Does disclosure of success rates induce patients to move to a better clinic? Evidence from In Vitro Fertilization

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1 May 2021

Does disclosure of success rates induce patients to move to a better clinic? Evidence from In Vitro Fertilization*

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Abstract

Many couples have had unsuccessful fertility treatments. In 2009, the U.K. government launched an online service to provide patients with the success rates of individual clinics. I use anonymized individual patient data between 1991 and 2016 with the instrumental variable technique to investigate whether the disclosure of success rates induces patients to move to a new clinic, resulting in improved treatment outcomes. I find four main results. (i) The disclosure increases the probability that a patient moves to a new clinic. (ii) The greater the number of treatment cycles a patient has previously had, the greater the probability of moving to a new clinic. (iii) When moving to a new clinic, a patient aged over 40 has a higher probability of getting one or more transferable embryos in one treatment cycle, while a patient aged under 39 has a low probability. (iv) Regardless of age, patients who have had five or more treatments have a higher probability of obtaining an embryo in a single treatment cycle. These results suggest that public disclosure of information can facilitate efficient matching between clinics and patients over the age of 40 who have had unsuccessful IVF attempts, resulting in higher success rates.

JEL classification: I12; I18; D8

Keywords: In Vitro Fertilization, Information disclosure, Patient behavior, Success rates, instrumental variable

* I would like to thank Masayoshi Hayashi, Yuta Kuroda, Kai Nomura, Takaki Sato, and Takeru Sugasawa, Junichi Yamasaki, and the participants at all seminars and conferences for valuable comments.
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1. Introduction

While fertility treatment including In Vitro Fertilization (IVF) is becoming popular around the world, many couples have been unsuccessful despite trying it many times.[1] According to the UK government's independent regulator, Human Fertilisation and Embryology Authority (HFEA), the success rate of IVF decreases with age (the average chance of a birth per embryo transferred in 2017 is 29, 24, 17, 11, 4, and 3 percent for women aged under 35, 35−37, 38−39, 40−42, 43−44, over 44, respectively). Moreover, the financial cost of IVF is quite expensive and the couple's, especially, woman's mental stress increases as the number of the treatment cycle (which means the number of trying IVF) increases. Thus, they want to succeed in as few treatment cycles as possible.[2]

In 2009, HEFA launched "Choose a Fertility Clinic," an online service that provides patients with the success rates of each clinic. Not only those who are planning to visit a clinic, but also those who have had treatment in the past but did not succeed can search for information on age, IVF or ICSI, whether to transfer fresh or frozen embryos, whether to create embryos themselves or use a donor, etc. Thanks to the online services, they can find a new clinic with a higher success rate than a current clinic. The effects of information disclosure on the IVF outcome is of interest to researcher and policymakers. However, we have not yet understood how information disclosure affects IVF outcomes by changing patients' behavior. In other words, we have not yet understood whether the unsuccessful patient could receive effective treatment by moving to a new clinic, resulting in higher success rates.

This paper examines the effect of the HEFA's online service on the behavior of patients who have previously had and is undergoing IVF. Specifically, I explore the following empirical questions: (I) did the information disclosure induce patients to move to a new clinic?; (II) did the patients move to a better clinic? (that is, was the probability that patients get at least more than one embryo that allows to transplant into a womb improved by moving to a new clinic?) Finally, I examine how much the probability of live birth is if the patient can transfer the embryo(s) into a womb.

There are both positive and negative effects of moving to a new clinic on IVF outcomes. The positive effects arise if patients receive a new treatment by better doctors and embryologists, resulting in higher success rates. The negative effects arise because they have to give up the next IVF cycle in the previous clinic that might be successful. The previous doctor knows the characteristics of patients better than the new doctor. Thus, patients face a low success rate of the marginal treatment cycle if the new clinic is not better than the previous one. In this paper, I investigate which effect is dominant for different age groups.

Policymakers, especially in developed countries, want to improve the live birth rate. However, it may be difficult for women to balance their careers with child-raising (e.g., Astrid et al., 2018). Thus, some

[1] In 2017, IVF accounts for 93 percent of total treatment cycles.

[2] Private IVF can cost between £3,000 and £5,000 per cycle. However, some clinics may charge patients for aftercare and drugs, which takes this cost up (https://metro.co.uk/2018/11/08/what-are-the-success-rates-for-ivf-and-how-much-does-it-cost-2-8110625/).

women place their positions in their work above children and postpone trying to get pregnant or choose not to give birth. Unfortunately, the chance of getting pregnant decreases with age. In such cases, IVF can be one of the policy interventions for women worried about infertility. Some countries, such as the UK, the US, Denmark, and Japan, introduce an insurance mandate and/or a subsidy that makes it easier for patients to access IVF. The UK has the National Health Service (NHS), a tax-funded institution that ensures that UK healthcare is free at the point of delivery. Couples/women do not always receive the NHS, but the success rate of IVF is still low, and thus they often try IVF many times. That is quite a burden for them from the viewpoint of heavy financial costs and mental stress. If patients can choose clinics based on appropriate information and succeed with fewer treatments, patients have less mental stress, and the government saves the financial cost for insurance and subsidies. This study contributes to understanding the role of information disclosure in high treatment costs and low success rates due to mismatching between patients and physicians (or treatment plans). In addition, this study calculates how many deliveries change in response to information disclosure through a back-of-the-envelope estimate.

To answer question (I), I estimate the effect of information disclosure on the probability that a patient moves to a new clinic. The key assumption for this identification is that in the absence of information disclosure, the probability would have changed smoothly. Since IVF is getting popular, the number of infertility clinics probably increases year by year, which may lead to increasing the probability year by year. I include the year dummy to check that the effect of disclosure on the probability is not just an annual trend; that is, I show that there is a discontinuity in coefficients of year dummy variables at the timing of disclosure.

To answer question (II), I examine the effect of moving to a new clinic on whether a patient gets at least more than one embryo that allows to transplant into a womb. The reason why I use this variable to evaluate the quality of the clinic is as follows. IVF involves four main stages and often fails at each stage: 1) preliminary treatments using medication; 2) collecting the eggs; 3) fertilizing the eggs (embryos); 4) transferring the embryo(s) into a womb. Unfortunately, some patients do not often reach stage 4. The key to success is how to create at least more than one embryo. Because of technical or medical reasons, no one knows which embryos could lead to birth or stop growing, which may be an exogenous event (as Lundborg et al., 2018 pointed out). However, we can observe who gets the embryos (i.e., who reaches stage 4) in this cycle. If patients obtain one or more embryos, they face a chance of transplanting the embryos (i.e., they have a chance of getting pregnant). If they do not, however, the possibility of getting pregnant is completely zero. That is why I use a dummy variable indicating whether a patient obtains one or more embryos in one treatment cycle as an independent variable.[3]

[3] When evaluating the outcome of treatment, I do not use how many embryos are created in one cycle to avoid misinterpreting the treatment outcome. For example, the treatment policy depends on doctors such as one doctor emphasize how to create a high-quality embryo, while another doctor emphasizes how to get a large number of embryos. The failure to get the embryos is a bad result, but the creation of a small number of embryos is not necessarily a bad result. In this study, in order to capture both treatment policies above, I use the indicator variable representing whether or not transplantable embryos have been created in one cycle as an independent variable.

The problem of the identification in question (II) is endogeneity because whether a patient moves to a new clinic is self-selected based on unobserved characteristics. To overcome the problem, I use a dummy variable indicating whether the information is disclosed as an Instrumental Variable (IV). Because disclosure is just a policy variable related to time does not directly affect the IVF outcome, it is only natural to assume that disclosure is uncorrelated with unobserved characteristics of patients. Moreover, in the analysis for question (I), I can obtain that the disclosure increases the probability that a patient moves to a new clinic with statistically significant at 99% confidence level, and the F-statistics referring to F-tests of the significance of the instrument in the first-stage regressions is 165. Therefore, the disclosure affects whether the patient gets one or more embryos in one cycle only through whether patients move to a new clinic to receive the treatment by a new doctor. In addition, monotonicity or no-defiers assumption should be held because patients who try IVF while paying a lot of financial costs have strong demand for children, and thus there should be no patients who never move to a new clinic no matter what happens (such as, patients who never move even if they know a new clinic with higher success rates than the current clinic and have no obstacle to moving). If no-defiers exist, then the only subpopulation in which *disclosure* can affect whether a patient move to a new clinic is the compliers.

The data used in this study are pooled cross-section data composed of patients who have had IVF at least once that are drawn from the HFEA's Anonymized Register. The Register covers the information on all fertility treatment including IVF and Donor Insemination (DI) with its outcome between the years 1991 and 2016, while the personal information such as income, the place of life, and to which clinic patients go, is banded or obscured, to protect patient privacy.

Focusing on the heterogeneity of patients' characteristics, I decompose the full sample into the following subsample: patients who have previously had IVF or DI between once and two times, three and four times, and more than five times. Patients who have had IVF or DI more than five times may have quite strong demand for children. So, I would expect that the effect of disclosure on the probability that a patient moves to a new clinic would be large. In addition, I consider a further specification that uses the observation within a three-year window around the year information disclosure started: that is I use subsample containing patients who registered between 2006 and 2011. Since the conceptual basis of a discontinuity-based estimate is local to the threshold, choosing a sample containing observations as close as possible to the discontinuity is generally preferred. In this case, however, patients can move to a new clinic whenever they want, it is not necessary to do that right after the time they search the individual clinic's information. On the other hand, patients cannot search the information before the year; they randomly choose a new clinic due to the lack of information. By using the observations between 1991 and 2016, I explore the long-term effect of accessing the proper information on the patient's behavior and the treatment outcome.

The main findings and policy implications are as follows. (i) The information disclosure significantly induces patients to move to a new clinic. (ii) The greater the number of treatment cycles a patient has previously had is, the larger the probability that a patient move to a new clinic is. (iii) By moving to a new

clinic, the probability that a patient aged over 40 gets one or more transferable embryos in one treatment cycle is increased, but the probability of a patient aged under 39 is decreased. (iv) The positive effect of moving on the outcome is larger for older patients. This suggests that younger patients should do vertical treatments (that is, trying one more cycle in the same clinic) and older patients should do horizontal treatments (that is moving to a new clinic to receive the treatment by a new doctor), resulting in the reduction of the patient's financial and psychological costs. (v) Regardless of age, if the number of treatment cycles a patient has previously had is more than five, then the probability that a patient gets one or more embryos in one cycle is increased by moving to a new clinic. This implies that efficient matching between clinics and patients who have been unsuccessful in IVF for a while are promoted by information disclosure, resulting in the improvement of their success rate.

The remainder of the paper is as follows. Section 2 reviews the previous literature relating to fertility treatment. Section 3 discusses the online service, IVF process, and the patient's behavior. Section 4 describes the data. Section 5 provides the empirical strategy. Section 6 presents my main set of results. Section 7 discusses the social impact of disclosure from the viewpoint of live birth. Section 7 concludes.

2. Literature review

IVF is a leading reproductive technology for women suffering fertility problems, while it is quite expensive. At first, economists focus on the public policy to reduce the patient's financial burden. Using a difference-in-differences approach, insurance coverage for IVF, which is mandated in fifteen states of the US, increases the first birth rate for women over age 35 (Schmidt 2005, 2007). Because IVF often fails, some patients want to transfer multiple embryos to improve the likelihood of birth, which has a risk for high-order birth. European countries have introduced embryo caps against such risky treatments. The strict policy, however, not only reduces the aggressive treatment but also reduces the likelihood of birth, which can lead some patients to forgo IVF. To internalize the expected cost of transferring multiple embryos, a price-based incentive policy (i.e. additional costs for transferring additional embryos) has been introduced (Einav, Finkelstein, and Williams, 2016; Hamilton et al., 2018). By developing a structural model for IVF that considers forward-looking patient's dynamic decision of treatment, Hamilton et al. (2018) evaluate these policies in terms of patients' surplus and total costs of treatments.[4]

Transferring multiple embryos into a womb, however, is not the only action a patient takes to increase the success rate. Patients may move to a new clinic to receive treatments by a new doctor, hoping that they improve the possibility of live birth. Many patients have moved to a new clinic in Japan, and the UK's

[4] The results are as follows: (i) insurance mandate substantially increases patient welfare by increasing IVF use, but it increases both treatment and per-birth costs; (ii) embryos caps reduce per-birth costs but low the probability of live birth, resulting in total costs becoming greater than when no patients have insurance; (iii) the additional costs can internalize the expected cost of transferring multiple embryos, which generates more patient surplus than the embryos cap, and total treatment costs are lower than no-insurance benchmark.

Anonymized Register shows that the number of patients who have moved is 166,194. However, there has been no analysis that focuses on patients' behavior of moving to a new clinic.

Other studies explore the effect of fertility treatments on the child adoption market and labor market. Gumus and Lee (2012) analyzed the causal relationship between the child adoption market and the frequency of assisted reproductive technology (ART) treatments. Lundborg, Plug, and Rasmussen (2017) analyzed the causal inference of childbearing on women's career and earnings by using IVF success at the first cycle as an instrumental variable.

3. In Vitro Fertilization and patient behavior

3.1 Information disclosure

"Choose a Fertility Clinic", launched by the HFEA in 2009, is an online service providing patients with success rates of the individual clinic. Patients can view some kinds of rating and treatment data for different clinics that are calculated in the same way, such as inspection rating of how the clinic meets HEFA's standard, patient rating based on their experience and care, success rates including birth per embryos transferred, birth per egg collection for different ages and donated or non-donated egg, multiple birth rates, and waiting times for donated eggs, sperm, and embryos. The success rate includes individual clinic's rate, national average rate, and the reliability range that is designed to show how confident we are that a clinic will repeat its success rate in the future.

3.2 IVF

Patients choose the type of fertility treatment, based on their preferences and the cost of treatment. In general, because of high out-of-pocket costs for IVF, physicians generally suggest the following two types of fertility treatment that are cheaper than IVF: better timing of intercourse (around the woman's ovulation cycle) and artificial insemination. If patients have been trying these treatments for a while to get pregnant but have not been successful, then physicians suggest IVF that has the best success rate among these options. Many patients try it even though the financial cost is about 10 times higher than the other methods.

IVF involves four main stages: 1) preliminary treatments such as suppressing your natural cycle with medication to boost the patient's egg supply; 2) collecting the eggs—a needle is inserted into the ovaries to remove the eggs; 3) fertilizing the eggs—the eggs are mixed with the sperm for a few days to allow them to be fertilized; 4) transferring the embryo(s)—1 or multiple fertilized embryos are placed into the womb.[5] If embryo(s) can be generated successfully in stage 3), patients choose to freeze the embryo(s) and transplant into the womb later or transplant the embryo(s) immediately. Once the embryo(s) has been transferred into a womb, patients need to wait about two weeks before taking a pregnancy test to see if the treatment has worked. Once they successfully get pregnant, they are the same as the normal expecting women without

[5] Hamilton et al. (2018) clearly illustrate the IVF stages.

trying IVF. Hopefully, patients give birth.

There are two differences among clinics that affect success rates. The first one is the treatment plan. The treatment plan differs depending on clinics and patients, such as whether to use medication or how much the doctor uses medication before collecting eggs to control hormone balances related to fertility and whether to use medication to encourage the ovaries to produce more eggs than usual. The second one is related to medical accidents. IVF process is hand-made medical care that cannot be automated by instruments, and medical accidents such as embryo destruction and ICSI failures may occur (Yoshida, 2011). That is, success rates vary among clinics depending on the medical and technical skills of both doctors and embryologists and accident avoidance efforts.

3.3 Patient behavior

Unfortunately, IVF can and does often fail at each stage: there may be no eggs to collect or there may be no embryos to transfer because fertilizing eggs is failed or the embryos stop growing before transplanting. How patients would do if they have been trying it many times but unsuccessful at one clinic? They have three options: one is to give up the fertility treatment and go on life without children or with adopted children; second is to try one more cycle in the same clinic (I call this action as vertical treatments); third is to move to a new clinic to receive the treatment by a new doctor (I call this action as horizontal treatments).[6] Patients who have experienced IVF many times and continue to do it may have strong demand for having children. Such patients may choose the third option if they can find a new clinic with a higher success rate than the current clinic via the HEFA's online service.[7] The success of IVF is defined as giving birth not getting pregnant because if patients have a miscarriage, then they often go to a clinic to try it again.

There is both positive and negative effect of moving to a new clinic on the treatment outcome. The positive effects arise if patients could receive a new treatment by better doctors and embryologists, resulting in the improvement of success rates. However, the negative effects arise because they have to give up the next IVF cycle in the previous clinic that might be successful. The previous doctor knows the characteristics of patients better than the new doctor. Thus, the chance of success for the marginal treatment cycle would be reduced if the new clinic is not better than the previous one. In this paper, I investigate which effect is dominant for different age groups.

4. Data

The data used in this study are drawn from the HFEA's Anonymized Register. The HFEA collects data for patients who registered to the HFEA and received fertility treatments from 1991 to 2016. By law, clinics

[6] Because of pooled cross-section data, we cannot know who and when stops the treatment.

[7] It may be difficult for patients to know exactly what kinds of treatment methods they will receive at the new clinic before they actually go to the new clinic, even though the clinic's information is disclosed. Patients just expect that they will receive the new treatment methods by a new doctor, resulting in a better result.

must submit data to the HFEA. Thus, the register may include close to 100% of patients' information. It is anonymized data, where no identifiers are present and some of the personal information is banded, or obscured, to protect patient privacy (i.e. pooled cross-section data).

The patients in the data are classified by age: 18–34, 35–37, 38–39, 40–42, 43–44, 45–50 years old. The data includes individual treatment outcome as follows: total number of embryos, that allow transferring into a womb, created in one treatment cycle; the live birth occurrence, which indicates whether the patient gives one or more births as a result of this cycle; the total number of previous cycles of IVF or and Donor Insemination (DI) the patient has previously had (I call it as "*tnpc*"); the total number of previous cycles of IVF the patient has previously had (I call it as "*tnpc of IVF*"); the total number of previous cycles of IVF or DI the patient has previously had at the clinic associated with this treatment (I call it as "*tnpc at the clinic*"). Thus, if *tnpc* is larger than *tnpc at the clinic*, then the patients have changed the clinic at least more than once. I use *tnpc* and *tnpc at the clinic* to construct a dummy variable, denoted as $clinic_{it}$ in equation (1), indicating whether a patent has moved to a new clinic at least more than once.[8]

From the Register, I draw my primary sample based on *tnpc of IVF*; I extract patients who have previously received IVF at least more than once between the years 1991 and 2016 from the Register. I exclude patients who miss the total number of embryos created in one cycle (the number of such patients is 23,161). As a result of sampling, 641,750 patients are a full sample of the paper. Based on the probability of success, I classify observations into four groups by age: 18–34, 35–39, 40–42, and over 43.[9] Figure 1 illustrates the change in the number of patients separated by the age groups. Table 1 provides sample means, standard deviations, min and max values for some variables of the full sample, pre-disclosure (the year from 1991 to 2008), and post-disclosure (the year from 2009 to 2016). As shown in Table 1, the mean of "*indicator of moving to a new clinic*", representing whether the patient has moved to a new clinic, is larger in post-disclosure than pre-disclosure for all age groups.

Focusing on the heterogeneity of patient's characteristics in terms of the total number of previous cycles the patient has previously had (that relates to the patient's demand for having children), I decompose the full sample into the following subsample:

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[8] In my sample, I was concerned about measurement errors in the dummy variable. Because the data do not contain information on when patients moved to a new clinic, we do not know whether patients registered in 2009 moved to a new clinic before or after 2009. The number of patients registered in 2009 is 30,615 (4.8% of the full sample). I can obtain the same result, even if I exclude these patients from the analysis. Patient try IVF twelve times a year at most because of the menstrual cycle, but IVF often fail at each stage and average *tnpc at the clinic* is 1.79. Thus, this measurement error might not arise for patients registered between 2010 and 2016. In addition, we cannot know an exact value for both *tnpc* and *tnpc at the clinic* if these variables are more than the value of 6 (i.e. the maximum value of these variables is 6 even though it is more than the value of 6). Thus, if both values are more than 6, then we cannot identify whether patients have moved to a new clinic. The number of patients whose *tnpc* and *tnpc at the clinic* are both more than 6 is 25,579 (4.0% of the full sample). I can obtain the same result even if I exclude these patients from the analysis.

[9] NHS presents the percentage of IVF treatments that resulted in a live birth between 2014 and 2016 (https://www.nhs.uk/conditions/ivf/#targetText=Chances%20of%20success&targetText=IVF%20isn't%20usually%20recommended,women%20aged%2035%20to%2037, last accessed on 31st October, 2019)

- Patients whose *tnpc* is between one and two times (431,339 patients, 67% of the full sample) ;
- Patients whose *tnpc* is between three and four times (133,588 patients, 21% of the full sample) ;
- Patients whose *tnpc* is more than five times (76,823 patients, 12% of the full sample);

In addition, as a robustness check, I choose my sample period to be the observations within a three-year window around the year the information disclosure started. That is, the subsample is composed of

- Patients who registered with the HFEA between 2006 and 2011 (181,310 patients, 28% of the full sample).

5. Empirical strategies

Effects of disclosure on the probability that a patient moves to a new clinic. To identify the effects of disclosure in individual clinic's success rates on the probability that a patient moves to a new clinic, I use the Ordinary Least Squares (OLS). Let $clinic_{it}$ be an indicator variable that takes a value of one if the patient i in year t has changed the clinic at least once (i.e., *tnpc* is larger than *tnpc at the clinic*) and a value of zero otherwise. Let $disclosure_t$ be an indicator variable that takes a value of one after the information disclosure of clinics (after the year 2009), and a value of zero if the year is from 1991 to 2008. Let age_{it} be a vector of age group dummy variables including *35–39* that takes a value of one if a patient i is between *35–39* years old, *40–42* that takes a value of one if the patient i is between 40–42 years old, and *over43* that takes a value of one if the patient i is over 43 years old. I use *18–34* that takes a value of one if the patient i is between 18–34 years old is a baseline of the age group dummy variable. Let $year_t$ be a vector of year dummy variables that control the year fixed effects. Then we may write

$$(1) \qquad clinic_{it} = \alpha_0 + \alpha_1 disclosure_t + \alpha_2 age_{it} + \alpha_3 disclosure_t \times age_{it} + \alpha_4 year_t + e_{it},$$

where the coefficients α_1 and α_3 measure the effect of information disclosure on the probability that a patient moves to a new clinic and e_{it} is the error term.

I would expect that α_1 and α_3 would be either positive or zero. α_1 and α_3 would reflect a positive relationship if patients could find at least one better clinic. On the other hand, α_1 and α_3 would reflect a zero if all patients could not find at least one better clinic from the comprehensive viewpoint of success rates, patient rating, and so on.

Effect of moving to a new clinic on the probability of creating transferable embryos. I evaluate the quality of the clinic by using whether the probability that a patient gets one or more transferable embryos (i.e. whether a patient reaches stage 4 of IVF) in one treatment cycle is improved or not. Let $stage4_{it}$ be an indicator variable that takes a value of one if the patient i gets at least more than one embryo in one cycle in year t and takes a value of zero otherwise. Estimates are based on a simple linear model for $stage4_{it}$. Then

we may write

$$(2) \qquad stage4_{it} = \beta_0 + \beta_1 clinic_{it} + \beta_2 age_{it} + \beta_3 clinic_{it} \times age_{it} + \beta_4 year_t + v_{it},$$

where the coefficient β_1 is the effect of moving to a new clinic on the probability that a patient i aged 18–34 (baseline) gets one or more embryos in one cycle, the coefficient β_3 is the effect on the probability that individual i aged 35–39, 40–42, and over 43 gets one or more embryos in one cycle, and v_{it} is the error term. $clinic_{it}$ is a variable that includes changes in not only doctors and a treatment plan, such as whether stimulation is used and whether medication before correcting eggs for regulating the patient's hormone balance is used, but also technical staffs such as embryologists that affect the probability of medical accidents.

As I mentioned in subsection 3.3, I would expect that β_1 and β_3 would be positive or negative. The positive effects arise if patients could receive new treatments from better doctors and staff, resulting in the higher probability that they get the embryos in one cycle. The negative effects also arise because they have to give up the next IVF cycle in the previous clinic that might be successful. The chance of success for the marginal treatment cycle would be reduced if the new clinic is not better than the previous one.

If $clinic_{it}$ is correlated with unobserved components of (2), then β_1 will be inconsistently estimated by OLS. In this case, a correlation may arise because whether patients transfer to a new clinic to receive treatments by a new doctor is self-selected based on unobserved characteristics. So, the control and treatment groups (i.e. patients who have previously moved to a new clinic or not moved) are not randomly assigned. To overcome the self-selection problem, I use $disclosure_t$ as an Instrumental Variable (IV) for $clinic_{it}$. The first stage regression is

$$(3) \qquad clinic_{it} = \gamma_0 + \gamma_1 disclosure_t + \gamma_2 age_{it} + \gamma_3 year_t + e_{it}.$$

If γ_1 is not zero at a sufficiently small significance level the F-statistics that refers to F-tests of the significance of the instrument in the regressions is more than 10, we can say that disclosure is relevant for explaining variation in $clinic_{it}$. In addition, because disclosure is just a policy variable related to time, it is only natural to assume that disclosure is uncorrelated with unobserved characteristics of patients. In other words, $disclosure_t$ affects $stage4_{it}$ only though whether the patient decides to move to a new clinic, $clinic_{it}$.

Before the disclosure, patients decide to move to a new clinic without knowing whether the success rate of the new clinic is better than that of the previous one. After the disclosure, patients can choose the new clinic after knowing its success rate. Therefore, by comparing the coefficients of $stage4_{it}$ before and after disclosure, we can answer whether the patient could choose a better clinic than the previous clinic by the disclosure; that is, whether the probability that the patient gets the embryos in one cycle is improved by moving to a new clinic.

Effects of whether a patient gets the embryos in one treatment cycle on live birth occurrence. Finally, I estimate the effect of whether a patient gets one or more embryos in one cycle on the probability of live birth by OLS. The estimation equation is as follows:

$$(4) \qquad livebirth_{it} = \pi_0 + \pi_1 stage4_{it} + \pi_2 age_{it} + \pi_3 stage4_{it} \times age_{it} + \pi_4 X_{it} + \pi_5 year_t + u_{it},$$

where $livebirth_{it}$ is an indicator variable that takes a value of one if there were one or more live births as a result of this cycle and a value of zero otherwise, X_{it} is a vector of treatment methods including $embryos\_transfer_{it}$ that represents the number of embryos transferred into the patient in this cycle and $frozen_{it}$ that takes a value of one if frozen embryos are used in this cycle and a value of zero otherwise, and u_{it} is the error term. The coefficients of interest are π_1 and π_3 which measure the effect of whether a patient gets one or more embryos on the live birth occurrence in different age groups. I would expect that π_1 and π_3 would be positive, and π_1 would be greater than π_3 because, usually, the older patient has the lower the success rate.

6. Results and discussion

6.1 Main results

Effects of disclosure on the probability that a patient moves to a new clinic. Table 2 reports the effect of information disclosure on the probability that a patient moves to a new clinic, based on the discontinuity-based OLS regression specified in equation (1). Column 1–3 show the results that are not separated by age groups, and I find that without controlling year and age fixed effects, information disclosure induces patients to move to a new clinic by 4.19 percent, but by controlling both year and age fixed effects, the effect is 13.5 percent. In column 4, I turn to the results that are separated by age group, and I also find that information disclosure induces patients aged 18–34, 35–39, 40–42, and over43 to move to a new clinic by 11.8, 14.1, 16.4, and 14.8 percent, respectively.

The intuitive reason why patients aged 40–42 have the highest probability is as follows. The doctor gives patients an explanation that the success rate substantially drops with age and it becomes quite low after age 43. So, patients want to have IVF as high success rates as possible. If patients have been trying IVF for a while to get pregnant but have been unsuccessful, they move to a new clinic before they are over 43 years old to receive the treatment by a new doctor that is likely to succeed. Patients aged over 43 have the second-largest probability. The intuitive reason for this is as follows. Since doctors need higher skills to lead the older patients to success in IVF, the variance in success rates of older patients among clinics (more precisely, the variance in the skills among doctors) is larger. Thus, it is easier for patients aged over 43 to find a clinic with higher success rates than the previous clinic. Moreover, patients who continue IVF even

though they face a low success rate may have a stronger demand for children. Thus, if they find a new clinic with a higher success rate, then they do not give up getting pregnant through IVF and continue it at the new clinic. On the other hand, the youngest patients have the lowest results because it is difficult to find a new clinic that has a substantially higher success rate than the current clinic; that is, it is difficult to choose a new clinic so that the marginal expected benefit of trying IVF at the new clinic is substantially larger than the marginal cost of stopping IVF at the current clinic.

The result in column 3 is consistent with the first stage estimates based on the specification in equation (3). I empirically prove that all the effects of disclosure on the probability that a patient moves to a new clinic are positive and statistically significant with corresponding F statistics far beyond the typical rules of thumb values for instrument relevance.

There are no external shocks that affect the probability that a patient moves to a new clinic in the year 2009. For example, one of the external shocks is health care services that make it easier for couples to try the treatment. Since they do not have to pay the full cost of the treatment, they can afford to pay the cost of moving to a new clinic and try it at the new clinic. The UK has the National Health Service (NHS), a tax-funded institution that ensures that UK healthcare is free at the point of delivery, but fertility treatments including IVF have been available since 2004 through the NHS (Werber, 2018).

Effect of moving to a new clinic on the probability of creating transferable embryos. Table 3 contains the IV estimates of the effects of moving to a new clinic on the probability that a patient gets one or more embryos (i.e. whether a patient reaches stage 4 in the IVF process) in one treatment cycle, based on the second stage specification in equation (2). Table 3 also shows, for comparison, the OLS estimates (without IV) on the effect of disclosure on the probability. The main results are shown in column 2.

In column 2, the coefficient of *Clinic* (aged 18–34) is -0.468 at a 99% significant level, which means that if a patient aged 18–34 moves to a new clinic, then the probability that the patient gets the embryos in one cycle decreases. From this result, I say that the negative effect of moving (i.e., the margins cost of giving up the next IVF cycle at the previous clinic that might be successful) dominates the positive effect (i.e., the marginal benefit of receiving a new treatment by a better doctor and staffs) for patients aged 18–34. I also find that, by moving to a new clinic, the coefficients of *Clinic*-age-cross-term are 0.275, 0.525, and 0.604 for patients aged 35–39, 40–42, and over 35, respectively. Combining the baseline results with the cross-term results, I can obtain that the negative effect of moving to a new clinic is dominant for patients aged under 39, but the positive effect is dominant for patients aged over 40.

Interestingly, the older patients are, the greater the magnitude of the positive effect is (i.e. by moving to a new clinic, the older patients have the greater increase in the probability that they get one or more embryos in one cycle). The intuitive interpretation is as follows. The success rate of older patients is extremely low, and thus it is quite difficult for doctors to make patients give birth. This means that the variance of doctor's skills is quite large. As a result, it is better to move to a new clinic to receive the treatment based on the new

treatment plan provided by a new doctor and embryologists than to continue it at the previous clinic where they have been unsuccessful for a while. On the other hand, the success rate of young patients is relatively higher. In other words, the skill difference among doctors has little effect on the treatment result of young patients. As a result, it is better to continue IVF at the previous clinic than to receive it from a new doctor because the previous doctor knows about the medical characteristics of patients more than the new doctor and thus the next treatment at the previous clinic has a higher success rate than that at the current one. Consequently, I conclude that the change in a doctor and the treatment plan through moving to a new clinic on treatment results are more critical to old patients than young patients.

There are completely different results between OLS regression and IV regression. The estimates in column 1, which are results from OLS regressions, show that the effect of moving is positive for all patients and its magnitude is decreased with age. In addition, the coefficients of the age dummy are positive for all age groups, which is completely different from the real success rates in IVF. Normally, since the youngest patients have the best success rate, the coefficients are negative and decrease with age. Consequently, the results of OLS regression have a bias, and we have to deal with the endogeneity problem caused by the self-selection of whether patients move to a new clinic or not.[10]

Effects of whether a patient gets the embryos in one treatment cycle on live birth occurrence. Finally, I show the relationship between whether a patient gets the embryos and the live birth occurrence based on the OLS specification in equation (4). In column 1 of Table 4, I find that when a patient gets one or more embryos in one cycle, the probability of live birth is increased by 10.0 percent. In column 2, I find that, by controlling the age fixed effects, it is increased by 2.1–12.2 percent, and that the increase rate drastically decreases at the age of over 40. In addition, I find that the more embryos are transferred into a womb, the more probability of live birth a patient has and that when patients use frozen embryos, they have a higher probability of live birth.

6.2 Heterogeneous effect

Table 5 reports the results of heterogeneity analysis. Columns 1 and 2 show the results for patients who have previously had IVF and/or DI between one and two times, three and four times, and more than five times, respectively. I find that the effect in column 2 is much larger than that in column 1 and the effect in column 3 is also larger than that in column 2. This result implies that patients who have had more experience of failure are more affected by the disclosure than those who have had less experience. The intuitive interpretation behind the result is straightforward. Those who have had IVF many times may have a stronger

[10] I test for endogeneity of $clinic_{it}$ in equation (2) by obtaining the residuals $\hat{v}_{it}$ from estimating the reduced form regression: $clinic_{it} = \gamma_0 + \gamma_1 age_{it} + \gamma_2 year_t + \gamma_3 z_{it} + v_{it}$. Adding $\hat{v}_{it}$ into the structural equation: $stage4_{it} = \beta_0 + \beta_1 clinic_{it} + \beta_2 age_{it} + \beta_2 year_t + \delta_1 \hat{v}_{it} + \eta_{it}$. The coefficient on $\hat{v}_{it}$ is δ_1 = -10.14, and t = -965.79. I conclude that $clinic_{it}$ is indeed endogenous.

demand for children, but they have been unsuccessful while paying high treatment costs (including financial costs and psychological costs) at the current clinic. If they find a better clinic in terms of success rates and the patients' rating, the marginal expected benefit of the next treatment at the new clinic is larger than the marginal expected cost of giving up the fertility treatment at the current clinic.

In addition, I consider a further specification that uses only observations within a three-year window around the year information disclosure started. In column 3, I find that the effect of disclosure is positive but its magnitude is smaller than that of results so far. The reason is that because of a three-year window, I capture only the short-term effects; that is, I cannot capture the long-term effect based on the behavior that patients search the information but do not move to a new clinic right after the searching.

Table 6 shows the second-stage regression results using each subsample. In column 1, I find a similar result to the results using the full sample, but the negative effect of moving to a new clinic dominates the positive effect for all age groups. This suggests that the patients who have previously had treatments less than two times should have one more cycle at the current clinic. In column 2, I can obtain a different result from that of the full sample, which is that the effect of moving is not statistically significant at even 10 percent level for patients aged 18–34, while the effect is positive for the other age groups and its magnitude becomes larger for older patients. In column 3, I find a different result from that of the full sample; that is, the effect of moving to a new clinic is positive for all age groups. These results suggest that the positive effect of moving dominates the negative effect if the patient has previously had the treatment more than four times. In other words, such patients are less likely to succeed if they repeat the treatment at the current clinic and should move to a new clinic to receive the treatment by a new doctor.

In column 4, I find two things. First, I obtain similar results to those reported in column 2 of Table 2. Thus, the results are robust even if we use observations within a three-year window. Second, the magnitude of coefficients is larger for all age groups than that reported in column 2 of Table 2. In particular, the results for a patient aged over 40 is more than 50 percent increase in the probability that the patient gets the embryos in one cycle. This implies that the short-term effect of information disclosure on the probability is quite large.

Table 7 shows the likelihood of live birth for patients who reach stage 4 of the IVF process using each subsample. Columns 1–3 show similar results to those obtained using the full sample. This implies that once patients get one or more embryos and it is transplanted into a womb, the likelihood of live birth does not crucially depend on the number of past treatment cycles. In column 4, I also find a similar result to those reported in columns 1–3.

7. Overall effect of information disclosure on the number of deliveries

In this section, using the results reported in column 1–3 of Table 5, 6, and 7, I obtain a back-of-the-envelope estimate of the magnitude of a per-patient increase in the live birth occurrence due to information disclosure

by multiplying my estimates of the change in the probability that a patient moves to a new clinic by the disclosure, times the change in the probability that a patient gets the embryos in one cycle by moving to a new clinic, times the change in the live birth occurrence by getting the embryos. For example, I can obtain the magnitude by $\gamma_1 \times \beta_1 \times \pi_1$ for patients aged 18–34. Since $livebirth_{it}$ takes a value of one if a patient gives one or more births (i.e. counting twins, triplets, and quadruplets as single birth), thus I can interpret the magnitude as the number of delivery. Moreover, multiplying this value times the number of patients between 2009 and 2016 yields how many deliveries are changed in response to the information disclosure.

The age-specific back-of-the-envelope estimates for each subsample are reported in Table 8. For example, I calculate the increase in the live birth occurrence (or the minimum increase in the number of live birth) per patient aged 18–34 who have previously had treatments more than five times, as $0.506 \times 0.600 \times 0.130 = 0.039$. Multiplying this value times the number of corresponding patients between 2009 and 2016 (that is 6,156 patients) yields 240 deliveries. This calculation implies that the information disclosure will be associated with at least 240 births. The total increase in the number of deliveries due to the positive effect of moving to a new clinic is 845 even though there are negative effects. In the UK there were 283 births of patients aged 18–34 as a result of the treatment cycle in 2016 (HEFA, 2018). These calculations are meant only as back-of-the-envelope estimates, but they make clear that the improvement in the number of live birth by information disclosure is socially significant.

8. Conclusion

By using the instrumental variable technique, this study explores: (I) whether the disclosure of individual clinic's success rates induces patients to move to a new clinic; and (II) whether patients have a higher rate of getting the embryos in one treatment cycle when moving to a new clinic. There are both merit and demerit of moving to a new clinic. The merit is that patients could receive treatments from a better doctor and staff. The demerit is that they have to give up the future treatment cycle at the previous clinic that might be successful. I investigate which one dominates, merits or demerits, by different age groups.

The findings and policy implications are as follows. (i) The information disclosure significantly induces patients to move to a new clinic. (ii) The greater the number of treatment cycles a patient has previously had, the greater the probability of moving to a new clinic. (iii) The merit of moving to a new clinic dominates for patients aged more than 40. The demerit dominates for patients aged less than 39 despite moving to a new clinic with higher success rates than the previous clinic via online services. (iv) Regardless of age, the merit dominates for patients who have previously had treatments more than five times. These results suggest that younger patients or patients who have previously had treatment less than three should do vertical treatments (that is trying one more cycle in the same clinic), while older patients or patients who have been unsuccessful for a while should do horizontal treatments (that is moving to a new clinic to receive the

treatment by a new doctor), resulting in the reduction of both financial and psychological costs of patients. This study empirically shows that efficient matching between clinics and relatively old patients who have been unsuccessful for a while are promoted by information disclosure, resulting in a higher success rate. However, it also induces the young patients who have little experience of the treatment to move to the other clinic, resulting in lower success rates.

There has been no theoretical and empirical analysis of how the clinic's information disclosure of individual clinics affects success rates of fertility treatments by focusing on a matching between clinics and patients. This study contributes to understanding the policy effect on the problem of welfare reduction, which is an important issue related to fertility treatments, due to heavy financial and psychological costs. Information disclosure may affect the patient's decision whether they give up the treatment or continue the treatment, and it may affect how many treatment cycles it takes to succeed.

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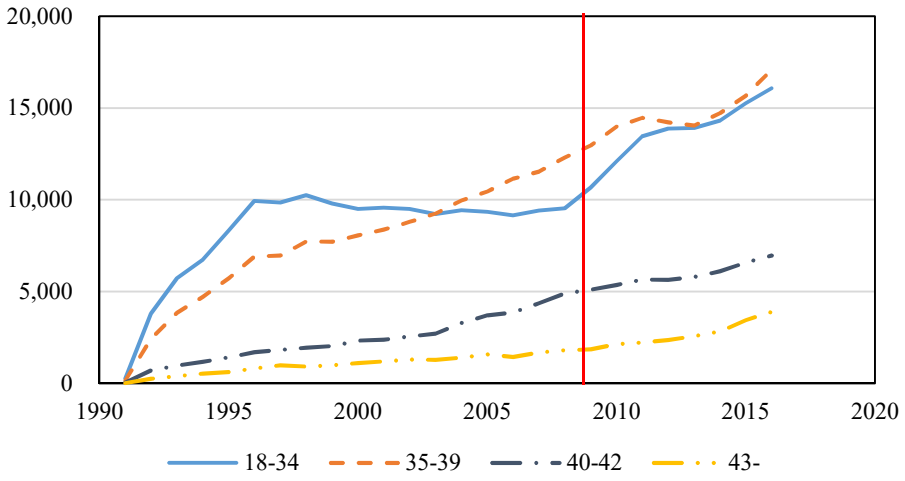

Figure 1—The number of age-specific patients who have had IVF more than once between 1991 and 2016

Notes: This graph illustrates the change in the number of patients I use in this study from 1990 to 2016 (the total number of patients is 641,750). I classify the patients into four groups by age: 18–34, 35–39, 40–42, and over 43.

Table 1—Descriptive statistics

	18–34 years old				35–39 years old			
	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Full sample								
Indicator of moving to a new clinic	0.17	0.38	0	1	0.23	0.42	0	1
Live birth occurrence	0.25	0.43	0	1	0.20	0.40	0	1
Indicator of getting embryos	0.57	0.50	0	1	0.61	0.49	0	1
Number of embryos created	3.84	4.69	0	51	3.50	4.15	0	49
Observations	258,990				253,534			
Pre-disclosure (1991–2008)								
Indicator of moving a new clinic	0.16	0.37	0	1	0.21	0.41	0	1
Live birth occurrence	0.21	0.41	0	1	0.17	0.38	0	1
Indicator of getting embryos	0.60	0.49	0	1	0.63	0.48	0	1
Number of embryos created	4.14	4.78	0	51	3.75	4.25	0	49
Observations	149,351				136,278			
Post-disclosure (2009–2016)								
Indicator of moving a new clinic	0.18	0.38	0	1	0.25	0.43	0	1
Live birth occurrence	0.30	0.46	0	1	0.24	0.43	0	1
Indicator of getting embryos	0.52	0.50	0	1	0.58	0.49	0	1
Number of embryos created	3.43	4.53	0	49	3.21	4.02	0	42
Observations	109,639				117,256			
	40–42 years old				43–50 years old			
	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Full sample								
Indicator of moving a new clinic	0.28	0.45	0	1	0.33	0.47	0	1
Live birth occurrence	0.13	0.34	0	1	0.13	0.33	0	1
Indicator of getting embryos	0.63	0.48	0	1	0.60	0.49	0	1
Number of embryos created	3.12	3.73	0	43	2.78	3.48	0	37
Observations	89,382				39,844			
Pre-disclosure (1991–2008)								
Indicator of moving a new clinic	0.24	0.43	0	1	0.30	0.46	0	1
Live birth occurrence	0.11	0.32	0	1	0.11	0.32	0	1
Indicator of getting embryos	0.64	0.48	0	1	0.60	0.49	0	1
Number of embryos created	3.28	3.79	0	43	2.91	3.50	0	37
Observations	42,100				18,461			
Post-disclosure (2009–2016)								
Indicator of moving a new clinic	0.31	0.46	0	1	0.35	0.48	0	1
Live birth occurrence	0.15	0.36	0	1	0.14	0.34	0	1
Indicator of getting embryos	0.62	0.49	0	1	0.59	0.49	0	1
Number of embryos created	2.98	3.67	0	42	2.67	3.45	0	32
Observations	47,282				21,383			

Notes: The table shows descriptive statistics for patients who have previously had IVF at least more than once (i.e., the total number of previous IVF cycles ≥ 1) before and after the disclosure. Indicator of moving to a new clinic" equals $clinic_{it}$ in equation (1). Indicator of getting embryos equals $stage4_{it}$ in equation (2), which takes a value of one if a patient gets one or more embryos in one treatment cycle and a value of zero otherwise.

Table 2—Effects of disclosure on the probability that a patient moves to a new clinic

	(1) All patients	(2) All patients	(3) All patients (First stage)	(4) All patients
Disclosure	0.0419***	0.150***	0.135***	0.118***
	(0.00104)	(0.0102)	(0.0105)	(0.0105)
Disclosure×35–39				0.0233***
				(0.00225)
Disclosure×40–42				0.0457***
				(0.00334)
Disclosure×over43				0.0304***
				(0.00492)
35–39 years old			0.0584***	0.0483***
			(0.00111)	(0.00146)
40–42 years old			0.104***	0.0814***
			(0.00167)	(0.00231)
over43 years old			0.153***	0.139***
			(0.00246)	(0.00351)
Constant	0.199***	0.0536***	0.0162	0.0226**
	(0.000678)	(0.0100)	(0.0103)	(0.0103)
Year fixed effects	No	Yes	Yes	Yes
F-statistics			165	
Observations	641,750	641,750	641,750	641,750
R-squared	0.003	0.006	0.018	0.018

Notes: The dependent variable is an indicator variable that takes a value of one if a patient has changed the clinic at least one time and a value of zero otherwise. Robust standard errors are in parentheses. *** denotes p<0.01, ** denotes p<0.05, and * denotes p<0.1. The F-statistics in the table refers to F-tests of the significance of the instrument in the first-stage regressions specified in equation (3).

Table 3—Effects of moving to a new clinic on the probability that a patient get embryos in one cycle: results from OLS and 2SLS (IV regression)

	(1) OLS	(2) 2SLS
Clinic (aged 18–34)	0.180***	-0.468***
	(0.00240)	(0.164)
Clinic×35–39	-0.0494***	0.275***
	(0.00324)	(0.0468)
Clinic×40–42	-0.0737***	0.525***
	(0.00424)	(0.0663)
Clinic×over43	-0.0778***	0.604***
	(0.00566)	(0.0949)
35–39 years old	0.0453***	0.00910
	(0.00154)	(0.0136)
40–42 years old	0.0693***	-0.0285
	(0.00221)	(0.0242)
over43 years old	0.0422***	-0.0801**
	(0.00322)	(0.0389)
Constant	0.462***	0.505***
	(0.0222)	(0.0246)
Year fixed effects	Yes	Yes
Observations	641,750	641,750
R-squared	0.027	0.013

Notes: The dependent variable is an indicator variable that takes a value of 1 if a patient gets at least more than one embryo in one treatment cycle, and zero otherwise. Robust standard errors are in parentheses. *** denotes p<0.01, ** denotes p<0.05, and * denotes p<0.1.

Table 4—Effects of whether a patient gets embryos in one cycle on the live birth occurrence

	(1)	(2)
	All patients	All patients
Stage4	0.100***	0.122***
	(0.00128)	(0.00186)
Stage4×35–39		-0.0403***
		(0.00225)
Stage4×40–42		-0.101***
		(0.00277)
Stage4×over43		-0.0975***
		(0.00368)
35–39 years old		-0.0272***
		(0.00160)
40–42 years old		-0.0750***
		(0.00204)
over43 years old		-0.0775***
		(0.00266)
Embryos transfer	0.0663***	0.0719***
	(0.000579)	(0.000569)
Frozen	0.0676***	0.0482***
	(0.00127)	(0.00127)
Constant	-0.109***	-0.0900***
	(0.0112)	(0.0113)
Age fixed effects	No	Yes
Year fixed effects	Yes	Yes
Observations	641,750	641,750
R-squared	0.041	0.058

Notes: The dependent variable is an indicator variable that takes a value of one if there were one or more live births as a result of this cycle and zero otherwise. Robust standard errors are in parentheses. *** denotes p<0.01, ** denotes p<0.05, and * denotes p<0.1.

Table 5—Effects of disclosure on the probability that a patient move to a new clinic: Heterogeneity analysis (First stage regression results)

	(1) Patients whose *tnpc* 1–2 times	(2) Patients whose *tnpc* 3–4 times	(3) Patients whose *tnpc* ≥ 5 times	(4) Patients who registered between 2006 and 2011
Disclosure	0.0548***	0.323***	0.506***	0.0444***
	(0.0105)	(0.0118)	(0.00774)	(0.00333)
Age fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Disclosure×age terms	No	No	No	No
Observations	431,339	133,588	76,823	181,310
F-statistics	27	751	4,283	177
R-squared	0.010	0.017	0.013	0.012

Notes: The dependent variable is an indicator variable that takes a value of one if the patient *i* in year *t* has changed the clinic at least one time and a value of zero otherwise. "*tnpc*" means the total number of previous cycles of IVF or DI the patient has previously had. Robust standard errors are in parentheses. *** denotes p<0.01, ** denotes p<0.05, and * denotes p<0.1. The F-statistics in the table refers to F-tests of the significance of the instrument in the first-stage regressions specified in equation (3).

Table 6—Effects of moving to a new clinic on the probability that a patient gets embryos: Heterogeneity analysis (Second stage regression results)

	(1) Patients whose *tnpc* 1–2 times	(2) Patients whose *tnpc* 3–4 times	(3) Patients whose *tnpc* ≥ 5 times	(4) Patients who registered between 2006 and 2011
Clinic	-0.877**	0.222	0.600***	-0.365***
	(0.415)	(0.476)	(0.116)	(0.122)
Clinic×35–39	0.301***	0.128**	0.0545	0.351**
	(0.0691)	(0.0641)	(0.103)	(0.139)
Clinic×40–42	0.418***	0.314***	0.351***	0.884***
	(0.100)	(0.0830)	(0.117)	(0.182)
Clinic×over43	0.461***	0.472***	0.300**	0.897***
	(0.149)	(0.117)	(0.140)	(0.266)
Age fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	431,339	133,588	76,823	181,310
R-squared	0.015	0.011	0.009	0.003

Notes: The dependent variable is an indicator variable that takes a value of 1 if a patient gets at least more than one embryo in one treatment cycle, and zero otherwise. "*tnpc*" means the total number of previous cycles of IVF or DI the patient has previously had. Robust standard errors are in parentheses. *** denotes p<0.01, ** denotes p<0.05, and * denotes p<0.1.

Table 7— Effects of whether a patient gets embryos in one cycle on the live birth occurrence: Heterogeneity analysis

	(1) Patients whose *tnpc* 1–2 times	(2) Patients whose *tnpc* 3–4 times	(3) Patients whose *tnpc* ≥ 5 times	(4) Patients who registered between 2006 and 2011
Stage4	0.120***	0.127***	0.130***	0.141***
	(0.00221)	(0.00432)	(0.00634)	(0.00379)
Stage4×35–39	-0.0401***	-0.0452***	-0.0517***	-0.0549***
	(0.00271)	(0.00504)	(0.00723)	(0.00442)
Stage4×40–42	-0.101***	-0.111***	-0.110***	-0.134***
	(0.00347)	(0.00605)	(0.00792)	(0.00517)
Stage4×over43	-0.110***	-0.0968***	-0.0923***	-0.133***
	(0.00486)	(0.00780)	(0.00910)	(0.00696)
Age fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	431,339	133,588	76,823	181,310
R-squared	0.059	0.055	0.052	0.057

Notes: The dependent variable is an indicator variable that takes a value of one if there were one or more live births as a result of this cycle and that takes zero otherwise. "*tnpc*" means the total number of previous cycles of IVF or DI the patient has previously had. Robust standard errors are in parentheses. *** denotes p<0.01, ** denotes p<0.05, and * denotes p<0.1.

Table 8—The per-patient minimally change in the number of live birth by information disclosure: Back-of-the-envelope estimates

	(1) Patients whose *tnpc* 1–2 times			(2) Patients whose *tnpc* 3–4 times		
	Number of patients after 2009	Per-patient change in live birth occurrence	Total change in the number of delivery	Number of patients after 2009	Per-patient change in live birth occurrence	Total change in the number of delivery
Patient aged 18–34	84344	-0.0058	-489	19139	0	0
Patient aged 35–39	78221	-0.0025	-196	25983	0.0034	88
Patient aged 40–42	27534	-0.0005	-14	11869	0.0016	19
Patient aged over43	11273	-0.0002	-2	5305	0.0046	24
Total			-701			132

	(3) Patients whose *tnpc* ≥ 5 times		
	Number of patients after 2009	Per-patient change in live birth occurrence	Total change in the number of delivery
Patient aged 18–34	6156	0.039	240
Patient aged 35–39	13142	0.024	315
Patient aged 40–42	7879	0.0096	76
Patient aged over43	4805	0.017	82
Total			713

Notes: The values are obtained by $\gamma_1 \times \beta_1 \times \pi_1$ for patients aged 18–34. Per-patient change in live birth occurrence can interpret as the change in the number of deliveries per patient. Total change in the number of delivery is obtained by multiplying the number of patients after 2009 times per-patient change in live birth occurrence.