_4 \text{MBG}_{it} + \varepsilon_{it} \quad (7)$$

$$\text{where PatFert}_{it} = \sum_{d=1}^{10} \text{SuccessRate}_{td} \,\%\text{Diag}_{itd}$$

$$\text{EmbryoNum}_{it} = \gamma_0 + X_{it}\gamma_1 + E_{it}\gamma_3 + \gamma_4 \text{MBG}_{it} + \gamma_5 \text{PatFert}_{it} + \eta_{it} \quad (8)$$

Subscripts i and t index the clinic and year, respectively. In equation 7, PatFert_{it} indexes clinic i's average patient fertility in year t. MBG_{it} is a dummy variable indicating whether clinic I offers MBG or not. The sign of coefficient β_4 captures whether MBG clinics have higher or lower fertility (quality) patients. This is the coefficient of interest and the sign could vary depending on combined effect of patient sorting and clinic sorting. Vector X_{it} is a vector of variables containing observed clinic characteristics such as natural log of number of doctors, the embryologist dummy, average previous live birth rate, natural log of total number of previous cycles, the surrogate service dummy, and the SART member dummy. Vector E_{it} contains 1)

environmental characteristics such as the natural log of number of competitors in its MSA and the infertility insurance dummy, 2) demographic characteristics including the natural log of a clinic's average state income and natural log of a clinic's MSA population, and 3) a dummy variable for each year in the data. The error term ε_{it} accounts for unobserved clinic characteristics. The standard errors were clustered by clinic id in all estimations.

In equation 8, EmbryoNum_{it} is the average number of embryos per transfer for clinic i in year t. We use a Poisson regression approach as the underlying data generating process follows that of a count variable. Most importantly, we include variable PatFert_{it} in the regression to capture the impact of patient fertility on the number of embryos transferred. Keeping patient fertility constant, if MBG clinics tend to transfer fewer numbers of embryos, one could infer that MBG clinics might be of higher quality because they use less aggressive treatment and consequently have lower higher long-term risks from multiple births. Even when MBG clinics transfer similar numbers of embryos, one could still infer that MBG clinics are of higher clinic quality as long as they achieve higher success rate.

Treatment Output. We next specify the Poisson regression estimations for treatment outcome variables including the live birth rate and multiple birth rate:

$$\text{LvBirRate}_{it} = \delta_0 + \text{X}'_{it}\delta_1 + \text{E}_{it}\delta_3 + \delta_4\text{MBG}_{it} + \delta_5\text{PatFert}_{it} + \delta_6\text{EmbryoNum}_{it} + \xi_{it} \quad (9)$$

$$\text{MultBirRate}_{it} = \mu_0 + \text{X}'_{it}\mu_1 + \text{E}_{it}\mu_3 + \mu_4\text{MBG}_{it} + \mu_5\text{PatFert}_{it} + \mu_6\text{EmbryoNum}_{it} + \varphi_{it} \quad (10)$$

In equations 9 and 10, LvBirRate_{it} is the clinic-level live birth rate, or the number of live births per 100 cycles, a measure of short-term treatment success. MultBirRate_{it} is the clinic-level rate of multiple births, or the number of triplet or more births for every 100 pregnancies, a

measure of long-term risks for the patients. Vector X'_{it} contains all variables in X'_{it} except for average previous live birth rate. Keeping patient fertility ($PatFert_{it}$) and treatment aggressiveness ($EmbryoNum_{it}$) fixed, if MBG clinics are of higher quality, we should expect δ_4 to be positive and μ_4 to be negative (or insignificant because multiple-birth risk can be fully explained by aggressive treatment).

Endogeneity, Instrument Variable (IV), and IV Estimation

There are two potential sources of endogeneity when estimating equations 7 ~ 9. Consider equation 9 rewritten as:

$$\mathrm{LvBirRate_{it}} = \delta_0 + \delta_x \mathrm{X_{it}} + \delta_4 \mathrm{MBG_{it}} + \vartheta_{it} + \mu_{it} + \overline{\xi_{it}}$$

Vector $\mathrm{X_{it}}$ is a vector of all our control variables. We are interested in assessing the relationship between $\mathrm{MBG_{it}}$ and $\mathrm{LvBirRate_{it}}$ (δ_4). However, the estimation of δ_4 may be biased for two reasons. First, the MBG decision may be correlated with unobserved patient quality (ϑ_{it}), which affects $\mathrm{LvBirRate_{it}}$ and other dependent variables. Second, the choice of MBG decision may be correlated with unobserved clinic quality (μ_{it}), which also affects $\mathrm{LvBirRate_{it}}$ and other treatment input and outcome variables. Nonetheless, the second impact is what we are looking for because signaling theory indicates that MBG works as a proxy for unobserved quality information. Only if MBG clinics have higher unobserved clinic quality can we expect them to use less aggressive treatment or get higher success rate after controlling for observed patient quality indicators. Our focus therefore is to handle the endogeneity issue caused by unobserved patient quality. We take care of MBG choice by building a full information maximum likelihood (FIML) model (e.g., Xiao 2009) that accounts for both the choice of the MBG decision and instruments for patient fertility. For robustness check, we also analyzed our data under a two-stage least squares IV regression and a limited-information maximum likelihood model (LIML).

We now explain our process of choosing the instrumental variables. It turns out that unobserved patient level factors such as patient quality (fertility) could be correlated to both the MBG decision and the treatment input and outcome variables. For example, even though we have created a patient fertility indicator based on diagnoses, it is possible that doctors use other patient fertility indicators that are unobservable to an econometrician to sort patients. Patient medical history, hormone levels, previous pregnancy information, and previous fertility treatments are all good examples of such factors. The direction of bias that these unobserved patient fertility indicators introduce in γ_4, δ_4, and μ_4 depends on the type of clinics that are getting higher fertility patients. For instance, MBG clinics may be more likely to screen for higher quality (i.e. more fertile) patients to avoid paying the money back. Likewise, higher quality patients may be attracted to MBG clinics to insure against the risk of failure. In such instances, parameters γ_4, δ_4, and μ_4 will be overestimated (in absolute values) as they absorb the impact of unobserved patient quality on treatment input and outcomes. In contrast, MBG clinics could also be getting lower quality (i.e. less fertile) patients if these patients have a greater preference for MBG clinics or if non-MBG clinics are of lower quality and thus more likely to screen for higher quality patients (see detailed discussions in Appendix C). In that case, parameters γ_4, δ_4, and μ_4 will be underestimated (in absolute values).

To control for this potential endogeneity issue, it is impossible to find instruments that are both demand and supply side shifters, nor is it possible to use a random exogenous shifter (conduct field experiments of any kind) in our context. Therefore, we use an instrument variable approach focusing on supply side shifters that affect the clinics' tendency to offer MBG, but not affect treatment aggressiveness (i.e., EmbryoNum_{it}) and treatment outcomes (i.e., LvBirRate_{it} and MultBirRate_{it}) except through its impact on MBGs. In addition, the instruments we use

should be uncorrelated to patient fertility either through patient or clinic sorting. Using these principles, we identified four such instruments.

Following Berry (1994) and Berry, Levinsohn and Pakes (1995), we use characteristics of other clinics in the market as the first and second instruments. Specifically, we calculate the first instrument $AvgSurrogate_{it}$ as the mean of surrogate service of all the competitive clinics in the focal clinic's local market (i.e., MSA). We then use the total number of MBG clinics in the focal clinics' local market, $MBGCompetitor_{it}$, as the second instrument. The rationale for these two IVs is that whereas the characteristics of other clinics in the market, such as whether they offer surrogate service or MBG, are likely to affect the focal clinic's MBG decision, these characteristics will not affect the focal clinic's treatment quality or patient fertility.

We also constructed a third instrument, a cost shifter, $MedCost_{it}$, as the product of the number of embryologists in clinic i and the prevailing medical wage index in that MSA (or micropolitan area). The medical wage index represents the general expense in healthcare in a local market (i.e., CBSA) and thus potentially affects the MBG incentive of IVF clinics in this market. However, this measure is constructed at the MSA level. To introduce clinic-level variation we multiply this medical wage index by the number of embryologists in the focal clinic. Essentially, the measure captures clinic i's cost of maintaining its embryology laboratory and reflects the clinic's financial capability, both of which directly impact its decision to provide MBG. Further, the cost of maintaining the embryology laboratory does not necessarily affect treatment quality for two reasons. First, the number of embryologists in a clinic measures the clinic scale, and does not necessarily imply better service quality. A clinic might need more embryologists simply because it is in a good location that generates high demand. Second, the embryologists' proficiency in handling embryos and microscopic instruments and consequently

treatment quality is determined by the training, hands-on experience and years of practice that the embryologists have. In essence, there is no spillover effect or economies of scope from having more embryologists. Our final instrument, PD_{it} is a dummy variable that captures whether clinics posted their price online or not. We believe this captures firms' technical ability and resources and is correlated to a firms' choice of MBG but is uncorrelated to the outcomes.

Using $AvgSurrogate_{it}$, $MBGCompetitor_{it}$, $MedCost_{it}$, and PD_{it} as exogenous instruments for endogenous variable MBG_{it}, we re-estimated equations 8, 9, and 10 by allowing error terms of dependent variables and that of MBG_{it} to be correlated with bivariate normal distribution i.e. $(\eta_{ijt}, \xi_{ijt}, \varphi_{ijt}), \epsilon_{it} \sim N\left\{\binom{0}{0}, \begin{pmatrix} 1 & \rho\sigma_u \\ \rho\sigma_u & \sigma_u^2 \end{pmatrix}\right\}$, where ϵ_{it} is the error term associated with the choice of MBG_{it}. We conduct FIML estimation using TREATREG in STATA. In addition, we also do robustness checks using other IV instrumentation methods like 2SLS and LIML.

RESULTS

Estimation Results

For brevity, we present the results for clinics across all age groups. The web appendix contains analysis by separate age groups. The results are broadly consistent. The OLS estimation for $PatFert_{it}$ (see Column 1 in Table 3) shows an insignificant coefficient for MBG_{it} (-.004) suggesting that MBG clinics and non-MBG clinics are treating patients with similar fertility. While the coefficient is negative (suggesting that MBG clinics get lower quality patients), it is likely that controlling for clinic quality reduces the variance around the MBG variable leading to the insignificant result.

Table 3 also reports the Poisson estimates for $EmbryoNum_{it}$, $LvBirRate_{it}$, and $MultBirRate_{it}$ within a clinic across all age groups. Column 2 shows the results from regressing $EmbryoNum_{it}$ against MBG and other control variables. We find that MBG clinics use less

aggressive treatment (-.032, $p < .05$) after controlling for observed patient fertility. This seems to suggest that compared to non-MBG clinics, MBG clinics are more efficient in their treatment and in minimizing the risks to both the mother and the babies. We also find that clinics that are SART Members (-.050, $p < .05$) are more likely to implant fewer numbers of embryos per transfer. Column 3 displays the results from a Poisson regression with LvBirRate_{it} as the dependent variable. The coefficient for MBG_{it} is positive and significant (0.082, $p < .05$) suggesting that MBG clinics are better at getting higher live births compared to non-MBG clinics. Note that we have controlled for the number of embryos transferred in this equation. Finally, column 4 shows the results from a Poisson regression with MultBirRate_{it} as the dependent variable. The coefficient for MBG_{it} is negative but insignificant (-.042, $p > .10$) suggesting that procedures adopted by MBG clinics do not cause multiple birth risks any higher than non-MBG clinics. Also note that that increasing the number of embryos implanted per cycle leads to increase in multiple birth rates (0.896, $p < .01$) providing some face validity to our analysis. However, the current results do not account for unobserved patient fertility. We turn to those results next.

- Insert Table 3 about here -

IV Estimation Results

Before we proceed, we provide validity check on our instruments. We first note that all our instruments significantly correlate with the endogenous variable MBG_{it} (for $\text{MBGCompetitor}_{it}$ ρ = -.118, $p = .000$, for AvgSurrogate_{it} ρ = -.110, $p = .000$, MedCost_{it} ρ = -.164, $p = .000$, PD_{it}, ρ = -.451, $p = .000$). The joint *LR* test for the **four** instruments from the first step yields $\chi^2(3) = 192.51$, indicating that these four instruments together are not weak.

Tests for exogeneity of instruments, over-identification and the Stock and Yugo (2005) tests for weak instruments using the 2SLS regression also show that our instruments are not weak. [10]

Table 4 reports the results from the FIML estimation for $EmbryoNum_{it}$, $LvBirRate_{it}$, $MultBirRate_{it}$ using all four instruments (Probit estimation for clinic's choice of MBG is reported in Appendix WA.10). In the last row, LR tests for independent equations for all estimations reject the null hypothesis that error terms are independent ($\rho = 0$), confirming our concerns regarding endogeneity. The estimates of all other parameters are similar to those obtained in the earlier analysis. Specifically, the significantly negative estimation for γ_4 (see Column 1) suggests that, all else equal, MBG clinics on average transfer 0.457 fewer embryos than non-MBG clinics. Next, the significantly positive estimation for δ_4 (see Column 2) indicates that MBG clinics achieve about 3.88% higher success rate than non-MBG clinics. Finally, the significantly negative estimation for μ_4 (see Column 3) shows that MBG clinics are imposing 0.9% lower multiple birth rate than non-MBG clinics.

The increase in magnitude of the parameters for MBG_{it} could be because overall, MBG clinics are getting comparatively lower fertility patients than non-MBG clinics. This is consistent with our prediction that MBG clinics would attract patients from the lower end of the fertility distribution (for insurance). The OLS parameters for MBG_{it} absorb the effect of lower patient fertility (negative effect on $EmbryoNum_{it}$ and positive effects on $LvBirRate_{it}$ and $MultBirRate_{it}$) and are therefore underestimated if we disregard the endogeneity of clinics' MBG choice.

- Insert Table 4 about here -

[10] We conducted the Hausman tests for over-identification with two, three and four instrument specifications. The tests are not able to reject the null hypothesis under all specifications suggesting that the instruments are indeed exogenous.

Collectively, we find that clinics offering MBG programs do not differ from clinics that do not offer MBGs in terms of patient fertility; yet, they secure higher success rates and impose lower long-term risks on patients and use less aggressive treatments as compared to clinics not offering MBG programs. Given the direction of estimation bias for parameters of MBG_{it}, it is possible that MBG programs, just like insurance mandates (Hamilton and McManus 2012), draw in infertile couples who would have avoided IVF treatment altogether by reducing their financial risks. Table 5 summarizes our results based on our expected hypotheses. These results, over multiple input and outcome variables, provide clear support to the beneficial role of MBG practice in contrast with the "dark" or marketing gimmick rationale.

- Insert Table 5 about here -

We also undertook multiple robustness checks (reported in the web appendix) to validate our findings. As noted before, our price information is relatively sparse (only 35% of clinics report prices) and contains only posted price. Nevertheless, we did robustness checks with the limited data we have. First, we found that there is no significant difference in posted prices between MBG clinics and non-MBG clinics. Tables WA.1, WA.2 and WA.3 repeat our main analysis using an OLS specification for our reduced form analysis and 2SLS and LIML specifications instead of the FIML specification for instruments. All the results are consistent with the findings reported in the main body. Tables WA.4 through WA.9 test our specifications across different age groups. While the results are broadly consistent across all age groups, some results are not consistent with any of our theories (for example, the multiple birth rate for age groups between 35-37 is positive in the FIML estimation while the "light" theory suggests that it should be negative. However the implantation rate for the same age group is consistent with

"light" theories rather than "dark" theories). Overall, the robustness checks are broadly in-line with our main analysis.

DISCUSSION

The market for IVF treatment is a unique context at the intersection of marketing, healthcare economics, and public policy. The treatment is not only emotionally, financially, and physically challenging but also fraught with potential risks for the would-be mothers, the babies, and the family as a whole. Furthermore, given the technical complexity and credence good nature of the service as well as the need to customize the service to each patient's condition (e.g., decision on how many embryos to transfer), there is significant information asymmetry between the patients and the service providers. This asymmetric information increases the clinics' potential to opportunistically prey on vulnerable and poorly informed patients. The introduction of MBG programs in these non-traditional markets, under which clinics have to pay back in case they fail to deliver a live baby, heightens such opportunistic concerns. Presumably, such clinics would have higher incentives to sort out and treat more fertile patients and/or over treat patients with more aggressive treatment protocols. In the absence of much evidence, it is not surprising to see why MBG programs have been denounced as nothing more than marketing gimmicks.

We take a fresh look at this controversy and offer an alternative rationale. Rather than being marketing gimmicks, we suggest that MBG practices could serve as a risk-sharing mechanism between the consumer and the clinic and/or consistent with signaling theory, could be offered by higher quality clinics. We constructed a comprehensive dataset and estimated multiple models that allow double-sided sorting; i.e. patients seeking out higher quality clinics and clinics sorting into higher fertility patients. Using an instrumental variables approach, to address the endogeneity concern that arise out of unobserved patient fertility, we find that MBG

clinics achieve higher success rate after accounting for patient fertility. More importantly, they treat patient less aggressively, impose lower multiple birth risks, and do not get higher fertility patients. All these findings, collectively, enable us to conclude that MBG clinics are more likely to be high quality clinics. In particular, these clinics might have developed a repository of skills and expertise that enable them to offer seemingly costly MBG programs without facing the adverse consequences. Since low quality clinics cannot afford to mimic this action, rational patients can therefore infer that it is the high quality clinics that are offering MBG. We find weak evidence for the insurance role of MBG but no evidence for the sorting role of MBG clinics. Our findings suggest that MBGs in the IVF industry are more likely, on average, to be beneficial to the consumers than being harmful.

One alternate theory on the role of MBG that has been proposed but not examined in detail in this paper is the stress alleviating role of MBG. Accordingly, MBG alleviate the patients' financial pressure, which decreases their stress and hence leads to better success rate. Anecdotal evidence suggests a great deal of fertility myths regarding spontaneous conception after holidays or after adoption when couples do not have the stress of trying to conceive. However, a recent meta-analysis (Boivin, Griffiths, and Venetis 2011) of 14 studies with 3583 infertile women undergoing a cycle of fertility treatment shows that the pre-treatment anxiety or depression caused by infertility or other life events co-occurring with treatment did not compromise the chances of getting pregnant. This finding seems to suggest that the signaling role of MBGs plays a bigger role in the decision behind clinics to offer MBGs than the stress alleviating role. Further studies should examine this distinction in more detail.

Our study provides important managerial and public health policy implications. For policy advocates, our study answers the controversy about marketing practice such as MBG in

the IVF and other healthcare market and the concern that MBG provision will exaggerate clinics' opportunistic behaviors. Our finding provides positive evidence that only high quality clinics can afford this costly program and MBGs are actually benefiting patients by providing them a holistic, and observable, signal of quality. Crucially, our results suggest that market-based solutions, that not only facilitate better decision making on the part of the consumers/patients but also enhance social welfare, can be feasibly devised even in markets characterized by technically complex and customized services and significant information asymmetry between the providers and the consumers. As an aside, the non-comparable pricing information we observed shows government regulations requiring clinics to present price information in a uniform manner will make it easier for consumers to choose the right clinic (Hawkins 2013). These kinds of regulations are not uncommon. For instance, the Truth in Lending Act has required all lenders to present cost information about loans in a similar manner (15 U.S. Code § 1601).

For patients, our analysis suggests that MBG clinics are not any more likely to sort than non-MBG clinics. The IVF market is characterized by heterogeneous consumers and heterogeneous clinics. Further, both patients and researchers have difficulty assessing the appropriateness of treatment aggressiveness. All these features make expertise fraudulence unavoidable (Dulleck and Kerschbamer 2006) and it is likely that both MBG clinics and non-MBG clinics are equally sorting and over treating patients. Therefore, patients who search information on clinic quality should be careful in not just comparing different clinics on their live birth rate (i.e. success rate). Rather they should complement this comparison with an assessment of additional variables that reflect clinic quality including experience (total number of previous cycles undertaken or total number of years in the market), clinic size, trainings of

doctors and embryologists, number of embryos transferred per cycle, and multiple birth rates, etc.

For clinic managers, our study explains the mechanism of MBG and shows that offering MBG does not necessarily lead to low profits. Rather, MBGs not only inform consumers about their service quality, but also attracts more patients (number of cycles as a proximate measure for demand) to the clinic. For those clinics that are high quality but haven't used MBG, it might be a good time to consider introducing this program, either directly or by partnering with underwriters. This is especially true nowadays because insurance coverage for IVF treatments still has many limitations and is potentially discouraged by Affordable Care Act (ACA). Only eight states in the U.S. have IVF mandates and these mandates usually have lifetime cap and strict eligibility requirements. Meanwhile, studies show that infertility mandates are threatened by ACA because the cost of passing new mandates or in excess of Essential Health Benefits (EHB) will be defrayed by the states (Devine et al 2014). MBGs become a more flexible market-initiated mechanism than insurance mandate and they cannot only benefits patients but also provide strategic advantages to high quality clinics.

Finally, our study provides some evidence on the role of marketing practices in non-traditional, complex, expert service markets. While our focus is in the IVF market, our results can be extended to other markets like legal and financial services. In most of these contexts, marketing and marketing practices are often perceived as a "*necessary evil*". Our study, though limited, suggests that the narrative is far too complicated for a "good" vs. "evil" distinction and that marketing is more likely to be a "*necessary good*."

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Table 1: Summary Statistics – MBGs, Clinic, Environment and Patient Characteristics

Constructs	Variables	Obs[1]	M	SD	Min	Max	T Test[2]
MBGs	MBG (0, 1)	984	0.365	0.482	0	1	
Clinic Characteristics							
Scale	# of Doctors	984	2.915	2.384	1	21	***
	# of Embryologist	984	1.441	1.815	0	13	***
Capability	Embryologist Dummy (0, 1)	984	0.645	0.479	0	1	***
	Avg. Pre Live Birth Rate (Clinic)	984	28.35	9.191	0	66.67	***
Price[3]	Price = min (Regular Price, MBG Price/3)	350	7383	1774	3333	12500	
	Regular Price (for 1 Cycle)	253	7889	1976	3333	12550	***
	MBG Price (for up to 3 Cycles)	199	21656	4644	10000	36487	
Experience	Cycles of Previous Years (Clinic)	984	2761	4485	0	40814	***
	Years in Market	984	12.16	5.243	1	18	***
Service Scope	Single Women Service (0, 1)	984	0.958	0.200	0	1	**
	Surrogate Service (0, 1)	984	0.880	0.325	0	1	***
	Cryopreservation Service (0, 1)	984	0.997	0.0552	0	1	**
Accreditation	SART Member (0, 1)	984	0.856	0.352	0	1	***
	Lab Accreditation (0, 1)	984	0.936	0.245	0	1	***
Environmental Characteristics							
Competition	# of Competitors (MSA[4])	984	10.80	11.80	0	37	***
	# of MBG Competitors (MSA)	984	2.796	2.724	0	9	***
Insurance	Infertility Insurance Mandate	984	0.552	0.498	0	1	***
Demographic Characteristics							
Income	State Income	984	51920	6980	36641	71836	
Population	MSA Population	984	5.7e+06	5.9e+06	129709	1.9e+07	**
Patient Characteristics							
	Patient Fertility (by diagnosis)	984	0.433	0.140	0.222	1.191	*

[1] Observations = 365 for Year 2012, = 358 for Year 2011, = 261 for Year 2010

[2] Last column: two-sample t-test with unequal variances for MBG Clinic VS. Non-MBG Clinics
*** p<0.01, ** p<0.05, * p<0.1

[3] Price excludes medication, monitoring, ICSI, AH, PGD, anesthesia, embryo cryopreservation, prescreening, etc.

[4] MSA = Metropolitan Statistical Area

Table 2: Summary Statistics – Treatment Input and Output

	All Clinics		MBG Clinics		Non-MBG Clinics		t- test[1]
Variables	M	SD	M	SD	M	SD	
Avg. # of Embryos per Transfer <35	2.022	0.296	1.947	0.237	2.065	0.317	***
Avg. # of Embryos per Transfer 35-37	2.214	0.358	2.133	0.288	2.260	0.385	***
Avg. # of Embryos per Transfer 38-40	2.526	0.465	2.461	0.385	2.565	0.502	***
Avg. # of Embryos per Transfer 41-42	2.790	0.714	2.788	0.608	2.791	0.772	
Avg. # of Embryos per Transfer 43-44	2.887	0.922	2.875	0.832	2.895	0.980	
Clinic Avg. # of Embryos per Transfer	**2.248**	**0.331**	**2.179**	**0.262**	**2.287**	**0.359**	***
Total # of Cycles <35	102.7	138.7	163.6	191.9	67.70	76.04	***
Total # of Cycles 35-37	52.42	81.46	82.73	109.9	35.00	51.85	***
Total # of Cycles 38-40	52.06	88.37	80.15	114.4	35.92	63.82	***
Total # of Cycles 41-42	26.88	51.36	39.31	60.48	19.73	43.77	***
Total # of Cycles 43-44	12.37	26.52	16.93	27.87	9.749	25.37	***
Clinic Total # of Cycles	**249.3**	**376.1**	**385.9**	**496.4**	**170.9**	**254.1**	***
Avg. Live Birth Rate <35	40.14	11.91	41.65	10.28	39.27	12.68	***
Avg. Live Birth Rate 35-37	31.73	13.86	32.56	11.63	31.25	14.98	*
Avg. Live Birth Rate 38-40	22.19	12.79	23.17	9.583	21.62	14.30	**
Avg. Live Birth Rate 41-42	12.10	14.40	12.30	11.20	11.98	16.01	
Avg. Live Birth Rate 43-44	5.722	14.20	6.015	12.98	5.528	14.97	
Clinic Avg. Live Birth Rate	**30.39**	**9.424**	**32.10**	**8.608**	**29.41**	**9.734**	***
Avg. Multiple Birth Rate <35	2.325	4.109	1.907	2.394	2.564	4.812	***
Avg. Multiple Birth Rate 35-37	2.679	7.145	2.397	4.552	2.848	8.318	
Avg. Multiple Birth Rate 38-40	2.976	8.576	2.955	7.801	2.989	9.021	
Avg. Multiple Birth Rate 41-42	1.870	8.951	1.702	6.146	1.990	10.51	
Avg. Multiple Birth Rate 43-44	0.0939	0.740	0.133	0.843	0.0595	0.635	
Clinic Avg. Multiple Birth Rate	**2.461**	**3.329**	**2.146**	**2.180**	**2.642**	**3.827**	***
N	**984**		**637**		**364**		

Table 3: OLS and Poisson Regressions on Input and Outputs (2010-2012)

Variables/ Measures	Patient Fertility Clinic-OLS	# Embryos Per Cycle Clinic - Poisson	Live Birth Rate Clinic - Poisson	Multiple Birth Rate Clinic - Poisson
Ln (# of Doctors)	-0.013	-0.004	-0.007	-0.395***
	(0.01)	(0.01)	(0.03)	(0.09)
Embryologist Dummy	-0.006	0.001	0.020	-0.120
	(0.01)	(0.01)	(0.03)	(0.08)
Ln (Previous Year Cycles)	-0.004*	-0.001	-0.014	0.052*
	(0.00)	(0.00)	(0.01)	(0.02)
Surrogate Service	-0.004	-0.004	0.029	0.049
	(0.02)	(0.02)	(0.04)	(0.13)
SART Member	0.025	-0.050**	0.019	0.078
	(0.02)	(0.02)	(0.04)	(0.12)
Ln (# Competitors in MSA)	-0.007	0.006	-0.038	0.042
	(0.01)	(0.01)	(0.03)	(0.06)
Infertility Insurance Mandate	-0.015	0.070***	-0.018	-0.126
	(0.01)	(0.01)	(0.03)	(0.09)
Ln (State Income)	-0.031	-0.088	-0.069	-0.761*
	(0.04)	(0.05)	(0.11)	(0.30)
Ln (MSA Population)	0.000	0.001	-0.006	-0.022
	(0.01)	(0.01)	(0.03)	(0.06)
Patient Fertility (Diagnosis)	-	-0.020	0.154	-0.250
		(0.06)	(0.12)	(0.38)
# Embryos Per Cycle	-	-	-0.089	0.896***
			(0.05)	(0.12)
MBG	**-0.004**	**-0.032*** **	**0.082*** **	**-0.042**
	(0.01)	**(0.00)**	**(0.00)**	**(0.07)**
Year 2011	0.187***	-0.017	-0.070*	-0.291**
	(0.01)	(0.01)	(0.03)	(0.10)
Year 2012	0.188***	-0.039*	-0.084**	-1.261***
	(0.01)	(0.02)	(0.03)	(0.13)
Constant	0.808	1.80***	4.50***	8.00**
	(0.50)	(0.33)	(0.85)	(3.51)
Observations	984	984	984	984
Wald Test	0.372	67.881	66.295	369.336
Pseudo R^2		0.002	0.033	0.185

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 4: Full Information MLE with 4 IVs (FIML 2010-2012)

Variables/ Measures	# Embryos Per Cycle	Live Birth Rate	Multiple Birth Rate
Ln (# of Doctors)	0.047*	-2.214***	-0.647***
	(0.03)	(0.77)	(0.23)
Embryologist Dummy	0.008	0.312	-0.259
	(0.02)	(0.75)	(0.21)
Ln (Previous Year Cycles)	0.004	-0.815***	0.159***
	(0.01)	(0.21)	(0.06)
Surrogate Service	0.040	-1.053	0.425
	(0.03)	(1.07)	(0.31)
SART Member	-0.109***	0.450	0.167
	(0.03)	(1.05)	(0.30)
Ln (# Competitors in MSA)	0.004	-0.717	0.079
	(0.02)	(0.69)	(0.20)
Infertility Insurance Mandate	0.121***	0.739	-0.471**
	(0.03)	(0.82)	(0.24)
Ln (State Income)	-0.210**	-1.075	-1.757**
	(0.09)	(2.82)	(0.81)
Ln (MSA Population)	0.016	-0.669	-0.012
	(0.02)	(0.63)	(0.18)
Patient Fertility (Diagnosis)	-0.059	4.935	-0.582
	(0.10)	(3.02)	(0.86)
#Embryos Per Cycle	-	-1.046	2.158***
		(1.08)	(0.31)
MBG	**-0.457*** **	**3.88*** **	**-0.892** **
	(0.08)	**(1.53)**	**(0.37)**
Year 2011	-0.038	-2.013*	-1.149***
	(0.03)	(1.03)	(0.29)
Year 2012	-0.088***	-2.326**	-2.765***
	(0.03)	(1.03)	(0.29)
Constant	4.247***	32.797	20.618*
	(1.21)	(37.82)	(10.80)
Observations	984	984	984
Wald Test for Model Fit	156.431	377.683	281.476
Rho	0.607	-0.863	0.329
LR Test for Independent Eqs	0.000	0.000	0.001

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 5: Summary of FIML Results

	Patient Fertility	# Embryos Per Cycle	Live Birth Rate	Multiple Birth Rate
Light Theories				
Insurance	-			
Signaling		-	+	-
Dark Theories				
Sorting	+			
Incentives		+	+	+
Results	**(-)**	**(-)*** **	**(+)*** **	**(-)** **

The values in brackets in the last row are the actual results from the analysis, stars denoting the level of significance, while the signs in the above four rows are the expected directions based on the different theories. Results are from FIML analysis that has accounted for unobserved patient quality.

Figure 1: Treatment Timeline

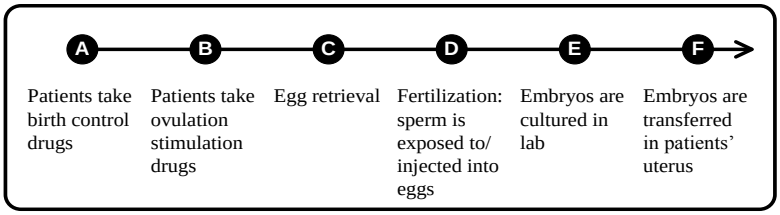
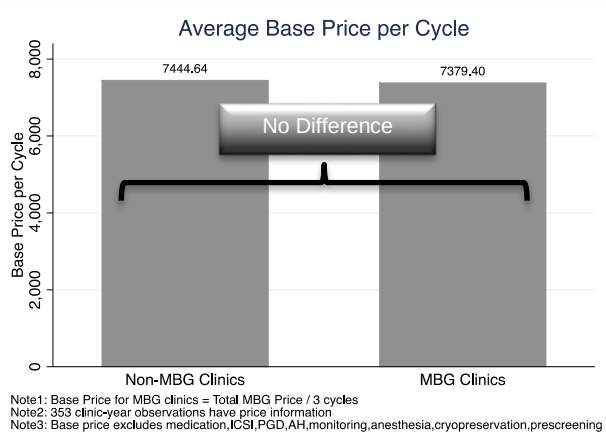
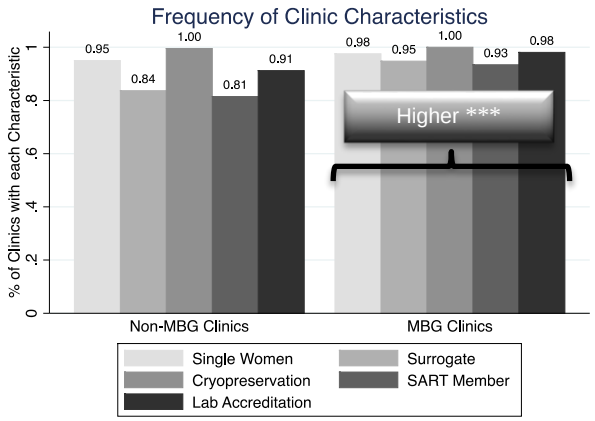
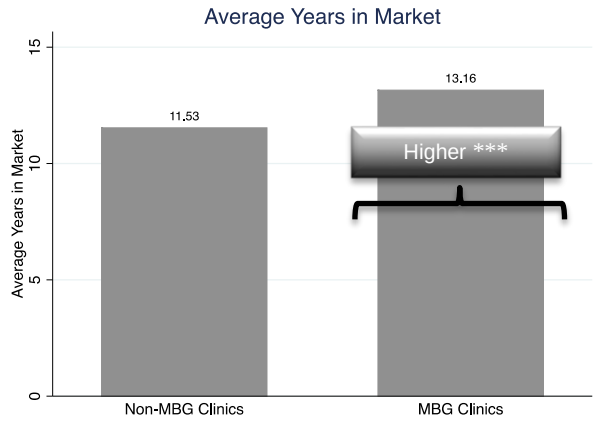
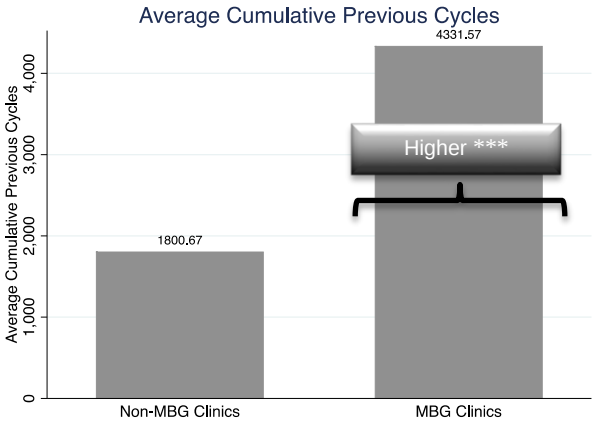


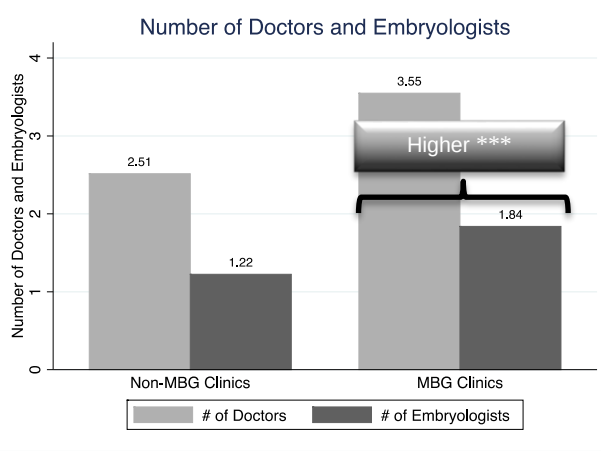
Figure 2: MBG Clinics VS non-MBG Clinics

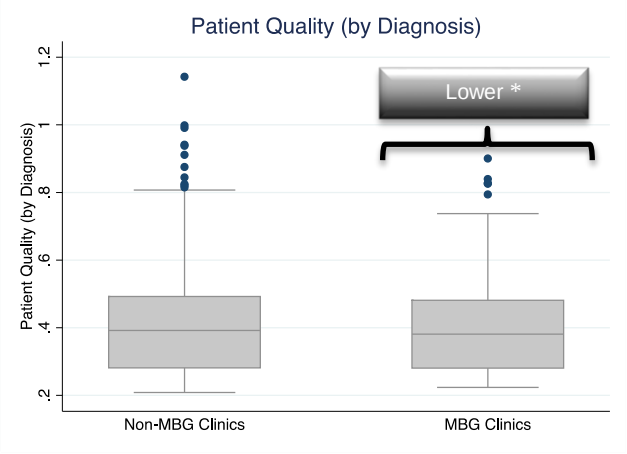


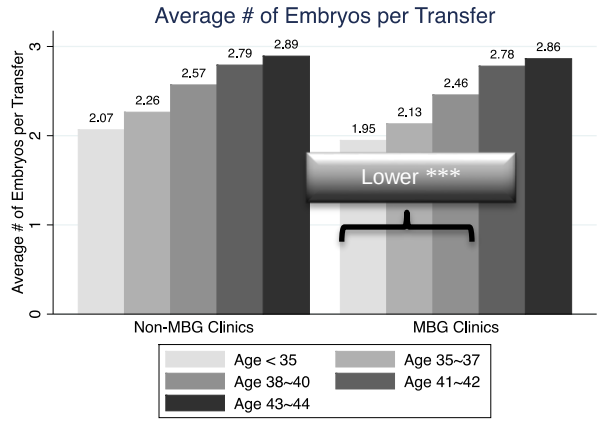


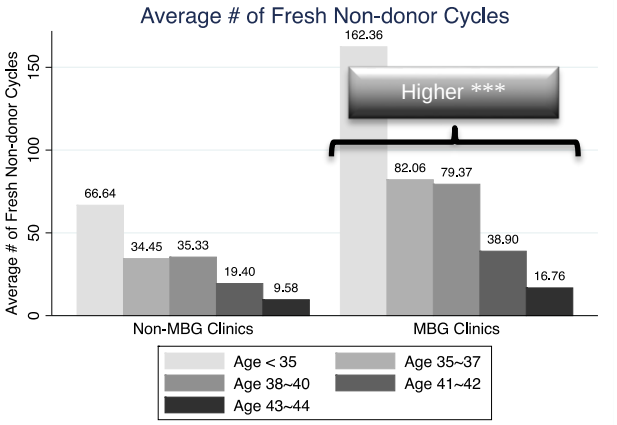


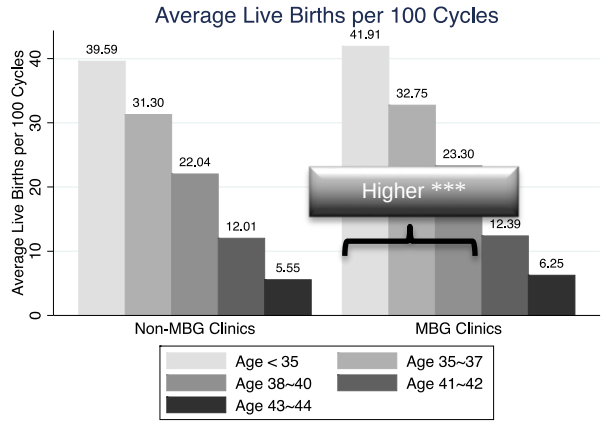


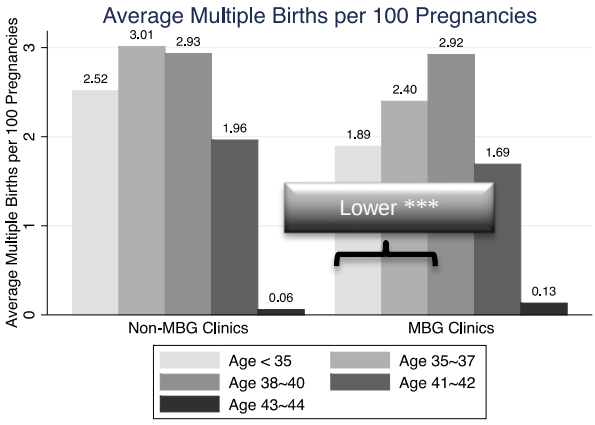

Number of Doctors and Embryologists
Number of Doctors and Embryologists
0
1
2
3
4
2.51
1.22
3.55
1.84
Higher ***
Non-MBG Clinics
MBG Clinics
# of Doctors
# of Embryologists


Patient Quality (by Diagnosis)
Patient Quality (by Diagnosis)
.2
.4
.6
.8
1
1.2
Lower *
Non-MBG Clinics
MBG Clinics


Average # of Embryos per Transfer
Average # of Embryos per Transfer
0
1
2
3
2.07
2.26
2.57
2.79
2.89
1.95
2.13
2.46
2.78
2.86
Lower ***
Non-MBG Clinics
MBG Clinics
Age < 35
Age 35~37
Age 38~40
Age 41~42
Age 43~44


Average # of Fresh Non-donor Cycles
Average # of Fresh Non-donor Cycles
0
50
100
150
66.64
34.45
35.33
19.40
9.58
162.36
82.06
79.37
38.90
16.76
Higher ***
Non-MBG Clinics
MBG Clinics
Age < 35
Age 35~37
Age 38~40
Age 41~42
Age 43~44


Average Live Births per 100 Cycles
Average Live Births per 100 Cycles
0
10
20
30
40
39.59
31.30
22.04
12.01
5.55
41.91
32.75
23.30
12.39
6.25
Higher ***
Non-MBG Clinics
MBG Clinics
Age < 35
Age 35~37
Age 38~40
Age 41~42
Age 43~44


Average Multiple Births per 100 Pregnancies
Average Multiple Births per 100 Pregnancies
0
1
2
3
2.52
3.01
2.93
1.96
0.06
1.89
2.40
2.92
1.69
0.13
Lower ***
Non-MBG Clinics
MBG Clinics
Age < 35
Age 35~37
Age 38~40
Age 41~42
Age 43~44

Appendix A: Insurance Mandate Summary

	State	Year of Mandate	For Infertility	For IVF	Limitations on Insurers or Treatments
***IVF Mandate* = 1**	**IVF Mandate without Restrictions**				
	Illinois	1991, 1997	Cover	Yes	
	Massachusetts	1987	Cover	Yes	
	Rhode Island	1989, 2007	Cover	Yes	
	New Jersey	2001	Cover	Yes	
	Connecticut	1989, 2005	Cover	Yes	
	IVF Mandate with Restrictions				
	Arkansas	1987	Cover	Yes	HMOs exempted; Patient's eggs must be fertilized with her spouse sperm; Patients with 2-yr infertility or specific diagnoses [a]
	Hawaii	1989, 2003	Cover	Yes	Patient's eggs must be fertilized with her spouse sperm; Patients with 5-yr infertility or specific diagnoses [b]
	Maryland	2000	Cover	Yes	Patient's eggs must be fertilized with her spouse sperm; Patients with 2-yr infertility or specific diagnoses [c]
***IVF Mandate* = 0**	**Infertility Mandate, excluding IVF**				
	California	1989	Offer	No	
	Texas	1987, 2003	Offer	No	Patients with 5-yr infertility or specific diagnoses [d]
	Louisiana	2001	Cover	No	
	New York	1990, 2002	Cover	No	Group insurers only
	Ohio	1991, 1997	Cover	No	HMOs only
	Montana	1987	Cover	No	HMOs only
	West Virginia	1995	Cover	No	HMOs only
	No Mandate				
	Other 35 States, D.C.				

Source: Resolve (http://www.resolve.org/family-building-options/insurance_coverage/state-coverage.html), with reference to Hamilton & McManus (2012), Schmidth (2007), and Jain et al (2002). We didn't include the information on insurance mandate after the enactment of Affordable Care Act (2014) since our data sample is between 2010 ~ 2012.

[a] Specific diagnoses include endometriosis; DES exposure; blocked or surgically removed fallopian tubes that are not the result of voluntary sterilization; abnormal male factors contributing to the infertility.

[b & c] Specific diagnoses include endometriosis; DES exposure; blocked or surgically removed fallopian tubes; abnormal male factors.

[d] Specific diagnoses include endometriosis; DES exposure; blockage of or surgical removal of one or both fallopian tubes; oligospermia.

Appendix B: Construct and Variable Definition

Construct	Variable Name	Description
Clinic Characteristics X_{it}, X_{ijt}:		
Scale	# of Doctors	Total number of endocrinologists and urologists
Capability	Embryologist Dummy	Whether the clinic has embryologist(s)
	Avg Pre Live Birth Rate (Clinic *i* or Age Group *j*)	Average live birth rate for all previous years (for clinic *i* or for age group *j*)
Price	No Price Dummy	Whether the clinic provides price information
	Price	MBG clinics: Price for MBG program divided by # of covered cycles Non-MBG clinics: Price for single regular cycle
Experience	Total Previous Cycles	Total number of cycles for all previous years (clinic *i*)
	Years in Market [a]	Total number of years the clinic exist in the market
Service Scope	Surrogate	Whether the clinic accept gestational carrier
	Single Women [b]	Whether the clinic provide service to single women
	Cryopreservation [c]	Whether the clinic provide embryo cryopreservation service
Accreditation	SART Member	Whether the clinic is SART member
	Lab Accreditation [d]	Whether the clinic has lab accreditation
Environmental Characteristics E_{it}:		
Competition	# Competitors in MSA	Total number of competitive IVF clinics in its MSA
	# MBG Competitors in MSA	Total number of competitive IVF clinics offering MBG in its MSA
Insurance	IVF Insurance Mandate	Whether the state has mandate requiring coverage for IVF treatment
Demographic Characteristics D_{it}:		
Income	State Income	Average Income of the clinic's state
Population	MSA Population	Total population of the clinic's MSA
Dependent Variables:		
MBGs	*MBG (i)*	Whether the clinic provide MBG program (clinic *i*)
Patient Fertility	*Patient Fertility (i)*	Patient fertility based on diagnosis (clinic *i*)
Treatment Aggressiveness	*Avg # of Embryos (i or j)*	Average number of embryos per fresh non-donor transfer (for clinic *i* or for age group *j*)
Total # of Cycles	*Total # of Cycles (i or j)*	Total number of cycles (for clinic *i* or for age group *j*)
Success Rate	*Live Birth Rate (i or j)*	Number of Live births per 100 fresh non-donor cycles (for clinic *i* or for age group *j*)
Multi Birth Risk	*Multi Birth Rate (i or j)*	Number of Triplets or more live births per 100 fresh non-donor pregnancies (for clinic *i* or for age group *j*)

[a] Years in Market is not included in the main analysis as it highly correlates to Cycles of Previous Years (Clinic)

[b, c & d] Single Women, Cryopreservation, Lab Accreditation are not included in the analysis as they lack variation (means > 0.9)

Appendix C: Patient Fertility and Double-sided Sorting

Assume that patient k has innate fertility rate $F_k \in [0, 1]$ where 0 indicates an extremely low probability of conceiving while 1 indicates an extremely high probability of conceiving naturally. The success rate of the IVF treatment depends on the patient's innate fertility, the treatment they undertake, and some random error term. Successful conception for a patient k can therefore be represented by the following equation.

$$\text{Success}_k = \varphi(\text{Tr}, F_k) + \varepsilon_k = \begin{cases} F_k + \varepsilon_k & \text{if Tr} = \text{N} \\ F_k^{1/\Delta} + \varepsilon_k & \text{if Tr} = \text{IVF} \end{cases} \quad (1)$$

Where $\varphi(\cdot)$ captures the probability of conception and is assumed to be monotonic in F_k. A patient attempting conception can choose to conceive either through "natural conception" (N) IVF, or IVF with MBGs. $1/\Delta$ captures the treatment effect, where $\Delta > 1$ and can be affected by both clinic service quality and treatment aggressiveness. Note that as Δ becomes bigger, the treatment becomes more effective. ε_k captures the uncertainty in the input-output process.

The expected utility from a given treatment Tr for patient k with innate fertility F_k is given by

$$EU(\text{Tr}|F_k) = \varphi(\text{Tr}, F_k) V_{1k} + [1 - \varphi(\text{Tr}, F_k)] V_{0k} - P_{\text{Tr}} \quad (2)$$

where V_{1k} is the value to patient k from birth of a live baby, V_{0k} is the value for patient k from no birth, and P indexes the price paid by the patient. For simplicity, we normalize $V_{0k} = 0$, $P_N = 0$ and assume that $P_{IVF} > P_N$. Then, equation 2 can be re-written as

$$\begin{aligned} EU(\text{Tr}|F_k) &= \begin{cases} \varphi(\text{N}, F_k) V_{1k} & \text{if Tr} = \text{N} \\ \varphi(\text{IVF}, F_k) V_{1k} - P_{IVF} & \text{if Tr} = \text{IVF} \end{cases} \\ &= \begin{cases} F_k V_{1k} & \text{if Tr} = \text{N} \\ F_k^{1/\Delta} V_{1k} - P_{IVF} & \text{if Tr} = \text{IVF} \end{cases} \end{aligned} \quad (3)$$

Our simple model allows us to build some testable hypothesis. First, consider the patient's choice of treatment between natural conception, N, and IVF. Our model specification

implies that only patients with $F_k \in [F^L, F^H]$, $0 < F^L < F^H < 1$ will prefer IVF over natural conception. A graphical rationale for this statement is provided in the web appendix (Graph WA.1 and WA.2). In other words, a patient with moderate fertility will get higher expected utility from IVF than from natural conception whereas a patient who is very infertile or very fertile will prefer to choose natural conception. This is intuitive because patients with a very high probability of conceiving a baby (i.e.,$F_k \in [F^L, 1)$) do not need IVF and will prefer natural conception (N). Likewise, patients with a very low probability of having a baby (i.e.,$F_k \in (0, F^L]$) will prefer natural conception (N) over IVF because the improved success rate from using IVF cannot justify the cost of IVF (i.e., P_{IVF}).

Now consider the choice between IVF without MBGs and IVF with MBGs. To make this choice decision equitable, we compare the expected utility a patient k can get from both scenarios for trying up to three cycles. This is because the price for almost all MBG programs covers multiple cycles (usually three) and money is refunded only at the end of third failed IVF cycle. A rational patient will therefore evaluate her utility for getting a live birth from either one, two or three cycles *a la carte* versus the utility of using a three-cycle MBG program.

Assume that a patient *k* chooses IVF treatment without MBG commits to three cycles. She will pay P_{IVF} if she succeeds in the first cycle, $2P_{IVF}$ if she succeeds in the second cycle, and $3P_{IVF}$ if she succeeds in the third cycle. Let φ be φ (IVF, F_k), P_{IVF} be the price of single IVF cycle without MBGs, and P_{MBG} be the price of MBG covering up to three cycles. Then, the expected utility for trying up to three cycles of IVF treatments without MBG is given by

$$\begin{aligned} &EU(Tr = IVF_{\leq 3Cycles} | F_k) \\ &= [1-(1-\varphi)^3]V_{1k} - [P_{IVF}\varphi + 2P_{IVF}\varphi(1-\varphi) + 3(1-\varphi)^2] \\ &= [1-(1-\varphi)^3]V_{1k} - P_{IVF}(\varphi^2 - 3\varphi + 3) \end{aligned} \quad (4)$$

while the expected utility for patient k for trying up to three cycles of IVF treatments with MBG is given by

$$\begin{aligned} &\mathrm{EU}(\mathrm{Tr} = \mathrm{IVF}_{\mathrm{MBG}}|\mathrm{F_k}) \\ &= [1-(1-\varphi)^3]\mathrm{V_{1k}} - \mathrm{P_{MBG}}[1-(1-\varphi)^3] \\ &= [1-(1-\varphi)^3]\mathrm{V_{1k}} - \mathrm{P_{MBG}}\varphi(\varphi^2-3\varphi+3) \end{aligned} \quad (5)$$

From equations 4 and 5, we get

$$\begin{aligned} &\mathrm{EU}(\mathrm{Tr} = \mathrm{IVF}_{\leq 3\mathrm{Cycles}}|\,\mathrm{F_k}\,) - \mathrm{EU}(\mathrm{Tr} = \mathrm{IVF}_{\mathrm{MBG}}|\mathrm{F_k}) \\ &= (\mathrm{P_{MBG}}\varphi - \mathrm{P_{IVF}})(\varphi^2-3\varphi+3) \\ &= (\mathrm{P_{MBG}}\varphi - \mathrm{P_{IVF}})[\left(\varphi-\frac{3}{2}\right)^2+\frac{3}{4}] \end{aligned} \quad (6)$$

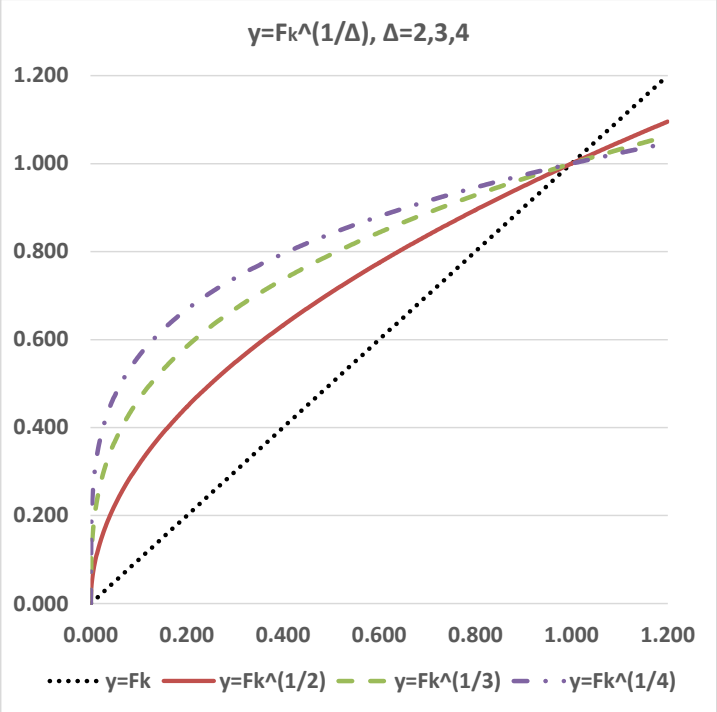
Because $\left(\varphi-\frac{3}{2}\right)^2+\frac{3}{4}>0$ for any value of φ, $\mathrm{EU}(\mathrm{IVF}_{\leq 3\mathrm{Cycles}}|\mathrm{F_k}) < \mathrm{EU}(\mathrm{IVF}_{\mathrm{MBG}}|\mathrm{F_k})$ when $\varphi < \frac{\mathrm{P_{IVF}}}{\mathrm{P_{MBG}}}$, i.e., $\mathrm{F^L} < \mathrm{F_k} < (\frac{\mathrm{P_{IVF}}}{\mathrm{P_{MBG}}})^{\Delta} < \mathrm{F^H}$. Similarly, $\mathrm{EU}(\mathrm{IVF}_{\leq 3\mathrm{Cycles}}|\mathrm{F_k}) > \mathrm{EU}(\mathrm{IVF}_{\mathrm{MBG}}|\mathrm{F_k})$ when $\varphi > \frac{\mathrm{P_{IVF}}}{\mathrm{P_{MBG}}}$ or $\mathrm{F^L} < (\frac{\mathrm{P_{IVF}}}{\mathrm{P_{MBG}}})^{\Delta} < \mathrm{F_k} < \mathrm{F^H}$. In other words, this suggests that a relatively lower fertility patient k (i.e., $\mathrm{F_k} < (\frac{\mathrm{P_{IVF}}}{\mathrm{P_{MBG}}})^{\Delta}$) gets higher expected utility under IVF with MBGs than under IVF without MBGs, while a relatively higher fertility patient (i.e., $(\frac{\mathrm{P_{IVF}}}{\mathrm{P_{MBG}}})^{\Delta} < \mathrm{F_k}$) will prefer IVF without MBGs.

This analysis suggests that, absent clinic sorting, a relatively low fertility patient may tend to choose IVF with MBGs while a relatively high fertility patient may tend to choose IVF without MBGs. Said otherwise, absent clinic sorting, if patients could select clinics based on clinics' MBG provision, one would expect to see MBG clinics to have patients with lower fertility compared to IVF clinics that do not offer MBGs.

On the contrary, if MBG (non-MBG) clinics sort patients, then one would expect to see MBG (non-MBG) clinics to have better quality (more fertile) patients than non-MBG (MBG) clinics. Note that both MBG clinics and non- MBG clinics have an incentive to sort and get higher fertility patients albeit for different motivations. Both MBG and non-MBG clinics would like to enhance their success rate information disclosed to SART and CDC by sorting high quality patients. However, MBG clinics have an additional incentive to sort patients if they are pretending to be high quality and using MBGs to lure patients. Similarly, non-MBG clinics may also have an extra incentive to sort patients if they are of lower quality than MBG clinics and they want to boost the treatment outcome disclosed to the public. What this implies empirically is that one can only distinguish between relative sorting behavior, i.e., are MBG clinics sorting more or less compared to non-MBG clinics.

Web Appendix

Graph WA.1: Conception Probability after IVF $y = F_k^{1/\Delta}$



Graph WA.2: $y = F_k^{1/\Delta} - F_k$

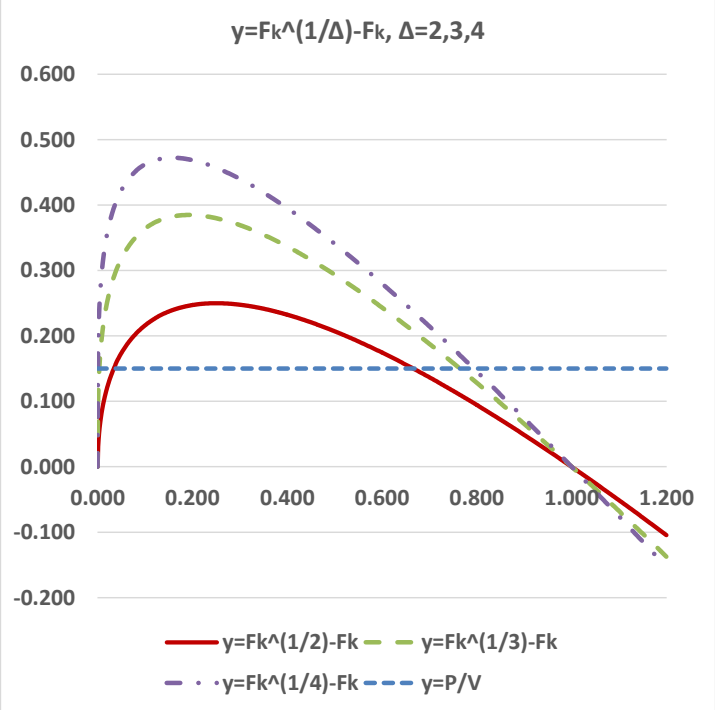


Table WA.1: OLS on Input and Outputs (Clinic Level 2010-2012)

Variables/ Measures	Patient Fertility	# Embryos Per Cycle	Live Birth Rate	Multiple Birth Rate
Ln (# of Doctors)	-0.013	-0.010	-0.244	-0.875***
	(0.01)	(0.02)	(0.66)	(0.22)
Embryologist Dummy	-0.007	0.002	0.741	-0.301
	(0.01)	(0.02)	(0.64)	(0.21)
Ln (Previous Year Cycles)	-0.004*	-0.001	-0.399**	0.113*
	(0.00)	(0.01)	(0.18)	(0.06)
Surrogate Service	-0.005	-0.008	0.962	0.196
	(0.01)	(0.03)	(0.92)	(0.30)
SART Member	0.025**	-0.117***	0.582	0.154
	(0.01)	(0.03)	(0.90)	(0.29)
Ln (# Competitors in MSA)	-0.008	0.013	-1.123*	0.127
	(0.01)	(0.02)	(0.59)	(0.19)
Infertility Insurance Mandate	-0.014*	0.156***	-0.582	-0.320
	(0.01)	(0.02)	(0.70)	(0.23)
Ln (State Income)	-0.032	-0.198**	-2.168	-1.629**
	(0.03)	(0.08)	(2.43)	(0.79)
Ln (MSA Population)	0.000	0.004	-0.184	-0.067
	(0.01)	(0.02)	(0.54)	(0.18)
Patient Fertility (Diagnosis)	-	-0.042	4.397*	-0.533
		(0.09)	(2.59)	(0.85)
#Embryos Per Cycle	-	-	-2.602***	2.338***
			(0.93)	(0.30)
MBG	**-0.008**	**-0.071*** **	**2.532*** **	**-0.146**
	(0.01)	**(0.02)**	**(0.66)**	**(0.21)**
Year 2011	0.187***	-0.039	-2.082**	-1.139***
	(0.01)	(0.03)	(0.88)	(0.29)
Year 2012	0.188***	-0.088***	-2.474***	-2.745***
	(0.01)	(0.03)	(0.89)	(0.29)
Constant	0.674**	4.445***	65.014**	17.710**
	(0.33)	(0.94)	(27.34)	(8.93)
Observations	984	984	984	984
R^2	0.370	0.113	0.091	0.223

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table WA.2: LIML on Input and Outputs (Clinic Level 2010-2012)

Variables/ Measures	# Embryos Per Cycle	Live Birth Rate	Multiple Birth Rate
Ln (# of Doctors)	0.002	-0.496	-0.819***
	(0.02)	(0.70)	(0.23)
Embryologist Dummy	0.008	0.625	-0.275
	(0.02)	(0.64)	(0.21)
Ln (Previous Year Cycles)	0.002	-0.462**	0.127**
	(0.01)	(0.19)	(0.06)
Surrogate Service	0.005	0.689	0.257
	(0.03)	(0.94)	(0.31)
SART Member	-0.113***	0.524	0.166
	(0.03)	(0.89)	(0.29)
Ln (# Competitors in MSA)	0.012	-1.091*	0.120
	(0.02)	(0.59)	(0.19)
Infertility Insurance Mandate	0.145***	-0.396	-0.362
	(0.02)	(0.72)	(0.24)
Ln (State Income)	-0.199**	-2.103	-1.643**
	(0.08)	(2.41)	(0.79)
Ln (MSA Population)	0.006	-0.237	-0.055
	(0.02)	(0.54)	(0.18)
Patient Fertility (Diagnosis)	-0.048	4.541*	-0.565
	(0.09)	(2.58)	(0.84)
#Embryos Per Cycle (Clinic)	-	-2.390**	2.290***
		(0.94)	(0.31)
MBG	**-0.143*** **	**4.031*** **	**-0.481**
	(0.05)	**(1.49)**	**(0.50)**
Year 2011	-0.039	-2.086**	-1.138***
	(0.03)	(0.88)	(0.29)
Year 2012	-0.088***	-2.464***	-2.748***
	(0.03)	(0.88)	(0.29)
Constant	4.403***	64.953**	17.724**
	(0.94)	(27.20)	(8.87)
Observations	984	984	984
R^2	0.104	0.086	0.221
Wald Test for Model Fit	122.534	90.295	282.574

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table WA.3: 2SLS on Input and Outputs (Clinic Level 2010-2012)

Variables/ Measures	# Embryos Per Cycle	Live Birth Rate	Multiple Birth Rate
Ln (# of Doctors)	0.002	-0.495	-0.822***
	(0.02)	(0.70)	(0.23)
Embryologist Dummy	0.008	0.626	-0.277
	(0.02)	(0.64)	(0.21)
Ln (Previous Year Cycles)	0.002	-0.462**	0.126**
	(0.01)	(0.19)	(0.06)
Surrogate Service	0.005	0.691	0.253
	(0.03)	(0.94)	(0.31)
SART Member	-0.113***	0.524	0.166
	(0.03)	(0.89)	(0.29)
Ln (# Competitors in MSA)	0.012	-1.091*	0.120
	(0.02)	(0.59)	(0.19)
Infertility Insurance Mandate	0.146***	-0.397	-0.359
	(0.02)	(0.72)	(0.23)
Ln (State Income)	-0.199**	-2.104	-1.642**
	(0.08)	(2.41)	(0.79)
Ln (MSA Population)	0.006	-0.236	-0.056
	(0.02)	(0.54)	(0.18)
Patient Fertility (Diagnosis)	-0.048	4.540*	-0.563
	(0.09)	(2.58)	(0.84)
#Embryos Per Cycle (Clinic)	-	-2.391**	2.294***
		(0.94)	(0.31)
MBG	**-0.141*** **	**4.023*** **	**-0.458**
	(0.05)	**(1.48)**	**(0.48)**
Year 2011	-0.039	-2.086**	-1.138***
	(0.03)	(0.88)	(0.29)
Year 2012	-0.088***	-2.464***	-2.748***
	(0.03)	(0.88)	(0.29)
Constant	4.404***	64.953**	17.723**
	(0.94)	(27.20)	(8.87)
Observations	984	984	984.000
R^2	0.105	0.086	0.222
Wald Test for Model Fit	122.560	90.302	282.631

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table WA.4: OLS – Number of Embryos per Transfer (Age-Group Level 2010-2012)

Variables/ Measures	(1) OLS < 35	(2) OLS 35 - 37	(3) OLS 38 - 40
Ln (# of Doctors)	-0.095***	-0.069***	0.011
	(0.02)	(0.03)	(0.03)
Embryologist Dummy	-0.002	-0.016	-0.000
	(0.02)	(0.02)	(0.03)
Ln (Previous Year Cycles)	-0.008	-0.006	-0.003
	(0.01)	(0.01)	(0.01)
Surrogate Service	-0.014	-0.065*	0.005
	(0.03)	(0.03)	(0.05)
SART Member	-0.159***	-0.061*	-0.135***
	(0.03)	(0.03)	(0.04)
Ln (# Competitors in MSA)	-0.012	-0.016	0.005
	(0.02)	(0.02)	(0.03)
Infertility Insurance Mandate	0.068***	0.104***	0.134***
	(0.02)	(0.03)	(0.03)
Ln (State Income)	-0.335***	-0.333***	-0.185
	(0.07)	(0.09)	(0.12)
Ln (MSA Population)	0.020	0.020	-0.017
	(0.02)	(0.02)	(0.03)
Patient Fertility (Diagnosis)	0.018	0.007	0.109
	(0.08)	(0.10)	(0.13)
# Embryos per Cycle (Age)	-	-	-
MBG	**-0.054*** **	**-0.074*** **	**-0.070** **
	(0.02)	**(0.02)**	**(0.03)**
Year 2011	-0.047*	-0.048	-0.076*
	(0.03)	(0.03)	(0.04)
Year 2012	-0.096***	-0.112***	-0.191***
	(0.03)	(0.03)	(0.04)
Constant	5.728***	5.836***	4.898***
	(0.81)	(1.02)	(1.36)
Observations	984	981	975
R^2	0.166	0.096	0.061

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table WA.5: OLS – Live Birth Rate (Age-Group Level 2010-2012)

Variables/ Measures	(1) OLS < 35	(2) OLS 35 - 37	(3) OLS 38 - 40
Ln (# of Doctors)	-0.282	-1.073	1.116
	(0.88)	(1.01)	(0.94)
Embryologist Dummy	1.048	0.081	-0.711
	(0.84)	(0.97)	(0.90)
Ln (Previous Year Cycles)	-0.382	-0.312	-0.270
	(0.24)	(0.27)	(0.25)
Surrogate Service	0.792	0.586	3.611***
	(1.20)	(1.41)	(1.30)
SART Member	0.105	1.043	1.033
	(1.19)	(1.36)	(1.27)
Ln (# Competitors in MSA)	0.327	-1.560*	-0.252
	(0.77)	(0.90)	(0.83)
Infertility Insurance Mandate	1.058	0.435	1.307
	(0.91)	(1.06)	(0.98)
Ln (State Income)	-2.187	2.293	1.197
	(3.20)	(3.71)	(3.41)
Ln (MSA Population)	-0.651	1.693**	-0.085
	(0.71)	(0.83)	(0.77)
Patient Fertility (Diagnosis)	1.004	7.912**	3.574
	(3.39)	(3.96)	(3.66)
# Embryos per Cycle (Age)	-3.875***	-2.672**	1.430
	(1.40)	(1.29)	(0.90)
MBG	**2.338*** **	**1.272**	**1.371**
	(0.86)	**(1.00)**	**(0.92)**
Year 2011	-1.738	-1.640	-0.874
	(1.16)	(1.35)	(1.25)
Year 2012	-1.677	-3.342**	-1.185
	(1.16)	(1.36)	(1.26)
Constant	81.704**	-9.771	2.236
	(36.25)	(41.87)	(38.38)
Observations	984	981	975
R^2	0.027	0.022	0.022

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table WA.6: OLS – Multiple Birth Rate (Age-Group Level 2010-2012)

Variables/ Measures	(1) OLS < 35	(2) OLS 35 - 37	(3) OLS 38 - 40
Ln (# of Doctors)	-0.450	-1.060**	-0.823
	(0.28)	(0.51)	(0.62)
Embryologist Dummy	-0.310	-0.645	-0.328
	(0.27)	(0.49)	(0.60)
Ln (Previous Year Cycles)	0.097	0.214	0.104
	(0.08)	(0.14)	(0.17)
Surrogate Service	0.015	-0.474	2.060**
	(0.38)	(0.72)	(0.89)
SART Member	0.446	0.711	-1.687*
	(0.38)	(0.70)	(0.87)
Ln (# Competitors in MSA)	0.279	-0.319	-0.206
	(0.25)	(0.45)	(0.55)
Infertility Insurance Mandate	-0.092	-0.553	-0.532
	(0.29)	(0.53)	(0.66)
Ln (State Income)	-1.014	-1.242	-1.389
	(1.03)	(1.87)	(2.29)
Ln (MSA Population)	-0.210	0.140	0.646
	(0.23)	(0.42)	(0.51)
Patient Fertility (Diagnosis)	-0.935	-1.542	2.567
	(1.09)	(2.03)	(2.51)
# Embryos per Cycle (Age)	3.861***	4.086***	1.863***
	(0.45)	(0.67)	(0.64)
MBG	**-0.182**	**0.097**	**0.193**
	(0.28)	**(0.50)**	**(0.61)**
Year 2011	-0.982***	-0.536	-2.141**
	(0.37)	(0.68)	(0.83)
Year 2012	-2.095***	-2.583***	-4.798***
	(0.37)	(0.69)	(0.85)
Constant	9.469	7.759	5.885
	(11.64)	(21.10)	(25.78)
Observations	984	959	933
R^2	0.157	0.094	0.076

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table WA.7: FIML – Number of Embryos per Transfer (Age-Group Level 2010-2012)

Variables/ Measures	(1) FIML < 35	(2) FIML 35 - 37	(3) FIML 38 - 40
Ln (# of Doctors)	-0.083***	-0.054**	0.033
	(0.02)	(0.03)	(0.04)
Embryologist Dummy	0.003	-0.009	0.010
	(0.02)	(0.02)	(0.03)
Ln (Previous Year Cycles)	-0.005	-0.002	0.002
	(0.01)	(0.01)	(0.01)
Surrogate Service	-0.002	-0.049	0.029
	(0.03)	(0.04)	(0.05)
SART Member	-0.155***	-0.056*	-0.128***
	(0.03)	(0.03)	(0.05)
Ln (# Competitors in MSA)	-0.014	-0.018	0.002
	(0.02)	(0.02)	(0.03)
Infertility Insurance Mandate	0.058***	0.091***	0.115***
	(0.02)	(0.03)	(0.04)
Ln (State Income)	-0.336***	-0.335***	-0.187
	(0.07)	(0.09)	(0.12)
Ln (MSA Population)	0.022	0.023	-0.013
	(0.02)	(0.02)	(0.03)
Patient Fertility (Diagnosis)	0.012	-0.001	0.097
	(0.08)	(0.10)	(0.13)
# Embryos per Cycle (Age)	-	-	-
MBG	**-0.122*** **	**-0.163*** **	**-0.197*** **
	(0.05)	**(0.06)**	**(0.07)**
Year 2011	-0.047*	-0.047	-0.074*
	(0.03)	(0.03)	(0.04)
Year 2012	-0.096***	-0.112***	-0.190***
	(0.03)	(0.03)	(0.04)
Constant	5.688***	5.783***	4.836***
	(0.81)	(1.02)	(1.36)
Observations	984	981	975
Wald Test for Model Fit	193.241	101.277	64.973
Rho	0.185	0.194	0.207
LR Test for Independent Eqs.	0.097	0.107	0.053

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table WA.8: FIML – Live Birth Rate (Age-Group Level 2010-2012)

Variables/ Measures	(1) FIML < 35	(2) FIML 35 - 37	(3) FIML 38 - 40
Ln (# of Doctors)	-0.377	-2.047*	0.763
	(0.95)	(1.15)	(1.15)
Embryologist Dummy	1.001	-0.371	-0.872
	(0.85)	(1.01)	(0.95)
Ln (Previous Year Cycles)	-0.407	-0.561*	-0.356
	(0.25)	(0.31)	(0.30)
Surrogate Service	0.682	-0.468	3.233**
	(1.27)	(1.53)	(1.48)
SART Member	0.085	0.753	0.932
	(1.18)	(1.39)	(1.27)
Ln (# Competitors in MSA)	0.342	-1.410	-0.211
	(0.77)	(0.91)	(0.83)
Infertility Insurance Mandate	1.142	1.243	1.596
	(0.96)	(1.16)	(1.12)
Ln (State Income)	-2.148	2.635	1.267
	(3.18)	(3.76)	(3.40)
Ln (MSA Population)	-0.674	1.469*	-0.149
	(0.71)	(0.85)	(0.77)
Patient Fertility (Diagnosis)	1.057	8.438**	3.755
	(3.37)	(4.02)	(3.66)
# Embryos per Cycle (Age)	-3.787***	-1.927	1.570*
	(1.43)	(1.37)	(0.94)
MBG	**2.947**	**7.311****	**3.439**
	(2.53)	**(3.45)**	**(4.02)**
Year 2011	-1.739	-1.653	-0.884
	(1.15)	(1.36)	(1.24)
Year 2012	-1.671	-3.288**	-1.177
	(1.16)	(1.37)	(1.25)
Constant	81.559**	-10.577	2.562
	(35.99)	(42.33)	(38.19)
Observations	984	981	975
Wald Test for Model Fit	20.627	23.694	20.415
Rho	-0.038	-0.317	-0.120
LR Test for Independent Eqs.	0.799	0.071	0.598

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table WA.9: FIML – Multiple Birth Rate (Age-Group Level 2010-2012)

Variables/ Measures	(1) FIML < 35	(2) FIML 35 - 37	(3) FIML 38 - 40
Ln (# of Doctors)	-0.297	-2.601***	-0.635
	(0.29)	(0.60)	(0.64)
Embryologist Dummy	-0.235	-1.366**	-0.246
	(0.27)	(0.57)	(0.61)
Ln (Previous Year Cycles)	0.138*	-0.174	0.148
	(0.08)	(0.16)	(0.18)
Surrogate Service	0.194	-2.174***	2.259**
	(0.39)	(0.84)	(0.91)
SART Member	0.478	0.286	-1.629*
	(0.38)	(0.82)	(0.87)
Ln (# Competitors in MSA)	0.254	-0.115	-0.224
	(0.25)	(0.53)	(0.55)
Infertility Insurance Mandate	-0.227	0.730	-0.689
	(0.30)	(0.62)	(0.67)
Ln (State Income)	-1.077	-0.657	-1.446
	(1.03)	(2.18)	(2.28)
Ln (MSA Population)	-0.173	-0.187	0.683
	(0.23)	(0.49)	(0.51)
Patient Fertility (Diagnosis)	-1.021	-0.811	2.483
	(1.09)	(2.37)	(2.50)
# Embryos per Cycle (Age)	3.719***	5.299***	1.778***
	(0.45)	(0.78)	(0.64)
MBG	**-1.166****	**9.638*****	**-0.899**
	(0.53)	**(0.51)**	**(1.20)**
Year 2011	-0.981***	-0.533	-2.142***
	(0.37)	(0.80)	(0.83)
Year 2012	-2.103***	-2.478***	-4.808***
	(0.37)	(0.80)	(0.84)
Constant	9.702	5.543	5.940
	(11.63)	(24.67)	(25.61)
Observations	984	959	933
Wald Test for Model Fit	184.860	423.825	77.082
Rho	0.191	-0.881	0.098
LR Test for Independent Eqs	0.030	0.000	0.290

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table WA.10: Probit for MBG (Age-Group Level 2010-2012)

Variables/ Measures	(1) Probit Clinic
Ln (# of Doctors)	0.476***
	(0.10)
Embryologist Dummy	0.253***
	(0.10)
Ln (Previous Year Cycles)	0.143***
	(0.03)
Surrogate Service	0.666***
	(0.16)
SART Member	0.252*
	(0.15)
Ln (# Competitors in MSA)	-0.061
	(0.09)
Infertility Insurance Mandate	-0.456***
	(0.10)
Ln (State Income)	-0.207
	(0.37)
Ln (MSA Population)	0.105
	(0.08)
Year 2011	-0.036
	(0.11)
Year 2012	-0.036
	(0.11)
Constant	-1.888
	(4.07)
Observations	984
Pseudo R^2	0.135

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1