Infertility Treatment Markets:
The Effects of Competition and Policy

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Abstract

For the 10%-15% of American married couples who experience reproductive problems, *in vitro* fertilization (IVF) is the leading technologically advanced treatment procedure. Two important issues are at the center of policy debates regarding IVF markets: 1) expanding access to infertility treatment, and 2) how to encourage IVF clinics and patients to minimize the risk of multiple births, which can be expensive and dangerous for both the mother and children. This paper evaluates the two principle policy proposals – insurance mandates and competition restrictions – for meeting these issues. Insurance mandates, which require that insurers pay for a couple's initial IVF treatments, succeed in attracting more patients into the market while also reducing multiple birth risks. Competition restrictions have been proposed as a way to reduce risky behavior by clinics and patients, but we find that this reasoning does not apply to the U.S. IVF market. Additional competition can substantially increase the number of patients without increasing the multiple birth rate.

Keywords: infertility; in vitro fertilization (IVF); access to IVF treatment; multiple births; insurance mandates; competition restrictions.

JEL Classifications: I110 Analysis of Health Care Markets; L100 Market Structure, Firm Strategy, and Market Performance: General

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1 Introduction

There is substantial debate in the United States over the appropriate policies to increase access to medical treatment and improve the quality of health care services. Some advocate universal insurance coverage or broad insurance mandates to ensure that individuals seeking care will be able to afford it, while others emphasize the role that competition could play in driving down costs and prices, hence improving both access and the quality of care.[1] Conversely, critics of each policy have suggested that these proposals may reduce welfare in medical markets.[2] A concern about expanded insurance coverage is that it will lead to moral hazard problems and the overprovision of medical services, while critics of competition argue that patients are relatively uniformed and health care providers will compete in ways that may actually reduce efficiency and quality. Unfortunately, it has been difficult to disentangle the impacts of insurance regulations and competition on the provision and quality of health care, since consumers may self-select (or be selected) into insurance plans, third-party payers may limit the choices available to individuals, and government regulations may limit firm entry and thus competition.

In this paper we study the market for infertility treatment, which is characterized by substantial variation in both insurance coverage and competition. Private insurance coverage of technologically-advanced assisted reproductive technologies (ART) such as *in vitro* fertilization (IVF)[3] is rare, but a small group of states have mandated that insurers provide generous coverage for infertility treatment. The entry of new ART clinics is largely unregulated, so competition varies across markets in response to local demand and cost conditions. These sources of variation allow us to evaluate how insurance and competition affect health care access and quality. We measure patients' access to treatment through the number ART cycles performed in a market,[4] and quality is captured by the birth rate (success rate) of an ART clinic along with its frequency of multiple births.

[1] Examples of these arguments can be found in Cutler [2004], who discusses the impact of universal insurance coverage on access to care, and Porter and Teisberg [2004], who argue for the benefits of enhanced competition in health care provision.

[2] Gruber [1994] summarizes the arguments for and against state health insurance mandates. Gaynor and Haas-Wilson [1999] provide and overview of the role of competition in health care markets. Dranove *et al.* [1992] investigate whether hospitals in competitive markets engage in a wasteful "medical arms race" to attract patients.

[3] Over 95% of ART treatments are IVF. In the remainder of the paper we often use these terms interchangeably, except where noted.

[4] An ART procedure consists of a sequence of treatments (a "cycle") performed over about two weeks.

Access to ART is a central issue in infertility treatment markets because of the large difference between the number of American couples who report reproductive difficulties and those who use ART. An estimated $10\% - 15\%$ of American married couples with a wife of reproductive age are infertile.[5] For these 5 million couples, infertility treatment can include simple medical advice, ovulation drugs, or the use of an ART procedure. Of these forms of treatment, ART procedures are the most technologically advanced, as they alone involve the deliberate creation of an embryo outside of a woman's body. Since the birth of the first test tube baby in 1978, IVF has spread rapidly and in 2001 accounted for 1% of all births in the U.S. But despite recent growth in the availability of ART, the procedure is sometimes regarded as an option primarily for the wealthy, given its high cost and the frequent absence of insurance coverage. IVF typically entails an out-of-pocket cost of \$10,000 - \$15,000 to the patient, with only a $25\% - 30\%$ chance of success (a birth). Advocacy groups and some lawmakers have suggested that insurers should be required to cover ART expenses. It is argued that infertility is a medical condition, and couples with unfavorable fertility characteristics should not bear extraordinary costs to receive medical care (Fidler and Bernstein [1999]). Arguments for mandatory insurance coverage have led some states to enact regulations which require varying forms of insurance coverage for infertility treatment. During our sample period of 1995 to 2001, thirteen states had mandates regarding insurance for ART costs. The ultimate extent of regulation is still an open issue, as two additional states enacted insurance mandates in 2001 while thirteen others are currently considering similar legislation. This state-level variation in regulation can lead to a so-called "zip-code lottery" in which couples who learn that they have a fertility problem are exposed by chance to different forms of insurance coverage.[6]

While generous insurance coverage can improve access to care, it is important to note that an increase in competition among clinics can lead to a similar result. Although insurance coverage substantially decreases treatment costs for couples whose insurance benefits have not been exhausted, coverage typically ends after a woman has made two or three attempts at IVF. Competition may have a less drastic effect on the prices couples pay for their initial cycles, but the benefits of competitive prices continue for all treatments that a couple might require or desire.

[5] Infertility is generally defined as the inability to become pregnant after 12 months of trying to conceive without contraception (Stephen and Chandra [2000]). Data from the 1995 National Survey of Family Growth indicate that 21% of childless women aged 35-44 have received infertility treatments (Abma *et al.* [1997]).

[6] We return below to the issue of whether variation in insurance regulations can be regarded as exogenous to a state population's propensity to seek treatment.

These issues related to ART access yield the first empirical objective of this paper: to measure the effect of insurance mandates and competition on patients' use of IVF.

ART treatment quality is affected by restricted access to care, since the out-of-pocket expense of IVF can substantially affect the choices made within treatment that determine the probabilities of births and multiple births, the primary measures of quality in this market. Both outcomes are influenced by the number of embryos that are transferred to the patient during treatment; this is determined jointly by the couple receiving treatment and their doctor. The current incentives and technology for infertility treatment has yielded a multiple birth rate that is much higher with ART ($30\% - 40\%$) than is true naturally (2%). This is seen as an important failing within ART, as multiple births are socially expensive and dangerous.[7] In this paper we assume that the highest quality outcome of an IVF cycle is the birth of a single healthy child.[8] Many of the immediate health costs of multiple births are paid by insurers, so moral hazard might influence patients' and clinics' choices on treatment intensity. An acknowledged policy goal of mandated insurance coverage for IVF is that these regulations will reduce patients' incentive to pursue aggressive treatment by reducing the costs of failure (Jain *et al.* [2002]).

Some observers of IVF markets have advocated limits on competition among clinics to further reduce multiple birth probabilities (Kolata [2002]; Bergh *et al.* [1999]; Wells [1999]). Their argument is that competitive pressures lead clinics to counsel aggressive treatment for their patients so that the clinics can advertise high success rates. However, this argument ignores the possibility that a monopoly clinic may exploit its market power to raise the price of an IVF cycle.[9] A patient who faces a high monopoly price may choose to transfer more embryos in order to reduce the likelihood that she will need to return for an additional expensive ART treatment. Thus, limits on competition may in fact increase multiple birth rates. The possibility that clinics will inflate their birth rates through aggressive treatment is also tempered by the many real costs of

[7] High-order pregnancies involve more health risks for a woman, and low-birthweight children require additional neonatal care and may experience more health problems later in life. Callahan *et al.* [1994] calculate the mean medical cost of delivering a singleton baby to be \$9,845, while a set of twins costs \$37,947 and triplets have a deliver expense of \$109,765.

[8] A twin birth may be the most desirable treatment outcome for a patient who wants to expand her family quickly, but we take the conventional view that the specific pursuit of a twin birth carries an undesirable risk of a very high-order gestation and birth which could harm both the woman and children.

[9] A survey of the literature by Dranove and White [1994] suggests that more concentrated hospital markets are associated with higher prices for hospital services.

multiple births that are not paid by insurers. Savvy patients should examine all aspects of clinic performance instead of ignoring twin and triplet probabilities. These (varying) predictions of how treatment choices and outcomes are determined yield the second empirical objective of the paper: to evaluate the effects of insurance mandates and competition on treatment success (i.e., quality) as measured through birth rates and multiple birth rates.

In order to achieve our empirical objectives, we define measures of insurance regulations and competition that are appropriate for ART markets. Treatment markets (metropolitan areas) may be located in states with no insurance regulation or they may have one of two forms of regulation: "Universal" and "Restricted" insurance mandates, which vary in the types of firms and insurers that are bound by these laws.[10] Similarly, we classify markets by whether they have zero, one, or two or more ("competitive") clinics. As we observe the activity of clinics and patients across ART markets, we take care to account for market characteristics (both observed and unobserved) that may complicate inference on how competition and insurance policy affect choices and outcomes. Previous studies, primarily in the medical literature, analyze the impact of insurance on IVF access and outcomes at the state rather than market level, while research examining the impact of competition on IVF outcomes treats market structure as exogenous and does not adjust for differences in observed characteristics (e.g., population, per capita income) across markets.[11]

Using a seven-year panel of clinic activity and a rich set of market characteristics, we find that an insurance mandate can increase IVF usage in a market, and women receive fewer embryos in markets with Universal insurance mandates. However, we note that an increase in competition expands ART access substantially as well, while also significantly reducing the number of embryos transferred. Among the new patients who may use IVF, we infer that a Universal insurance mandate induces more low-fertility couples to take treatment, while Restricted mandates and competition do not have strong effects on patient characteristics. The full effect of a Universal mandate on patient selection and treatment choices leads to a reduction in the multiple birth rate

[10] A small number of markets straddle state boundaries, and we account for the mixture of regulatory regimes within them.

[11] Jain *et al.* [2002] compares the number of IVF treatment cycles and outcomes in insurance mandate states with those in non-mandate states. Steiner *et al.* [2005] contrast IVF treatments and outcomes in markets with 1-2 clinics vs. markets with 3-7 and 8-22 clinics in 2000. In the economics literature, Schmidt [2005] and Bitler [2005] use Vital Statistics and Detailed Natality data to investigate the impact of insurance mandates for ART on population-level birthrates and infant health outcomes, respectively. Schmittlein and Morrison [2003] theoretically investigate the marketing and pricing strategies of IVF clinics.

for women under 35. Contrary to warnings about the deleterious effects of competition, we find that an increase in competition leads to a reduction in multiple birth risks for women both under and over age 35, even after accounting for the potential endogeneity of market structure. Finally, we examine market characteristics that attract the entry of new ART clinics, and we find that clinics are generally attracted to areas where women are more educated and wealthier.

2 A Primer on ART and IVF

2.1 What happens during an IVF cycle?

An individual or couple seeking infertility treatment generally begins with medical tests and advice on how to get pregnant without additional medical intervention. The next step is usually infertility drugs to stimulate egg production, for which the couple pays several hundred dollars out-of-pocket.[12] If these simple and relatively inexpensive treatment methods are unsuccessful or if the woman's reproductive window is closing due to her age, an ART procedure may be recommended by the doctor or demanded by the patient. ART is a procedure in which eggs are surgically removed from a woman's ovaries, combined with sperm in the laboratory, and embryos (fertilized eggs) are returned to the woman's body or donated to another recipient.[13]

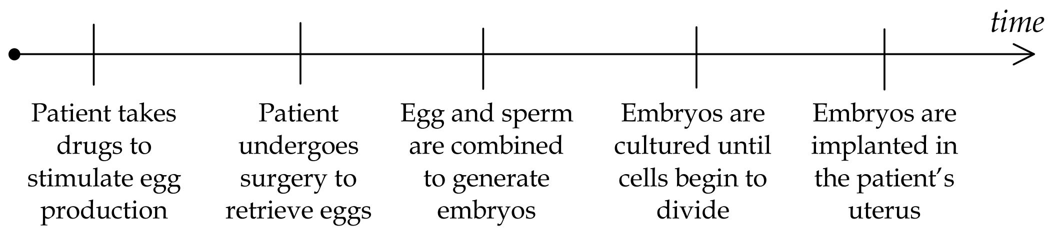
The dominant type of ART used in the U.S. is IVF. Events within a cycle of IVF treatment are illustrated in Figure 1. A woman first receives drugs that stimulate egg production. While there are broad guidelines for recommended dosages of these drugs to yield the optimal quantity and quality of eggs, the dosage received may vary by physician and patient. During this period, the woman visits the fertility clinic frequently to monitor egg development. The patient then undergoes surgery to retrieve the eggs for insemination in the laboratory. While the sperm and egg may be simply placed together to achieve fertilization, a more advanced technique known as intracytoplasmic sperm injection (ICSI) may be used.[14] With ICSI, a single sperm is injected

[12] Infertility drugs alone are lower-quality treatment than IVF in two ways. First, per-egg success probabilities are lower because fertilization is not assisted. Second, the variance in the multiplicity of embryos is higher because the drugs may generate a large number of eggs available for fertilization. The relatively low price of drug treatment combined with the high variance in multiple birth risk leads to the unfortunate coincidence of low income families and dangerously high-order pregnancies.

[13] An exception among ART procedures is gamete intrafallopian transfer (GIFT), which does not include combining eggs and sperm outside of a woman's body.

[14] In a related paper (Hamilton and McManus [2005]) we provide evidence that ICSI diffused first to competitive

Figure 1: An IVF Treatment Cycle



directly into the egg.[15] The use of ICSI generally adds $900 - $1200 to the $10,000 - $15,000 in expenses from the other steps of an IVF cycle. The drugs that are required during IVF account for approximately $3,000 of this expense, and these drugs are an out-of-pocket cost to the patients even if insurance coverage is present.

The fertilized embryos are then cultured in the lab for 2 to 6 days as the cells begin to divide. A lab technician grades the quality of the embryos, and a decision is made as to when embryos should be transferred into the patient's uterus. Additionally, the patient and her doctor must decide how many embryos will be transferred, based on embryo quality.[16,17] This is perhaps the most important decision made by the doctor and patient during the IVF treatment cycle. Increasing the number of embryos to transfer increases the likelihood of pregnancy. However, it also raises the likelihood of multiple gestation, which is associated with higher miscarriage rates and lower birthweights. If the patient has a large number of high-quality embryos and the lab is adept at culturing the embryos, the physician may delay the transfer until day 5 or 6. At this point

IVF markets.

[15] ICSI is used to increase the likelihood of fertilization, although some reproductive physicians may prefer more "natural" fertilization when possible for reasons of natural selection of the sperm. Hansen *et al.* [2002] examine birth defect risks among children conceived using IVF with and without ICSI, and they are unable to reject the hypothesis that defect rates are unaffected by ICSI use.

[16] In cases where the woman is unable to produce eggs, donor eggs from another woman, or frozen embryos from a previous IVF cycle may be used. These phenomena were not very common during 1995-2001, and we do not consider them in this paper.

[17] When there are "left over" embryos that are not transferred to the patient, the extra embryos are usually frozen and preserved. Schieve *et al.* [1999] use patient-specific ART data to test whether cryopreservation is a significant indicator of quality-based selection among embryos. They find that the presence of cryopreservation is positively correlated with live birth rates, but there was no significant relationship between this treatment practice and multiple births.

there is more information as to which embryos are the most viable; this allows the physician to transfer fewer embryos and minimize the multiple pregnancy risk for a given birthrate. Otherwise, the transfer is made more quickly following fertilization. A high-quality ART clinic will transfer fewer embryos and have a lower rate of multiple births while still maintaining a high pregnancy and birthrate. A low-quality clinic might transfer more embryos and have more multiple births in order to raise its birthrate.[18,19]

Between 1995 and 2001 the number of ART treatment cycles rose from approximately 60,000 to 108,000, and the number of ART-conceived babies increased from 16,600 to 40,700.[20] Table 2.1 summarizes recent state of IVF's popularity and practices. About half of all IVF patients are under 35 years old, and birthrates for the procedure decline with a patient's age. Relatively young women have an average success rate near 30%, while women over 40 give birth after only 10% of all cycles. Multiple birth risks also decline with age (while the average number of embryos rises); these factors together reflect the decline in fertility by age among IVF patients. It is important to note that changes to biological fertility as well as selection effects (through survivorship bias) create this pattern. During 1995-2001 overall IVF birthrates increased from 20% to 28%, while the multiple birth rate declined slightly from 38% to 36%.

2.2 Insurance mandates for IVF

Fifteen states currently have mandates regarding insurance for infertility treatment, summarized in Table 2.2. There are four important differences among these regulations. First and most obvious is the year that the mandate was enacted. Infertility treatment mandates were introduced as early as 1985 and as recently as 2001. There is typically a lag between when a regulation is passed and when it becomes effective, so we assume that a mandate becomes effective in the year

[18] Of course, these effects are complicated by variation in the innate fertility of patients. Once patients are allowed to sort themselves across clinics by their treatment needs, simple relationships between outcomes and quality are unlikely to exist.

[19] Some clinics also use less advanced forms of ART, which include gamete intrafallopian transfer (GIFT) and zygote intrafallopian transfer (ZIFT). GIFT and ZIFT are both more invasive than IVF and less frequently successful. Their combined market share peaked at 25% in 1990 and was 1% in 2001.

[20] Many of these children were born as a twin, triplet, or more. To calculate the number of babies born through ART in 1995, we assume that women giving birth to triplets or more had 3.2 babies, since the CDC did not report this number in that year. See Reynolds *et al.* [2003] for additional details on the relative importance of ART to multiple birth rates in the United States.

after its passage. Thus, we are unable to evaluate Louisiana's or New Jersey's 2001 insurance mandates. Second, the regulations vary in whether they include ART procedures. Some states (*e.g.* New York) explicitly exclude IVF from their mandates. Third, the laws that include IVF vary in whether they are mandates for insurance to *cover* treatment or simply *offer* coverage. The former is more generous; the latter can be completely toothless if an insurance provider chooses to offer ART coverage at a very high price. Finally, the coverage mandates vary in whether they require all firms and insurers to provide coverage (*i.e.*, coverage is "Universal"), or the mandates apply only to certain organizations (*i.e.*, the coverage mandate is "Restricted").[21] In this paper we analyze the effects of infertility regulations that were effective between 1995 and 2001, include IVF procedures, and are mandates to cover the expense of treatment. Among these mandates of interest, we treat Universal and Restricted coverage regulations separately in the empirical analysis of Sections 5 and 6.

3 A Model of the ART Market

Many factors simultaneously affect the choices of ART clinics and their potential patients. In order to better understand the main ways in which insurance regulations and market structure affect these choices, we present a simple model of an ART market. The model is static, with some discussion added to provide intuition for dynamic phenomena not covered by the model. In a related working paper (Hamilton and McManus [2003]), we provide a more rigorous analysis of dynamic decisions by patients and clinics.

3.1 Preferences, fertility, and technology

Assume that the market for ART treatment is populated with N initially childless couples (potential ART patients) who make one choice regarding reproduction. All couples share the goal of having one child, and the lifetime utility value of one child is B. Couples vary in their innate fertility, t, which is distributed uniformly on $[0, \gamma]$ with $\gamma < 1$. Couples, who have no uncertainty regarding their own value of t, may attempt to conceive naturally or use an ART clinic. Natural reproduction occurs with probability t, while a clinic with technology $k > 1$ provides the conception probability

[21] The most important differences among the insurance states concern which ART procedures are covered (*e.g.* ICSI) and whether all insurance providers in the market are subject to the regulation. For example, Arkansas excludes HMOs from its regulation, while the Ohio and West Virginia mandates apply to HMOs only.

$\phi(t,k) \geq t$. For convenience, we parameterize ϕ as $\phi(t,k) = kt$ for $t \leq \gamma/k$ and $\phi(t,k) = \gamma$ for $t > \gamma/k$. An advantage of this functional form is that a higher k implies (weakly) higher birth probabilities; this is illustrated on Figure 2. Additionally, $\phi(0,k) = 0$ and $\phi(\gamma,k) = \gamma$, so very low and very high fertility couples do not gain much from using the clinic's services. The clinic collects a price of p for each use of its services, and couples pay the additional fee d (for drugs and other expenses) when they use ART. Let $x = p + d$ be the full expense of one ART cycle. The disutility from x is αx, where α is interpreted as price sensitivity. Variation in tastes for ART across markets, perhaps due to wealth or household characteristics, may be incorporated through variation in α.

We assume the ART clinic uses the same technology in treating all of its patients, and all patients are charged the same price. Clinics' choices of k are not analyzed in this paper, but are covered in Hamilton and McManus [2003].

3.2 Optimal choices by patients

We begin by considering what happens when the N couples in the ART market have the opportunity to use a monopoly clinic. Given the clinic's p and k, couples evaluate whether they will purchase treatment by comparing the expected utility from their two options. The return from treatment is $B\phi(t,k) - \alpha x$, and a couple has expected utility of Bt if they forego ART. The simple form of ϕ yields a pair of indifference conditions that defines the set of couples who seek treatment. Couples with values of t in $[t_1, t_2]$ use the ART clinic,[22] with

$$t_1 = \frac{\alpha x}{B(k-1)} \quad \text{and} \quad t_2 = \gamma - \frac{\alpha x}{B}.$$

These couples have the largest gain in birth probability from treatment. The separation of couples across reproduction options is illustrated in Figure 3. The set of fertility types who choose treatment expands with technology k and contracts with p (through x). Also, if we decrease price sensitivity – perhaps because couples become more wealthy or they have not spent as much in periods prior to the present one – the measure of treated couples increases.

[22] We assume that the zero-measure population of consumers who are indifferent among treatment options always break these ties by taking "more" treatment.

3.3 Extensions to insurance, embryos, and competition

We now consider a group of extensions to the simple model introduced above. A thorough consideration of many issues related to the ART market requires a dynamic model of repeated reproductive decisions. We believe that including such a model is beyond the scope of the present paper, but many of the relevant dynamic issues may be explored sufficiently if we simply think of patients going through several iterations of the choices described above.

3.3.1 Insurance

Mandated insurance coverage allows couples to take a small number of cycles with the clinic's fees (p) covered by their insurance providers, but the expenses of all subsequent cycles are paid out-of-pocket. We model this policy as the opportunity for a couple to take one cycle under insurance. This reduces the total expense of treatment to d for an insured couple. The direct price effect of this change in x expands the fertility thresholds t_1 and t_2, and the market grows as new lower- and higher-fertility couples are treated. In addition, the effect of insurance mandates on birthrates depends on the relative fractions of low- and high-fertility patients induced to enter the IVF market as a result of insurance.

The dynamic effect of the limited insurance policy is likely to move patients toward earlier treatment. Consider a couple's trade-off between enhanced fertility today and additional consumption (and possibly treatment) tomorrow. A high out-of-pocket p means that the benefits of delaying ART include a substantial avoided cost if the couple becomes pregnant naturally while young. Insurance reduces this benefit of waiting, and couples will take treatment earlier.[23] As a result, we expect insurance mandates to expand the IVF market relatively more for younger couples than older couples.

3.3.2 Embryos and insurance

As noted in Section 2, perhaps the most important decision within an IVF treatment concerns the number of embryos transferred to the woman. Suppose that a couple can choose to take either

[23] An additional implication of optimal choices for insurance is that couples who plan to take treatment multiple times if necessary (beyond what their insurer would cover) should use their insurance coverage on their first trips to the clinic. The couple would not want to "risk" success on their first try at ART while paying out-of-pocket and leave their insurance coverage on the table.

one or two embryos for the same treatment price p.[24] The one-embryo option is exactly as we describe treatment in Section 3.1. The two-embryo choice increases the chance of a birth as if k has increased to λk, with $\lambda > 1$. We assume that the probability of twins conditional on two embryos is τkt, so that chance of bearing twins is increasing in the clinic's general level of k and the couple's innate fertility. The probability of a singleton birth conditional on two embryos is $\phi(t, \lambda k) - \tau kt$. The utility value of twins is $(1-\delta)B$, with $\delta \in (0, 1)$ to capture the additional costs and risks associated with multiple births.

This specification of ART technology leads lower-t couples with $t \in [t_1^E, t_2^E]$ to choose two embryos, while higher-t couples with $t \in (t_2^E, t_3^E]$ take one embryo.[25] These threshold values of t have the property $t_1^E < t_2^E < t_3^E$, and

$$t_1^E = \frac{\alpha x}{B[k(\lambda - \delta\tau) - 1]} \qquad t_2^E = \frac{\gamma}{k(1 - \delta\tau)} \qquad t_3^E = \gamma - \frac{\alpha x}{B}.$$

Couples with fertility less than t_2^E have the most to gain from an additional embryo because their chance of twins is relatively small. We illustrate this separation among couples on Figure 4. If one-time insurance coverage becomes available, we expect the market to grow (a reduction in t_1^E and an increase in t_3^E) due to the price effect of insurance. Because couples pay the same price for treatment regardless of the number of embryos, insurance does not immediately affect t_2^E. However, this threshold might decrease due to an intertemporal income effect. The large out-of-pocket expense of ART may encourage couples without insurance to take more aggressive treatment (*i.e.*, two embryos) because they cannot afford treatment again in a later period. Insured treatment in the present period allows couples to carry more assets into subsequent periods. Overall, the effect of insurance on embryo choice is ambiguous. For a given k, the average number of embryos declines if t_2^E falls and t_3^E increases sufficiently to outweigh the entrance of new low-fertility couples into the market. Note that a reduction in multiple birth risk (average embryos weighted by birth probabilities) does not imply a reduction in multiple births. The increase in the number of treated two-embryo couples may overwhelm a reduction in twins risk.

[24] This assumption is empirically accurate.

[25] We require the model's parameters to take "reasonable" values so that both embryo choices are selected and the market shares are adjacent in t.

3.3.3 Competition

Finally, we consider how competition among clinics may affect the market. We return to our base assumptions about the market, without insurance coverage or embryo choices. Suppose there are n symmetric clinics which engage in a simultaneous-move quantity game (Cournot competition). Each clinic has a marginal cost of c and a fixed entry cost of F. The proportion of the population who purchase from the clinics is $s = [t_2 - t_1]$, with the values of t identical to those in the monopoly setting considered above. Given the aggregate market share s, market demand is $Q = N \times s$. The simple form of the critical t values yields a linear inverse demand function,

$$p(Q) = \left[\frac{B\gamma(k-1)}{\alpha k} - d\right] - \left[\frac{B(k-1)}{\alpha k N}\right] Q.$$

This demand function can be written as $p(Q) = a - bQ$ with the appropriate construction of the parameters a and b. The equilibrium quantity choices of the n clinics yields a price $p = \frac{a+cn}{n+1}$, which is decreasing in n. It is obvious that a reduction in p increases quantity by expanding the interval $[t_1, t_2]$. It is also important to note that an increase in n (and subsequent reduction in p) affects the distribution of fertility characteristics for treated patients. Thus, success rates and embryo transfer decisions are likely to be affected by the level of competition in a market even if doctors' treatment incentives are not subject to concerns about harmful "birthrate races."

This model also provides a good opportunity to consider the empirical implications of clinics' equilibrium entry decisions. Conditional on n clinics in a market and equilibrium quantity choices, each Cournot competitor receives profit equal to $\pi = \frac{1}{b}(\frac{a-c}{n+1})^2 - F$. We expect that potential clinics enter a market until additional entry leads to negative profit, which means that markets with lower entry costs or a larger consumer population will support more clinics in equilibrium. Similarly, suppose that differences across markets are described in a simple way, with the demand intercept a written as a linear function of observed (X) and unobserved (ε) factors: $a = X\beta + \varepsilon$. Markets with high values of a will attract more clinics, and the interaction of local tastes and competitive prices will lead to changes in the number of treated patients and their success probabilities. It is a goal of this paper to evaluate the independent effect of an increase in n on patients' choices and treatment outcomes. To this end, we must beware of variation in differences in unobserved tastes for ART (ε) that are correlated with both n and treatment choices. This intuition motivates our discussion below of cost-shifting instruments that can affect market structure for a fixed set of demand characteristics.

This simple Cournot model is primarily helpful in illustrating how markets with competitive prices can increase quantity while also affecting the average fertility characteristics among treated couples. If we extend the model to include differentiation among clinics, the effects of changes to competition can be greater. Spatially differentiated clinics within a market may lead to better matches between clinics and potential patients. Vertical differentiation in technology levels (through different values of k) may lead to higher-technology clinics serving patients with greater medical needs, while lower-technology options are available for couples who do not need highly specialized treatment. However, this sorting pattern suggests caution in attempting to infer clinic quality from success rates. Although a high-k clinic can provide a better success probability to a couple of fixed t than the low-k clinic, in equilibrium the high-k clinic may report a lower success rate for its patients. See Hamilton and McManus [2003] for a consideration of equilibrium price and technology choices in a market with two vertically differentiated ART clinics.

4 Market and IVF Clinic Data

Our data on ART clinics cover two distinct periods and come from two sources. The primary data, which cover the years 1995-2001, are clinic-level treatment statistics that are available from the Centers for Disease Control and Prevention (CDC). These data aggregate treatment and outcome information within several patient age categories, and we use these data for our main analysis of insurance and market structure on IVF treatment. We supplement the primary data with additional information on clinic activity during 1987. These secondary data are the result of a congressional subcommittee hearing led by (then-) U.S. Representative Ron Wyden in 1989 and were provided to us by the Society for Advanced Reproductive Technology (SART). While the 1987 sample does not provide information on embryo transfer or comparable multiple birth rates, we show below that the data provide useful support for the exogeneity of insurance mandate laws.

Each data set contains information from virtually every clinic in the U.S., so we treat the data as exhaustive.[26] There are 566 unique clinics in the data, with 114 of the 173 clinics that operated during 1987 appearing in both data sets. Between 1995 and 2001 the number of clinics grew from 257 to 418.

The remaining data are: demographic information from the U.S. Census Bureau, the number

[26] Reporting for both data periods was federally mandated. The 1987 data were collected via subpoena for the Wyden hearing. The CDC estimates that it has obtained data for 95% of all clinic-year combinations between 1996 and 2001. Unfortunately for the purposes of this research, clinics have never been asked to report their price schedules.

of Catholics in each U.S. county from the Glenmary Research Center [2002], hospital and medical personnel data from the Area Resource File, and information on states' Certificate of Need (CON) laws provided to us by the Missouri CON Program. Many of these variables are observed annually, but in some cases we have data from 1990 and 2000 only. In these cases we fill in the data for the missing years via linear interpolation.

4.1 Markets

We assume that the U.S.'s Metropolitan Statistical Areas (MSAs) comprise the markets for ART services. When multiple U.S. counties or MSAs together form a Combined Statistical Area (CSA), we use the CSA's boundaries to define the market. For example, Washington D.C. and Baltimore each have their own MSAs, but the Census Bureau has identified a CSA that includes both of these MSAs. Two aspects of ART treatment support our assumption about market boundaries. First, during 1987 and 1995-2001, only 5 clinics (with 21 clinic-year combinations) operated outside of an MSA. Second, we believe that ART treatment is expensive and important enough to compel a couple to travel across a metropolitan area to receive the treatment they think is best, but the repeated clinic visits required for an ART cycle are likely to restrict a couple from seeking treatment outside of their home city.[27] The number of MSAs with at least one clinic grew from 72 to 98 between 1987 and 1995, and to 107 by 2001. Most of the entry by new clinics occurred in markets where other clinics were already present.

4.1.1 Demand shifters

The number of clinics in a market and the number of treatment cycles are affected by several important exogenous demographic characteristics. MSAs with ART clinics tend to be larger, richer, and have more educated residents. See the top half of Table 4.1 for a description of markets with and without ART clinics in 2000.[28] It is not surprising that a large population of potential patients is required to support clinics with substantial fixed costs of entry. It is interesting to note that MSAs with clinics have larger percentages of women working and with post-secondary degrees. This supports the notion that clinics may largely serve women who delayed childbearing in favor of education or employment. We note the percentage of Catholics in the market because

[27] Steiner *et al.* [2005] also treat the MSA as the relevant market for ART.

[28] We choose to report statistics for 2000 (rather than 2001) because of the 2000 decennial census.

this is the only major religion in the U.S. which counsels its adherents to forego IVF and virtually all other infertility treatments (U.S. Congress Office of Technology Assessment [1988]).

4.1.2 Cost shifters

We are concerned that the number of firms in a market is correlated with unobserved factors that also affect consumer demand and treatment decisions. For example, suppose that couples in a certain market are especially disposed to attempt IVF if they encounter reproductive difficulties. This factor would likely increase the equilibrium number of clinics in a market, thereby leading to correlation between market structure and an unobserved component of patients' tastes. Additionally, we argued above that treatment decisions (*e.g.*, number of embryos) are related to patients' characteristics, and the distribution of treated couples' traits changes as demand shifts and more clinics enter a market. Since we use competition as a predictor of access and quality measures in our analysis below, we obtain a set of four cost-shifting instruments to control for the endogeneity of market structure. Summary statistics for these variables are provided in the bottom half of Table 4.1.

In general, ART clinics face high fixed costs for equipment, and they need trained embryologists and lab personnel. We identify two instruments – the number of hospitals in a market and the number of beds per hospital – with fixed costs in mind. Many clinics are associated with hospitals, with which they may share administrative expenses, medical facilities, and equipment. We anticipate that larger, more specialized hospitals are more likely to have equipment or services that might be shared with an IVF clinic.

Two additional instruments – the number of research MDs per capita and a measure of regulatory barriers to entry – are motivated by labor supply issues. IVF procedures are generally performed by reproductive endocrinologists, who are research-oriented gynecology specialists. These doctors need lab personnel who will work productively in the clinic, and we expected that personnel with the appropriate characteristics are easier to find in markets with a high number of research MDs. The entry barriers are Certificate of Need (CON) laws, which restrict the establishment of new medical facilities. While CON laws do not apply directly to infertility clinics, a market with restrictive CON laws will have fewer potential workers with training or experience in medical offices and labs. In our empirical analysis, we use a "CON score" measure constructed by the Missouri CON Program which accounts for the number and severity of these laws (a higher value implies stricter laws).

4.1.3 Insurance

We incorporate insurance mandates into our data by calculating the portion of each MSA's population under an IVF-specific regulation. This treatment of insurance coverage accounts for MSA boundaries that cross state lines. For example, the St. Louis MSA is a mixture of Missouri and Illinois counties, and these states differ in their insurance regulations. Our coverage measure therefore accounts for the fact that some of the patients at Washington University's IVF clinic, which is located in Missouri, live and work in Illinois. An MSA that is entirely within one state is a simpler case – all of its population is exposed to the same insurance regime. This situation is also much more common; only 5.2% of markets are a combination of states with and without insurance mandates.

Out of 2,226 market-year combinations from 1995 to 2001, there are 196 observations (8.8%) that are associated with a Universal insurance mandate. 238 market-year combinations (10.7%) are associated with a Restricted mandate. No markets cross state boundaries in a way that leads to both regulations existing in the same market.

A shortcoming of our data is that we do not know the decisions of insurance companies to offer ART coverage when they are not legally obligated to do so. However, it is reasonable to assume that privately offered insurance for IVF would be more expensive than other insurance options within the same market, and fewer potential patients in unregulated states would receive ART under insurance coverage.

4.1.4 Are insurance mandates exogenous?

An obvious concern in our empirical analysis below is whether observed differences in ART usage rates, treatment decisions, and birth outcomes are due to regulatory policy or market- (or state-) specific unobserved preferences for infertility treatment. This is important for policy, since we would like to know whether a mandate actually increases ART usage or simply provides a transfer to treated couples who would have purchased treatment even without a subsidy through insurance. We investigate the exogeneity of insurance mandates with respect to preferences for IVF treatment in two ways.

First, in Table 4.2 we compare states with and without IVF-specific insurance mandates to determine how residents of these groups of states are different in their *observable* characteristics. At the top of the Table we present demographic measures that may be related to families' childbearing decisions or likelihood to take infertility treatment. The demographic variables we consider include female labor force participation rates, female educational attainment, average family size, and median household income. The measures, which are collected from the 1990 decennial census, do not differ significantly between the nine states with IVF-specific coverage regulations and the remaining states. The bottom rows of Table 4.2 show that the main observable difference between states with and without IVF regulations appear to be in their residents' preferences for government intervention in medical markets. IVF regulations tend to be a small part of a broad slate of insurance mandates that cover a variety of health issues. The presence of an IVF mandate is correlated with laws that support colorectal cancer screenings, Medicaid funding of abortions, and mental health parity.[29] Moreover, residents of IVF insurance states are more likely to vote for a Democrat in presidential elections. These findings are evidence that state residents vary in their governing tastes but not necessarily their preferences for children or other related life-cycle decisions.

Second, we search for evidence of *unobserved* differences between states with and without IVF-specific mandates by analyzing the 1987 data on clinic size and the number of clinics in each market. As we discussed in Section 2, few states had implemented insurance mandates by 1987. Consequently, we estimate a "pre-program" regression (Heckman and Hotz [1989]) of the number of patients receiving treatment at ART clinics in 1987 as a function of future regulatory status along with other contemporary control variables. If a particular state's residents are especially disposed to take infertility treatment independent of the regulatory environment, then the markets in these states will exhibit high treatment levels even before an insurance mandate is approved. The coefficient estimates presented in the first column of Table 4.3 show that this is not the case. Clinics in markets that will be covered by a Universal mandate in the future actually see fewer patients than clinics in markets that never adopt a mandate, although the difference is not statistically significant. In addition, the second column of Table 4.3 indicates no significant difference between the number of clinics in future-mandate and never-mandate markets. Combined with our findings from Table 4.2, we conclude that residents of mandate states do not differ from others in their underlying preferences for infertility treatment, and that the passage of mandate laws appears to

[29] One might argue that the extensive use of health insurance mandates in states with coverage for IVF may lead employers to drop insurance coverage for employees or to self-insure. If true, mandates may have little effect on access to IVF. However, Gruber [1994] finds no evidence that states with more mandates have lower rates of insurance coverage or higher rates of self-insurance.

reflect the political preferences of these state residents for government intervention in a wide variety of medical markets.

4.1.5 Competition

We characterize the amount of competition in a market with a simple discrete indicator for whether the market is a monopoly. In 1995 51% of all markets with clinics were monopolies, and by 2001 this figure fell to 43%. The mean number of clinics in a market (conditional on at least one clinic) from 1995 to 2001 was 3.2, with this statistic increasing from 2.6 to 3.5 during this period.[30] The distribution of clinics across markets is quite skewed; a small number of highly populated markets contain a relatively large number of clinics. During 1995-2001, the MSAs with the five largest populations had an average of 18.5 clinics.[31]

4.2 Clinics and infertility treatment

The treatment data are aggregate statistics that track the progress of cycles initiated at an ART clinic. The statistics are divided into a few categories by patients' ages, but the ages that define the boundaries of these categories vary from year to year. In order to handle these categories consistently across years of data, we combine the treatment statistics into two broad age groups for patients: under and over 35 years old. Age 35 is near the median patient age.

We take a preliminary look at the relationship between insurance coverage and demand with the statistics in Table 4.4. We divide the markets with clinics into three groups: without insurance regulation, with a Restricted mandate, and with a Universal mandate. Markets covered by Universal mandates have more clinics and each clinic treats a substantially larger number of patients. Restricted mandates appear to have little impact on clinic entry and modest effects on clinic size. However, Universal and Restricted mandates have similar effects on treatment decisions and outcomes. Embryo transfers, birthrates, and multiple birth rates under both types of insurance mandate are lower than those in other unregulated markets. This may be evidence of more conservative treatment practices for women with insurance, but the statistics may also be driven by differences in the characteristics of women who receive treatment under the mandates.

[30] Additionally, the treatments were fairly concentrated within markets. The average Herfindahl-Herschman Index (HHI) in the markets is over 7,300.

[31] The five markets are New York City, Los Angeles, Chicago, Washington D.C-Baltimore, and San Francisco. All are CSAs. Within these markets, the mean HHI is 1,478.

This provides additional motivation for the more detailed analysis below, in which we can more carefully assess the relative impact of the different types of insurance regulation.

We provide a similar preliminary analysis of market structure and IVF treatment in Table 4.5. Competitive clinics are larger than those in monopoly markets. In the other measures presented in the Table, monopoly and non-monopoly clinics appear to perform very similarly. Differences across market structure in embryo transfers, birthrate, and multiple birth rate are miniscule. Thus, simple data analysis suggests that there is little to fear from ART treatment practices when competition intensifies. In fact, in Section 6 we show that competition leads to significantly more conservative treatment once we account for the effect of other demand shifting variables and control for the endogeneity of market structure.

5 What Determines the Number of Clinics in a Market?

In the Sections above we conjectured that certain demographic and policy variables affect the existence and behavior of ART clinics. These predictions may be divided into two broad areas, market-level and clinic-level effects. We begin our empirical analysis by investigating whether insurance regulations affect the number of ART clinics in a market. This is also an opportunity to learn which demographic features of a market attract additional clinics.

Entry of new IVF clinics and subsequent price competition clearly benefits potential patients by expanding access to treatment. A market may attract clinics because of characteristics such as high incomes or a large population of likely patients. Additionally, the increase in demand for ART that is likely to follow an insurance mandate may lead to the establishment of new clinics. If insurance mandates stimulate clinic entry, this would provide an additional indirect benefit of insurance regulation to ART patients. Competition among clinics would reduce treatment expenses for patients whose insurance coverage is exhausted and are required to pay for ART out-of-pocket.

We use an ordered probit model to estimate the effects of various market characteristics and insurance policy on the number of clinics. For market i in year t, we define the vector X_{1it} to contain the demand- and cost- shifting variables discussed above, and the vector $INSUR_{it}$ to include measures of Universal and Restricted insurance mandates for i. Further, we assume that there are unobserved components to tastes and fixed costs among the potential entrants in i that are captured in the error term ε_{it}. Let ε_{it} be distributed $N(0,1)$, iid across markets (i), but clustered within i across t to account for local variation in tastes. We assume that n^* is a latent, continuous measure of the competition in each market in a free entry equilibrium, and $n_{it}^* = X_{1it}\theta_1 + INSUR_{it}\theta_2 + \varepsilon_{it}$. While we do not observe n^*, we estimate θ with n, the actual number of clinics in i during t. This empirical model differs from the static entry models more commonly specified in the industrial organization literature.[32] These models explicitly account for the way in which a firm's profit falls as the number of competitors in a market increases. We choose our entry specification in order to facilitate analysis of a different set of issues. Specifically, we use the results of our entry model to construct instrumental variables estimates of the impact of competition on IVF access and outcomes in the clinic-level analysis in the next section.

The results from our entry model using data from the years 1995 to 2001 are presented in Table 5.1. The summary statistics in Table 4.4 indicated that an insurance mandate appears to have a greater effect on the size of clinics than their number. This pattern is confirmed in the ordered probit estimates, which show no significant effect of insurance mandates on the number of clinics.[33] Not surprisingly, the number of clinics in a market is positively and significantly related to the market's median income, given that ART is usually a fairly expensive patient-pay procedure. Also, greater female educational attainment is positively related to the number of clinics in the market, but the parameter estimates are not statistically significant. Finally, the proportion of a market's population that is Catholic has no significant effect on the number of clinics.[34]

To verify that we have selected an appropriate set of cost-shifting instruments to control for the endogeneity of competition in the analysis below, we also report the effects of these variables within the ordered probit model. The instruments' coefficients have the expected signs. Two instruments (the number of hospitals, the number of beds per hospital) have a statistically significant effect on the number of ART clinics. We interpret these results as indicating that the instruments can jointly have a substantial effect on the number of clinics in a market.

[32] See Bresnahan and Reiss [1991] for a study of entry in homogeneous-product markets. See Mazzeo [2003] or Seim [2004] for examples of how to incorporate product differentiation into an entry model.

[33] A similar result is uncovered by Abraham, Gaynor, and Vogt [2003] in their study of factors that affect hospital entry. The authors find that the presence of an HMO reduces entry in a market.

[34] The insignificant effect of population on entry is likely due to the correlation of this variable with the number of hospitals. If we remove the number of hospitals from the model, population has a significant positive effect on entry. Also, removing the hospital count from our instrument set in Section 6 has no qualitative effect on the IV model estimates show in Tables 6.1-6.6.

6 Clinic-Level Effects of Insurance and Competition

A primary objective of insurance mandate legislation is to improve couples' access to and usage of ART. Despite the insignificant effect of insurance on clinic entry reported above, our summary statistics indicate that couples with mandated insurance coverage may still receive ART treatment at a relatively high rate. Indeed, a policy-maker who is primarily concerned about access to ART may not have a strong preference among possible market structures, so long as the number of patients receiving treatment increases significantly. In addition, substantial concern has been expressed regarding the potentially perverse impacts of competition on decisions concerning patient treatment, in the form of a clinic "birthrate race." We now consider the impact of insurance and competition on clinic treatment decisions and outcomes. In this section, we employ the following regression model:

$$y_{aijt} = \alpha_{1a} INSUR_{it} + \alpha_{2a} COMP_{ait} + \alpha_{3a} Z_{aijt} + e_{aijt}. \quad (1)$$

For patients of age category a in market i at clinic j during year t, we regress treatment practices or outcomes (y_{aijt}) on measures of i's insurance mandate status ($INSUR_{it}$), a measure of the competitiveness of the market ($COMP_{ait}$), and a vector (Z_{aijt}) of demand-shifting features of the market and the clinic's characteristics.[35] As in the previous section, $INSUR$ is a two-entry vector that contains the percentages of market population living under a Universal and Restricted IVF coverage mandates. $COMP$ is a dummy variable equals one if clinic i operates in a market with 2 or more clinics, and zero if it is a monopoly.[36] The error term e_{aijt} accounts for unobserved clinic and market characteristics.

We suspect that our measure of competition may be correlated with e, so we report two sets of estimates for each regression model. First, we estimate (1) under the assumption that the number of clinics is exogenous, as in OLS. Next, we estimate (1) while treating $COMP$ as a dummy endogenous variable. Following the suggestion of Angrist (2001), we correct for endogeneity by

[35] Variables in Z include the population of women in age category a, median income, measures of labor force participation and education for women in a, percent Catholic, and year dummies. At the clinic level, we include a dummy variables for whether the clinic is associated with the Society for Assisted Reproductive Technology and whether the clinic accepts single women as patients.

[36] We also estimate two supplemental specifications. First, we decompose non-monopoly markets into those with 2 to 4 clinics and 5+ clinics in order to investigate the impact of high levels of competition on outcomes. Second, we estimate the model with HHI as our measure of competition. The qualitative patterns in the results are largely unchanged. These results are available from the authors upon request.

using estimates similar to those reported in Table 5.1 to predict whether a market will not be a monopoly as a function of Z, $INSUR$, and the cost-shifters.[37] These predicted values are then used as instruments for $COMP$ in the second stage estimation of (1). In the discussion below, we refer to the set of estimates obtained under the assumption of exogenous $COMP$ as OLS and the estimates that treat $COMP$ as endogenous are identified as IV results.

6.1 Do clinics grow with insurance and competition?

We first investigate how insurance affects the size of individual clinics in a particular market, and how the effects of competition are distributed across clinics. Focusing on the IV estimates, the second column of Table 6.1 shows that a clinic in a market covered by a Universal mandate treats approximately 58% more patients under 35 than does a clinic in a non-mandate market, while the impact of a Restricted mandate is substantially smaller in magnitude and is not significant. As we argued in Section 3, comparison of the second and fourth columns of the table suggests that younger patients are more responsive to Universal mandates than are women over the age of 35. Older women are more likely to have already exhausted their insurance benefit, implying that mandates will have less effect for this group. In addition, alternative infertility treatments such as hormone therapy are less effective for older women, leaving IVF as their primary option. Consequently, insurance mandates are less likely to induce substitution of IVF for alternative treatments among patients in this age group. Overall, despite evidence that insurance mandates do not encourage clinic entry, they do appear to improve access to IVF treatment through the increased scale of clinics in Universal mandate markets.

There is a substantial positive effect of competition on clinic size in the IV estimates. We interpret this result as a positive one from a welfare perspective, because it indicates that the expanded number of cycles in a more competitive market is not associated with severe market share cannibalization and redundant expenditures on fixed costs. Additionally, the increased firm sizes are consistent with the a reduction in price-cost margins in a free entry equilibrium. If additional entry causes downward pressure on margins, then each clinic must serve a greater

[37] We re-estimate the ordered probit model from Section 5 conditional upon the existence of at least one clinic in the market, and use these coefficient estimates to construct predicted values. The magnitude and significance of the coefficients in this specification is very similar to those presented in Table 5.1, and are available from the authors upon request.

number of patients in order to cover its fixed costs.[38]

6.2 What affects embryo transfers?

In the model presented in Section 3, we noted two important factors that affect the number of embryos transferred. First, we must consider the characteristics and optimal choices of new patients who enter the market because of lower treatment prices due to insurance and competition. Second, we note that an individual's dynamic treatment strategy with regard to embryo choice may be affected by the intertemporal income effects of insurance coverage and competitive prices. We now ask whether these relationships among market characteristics and treatment procedures exist in the data. Recall from Section 2 that a reduction in transferred embryos lowers the risk of a multiple pregnancy and birth. A concern about competitive ART markets is that clinics engage in a "birthrate race" and transfer "too many" embryos in order to increase their birthrates, although this also increases the chance of a multiple pregnancy. To differing extents, clinics and patients do not bear all of the costs of a multiple pregnancy and birth.

We report the effects of insurance and competition on embryo transfers on Table 6.2. We find that a Universal insurance mandate leads to a significant reduction in the number of embryos for patients under and over 35. Restricted mandates do not have an appreciable effect on patients in either age category. By themselves, these results do not firmly establish that Universal mandates reduce moral hazard in embryo transfers while Restricted mandates do not. It is possible that the new patients who are brought into the market with insurance simply have different fertility characteristics than those served in an unregulated market, and the observed embryo patterns reflect different choices made by women who face the same incentives with and without an insurance mandate. However, our results in the next section on birthrates imply that it is unlikely that high fertility couples are disproportionately induced to attempt IVF by a Universal mandate. Less fertile couples (who need more embryos to achieve a desired birthrate) appear to be encouraged to enter the market, so more comprehensive insurance mandates are effective in encouraging clinics and patients to transfer fewer embryos.

We find no evidence that additional competition leads to patients receiving an increased number of embryos relative to individuals in monopoly markets. Patients transfer significantly fewer embryos at clinics in competitive markets, especially among women over 35. Moreover, if we decompose $COMP$ into markets with 2-4 and 5+ clinics, we find that the reduction in embryo

[38] See Bresnahan and Reiss [1991].

transfer remains significant in highly competitive (*i.e.*, 5+ clinics) markets.[39] We also infer in the next section that treated couples in monopoly markets do not have better fertility characteristics than those in non-monopoly markets, so we conclude that the reduction in embryos at clinics in competitive markets is due to shifting incentives rather than patient selection. This is evidence against the assertions of medical researchers that increasing levels of competition will lead to more aggressive embryo transfers and higher risks of multiple births. While we do not have data on prices charged by fertility clinics, the evidence in Section 6.1 on clinic size suggests that competitive clinics charge lower prices. As we argued in Section 3, lower prices may create an incentive for patients to reduce embryo transfers.

6.3 Birthrates, multiple birth risk, and patient selection

The introduction of an insurance mandate or a reduction in clinic concentration increases the number of couples in a market who receive fertility treatment. Are these couples more or less fertile than those who use ART in a relatively concentrated market or one without insurance coverage? The position that infertility is a serious and widely untreated medical condition suggests that a policy goal should be to improve the conception chances of couples with poor fertility characteristics. Thus, a policy that results in new ART treatment by (relatively) high fertility couples would not achieve the apparent objective of insurance mandate proponents. However, such an outcome would certainly benefit the couples who take treatment, and may be defended from a social welfare perspective.

We evaluate indirectly the ability of insurance mandates and competition to attract new, low-fertility ART patients. We estimate a model of birth outcomes and check whether success probabilities decline with competition or an insurance mandate. After controlling for the number of embryos transferred and the use of ICSI, unobserved patient fertility is likely to have an important effect on outcomes. If we observe that birth probabilities fall (rise), we infer that the fertility characteristics of the couples receiving treatment are on average less (more) favorable than those treated in markets without an insurance mandate or competition among ART clinics. We estimate regression models on two types of outcomes: birthrates and multiple birth risk. We also report corresponding estimates for specifications in which the number of embryos transferred and

[39] Relative to patients at monopoly clinics, our IV esimates of this specification imply that women under (over) 35 treated at a clinic in a highly competitive market receive 0.315 (0.507) fewer embryos, on average, with a t-statistic of -1.97 (-3.61).

the use of ICSI are excluded in order to provide an indication of the full impact of insurance and competition on success rates.[40]

The results from models of birth probabilities shown in Tables 6.3 and 6.4 indicate that the percentages of women under 35 and over 35 who give birth after IVF treatment are significantly lower in markets covered by a Universal insurance mandate. The estimated effects of a Restricted mandate are also negative, but these estimates are not significantly different from zero. Given our controls for clinic technology and embryo choice in the specification reported in Table 6.3, this indicates lower innate fertility of ART clients in these markets.[41] The differences between the effects of insurance in Tables 6.3 and 6.4 are minor.

The IV results in Tables 6.3 and 6.4 provide mild evidence that moving from monopoly to a competitive market is associated with a decline in birthrates, although the coefficient estimate is only marginally significant for women over 35. Following our model in Section 3, these findings suggest that the entry of a new clinic into a monopoly market may attract relatively more couples with lower innate fertility.

We next turn to the question of whether insurance and competition reduce the incidence of multiple births. The results for this analysis are presented on Tables 6.5 and 6.6. For women under 35, the effect of a Universal insurance mandate is a reduction in multiple birth rates. The effect of embryo transfers on outcomes can be seen in a comparison of Tables 6.5 and 6.6. We interpret the reduced multiple birth rates on Table 6.5 as evidence of diminished fertility characteristics for treated women; the further reduction in multiple births on Table 6.6 demonstrates that incentives to transfer fewer embryos have the expected effect on treatment outcomes. The effects of Restricted mandates on both age groups are not statistically significant. The findings shown in Tables 6.5 and 6.6 continue the pattern of insurance regulations having a greater effect among younger women.

With regard to the impact of competition, there is little evidence to support the concern that a clinic operating in a competitive market will increase the multiple birth risk among treated patients. Instead, Table 6.6 shows that multiple birth rates are lower at clinics in competitive

[40] We noted in Section 6.2 that embryo transfers may be affected by insurance mandates and competition. Additionally, in analysis not reported here we have found that ICSI usage can vary with insurance and competition.

[41] An alternative explanation for the decrease in birthrates is that clinics reduce their quality in unobserved ways when they operate under an insurance mandate. One way to observe this effect indirectly is to look for an increase in the nubmer of cycles cancelled before the embryos are transferred (because the created embryos are too few or insufficiently healthy). We have investigated this possibility, and and we found that cycle cancellations actually decrease with insurance. This is evidence against a reduction in unobserved clinic quality.

markets compared to monopolies. Again, comparison of Tables 6.5 and 6.6 suggests that this in part reflects the transfer of fewer embryos at competitive clinics. Overall, the effects of competition on embryo transfers, birthrates, and multiple birth rates do not imply an increased likelihood of a multiple birth for each patient.

7 Discussion and Conclusions

The most important economic issues in contemporary ART markets are: 1) access to treatment and 2) treatment success, as measured through birth rates and multiple birth rates. These issues of access and quality are also the central concerns for U.S. health care markets in general. Across the medical sector of the economy and in IVF markets in particular, it has been suggested that altering the competitive structure of markets or the extent of insurance coverage can improve both access to care and quality. In the market for infertility treatment, mandatory insurance coverage is predicted to bring new patients into the market and reduce the incentive to transfer a dangerously high number of embryos during treatment, thereby increasing the quality of care. While price-reducing competition is likely to improve access to IVF, there exist concerns that competing clinics will attempt to win new patients by inflating birthrates using treatments that also raise the risk of multiple births. However, concerns about quality-reducing competition may be incorrect, and in fact additional competition can decrease multiple birth rates by reducing patients' incentive to seek aggressive treatment for their fertility problems. With the present paper we evaluate the impacts of both mandated insurance coverage and an increase in competition on ART access and treatment success rates.

Our empirical analysis confirms the existing intuition that an insurance mandate can increase access to IVF while decreasing the number of embryos that patients transfer during treatment. However, we find significant differences in the effects of Universal and Restricted mandates. The latter has negligible effects on IVF treatments and outcomes. Additionally, we find that competition substantially increases ART usage while reducing embryo transfer rates. The effects of Universal insurance mandates and competition on embryo transfer rates are likely to be due to shifts in incentives rather than variation in the selection of patients. The evidence for this conclusion is strongest for a generous (Universal) insurance mandate, which we find brings more low-fertility patients into the market who, without adjusted dynamic incentives, would be expected to transfer more embryos. Finally, we report that a Universal insurance mandate reduces multiple birth risks among under-35 women, and competition significantly reduces rates for women of all ages. This rebuts the argument that competition in ART markets leads to a costly and dangerous "birthrate race" among clinics. While this result effectively removes concern that clinics' incentives for moral hazard reduces efficiency in IVF markets, an investigation of efficient embryo transfer rates requires both additional data and a utility-based empirical model of physician and patient choices.

Although our results indicate that multiple birth *rates* from IVF can fall with insurance and competition, it is important to note that the *number* of twins and triplets may not be reduced. In fact, our results imply that the opposite is likely to occur because of the substantial growth in the number of ART cycles following a Universal insurance mandate or an increase in competition. Consider the case of under-35 women in a monopoly market. We calculate that adding a Universal insurance mandate to the market would result in a 31% increase in the number of IVF births for these women and a 22% increase in multiple births.[42] Whether the increase in multiple births observed in these markets will lead to substantially higher health care costs depends on the types of patients induced to attempt IVF. If new IVF patients are drawn entirely from the population of women who are taking no alternative infertility treatment, the number of twins and triplets in the population would increase due to the effects that we identified above and the substantial difference between the natural rate of multiple births and that under ART. However, if new infertility patients take IVF instead of continuing with ovulation drugs, there is again an ambiguous effect of expanding ART on the number of multiple births. Ovulation drugs tend to have higher variation in their outcomes, and may have a higher risk of twins and triplets than IVF.

In this paper we have used the available data to estimate shifts in measures of treatment access and quality, but we have not evaluated the extent to which these shifts increase or decrease social welfare. The overall welfare effects of public policy on treatment access and outcomes is a rich area for future study, both in the number of questions to be answered and the importance of these issues to choices made by women in the U.S. Although IVF has been fairly recently introduced, its use is spreading rapidly. The percentage of all births in the U.S. due to IVF procedures using fresh, non-donor eggs grew from 0.3% in 1995 to 0.7% in 2000. For women over age 35, the share

[42] These calculations begin with our estimate of a 58.1% increase in cycles for under-35 women following the introduction of Universal insurance to a monopolized market. Insurance leads to declines in the birthrate (from 31.0% to 25.7%) and multiple birth risk (from 41.1% to 38.4%). The key point is that the substantial expansion of women receiving IVF treatment in an insured market outweighs the reduction in birth probabilities, yielding an increase in multiple births. A similar argument can be applied to competitive situations with appropriate changes in outcome measures.

of IVF births increased from 0.9% to 1.6% during the same period.[43] We expect the use of IVF to continue to grow, as treatment expenses fall with competition and technological progress, and more women account for the possibility of ART while making related life cycle choices regarding education, career, and marriage. Indeed, the changing economic environment of the late 20th century is likely to have shifted substantially the demand for infertility treatment services. As women's labor force participation rates and real wages have increased, couples have deferred the decision to have children.[44] However, biological fertility decreases with age (Menken *et al.* [1986]), so women who delay having children are more likely to benefit from medical treatment for infertility. Thus, infertility treatments such as IVF can permit an important increase in control over the timing of education, career, and family choices; this is similar to the function that Goldin and Katz [2002] ascribe to the birth control pill. Ultimately, public policies that increase the efficiency of ART provision and practices may have a substantial impact on the welfare and productivity of women and their families.

[43] Note that the "1% of all births" statistic earlier in the paper includes IVF treatments that involved eggs from donors, frozen eggs, and surrogate mothers.

[44] Between 1970 and 2000 the average age of the mother at first birth in the United States rose 3.5 years (Mathews and Hamilton [2002]).

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TABLE 2.1

ART Outcomes in 2001

Patient's Age	< 35	35 – 37	38 – 40	> 40
Number of cycles	33,984	17,791	16,283	7,004
% cycles with a birth	35.2	28.4	19.6	10.4
Number of embryos	2.8	3.1	3.4	3.7
% births with twins +	39.7	34.7	27.2	17.9

Note: We exclude from this table ART procedures that use donor eggs or frozen embryos.

TABLE 2.2

ART Regulations

States with coverage mandates for IVF		Other states with infertility treatment regulations			
	Year[1]		Year[1]	Include ART?	Cover or Offer?
Universal mandate					
Illinois	1991	New Jersey	2001	Yes	Cover
Massachusetts	1987	Connecticut	1989	Yes	Offer
Rhode Island	1989	Texas	1987	Yes	Offer
		California	1989	No	Offer
Restricted mandate		Louisiana	2001	No	Cover
Arkansas	1987	New York [3]	1990	No	Cover
Hawaii	1987				
Maryland	1985				
Montana[2]	1987				
Ohio	1991				
West Virginia	1977				

Notes:
1: Year that the regulation was passed. We assume that the regulation became effective in the following year.
2: The extent of Montana's law is untested, as there has never existed an ART clinic in the state.
3: New York updated its law in 2002 but did not mandate coverage of ART procedures.

TABLE 4.1

Market Characteristics

	MSA Means (2000)	
	With ART Clinics (*N* = 107)	Without ART Clinics (*N* = 211)
Total Population	1,812,243	223,133
Median Household Income	$28,883	$24,063
Women age 16+, % Employed	56.6	52.6
Women age 25+,		
% with Bachelor's Degree	16.6	12.6
% with Graduate Degree	9.3	7.0
% Catholic	18.8	15.6
Instruments for Number of Clinics		
Beds per hospital	213.1	183.7
Number of hospitals	27.9	4.9
Research MDs per 100,000	6.2	0.9
CON score	8.2	8.7

TABLE 4.2

Characteristics of states with and without mandates to cover IVF [1]

	States with Mandates	States without Mandates
Number of ART clinics in 2001	66	353
State characteristics from the 1990 decennial census		
Total population	40 million	209 million
Percentages of women:		
Age 25+ with high school degree	75.56 (3.98)	74.69 (4.50)
Age 25+ with bachelor's degree	18.05 (4.37)	17.55 (2.94)
Age 25+ with post-college degree [2]	5.99 (1.83)	5.61 (1.37)
Age 16+ in labor force	57.09 (4.73)	56.76 (3.00)
Average family size	3.16 (0.08)	3.16 (0.12)
Median Household Income (1989)	$31,680 (5,657)	$30,080 (4,774)
Political leanings and medical mandates		
Percentage of states with mandated insurance coverage for:		
Medicaid funding of abortion	67%	41%
Colorectal cancer screening	44%	24%
Percentage of states with:		
Plurality of 1992 votes for Bill Clinton	100%	56%
Mandated mental health parity	89%	66%
	N = 9	N = 41

Notes: Standard deviations are given in parentheses
1: The states with IVF-specific insurance regulations are: Arkansas, Hawaii, Illinois, Maryland, Massachusetts, Montana, Ohio, Rhode Island, and West Virginia. On this table, we do not differentiate between Universal and Restricted mandates.
2: A "post-college degree" includes master's, doctoral, and professional degrees.

TABLE 4.3

Pre-Program Regressions, 1987 Data

Dependent Variable	Log Cycles at Clinic	Number of Clinics in Market
Specification	OLS	Ordered Probit
Future insurance mandate		
Universal	-0.605 (-1.27)	-1.218 (-1.25)
Restricted	0.041 (0.12)	0.918 (1.49)
Observations	154	71

Notes: t-ratios in parentheses. Standard errors in first column account for clustering of clinics within markets. Regression in first column also includes the demographic controls listed in Table 4.1 and indicators for the number of clinics operating in the market. Ordered probit model in second column includes demographic controls and the instruments listed in the bottom four rows of Table 4.1.

TABLE 4.4

Mean Treatment and Outcome Statistics by Insurance Regime

Insurance Regime:	No Mandate		Restricted Mandate		Universal Mandate	
Clinics in market	3.2		3.2		4.5	
Cycles per clinic	127.3		159.5		340.0	
Patient Age	Under 35	Over 35	Under 35	Over 35	Under 35	Over 35
Cycles per clinic	65.7	61.6	80.0	79.5	159.2	180.7
Embryos transferred [1]	3.43	3.63	3.27	3.48	3.09	3.20
Birthrate [1]	31.0	19.3	26.0	16.5	23.2	13.5
Multiple birth rate [2]	40.8	31.6	37.5	26.9	34.6	30.9

TABLE 4.5

Mean Treatment and Outcome Statistics by Market Structure

Market Structure:	Monopoly		2+ Clinics	
Cycles per clinic	129.8		154.1	
Patient Age	Under 35	Over 35	Under 35	Over 35
Cycles per clinic	69.1	60.8	75.8	78.4
Embryos transferred [1]	3.23	3.58	3.28	3.62
Birthrate [1]	30.8	19.9	31.7	19.4
Multiple birth rate [2]	40.8	31.4	40.8	31.5

Notes for Tables 4.4 and 4.5

1: weighted by number of treatments

2: weighted by number of births

TABLE 5.1

Clinic Entry

Dependent Variable	Number of Clinics in Market
Specification	Ordered Probit
Insurance mandates	
Universal	-0.167 (-0.41)
Restricted	0.045 (0.23)
Demand-shifting demographic variables	
Median income/10,000	0.104 (3.57)
Population of women, ages 25-44 (Pop / 10,000)	0.006 (0.43)
Female labor force participation rate	1.100 (0.59)
Percent Catholic	-0.313 (-0.61)
Pct. women with bachelor's degree	5.850 (1.63)
Pct. women with graduate degree	2.408 (0.68)
Cost-shifting instruments	
Number of hospitals	0.049 (3.89)
Beds per hospital	0.004 (4.26)
Medical Researchers per capita	0.091 (1.17)
Certificate of need score	-0.007 (-0.92)
N	2,226

Notes: t-ratios in parentheses. Each regression also includes year dummies and average household size. Standard errors account for correlation within markets.

TABLE 6.1

Clinic Size and Market Characteristics
Dependent variable: Log Cycles

	Patient age < 35		Patient age > 35	
Specification	OLS	IV	OLS	IV
Insurance mandate				
Universal	0.584 (2.63)	0.581 (2.53)	0.389 (1.74)	0.384 (1.65)
Restricted	0.184 (0.98)	0.114 (0.56)	0.128 (0.61)	0.048 (0.20)
Number of clinics				
2+ clinics	-0.113 (-0.96)	0.543 (2.18)	-0.085 (-0.76)	0.648 (2.53)
N	2,354	2,354	2,348	2,348

Notes: t-ratios are in parentheses. Standard errors account for clustering within clinics. Regressions also include the demographic controls listed in Table 4.1, year dummies, and clinic characteristics on SART membership and whether unmarried patients are accepted for treatment.

TABLE 6.2

Treatment Decisions
Dependent variable: Average number of embryos transferred

	Patient age < 35		Patient age > 35	
Specification	OLS	IV	OLS	IV
Insurance mandate				
Universal	-0.240 (-2.35)	-0.232 (-2.25)	-0.303 (-2.04)	-0.287 (-1.94)
Restricted	0.035 (0.38)	0.069 (0.69)	0.140 (1.11)	0.174 (1.32)
Number of clinics				
2+ clinics	0.018 (0.27)	-0.264 (-1.67)	-0.168 (-2.40)	-0.539 (-3.48)
N	2,354	2,354	2,346	2,346

Notes: All details are the same as in the notes for Table 6.1, except clinic controls also include the overall ICSI and IVF rates at the clinic.

TABLE 6.3

Treatment outcomes, including controls for embryos and ICSI
Dependent variable: Births per 100 treatments [1]

	Patient age < 35		Patient age > 35	
Specification	OLS	IV	OLS	IV
Insurance mandate				
Universal	-6.204 (-3.37)	-6.124 (-3.32)	-4.564 (-3.27)	-4.536 (-3.25)
Restricted	-0.935 (-0.63)	-0.632 (-0.42)	-1.014 (-0.92)	-0.928 (-0.83)
Number of clinics				
2+ clinics	-0.486 (-0.46)	-3.011 (-1.35)	-1.855 (-2.47)	-2.771 (-1.62)
N	2,354	2,354	2,348	2,348

TABLE 6.4

Treatment outcomes, excluding controls for embryos and ICSI
Dependent variable: Births per 100 treatments [1]

	Patient age < 35		Patient age > 35	
Specification	OLS	IV	OLS	IV
Insurance mandate				
Universal	-5.332 (-3.01)	-5.284 (-2.98)	-4.587 (-3.32)	-4.546 (-3.29)
Restricted	-1.657 (-1.13)	-1.470 (-1.00)	-1.277 (-1.16)	-1.838 (-1.06)
Number of clinics				
2+ clinics	-0.517 (-0.46)	-2.081 (-0.90)	-2.013 (-2.65)	-3.019 (-1.77)
N	2,354	2,354	2,348	2,348

Notes for Tables 6.3 and 6.4: All details are the same as in the notes for Table 6.1 and 6.2, respectively.

TABLE 6.5

Treatment outcomes, <u>including</u> controls for embryos and ICSI
Dependent variable: Multiple births per 100 births [1]

	Patient age < 35		Patient age > 35	
Specification	OLS	IV	OLS	IV
Insurance mandate				
Universal	-2.306 (-2.12)	-2.256 (-2.09)	-1.297 (-0.93)	-1.220 (-0.87)
Restricted	-0.461 (-0.41)	-0.270 (-0.24)	0.177 (0.13)	0.411 (0.29)
Number of clinics				
2+ clinics	-1.028 (-1.16)	-2.620 (-1.46)	-1.022 (-0.92)	-3.450 (-1.71)
N	2,354	2,354	2,262	2,262

TABLE 6.6

Treatment outcomes, <u>excluding</u> controls for embryos and ICSI
Dependent variable: Multiple births per 100 births [1]

	Patient age < 35		Patient age > 35	
Specification	OLS	IV	OLS	IV
Insurance mandate				
Universal	-2.782 (-2.52)	-2.715 (-2.49)	-2.267 (-1.42)	-2.118 (-1.33)
Restricted	-0.563 (-0.47)	-0.304 (-0.25)	0.804 (0.57)	1.138 (0.81)
Number of clinics				
2+ clinics	-0.982 (-1.07)	-3.151 (-1.701)	-1.494 (-1.28)	-5.051 (-2.48)
N	2,354	2,354	2,262	2,262

<u>Notes for Tables 6.5 and 6.6:</u> All details are the same as in the notes for Tables 6.1 and 6.2, respectively.

FIGURE 2

Fertility-Enhancing Technology

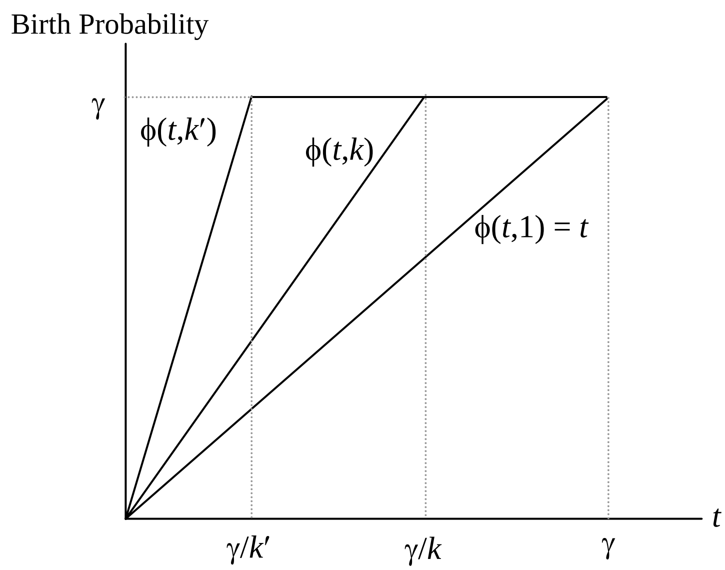
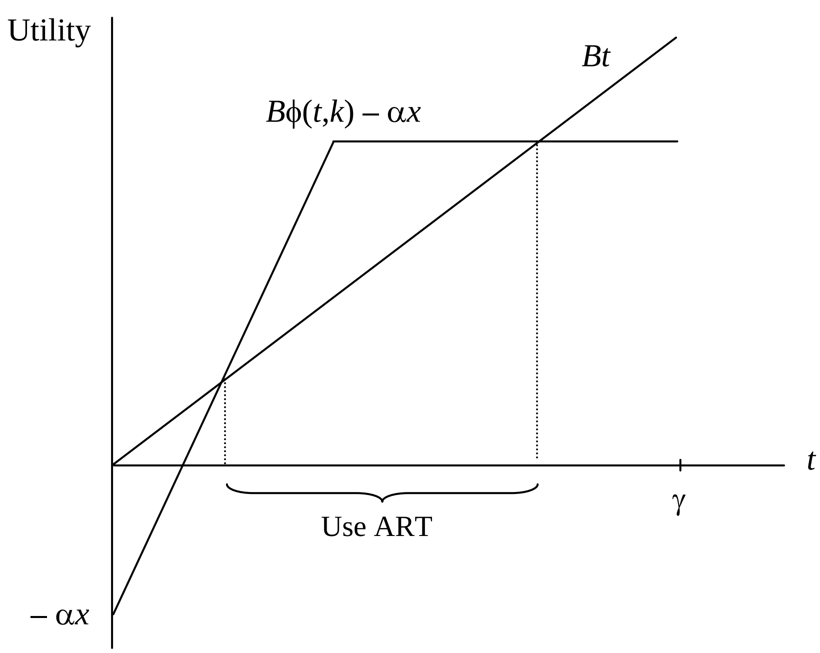


FIGURE 3

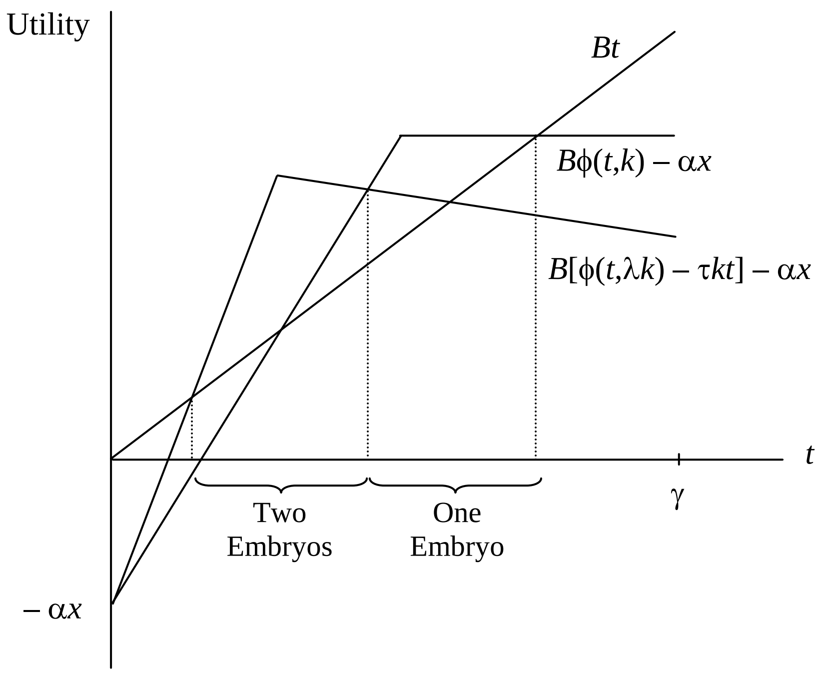
Treatment Choice under Monopoly as t Varies



Possible actions are: no treatment (N) and treatment (T). Couples choose the action that provides the highest utility.

FIGURE 4

Embryo Choice under Monopoly as t Varies



Possible actions are: no treatment (N) and treatment (T). Conditional on treatment, couples take one or two embryos. Utility maximization guides choices.