Uterus at a Price: Disabilty Insurance and Hysterectomy

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Abstract

Taiwanese Labor, Government Employee, and Farmer Insurance programs provide 5-6 months of salary to enrollees who undergo hysterectomy or oophorectomy before their 45th birthday. These programs result in more and earlier treatments, referred to as inducement and timing effects. Difference-in-difference and nonparametric methods are used to estimate these effects on surgery hazards between 1997 and 2011. For Government Employee and Labor Insurance, inducement is 11-12% of all hysterectomies, and timing 20% of inducement. For oophorectomy, both effects are insignificant. Induced hysterectomies increase benefit payments and surgical costs, at about the cost of a mammogram and 5 pap smears per enrollee.

Keywords: disability insurance, moral hazard, hysterectomy, oophorectomy

JEL: I00, I10, I12, I18

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1 Introduction

In this paper, we study the effect of disability insurance on the moral hazard of health care use. Disability insurance compensates enrollees for accidental or inherited loss of physical and mental capacities that adversely affect labor market potentials (Staubli, 2011; Maestas, Mullen and Strand, 2013; French, and Song, 2014). Taiwan adopts a set of comprehensive employment-based mandatory disability programs. The incentive effects of disability insurance are well known. However, the Taiwanese programs have an uncommon component: they include coverage for women's infertility due to i) hysterectomy (surgical removal of the uterus), ii) oophorectomy (surgical removal of both ovaries), and iii) radio-chemo therapy. Enrollees are entitled to a cash benefit, equal to about 5 to 6 months of salary when they undergo these treatments, but the coverage ends when enrollees become 45 years old.

Organ dismemberment insurance policies are not uncommon. However, we are unaware of evidence that these policies have "caused" enrollees to lose a thumb, a toe, an eye, or get an eardrum perforated. Normally, compensations are insufficient to cause excessive claims because the loss disutility is too high. However, the Taiwanese programs afford us the rare opportunity to examine cases in which some enrollees react to coverage by electing to have organ-removal surgeries.

We study disability insurance's effect on the incidence of hysterectomy and oophorectomy, both of which involve the removal of major organs. We are unaware of the same infertility coverage or age limit in any other social insurance program.[1] Although it may sound sinister to suggest that enrollees undergo serious organ-removal surgeries to qualify for disability benefits, the economic perspective is that the coverage, perhaps unintentionally, has created such an incentive. Furthermore, there is an incentive to undergo surgeries before the benefit expires at the 45th birthday. Clearly, hysterectomy and oophorectomy must be performed based on illness indications, but they may still be performed when the indicated severity may not fully justify surgery. Does disability insurance lead to excessive treatments that would not have been performed in the absence of the insurance: an inducement effect? Does disability insurance lead to treatments being expedited

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[1] In Japan, benefits due to infertility suffered at work are covered, but the Taiwan programs are universal, not limited to injury at work.

to before the 45th birthday: a timing effect?

Only hysterectomy exhibits significant inducement and timing effects; oophorectomy does not. These are striking results. First, we can interpret the infertility coverage as a natural experiment that offers the same benefit on infertility due to hysterectomy or oophorectomy. However, oophorectomy has far more serious adverse health consequences than hysterectomy (more thorough discussions in Subsection 2.1). If an enrollee chose to undergo one procedure solely for the disability benefit, the preferred procedure would be hysterectomy due to lower disutility. The likely scenario is that a medical intervention is indicated due to an illness. Our results indicate that the monetary disability benefits would have no effect on oophorectomy, but would lead to more hysterectomies. This natural experiment yields behaviors that are consistent with optimizing behavior—even when the decision involves a surgery to remove a major organ.

Second, our results indicate that the way the disability insurance is implemented may be very costly. About 11-12% of hysterectomies in our sample can be attributed to inducement. The costs of these surgeries are incurred precisely because the qualification requires it. Although the induced surgeries may result in some benefits (such as reduced pain, incidences of cancer later), the costs must outweigh these benefits. The Taiwanese already enjoy national health insurance, so surgery inducement due to disability insurance occurs in additional to moral hazard due to health insurance. Linking a disability to a surgical procedure creates double moral hazard, one in the disability claim, and another in health care use. Our results serve as a warning against using a medical treatment as a qualification for disability insurance benefits.

Third, this study sheds some light on monetary incentives and human organs in general. Our evidence suggests that individuals make consistent choices. The lack of inducement and timing effects in oophorectomy perhaps is the strongest evidence that for a given price of an organ, individuals reject the offer if and only if the disutility of its removal is sufficiently high. We have also found that, in the income-stratified samples, induced-hysterectomy rates are increasing in the benefit level.

We estimate the inducement and timing effects by the difference-in-difference and nonparametric methods. Our difference-in-difference design is based on the comparison of enrollees in three disability insurance programs and those uninsured between 1997 and 2011. The three programs are Labor Insurance, Government Employee Insurance, and Farmer Insurance. The uninsured are mostly women who are inactive in the labor force. Our data are from Taiwan's National Health Insurance, and indicate the type of disability insurance for each individual, and if and when hysterectomy, oophorectomy, or both surgeries have taken place. In addition, the data are merged with variables obtained from the Survey of Family Income and Expenditure (SFIE) to help control for socio-demographic and economic factors.

We follow female enrollees in the three insurance programs and the uninsured between their 39th and 50th birthdays. In the main analysis, we include only enrollees who have not changed their insurance programs in the sample years. We then group enrollees by their birth cohorts and insurance programs, and calculate the corresponding hysterectomy and oophorectomy hazards. Our main variable is the quarterly surgery hazard in the number of quarters (a 91-day period) from the 45th birthday. Because we follow enrollees for 11 years, there are 24 such benefit quarters before the 45th birthday, and 20 quarters after. For each birth cohort, we also use the average numbers of children and sons, marital status, and household income as covariates.

Our difference-in-difference design is unconventional because there is not a before-and-after policy regime change. However, the insured lose the infertility insurance benefit at age 45. Obviously, that benefit expiration is irrelevant to the uninsured. Our hypothesis is that the disability insurance incentive effect is muted when the enrollees are young. This is because uterine problems mostly occur past late thirties. Opting for surgeries to qualify for benefits is infeasible until uterine or ovarian problems become manifested.[2] To operationalize our empirical strategy, we let the insurance benefit become relevant when enrollees turn 40 years old. In other words, we treat the benefit expiration at the 45th birthday as a policy intervention on program enrollees at their 40th birthday. Our approach is conservative: quarters just after the 40th birthday need not exhibit differences. If the relevance of the deadline only appears at some time after the 40th birthday, our difference estimates would simply vanish.

Using the hazards before age 40 as the benchmark, we examine the dynamic, quarter-by-quarter hazard differences between the insured and uninsured, for the 5 years before and 5 years after the 45th birthday (20 quarters before and after the benefit expires). How do the hazards differ when enrollees are approaching their

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[2] In other words, it is implausible to assume that physicians would perform an operation when patients present no medical problems.

45th birthday? How do they differ thereafter? Indeed, for hysterectomy, Labor Insurance and Government Employee Insurance enrollees' hazards begin to rise rapidly 8 quarters before expiration, but drop rapidly for 2 quarters after. Enrollees in Farmer Insurance show similar but less pronounced hazard changes. For oophorectomy, these rapid changes are absent in all insurance programs.

From the estimates we calculate inducement and timing effects. The inducement effect is the total number of insured enrollees' extra surgeries between their 40th and 50th birthdays compared to the uninsured. The timing effect consists of the total number of surgeries that the insured would have undergone after the 45th birthday compared to the uninsured. In our sample, Labor Insurance enrollees have a total of 43,845 hysterectomies, and the inducement effect is 5,076 hysterectomies, or about 11.6%. For Government Employee Insurance, the total is 7,262, and the inducement effect is 789, or 10.9%. For Farmer Insurance, the total is 9,100, and the inducement effect is 347, or 3.8%. (Later, we will provide all the details of these three insurance programs, which partially account for some of the magnitude of differences.) No inducement or timing effects have been found for oophorectomy.

We also use a nonparametric, bunching method (see e.g. Saez, 2010; Chetty et al., 2011), which assumes that surgeries do not happen abruptly over time. We use hazards in benefit quarters far from the 45th birthday to fit a polynomial. Then we use the fitted polynomial to predict the hazards in benefit quarters near the 45th birthday. Any discrepancy between the predicted and actual hazards is attributed to benefit expiration. These discrepancies are used to define the inducement and timing effects analogously. The nonparametric estimates of the inducement and timing effects for hysterectomy and oophorectomy are similar to those in the difference-in-difference method.

As a check, we estimate inducement and timing effects of two other surgeries: partial oophorectomy (the removal of one ovary), and myomectomy (the removal of the inner lining of the uterus). These procedures are used to alleviate problems in the female reproductive system, but do not qualify for the infertility insurance benefit. We have found no inducement or timing effects for these procedures.

We also consider a number of robustness issues and policy implications. Our primary sample consists of female enrollees who have not switched between insurance programs. For a larger sample, we include those who have switched between programs. Next, our data include medical records of women aged between 39 and 49 years old during the period 1997 to 2011. Therefore, the panel is unbalanced: early cohorts are subject to left censoring while late cohorts are subject to right censoring. For a smaller sample, we only use data from those with uncensored medical records in the sample period. Our results are robust to various compositions of samples.

We estimate benefits and surgery costs induced by disability insurance programs over enrollees' lifetimes. Benefit payments are transfers, which may be inefficient or unintended. Induced hysterectomies may result in some health benefits; but the costs due to inducement are in addition to the excessive consumption cost due to health insurance, so must be lower than health benefits. We estimate that on average, the increase in benefit payment is about NT$1,410 per enrollee, and the hysterectomy cost is about NT$400 per enrollee. For comparison, the reimbursement rate for mammogram and pap smear are, respectively, NT$1,245 and NT$80. Hence, the inducement cost is more than enough to pay for 1 mammogram and 5 pap smears for each enrollee during her lifetime.

The plan of the paper is as follows. In the next subsection, we review the literature. We present the study background in Section 2. Section 3 describes the data for the study, and the construction of our sample of enrollees who have not changed insurance status throughout the entire sample period. We also present sample statistics. In Section 4, we present the two econometric methods. Subsection 4.1 is on the difference-in-difference method, and Subsection 4.2 is on the nonparametric method. In each case, we set up the regression equations, and define the inducement and timing effects. The two subsections in Section 5 contain the estimation results. In Section 6, we consider a bigger sample that includes individuals who may have switched insurance programs, and a smaller sample in which data are uncensored. Then we perform various robustness checks based on these expanded and restricted samples. Next, we stratify the sample of Labor Insurance enrollees according to five benefit levels, and examine the size of inducement with respect to benefit levels. Finally, we present estimates of social costs due to inducement. We draw some conclusions in Section 7. Appendix A contains tables of estimation results, and Appendix B contains plots of actual and counterfactual hazard distributions from the nonparametric method.

1.1 Literature review

Insurance benefits that are based on age and time are quite common. Medicare in the United States provides health insurance to individuals over 65 years old. In most countries, unemployment benefits expire after a period of time. The incentives of insurance benefits that are based on time and enrollees' age influence enrollees' behaviors. For instance, research has shown that i) patients delay treatment or surgeries until they become eligible for Medicare, and ii) recipients of unemployment insurance delay job search until benefits are about to expire. In both cases spikes of medical treatment post qualification and unemployment duration around expiration have been observed (see McWilliams et al., 2003, McWilliams et al., 2007, Card, Dobkin and Maestas, 2008, Card, Dobkin and Maestas, 2009 for Medicare; and Caliendo, Tatsiramos, and Uhlendorff, 2013, Farber and Valletta, 2015, Schmieder, von Wachter, and Bender, 2016, for unemployment insurance). In the Taiwanese setting, the infertility benefits expire at age 45. However, benefit qualification requires hysterectomy or oophorectomy, and Taiwan's National Health Insurance covers these surgeries. In other words, an enrollee's incentive to qualify for the benefit implies a second incentive for a surgery.

Our empirical strategy uses a modified difference-in-difference regression, and a nonparametric method. Difference-in-difference regression is the standard method for program evaluations and policy assessments (for a review see Imbens and Wooldridge, 2009). Here, we go beyond estimating the average effect to study policy effects over time, especially periods right before and after benefit expiration. As in Chandra, Gruber, and McKnight (2010), we use quarter-by-quarter estimates for the policy effect over time. Autor, Kerr and Kugler (2007) use a similar year-by-year difference-in-difference model to understand how mandated employment protections reduce productive efficiency. Hoynes, Miller and Simon (2015) also use the same method to study how earned income tax credit influences infant health outcomes.

Our nonparametric method is similar to the bunching method for assessing discontinuity effects created by policies. For example, taxes can be discontinuously related to reported incomes (Saez, 2010; Chetty et al., 2011; Kleven and Waseem, 2013), tax reliefs may be available to couples only if marriages or child births happen before a certain date (Persson, 2015), or students' test scores bump up over key grade cutoffs in nationwide math tests, and teachers use discretion in their grading to achieve the discrete jumps (Diamond and Persson, 2016). We use the standard assumption that, absent the policy, the variable of interest should change smoothly, so any bunching is due to the policy However, our method is more closely related to Diamond and Persson (2016) in that we adopt an optimality criterion—minimum mean-squared errors—to determine the manipulated regions and then estimate the counterfactual surgery polynomials.

2 Background

2.1 Hysterectomy and oophorectomy

Hysterectomy is the surgical removal of a woman's uterus, the organ that holds the fetus. This is the second most common elective surgery among women, after cesarean section for childbirth. Hysterectomies are performed mainly for uterine fibroids and malignant tumors in a woman's reproductive system.[3] Common indications are menstrual irregularities, such as heavy bleeding, and serious pain (Department of Health and Human Services, 2011). Alternative treatments for some of these indications are available. Myomectomy—the surgical removal of some uterine lining—may be a remedy for uterine fibroids. Endometrial ablation—surgical removal of endometrium—may be suitable for excessive bleeding. Pain medication, synthetic steroid hormones, and pelvic floor exercises are other alternatives.

Usually performed by a gynecologist or an obstetrician, hysterectomy can be either complete (removal of the uterus and cervix) or partial (without the removal of the cervix). There are three variants of the surgical procedure: abdominal, vaginal, and laparoscopic. Hysterectomy carries a minimal morbidity risk, at a mortality rate below 0.05%. Complications, such as bleeding and dysfunctional uterine parity, are also rare (McPherson et al., 2004). The length of hospital stay for the procedure ranges from 3 to 5 days.

The incidence of hysterectomy exhibits an age pattern over a woman's lifetime: the rate rises steadily from ages 30 to 39, reaches a peak between 45 and 49, and then declines steeply (McPherson, Gon and Scott, 2013). Incidence rates vary substantially across different countries. According to OECD Statistics, in 2012, the average hysterectomy incidence rate was 179 per 100,000 women, but it was 318 in Germany, and only 49 in Denmark (McPherson, Gon and Scott, 2013).

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[3] In a random sample of 658 Taiwanese women, the most common indication for hysterectomy was uterine fibroids (at 46.2%), followed by malignancy and pre-malignancy (at 22.2%) (Wu et al., 2005).

For Asian countries, the incidence rate (per 100,000 women) for South Korea was 198 in 2012 (OECD Health Statistics, 2016). In Taiwan, with a population of 23 million, an average of 23,000 hysterectomies are performed each year. From 1996 to 2005, Taiwanese hysterectomy incidence rates varied between 268 and 303 (Wu et al, 2010). According to National Health Insurance Data, when Taiwanese women become 50 years old, more than 20% of them would have had hysterectomies.

2.2 Disability insurance

In Taiwan, three mandatory social insurance programs provide disability insurance to the working population. Enrollment is only for the individual; there is no family coverage. Labor Insurance is the largest program, covering nearly 9 million workers in the private sector in 2012. When it was first established in 1956, it provided only health insurance, but by 1978 insured enrollees had coverage for disability, maternity, occupational injuries, unemployment, pension, and death. After 1995, Taiwan's National Health Insurance replaced health insurance in Labor Insurance.

The second largest social insurance program is Farmer Insurance. In 2012, this program covered 1.5 million farmers. Government Employee Insurance, the third program, is for public employees and teachers in both public and private schools and colleges. In 2012, Government Employee Insurance covered about 0.6 million lives. Similar to Labor Insurance, Farmer Insurance and Government Employee Insurance provide a portfolio of benefits, which include disability insurance.[4]

With few exceptions, disability insurance benefit is paid as a lump sum;[5] the benefit amount varies according to the type and severity of disabilities. In this research, we focus on the disability benefit for a female enrollee's loss of her reproductive function. A woman is eligible for this disability benefit if, due to illnesses, she undergoes any of three medical procedures before turning 45 years old: hysterectomy, complete oophorectomy, and radio-chemo therapy on ovaries. The disability insurance benefit is not meant to compensate for medical expenses because Taiwan's National Health Insurance covers most in-patient medical

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[4] Government Employee Insurance does not provide unemployment insurance. Farmer Insurance does not offer unemployment insurance or pension scheme.

[5] Disability insurance does provide long-term benefits for those who contract chronic illnesses or have accidents that impair their capacity to work.

expenses.[6]

One naturally questions the rationale behind the Taiwanese infertility coverage. In Chinese culture and customs, children often take care of their parents, so infertility can be likened to a loss of future resources. Besides, infertility likely adversely affects a woman's prospect in the marriage "market." Both reasons can be the motivation for the government's policy of protecting women from negative income shocks.

Recipients of insurance benefits are mostly patients who have undergone hysterectomy. Complete oophorectomy and radiation and chemotherapy are less common. Our hypothesis is that the cash benefit from disability insurance may cause excessive treatments. The effect of disability insurance on hysterectomy is plausible because the adverse consequences of hysterectomy are relatively mild. On the other hand, radio-chemo therapies have very serious consequences and side effects, so the insurance benefit is unlikely to have any effect on such decisions. Oophorectomy also carries adverse consequences, but we will study the effect of insurance on this treatment. As a check, we will study partial oophorectomy and myomectomy, which do not qualify for insurance benefit.

The disability benefits are calculated according to an enrollee's "insurance salary," to be defined next; they are 6 months of insurance salary in Government Employee Insurance, and 5.3 months in both Labor Insurance and Farmer Insurance. For Farmer Insurance, the insurance salary is fixed at NT$10,200 per month, so the reproductive disability benefit is fixed at NT$54,060 (= 10200×5.3). (In 2015, the exchange rate was about NT$30 to US$1.) For Labor Insurance, in 2013, the insurance salary is defined to be the lower of an enrollee's actual monthly salary and NT$43,900. For Government Employee Insurance, the insurance salary is the lower of an enrollee's base monthly salary and NT$53,900. However, the base salary does not include various stipends (e.g. research stipends for teachers), and an enrollee in Government Employee Insurance typically has actual monthly earnings higher than the base salary.[7]

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[6] The co-insurance rate of inpatient services for Taiwan's National Health Insurance is 10%, with spending caps. In 2011, the caps per admission and per year were NT$28,000 and NT$47,000 respectively.

[7] For instance, the base salary and the research stipend for an assistant professor in 2012 was approximately the same, at NT$41,755 and NT$39,555, respectively.

3 Data and samples

3.1 Data

Our sample period spans the 15 years between 1997 and 2011. The subjects are females born between 1948 and 1972, and we study their experiences between their 39th and 50th birthdays during the sample period. We use three data sets. The first is the set of hospital claims of Taiwan National Health Insurance between 1997 and 2011. The claims data include all inpatient admissions in Taiwan because National Health Insurance covers the entire population. Each claim includes a patient's demographics (gender and date of birth), admission date, disease diagnoses, medical reimbursement, and any surgery performed during the admission. Each claim also has scrambled unique identifiers for a patient, doctors and hospitals. We use the surgical-procedure information to identify those who have undergone hysterectomy, oophorectomy, myomectomy, and partial oophorectomy. We use a patient's date of birth and admission date to check whether hysterectomy and oophorectomy have been performed before the 45th birthday.[8]

Our second data set is the National Health Insurance enrollment file. The file contains the last entry of each enrollee's insurance program and disability insurance salary at the end of a calendar year. We first use an enrollee's insurance type to infer the disability insurance status. National Health Insurance started in 1994 by merging many private and public insurance programs, and its enrollment file has continued to track enrollees' other social insurance modules. From the enrollment file, we classify subjects' disability insurance status into four groups: Government Employee Insurance, Labor Insurance, Farmer Insurance, and otherwise uninsured. However, the current-year insurance program status may be inappropriate if some enrollees change insurance status and programs after undertaking a hysterectomy. Later we use an enrollee's disability insurance status in the previous year as a robustness check.[9]

Next, we obtain enrollees' disability benefit information in the National Health Insurance enrollment

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[8] The infertility benefit is paid once even if both hysterectomy and oophorectomy have been performed.

[9] Up until 2002, the National Health Insurance enrollment file contained full disability insurance enrollment records. From 2003 onward, the enrollment file only contained enrollees' last disability insurance record in a calendar year; it no longer tracks an enrollee's disability insurance program changes during the year. For consistency, we use the last disability insurance record even for years before 2003

file. National Health Insurance charges a premium equal to a percent of an enrollee's monthly salary up to NT$188,000, which is much higher than the salary caps for disability insurance benefits. Therefore, from the National Health Insurance premium, we can infer an enrollee's salary, and, in turn, the benefits. This inference is exact for enrollees in Labor Insurance. Government Employee Insurance uses the base salary, a fraction of the total salary, for benefit calculation, so the enrollee's salary in the National Health Insurance enrollment file will over-estimate the benefit. (For this reason, our analysis in Subsection 6.2 will be based on Labor Insurance enrollees.) The disability benefit in Farmer Insurance is fixed, so we do not need to use salary information from National Health Insurance.

Our third data set is from the Survey of Family Income and Expenditure (SFIE), conducted by Taiwan's Directorate General of Budget, Accounting and Statistics. Each year the survey randomly samples 13,000-16,000 households (or about 52,000–68,000 individuals) and collects information on socio-demographic characteristics of each member of the sampled households. For our sample period 1997-2011, we obtain the following information about female respondents who are in the 39-49 age group: highest education level, marital status, number of children by gender, monthly household earnings, and disability insurance type. We then use the insurance information to merge with the enrollment files to control for demographics of enrolled populations.

3.2 Samples

We define our sample in the following way. First, we follow enrollees' decisions for six years before, and five years after, the 45th birthday which is the benefit expiration point. Next, we impose a number of restrictions. We remove those in Labor Insurance whose enrollments were through trade union memberships, because these enrollees are able to manipulate their benefit levels by misreporting self-employment income.[10] We also delete a small number of enrollees who were in military or welfare programs, because their access to health services might be different.

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[10] Labor law in Taiwan requires private companies with five or more employees to purchase Labor Insurance for all employees. Self-employed workers or those who work in firms with fewer than 5 employees are not required to participate, or they can participate through trade unions. Salaries of these workers are often unstable or under-reported. For the comparison between insured salary and earned salary in various insurance groups, see Lien (2011).

Table 1: Insurance program changes before hysterectemy

	Insurance program in the year of hysterectomy					
Insurance program in the year before hysterectomy	(1) Labor Insurance	(2) Government Employee Insurance	(3) Farmer Insurance	(4) Trade Union	(5) Uninsured	Total
Percentage changes						
(1) Labor Insurance	91.94%	0.03%	0.18%	3.54%	4.30%	100%
(2) Government Employee Insurance	0.95%	97.55%	0.06%	0.19%	1.26%	100%
(3) Farmer Insurance	1.66%	0.00%	96.54%	0.79%	1.01%	100%
(4) Trade Union	2.19%	0.01%	0.03%	96.93%	0.83%	100%
(5) Uninsured	5.81%	0.10%	0.64%	6.84%	86.61%	100%
Enrollees with hysterectomies in different program (obs.)	67,719	8,920	11,693	53,911	37,748	179,991

Furthermore, enrollees may change social insurance programs through employment changes because of differences in disability-insurance benefits. The strategic switch between disability insurance programs creates a selection problem. For the main analysis we use a sample of enrollees who have never changed their insurance status within the sample period. We call this the nonswitching sample. The general sample refers to all female enrollees regardless of any change in insurance programs during the sample period.

Table 1 illustrates the extent of strategic insurance program switches. The table includes all enrollees who have had hysterectomies during the sample period, and also those in Labor Insurance covered by trade union memberships. There are almost 180,000 hysterectomies. For each enrollee, we note her insurance program in the year in which hysterectomy is undertaken, and her insurance program the year before. Consider the row under Labor Insurance in Table 1. The number 91.94% is the fraction of all Labor Insurance enrollees who have undergone hysterectomies under the same program. Only 0.03% of Labor Insurance enrollees have changed to Government Employee Insurance when they have had hysterectomies the following year; 0.18% of Labor Insurance enrollees have changed to Farmer Insurance, etc.

Table 1 shows that insured enrollees overwhelmingly have had the same insurance program as the year before when they undergo hysterectomy. More than 90% of those in Labor Insurance have not changed the program from the year before hysterectomies; the corresponding numbers for Government Employee Insurance and Farmer Insurance are even higher, at 98 and 97%. The lower corresponding percentage of just below 87% for the uninsured likely indicates some strategic changes. Almost 6% of the uninsured have

Table 2: Sample censoring and balance

Cohorts	Age at 1997	Age at 2011		Years in sample	Data at 45th birthday
1948	49	63	left-censored	1	no
.	.	.	.	.	.
1952	45	59	left-censored	5	no
1953	44	58	left-censored	6	yes
.	.	.	.	.	.
1956	41	55	left-censored	9	yes
1957	40	54	left-censored	10	yes
1958	39	53	balanced	11	yes
1959	38	52	balanced	11	yes
1960	37	51	balanced	11	yes
1961	36	50	balanced	11	yes
1962	35	49	balanced	11	yes
1963	34	48	right-censored	10	yes
1964	33	47	right-censored	9	yes
.	.	.	.	.	.
1966	31	45	right-censored	6	yes
1967	30	44	right-censored	5	no
.	.	.	.	.	.
1972	25	39	right-censored	1	no

become insured under Labor Insurance when they have hysterectomies, and almost 7% have become insured through trade union memberships. We use the nonswitching sample for the main analysis, and the general sample for robustness check and social cost calculations.

Our data period is the 15 years between 1997 and 2011. We include female enrollees born between 1948 and 1972 for their experiences between their 39 and 49 birthdays, when these experiences happen between 1997 and 2011. Table 2 presents the birth cohorts and their corresponding ages in 1997 and 2011. The oldest cohort, those born in 1948, would be 49 years old in 1997, so would only stay in the sample for one year. They would also have experienced the deadline prior to the data period. The youngest cohort, those born in 1972, would be 39 years old in 2011. Likewise, they would only stay in the data period for one year, and they would experience the deadline after the data period. In other words, enrollees' experiences can be left censored or right censored. However, for those enrollees born between 1958 and 1962, they would spend all their 11 years between their 39th and 49th birthdays within the data period between 1997 and 2011. These enrollees constitute a balanced sample.

In total we use three samples. The nonswitching sample is used throughout. We use the general and balanced samples for robustness checks. We use the balanced sample for social cost calculation. Censoring happens in both nonswitching and general samples, but they have a lot more enrollees. Censoring does not happen in the balanced sample, but it is much smaller.

Disability insurance is employment based. Employment and job decisions are complex and conscious acts, so members in our sample have never been randomly assigned. However, the relevant issue is whether the insured and the uninsured suffer from uterine and ovarian problems in the same random fashion. If the illness incidence is uncorrelated between the insured and uninsured, then comparing their behavioral differences is valid. We are unaware of correlation between employment and the prevalence of medical problems in female reproductive organs. In a 2009 study on almost 190,000 women in the 2004 U.S. Behavioral Risk Factor Surveillance Survey database, Ereksob et al. (2009) find that women who were unemployed did not have higher odds of having a hysterectomy than women who were employed. More important, as we will show in Figures 3 and 4 below, the insured and uninsured have similar hazards in partial oophorectomy and myomectomy, which do not qualify for benefits. This is strong evidence that in terms of uterine and ovarian problems, the insured and uninsured share the same risks.

3.3 Summary statistics

The first half of Table 3 presents the summary statistics of the nonswitching sample in 2000, 2005 and 2010. The number of subjects ranges from 0.93 to 1.23 million in these years. Because each subject is included when she is between 39 and 49 years old in that sample year, there is a significant change in the distribution of birth cohorts across the years. In 2000, subjects born between 1960 and 1964 account for 17.9% of the subjects in that year, but those born between 1950 and 1954 account for 38%, and those born between 1955 and 1959 account for the rest. In 2005, the birth-year distribution shifts forward: none were born between 1950 and 1954, but 33.0% were born between 1955 and 1959, with the largest group (45.7%) being born between 1960 and 1964. For the year 2010, the subjects' birth-year distribution follows the same forward-shift pattern.

Table 3 also shows the distributions of the enrollees' insurance programs in the nonswitching sample. The percentages of enrollees having Government Employee Insurance seem to be quite stable in the three

Table 3: Summary statistics of female enrollees between 39 and 49 years old

	Nonswitching Sample			General Sample		
	2000	2005	2010	2000	2005	2010
Birth year						
1950-54	37.7%	0.0%	0.0%	32.3%	0.0%	0.0%
1955-59	44.3%	33.0%	0.0%	46.9%	32.4%	0.0%
1960-64	17.9%	45.7%	29.9%	20.7%	47.2%	34.0%
1965-69	0.0%	21.4%	47.3%	0.0%	20.4%	46.4%
1970-74	0.0%	0.0%	22.8%	0.0%	0.0%	19.6%
Insurance programs						
Government Employee	9.6%	10.2%	9.6%	7.3%	7.3%	8.1%
Labor	47.8%	52.7%	56.5%	49.1%	51.3%	55.6%
Farmer	11.7%	9.0%	6.3%	9.7%	7.5%	6.2%
Uninsured	31.0%	28.2%	27.5%	33.9%	33.8%	30.1%
Surgery incidence rate per 100,000						
Hysterectomies	766.5	582.8	526.7	702.1	556.2	516.0
Myomectomies	124.2	198.5	273.1	109.9	173.6	234.1
Total oophorectomies	146.2	67.4	55.2	127.4	63.6	57.5
Partial oophorectomies	93.7	246.9	267.3	81.6	220.7	236.3
N (number of enrollees at year end)	931,632	991,952	1,232,835	1,348,413	1,477,946	1,523,745

years, ranging from 9.6% to 10.2% in the sample. Labor Insurance has the largest share of enrollment, about 50%, in each of the three years. However, the share of Farmer Insurance enrollments gradually declines over time. This is likely due to the diminishing and aging farmer population. Finally, the shares of the uninsured females seem to exhibit a slightly downward trend, declining from 31.0% in 2000 to 27.5% in 2010.

The second half of Table 3 shows the corresponding figures in the general sample. In contrast with the nonswitching sample, the general sample has a higher percentage of enrollees in Labor Insurance and uninsured groups. Enrollees in Government Employee Insurance and Farmer Insurance are less likely to change programs, so their shares become smaller when this restriction is lifted. Likewise, a higher percentage of older cohorts can be observed because those enrollees are more likely to switch between insurance groups (e.g. from being employed to being unemployed and hence uninsured).

The lowest part of Table 3 displays the incidence rates of four reproductive-organ related surgeries in the nonswitching sample. Whereas the incidence rates of hysterectomy fall from 1,128 (per 100,000) in 2000 to 695 in 2010, myomectomy incidence rates almost double between 2000 and 2010. This likely indicates that myomectomy has become a more effective treatment for those suffering from uterine fibroids. Myomectomy may also become a more popular substitute for hysterectomy. For oophorectomy, the incidence rates of complete oophorectomy decline over time, but the opposite is true for partial oophorectomy. Better diagnosis and more conservative treatments may have been behind this trend. Similar trends can be also found in the general sample.

4 Econometric methods

Our hypothesis is that an enrollee's decision to undergo hysterectomy or oophorectomy is significantly affected by the disability insurance. Nevertheless, our data do not allow us to test this directly at the individual level because we do not have information of individual or household income, marital status, or number of children. However, from SFIE we obtain these variables for birth cohorts. Therefore, we aggregate medical records in order to construct cohort hazards. If individual surgery decisions respond to incentives, enrollees as a group also respond similarly. Our data allow us to test our hypothesis at the cohort level.

We group enrollees into cohorts by two discrete time scales: i) a natural time scale and ii) the amount of time from the 45th birthday. The natural time scale is represented by the vector $c \equiv (y, s)$, where y is a year and s is a season, or a three-month period of the year. An enrollee's birthday fits her into a birth cohort $c \equiv (y, s)$. Our sample consists of female enrollees born between 1948 and 1972, so we have 100 (= 25 years × 4 seasons) birth cohorts, with y taking values of 1948, 1949,…, and 1972, and s taking values of 1, 2, 3, and 4.

The second time scale measures how much time an enrollee has available before, or elapsed after, the expiration of the disability insurance benefit. We call the second time scale an enrollee's benefit quarter, and denote it by the variable q. The 91-day period that begins with the 45th birthday is called quarter 0; the next 91 days is quarter 1; the 91 days before quarter 0 is quarter -1, and so on. Enrollees in our sample are between 39 and 49 years old, so the benefit-quarter variable q takes values -24, -23,…, -1, 0, 1,…,19. By making distinctions between year, season, and benefit quarters we allow for more decision variations.

Clearly, the choice of a 91-day length for a time unit, both for chronological and benefit dimensions, is for convenience and practicality. A shorter time length may imply sharper differences between adjacent cohorts because treatment incidences occur less frequently, whereas a longer time length reduces the number of groups. (We have also defined the cohort length to be six months, and have verified that results are similar.)

For each birth cohort in a given benefit quarter, the hysterectomy hazard is defined to be the ratio of the total number of enrollees undergoing hysterectomy within this benefit quarter to the total number of enrollees who have not undergone hysterectomy at the beginning of the benefit quarter. We define analogously the hazards of total oophorectomy, partial oophorectomy, and myomectomy. All the hazards are calibrated separately for the three insured groups and the uninsured group. For easy presentation, we multiply the calculated hazards by 100,000. (We do the same for the regressions later.) In Figures 1 to 4, we plot the hazards of the three insured groups and the uninsured group. The grey curve plots the hazards of the uninsured; the red curve is hazards of enrollees in Labor Insurance, whereas the blue and green curves are for those in Government Employee Insurance and Farmer Insurance, respectively. We use a different scale on the vertical in Figure 1 because hysterectomy hazards are much larger than others.

The four figures show some striking patterns. First, in Figure 1, enrollees' hysterectomy hazards in Labor Insurance and Government Employee Insurance exhibit a sharp increase just before the 45th birthday, but drop significantly right after; a similar but less pronounced pattern can also be observed for those in Farmer Insurance. After a few quarters past the 45th birthday, hazards of all insured return to the same smooth trend. However, hazards of uninsured enrollees follow a smooth pattern throughout the entire time.

In Figure 2, total oophorectomy hazards follow an increasing trend. However, it is unclear whether Government Employee Insurance and Labor Insurance enrollees' hazards show an accelerated increase just before the 45th birthday. In Figures 3 and 4, myomectomy and partial oophorectomy hazards do not exhibit any abrupt changes, either for the insured groups or uninsured group.

There is no medical literature to support the pattern of hysterectomy among female enrollees in Government Employee, Labor, and Farmer Insurances. Adverse uterine conditions cannot be especially serious in the few quarters before the 45th birthday, but the opposite will happen the few quarters after. Our

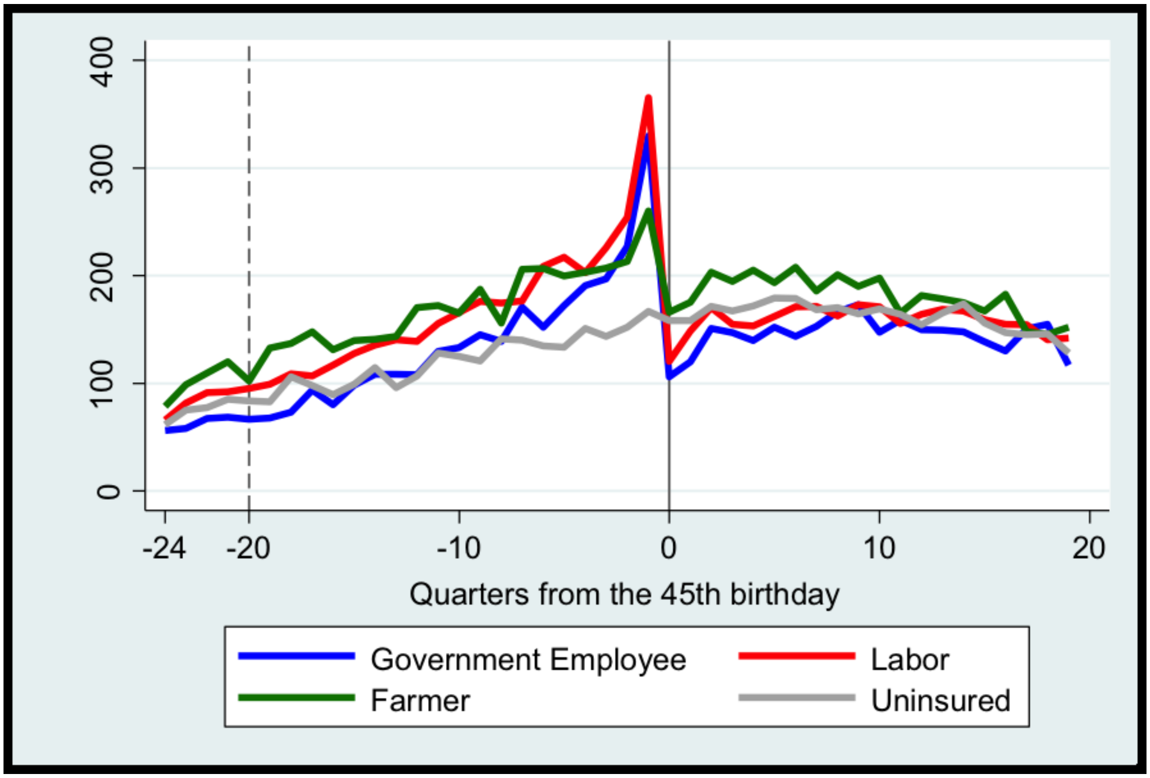

Figure 1: Hysterectomy hazards

hypothesis is that such a pattern is caused by the disability-insurance benefit expiration when enrollees turn 45 years old.

The hypothesis is consistent with the lack of any abrupt changes in myomectomy and partial oophorectomy hazards. Total oophorectomy indeed qualifies for the disability benefit before the 45th birthday. However, the removal of both ovaries carries much higher short-term and long-term health risks than the removal of the uterus. Because the same benefit is paid to both hysterectomy and oophorectomy, we should expect different responses because these two treatments carry different explicit and implicit health disutilities.

For hysterectomy, the plots in Figure 1 suggest a timing manipulation effect. Some hysterectomies may have been moved earlier to qualify for disability benefits, a timing effect. There is, however, a more serious possibility. Some hysterectomies may not have been performed absent the insurance benefits, an inducement effect. We estimate these effects by two methods. The first is based on the difference-in-difference method: enrollees in the three insurance programs are to be compared to the uninsured, and we estimate dynamic,

Figure 2: Oophorectomy hazards

quarter-by-quarter effects. The second is a nonparametric method based on a smoothness hypothesis: there should not be any abrupt changes in enrollees' probability of undergoing hysterectomy at the 45th birthday if there were no disability benefit. The nonparametric method estimates a counterfactual hazard distribution for the insured as if the disability benefits were absent.

4.1 Difference-in-difference by benefit quarters

We estimate the difference of surgery experiences between the insured and the uninsured, the first difference. However, the disability insurance programs have been in place for the entire sample period, so there are no intervention date or "before-and-after" regimes. Theoretically the inducement effect would become relevant right at individuals' labor-market participation. However, younger females seldom have reproductive problems that potentially lead to hysterectomies, which are uncommon before the fifth decade of life.[11] We

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[11] In a 1982 sample survey of 1,796 participants in upstate New York, 24 hysterectomies were reported by 797 women under the age of 40; see Table 2 in Howe (1984).

Figure 3: Partial oophorectomy hazards

assume that disability benefit is irrelevant due to absence of medical problems until enrollees turn 40 years old. Those years before the 40th birthday become the "before" regime, while the years after become the "after" regime; it is as if disability insurance intervention happens at each enrollee's 40th birthday. The validity of this assumption can be seen in Figure 5: the insured and uninsured have almost identical hysterectomy hazards from 35 to 40 years old (respectively, 40 and 20 quarters to the 45th birthday). To implement this empirical strategy, we have chosen the 4 quarters between the 39th and 40th birthdays as the omitted benefit quarters. Results from estimations that use more omitted benefit quarters are similar. We adopt this assumption on the other three surgeries.

The three insurance groups (Government Employee Insurance, Labor Insurance, and Farmer Insurance) have different disability benefits, so we use a separate regression for each group. We present the regression

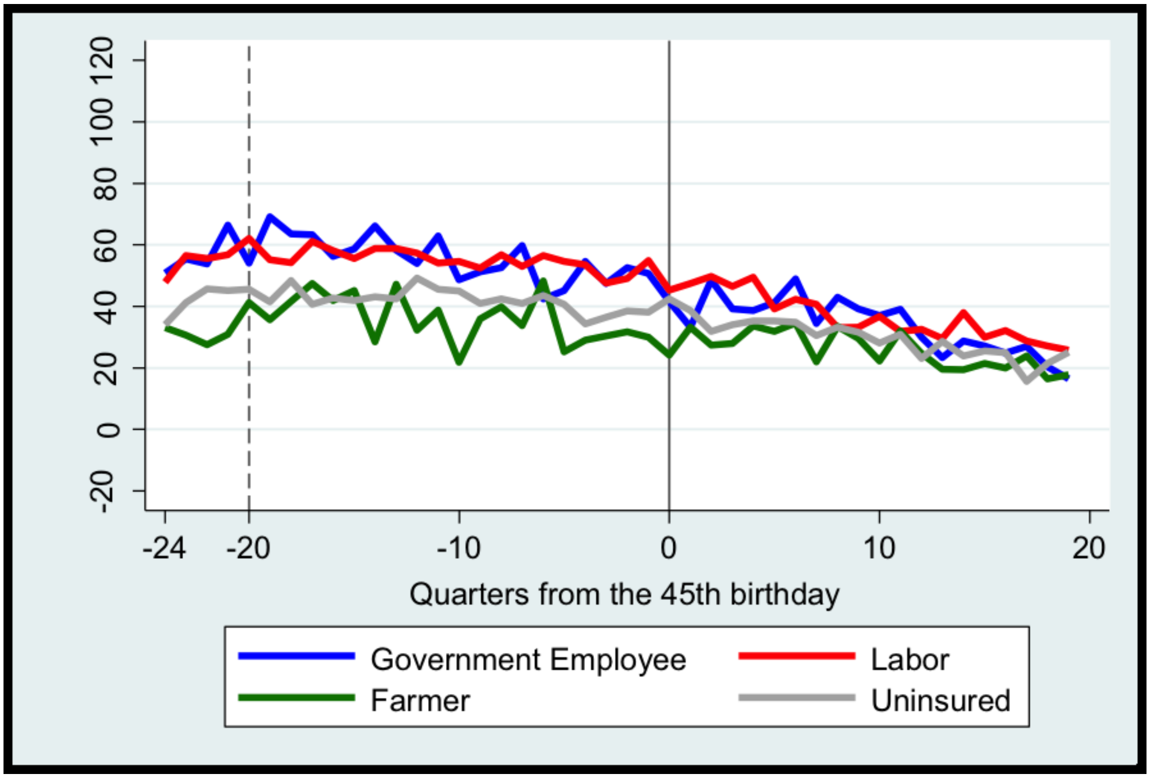

Figure 4: Myomectomy hazards

equation for hysterectomy; the regression equations for the other three procedures can be set up analogously:

$$H_{c,q} = \alpha + \beta \times Insured + \sum_{i=-20}^{19} \gamma_i \times 1[i=q] + \sum_{i=-20}^{19} \rho_i \times 1[i=q] \times Insured$$
$$+\mathbf{X}_{c,q}\boldsymbol{\eta} + \sum_{j=1998}^{2011} k_j \times 1[j=T(c)] + \varepsilon_{c,q} \tag{1}$$

$$\text{where } c \equiv (y,s) \text{ with } y = 1948, 1949, ..., 1972 \text{ and } s = 1,2,3,4,$$

$$\text{and } q = -24, -23, ... -1, 0, 1, 2, ..., 19.$$

In equation (1), $H_{c,q}$, either for the insured or the uninsured, is the hysterectomy hazard (multiplied by 100,000) of birth cohort c at benefit quarter q, a birth cohort c being defined by birth year y and birth quarter s. The variable $Insured$ is the dummy variable for an insured group (Government Employee Insurance, Labor Insurance, or Farmer Insurance). It is set to 1 if the hazard belongs to the insured, and 0 otherwise. The function 1[i = q] is an indicator, and set at 1 if the condition inside the square brackets is satisfied; it is set at 0, otherwise. The covariates $\mathbf{X}_{c,q}\boldsymbol{\eta}$ are cohort-cell means of variables of the total number of children,

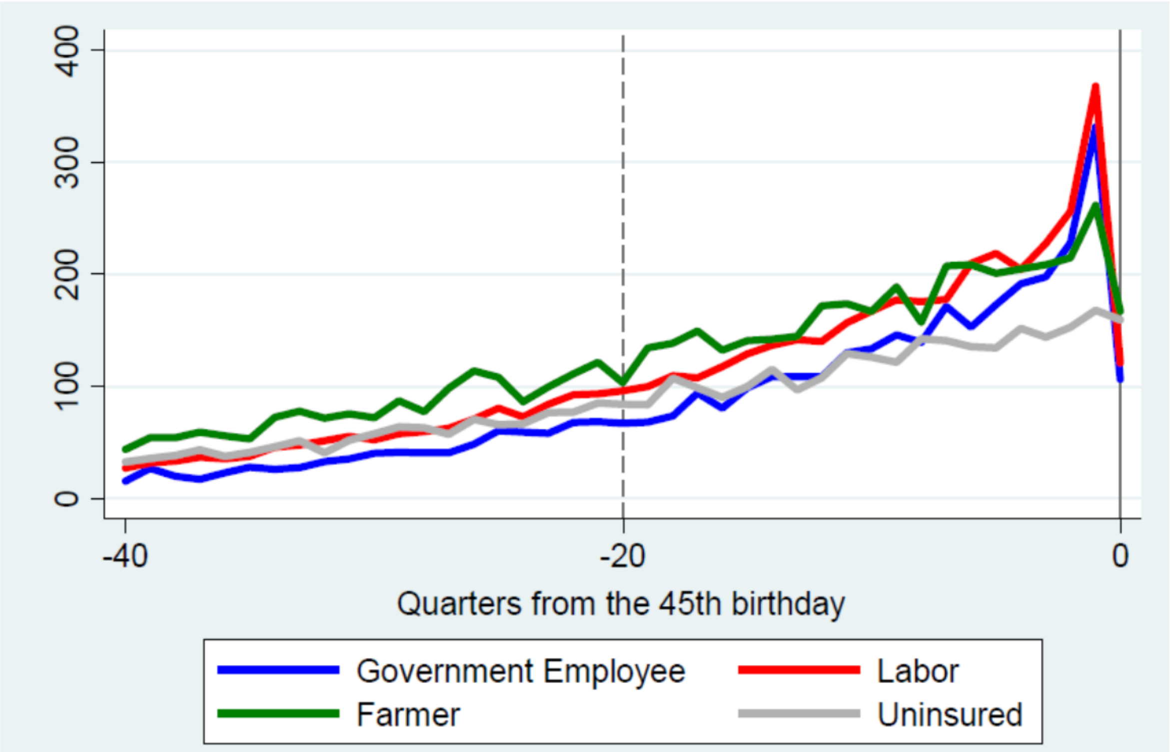

Figure 5: Hysterectomy hazards from age 36 to age 45

the number of sons, marital status, and log household incomes (these data are from SFIE). The function $T(c) \equiv \text{Int}[y+45+s/4]$ is the smallest integer that is bigger than $(y+45+s/4)$, so its range is simply the years between 1997 and 2011; $T(c)$ is used for the data-year fixed effects. Finally, $\varepsilon_{c,q}$ is the error term. To mitigate serial correlation errors, we implement clustered standard errors.[12]

In equation (1), parameter ρ_q is the mean hysterectomy hazard difference between quarter q and the omitted quarters $q = -24$ to $q = -21$, those in age 39. The common time trend before age 40 has already been noted; see Figure 5. In any case, our assumption that inducement begins at $q = -20$ is conservative, so our estimates can be regarded as lower bounds. Furthermore, our results change only slightly when the benchmark age quarters are extended to those quarters corresponding to ages from 35 to 39. For $q = -20, .., 19$, the parameter ρ_q measures the incremental difference between the insured and the uninsured, our chief focus. If disability insurance does not affect enrollees' hysterectomy decisions, all estimates of ρ_q

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[12] For details as to why the standard errors of the coefficient estimates of interest tend to be underestimated in the difference-in-difference model, see Bertrand, Duflo, and Mullainathan (2004) and Donald and Lang (2007).

should be zero.

In equation (1), the inducement effect is the total increment of hysterectomies of the insured over the uninsured in the period between the 40th and 50th birthdays. Let $\widehat{\rho}_q$ denote the estimate of ρ_q. Let n_q denote the number of enrollees who have not undergone hysterectomy at the beginning of quarter q. The inducement effect on hysterectomy is $\sum_{q=-20}^{19} \widehat{\rho}_q \cdot n_q$. If this measure is zero, we conclude that the disability benefit has not increased the total number of hysterectomies among enrollees over their lifetime.

Next, the timing effect is the total number of hysterectomies that the insured would have undergone after the 45th birthday in the absence of the benefit. If disability insurance has incentivized enrollees to have hysterectomies earlier, there will be fewer of them after the 45th birthday. The timing effect on hysterectomy is $\sum_{q=0}^{19} \widehat{\rho}_q \cdot n_q$. If disability insurance has not favored earlier hysterectomies, then this measure will be zero.

We will report only point estimates of the inducement and timing effects. The inducement and time effects are linear combinations of the twenty estimates $\widehat{\rho}_q$, $q = -20, .., 19$. Their coefficients n_q are large, so the standard errors of the inducement and timing effects are not meaningful.

Finally, our analysis is at the birth cohort level, and the dependent variable is hysterectomy hazard of enrollees born at a certain time. In effect, we use the number of enrollees at every birth cohort as weights in the estimation. Given that all the covariates within a birth cohort are constant for each enrollee, estimates obtained from the individual-level regression would be identical to those from the cohort-level regression (Lee and Card, 2008; Lemieux and Milligan, 2008).

4.2 Nonparametric counterfactual estimation

As an alternative, we use a nonparametric method that is based on a “smoothness” assumption: without the expiration of disability benefits, there should not be any abrupt hysterectomy-hazard changes at age 45. For this estimation we have extended the data periods to 40 quarters before and after the 45th birthday, so these hazards are for ages between 35 and 55. We use Figure 6 to illustrate this method. There, the blue curve plots the empirical distribution of hysterectomy hazard of an insured group. It shows the sudden hazard changes around the 45th birthday. To construct a counterfactual distribution, we imagine that the

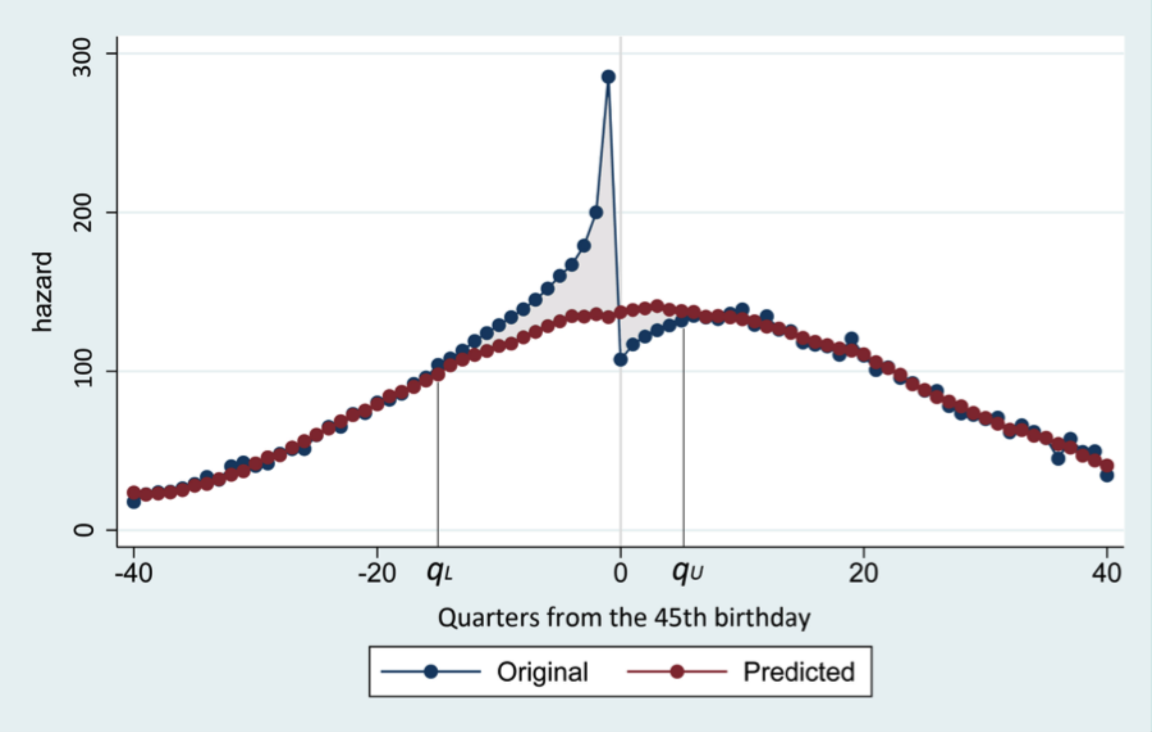

Figure 6: Illustrative example of nonparametric hazard method

abrupt changes had not existed. We choose a lower quarter threshold and an upper quarter threshold, which are denoted, respectively, by q_L and q_U, with $q_L < 0 < q_U$. We then use hazard data outside of quarters between q_L and q_U to fit an Nth-order polynomial. The fitted curve is then used to predict the hazards between quarters q_L and q_U. This is the red curve in Figure 6. The interpretation is that quarter q_L marks the beginning of disability insurance impact on hysterectomy before the 45th birthday, whereas quarter q_U marks the end of the impact after the 45th birthday.

We use more observations outside the q_L and q_U thresholds than the difference-in-difference method for a better fit of the polynomial. The 20-year window of quarter ages doubles the time window for the difference-in-difference estimation. We augment the sample in the difference-in-difference analysis with enrollment and surgery records between 35 and 39 years old, and between 50 and 54 years old. These new data are used even if some enrollees have changed insurance programs between 35 and 39 years old, or between 50 and 54 years old. This is to maintain the same set of enrollees in the nonparametric method as those in the difference-in-difference estimation.

The regression for estimating the counterfactual hysterectomy hazard is this:

$$H_{c,q} = \alpha + \beta \times Insured + \sum_{n=0}^{N} \alpha_n \times q^n + \sum_{j=q_L}^{q_U} \rho_j \times 1[i = q] + \varepsilon_{c,q} \tag{2}$$

$$\text{where } c \equiv (y, s) \text{ with } y = 1948, 1949, ..., 1972 \text{ and } s = 1, 2, 3, 4,$$

$$\text{and } q = -40, -23, ... -1, 0, 1, 2, ..., 39.$$

In (2), $H_{c,q}$ is the hysterectomy hazard of birth cohort c at benefit quarter q; q^n is quarter q raised to the power n; q_L and q_U are the lower and upper bounds; and $\varepsilon_{c,q}$ is the error term. Notice that the birth cohorts still range between 1948 and 1972, the same cohorts in difference-in-difference estimation, but the quarter number now is from -40 to 39 because we incorporate more data points. Notice also that our data period spans 15 years, but we attempt to track enrollees' experiences for 20 years, so a balanced sample would be impossible to construct.

Following Kleven and Waseem (2013), we use a fifth-order polynomial in the main specification ($N = 5$). For each quarter between q_L and q_U we use a coefficient ρ_j to capture the difference between the empirical and the counterfactual hazards at quarter q. If disability insurance has no effect on enrollees' hysterectomy decisions, all estimates of ρ_j should be zero.

For each insured group, we use a grid search over the ranges of $q_L \in [-18, -9]$ and $q_U \in [2, 12]$ to select a pair of bounds that minimize the root mean squared error (RMSE) of the regression, a common optimality criterion in econometric models (Ichimura and Todd, 2007; Lee and Lemieux, 2010; Imbens and Kalyanaraman, 2012).[13] Because each insured group has its own (optimal) lower and upper thresholds, the number of estimated coefficients in each insured group is different. As in the difference-in-difference estimation, we are able to obtain inducement and timing effects. The inducement effect is $\sum_{q=q_L}^{q_U} \widehat{\rho}_q \cdot n_q$, where $\widehat{\rho}_q$ is the estimate of ρ_q in equation (2), and n_q is the number of enrollees who have not had

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[13] RMSE is a common measure for comparing the performance of different econometric models or parameter selections. For example, Ichimura (1993) proposes a semiparametric model and compares its RMSE to those of other models such as the truncated Tobit, binary choice, and duration models. RMSE is also the optimality criterion for selecting the smoothing parameter in nonparametric methods (Ichimura and Todd, 2007); for selecting the bandwidth for regression discontinuity designs (Imbens and Kalyanaraman, 2012); and for selecting the polynomial order of the regression function of regression discontinuity designs (Lee and Lemieux, 2010).

hysterectomy at the beginning of quarter q. Likewise, the timing effect is $\sum_{q=0}^{q_U} \widehat{\rho}_q \cdot n_q$. We also only present point estimates of these effects.

5 Estimation results

5.1 Difference-in-difference estimation

Each of the three columns in Table 4 shows separate regression estimates $\widehat{\rho}_q$, $q = -20, .., 19$ in equation (1) results of Labor Insurance, Government Employee Insurance, and Farmer Insurance. The number of observation is 5,280, smaller than one would expect from a complete sample of balanced data (which would have 25 years $\times$ 4 seasons $\times$ 44 birth quarters $\times$ 2 insurance status or 8,800 observations). This is because quite a number of enrollees only appear in a few years in the data; censoring reduces the number of observations.

Table 4 presents only estimates $\widehat{\rho}_q$ for q between -10 and 7; these benefit quarters are around the 45th birthday; most estimates $\widehat{\rho}_q$ omitted are insignificant. For an effective illustration, Figure 7 plots the entire set of $\widehat{\rho}_q$, $q = -20, ..., 19$. The red plots are for enrollees in Labor Insurance, the blue plots and the green plots are for enrollees in Government Employee Insurance and Farmer Insurance, respectively. Significant estimates are plotted with solid dots, whereas insignificant estimates are plotted with hollow dots. (The scale in plots of estimates for hysterectomy is different from those for other surgeries because of its hazard magnitude.)

In Figure 7, for Labor Insurance enrollees, $\widehat{\rho}_q$ starts at almost zero at $q = -20$, gradually increases, and becomes significantly different from zero (solid dots) at $q = -14$. Then $\widehat{\rho}_q$ continues to increase as enrollee's age approaches 45, peaks at $q = -1$ (the difference between the two groups being 193.8 cases per 100,000 enrollees at $q = -1$) and then sharply declines at $q = 0$. Most estimates after $q = 0$ are small and insignificant. Likewise, the plot of Government Employee Insurance group follows a similar pattern. The plots of Farmer Insurance group also peak at one quarter before age 45, though the magnitude is only half of the other two insurance groups.

In equation (1) the parameter β measures the average difference between the insured and uninsured. The $Insured$ dummy estimate is also in Table 4, and this is significant for each of the insured group. For

Table 4: Difference-in-difference estimates $\hat{\rho}_q$ for hysterectomy (nonswitching sample)

Quarter to 45th birthday $q \times Insured$ $\widehat{\rho}_q$	(1) Labor Insurance Insurance	(2) Government Employee Insurance	(3) Farmer Insurance
-10	34.18**	22.65	15.70
	(7.950)	(12.06)	(15.01)
-9	49.37**	39.66**	41.90*
	(8.231)	(14.67)	(16.79)
-8	27.68**	13.19	-10.03
	(9.025)	(12.78)	(13.61)
-7	31.19**	46.67**	40.20*
	(7.053)	(16.19)	(15.74)
-6	69.09**	34.25**	46.10**
	(9.824)	(11.08)	(15.98)
-5	79.12**	55.79**	38.98*
	(8.240)	(15.62)	(15.46)
-4	47.85**	57.38**	24.64
	(8.316)	(16.96)	(15.52)
-3	78.11**	70.66**	36.32**
	(10.81)	(14.46)	(13.09)
-2	97.91**	92.00**	34.47*
	(11.05)	(15.91)	(15.24)
-1	193.8**	179.2**	66.70**
	(14.95)	(19.70)	(15.91)
0	-42.88**	-36.57**	-18.56
	(9.071)	(13.37)	(13.83)
1	-14.10	-21.98	-9.601
	(10.70)	(13.94)	(16.11)
2	-4.997	-4.015	4.841
	(8.992)	(12.62)	(16.31)
3	-15.78*	-3.447	0.480
	(7.703)	(13.86)	(15.61)
4	-21.51*	-14.79	6.320
	(8.839)	(14.65)	(14.86)
5	-19.64*	-9.188	-12.71
	(9.068)	(14.54)	(15.06)
6	-10.01	-16.81	1.950
	(10.21)	(12.54)	(15.08)
7	1.204	3.337	-9.745
	(7.572)	(15.31)	(14.17)
$Insured$	8.764**	-17.23**	33.22**
	(3.289)	(4.228)	(5.825)
Log household income	-12.10*	-8.788*	-25.33**
	(5.502)	(4.044)	(5.940)
Total number of children	-20.34*	-11.82	-18.43*
	(8.306)	(8.496)	(7.395)
Number of sons	4.045	0.544	-1.099
	(10.98)	(10.57)	(10.32)
Married	48.33*	38.68	25.93
	(18.66)	(21.29)	(23.07)
Estimated inducement effect	5,076	789	347
Estimated timing effect	1,008	143	283
Observations	5,280	5,280	5,280

Notes: Robust standard errors are in parentheses; ** p<0.01, * p<0.05

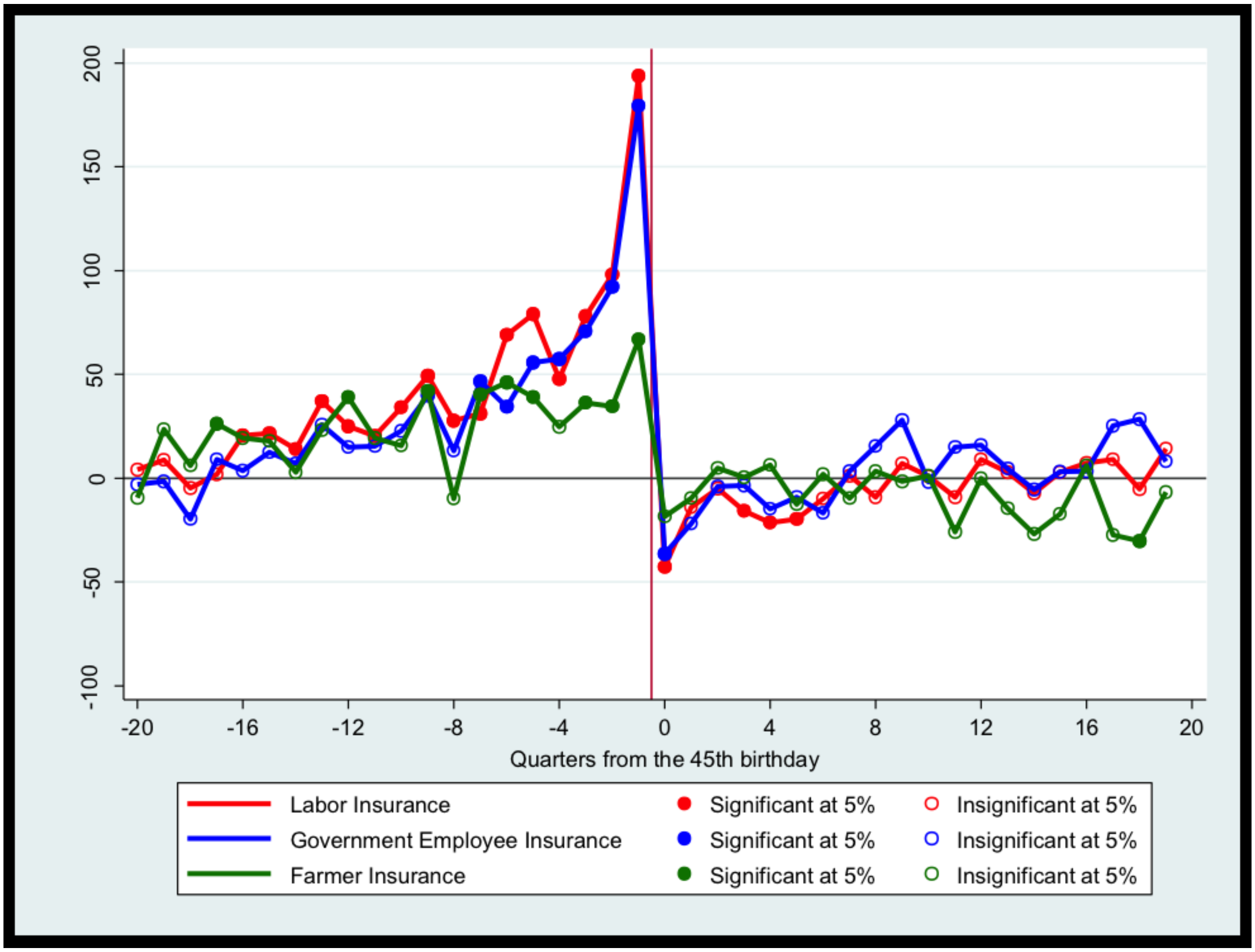

Figure 7: Difference-in-difference estimates $\widehat{\rho}_q$ for hysterectomy

Labor Insurance and Farmer Insurance enrollees, their hysterectomy hazard is higher than the insured, and this is stronger for Farmer Insurance than Labor Insurance. For Government Employee Insurance enrollees, this difference turns out to be negative. The identification power is not diminished by the sign differences in $\widehat{\beta}$ because the insured and uninsured share the same time trend. This can be seen from the insignificant coefficients in the first few quarters in Figure 7.

Finally, equation (1) includes a number of controls. In all three equations, enrollees with higher household income are less likely to undertake hysterectomy. This is consistent with wealthier households being less responsive towards financial incentives. Enrollees with more children tend to have a smaller hysterectomy hazard, though this effect is insignificant for Government Employee Insurance enrollees.[14] Conditional on the total number of children, the number of sons does not seem to matter. Finally, being married is associated with a higher hazard, but the estimate is only significant for the Labor Insurance enrollees. Estimated coefficients from controls are consistent with common models of health care services.

We now turn to the inducement and the timing effects. Inducement effect on hysterectomy $\sum_{q=-20}^{19} \widehat{\rho}_q \cdot n_q$ for enrollees in Labor Insurance is measured at 5,076 hysterectomies. This is about 11.6% of the total 43,845 hysterectomy surgeries undertaken by Labor Insurance enrollees between 40 and 49 years old in the sample period. The timing effect is $\sum_{q=0}^{19} \widehat{\rho}_q \cdot n_q$. Generally, hysterectomies have been expedited, so the timing effect will turn out to be negative. For ease of exposition, we omit the negative sign when we present timing effects. For Labor Insurance enrollees, the timing effect is measured at 1,008 hysterectomies, or at about 20% of the inducement effect. However, the value of $\widehat{\rho}_q$ at $q = 0$ is significantly negative for the Labor Insurance enrollees. Although the overall timing effect is not large, we are confident that some hysterectomies have been shifted earlier due to the disability benefit.

Columns (2) and (3) in Table 4 present the estimates $\widehat{\rho}_q$ for Government Employee Insurance and Farmer Insurance enrollees. These two columns exhibit the same pattern as Column (1): a large increase in hazard just before quarter 0, and then vanishing. In Government Employee Insurance, the inducement effect is measured at 789 hysterectomies, or about 11% of the total hysterectomy cases among Government Employee Insurance enrollees between 40 and 49 years old in the sample period while the timing effect is 142 cases. For Farmer Insurance enrollees, the inducement effect is smaller, at 347 cases, or about 3.8% of all hysterectomy surgeries among Farmer Insurance enrollees between 40 and 49 years old in the sample period. The timing effect for Farmer Insurance is measured at 283 cases.

Regression results on hysterectomy hazards are strong evidence that enrollees respond to incentives created by the disability insurance program. The differences in inducement and timing effects in the three treatment groups are consistent with the differences in the three disability insurance programs. Benefits of Labor and Government Employee Insurance are higher than Farmer Insurance.

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[14] Studies have shown that the number of pregnancies (or living children) is negatively related to the prevalence of uterine fibroids, one of the major causes for hysterectomy (Ross et al., 1986; Chen et al., 2001).

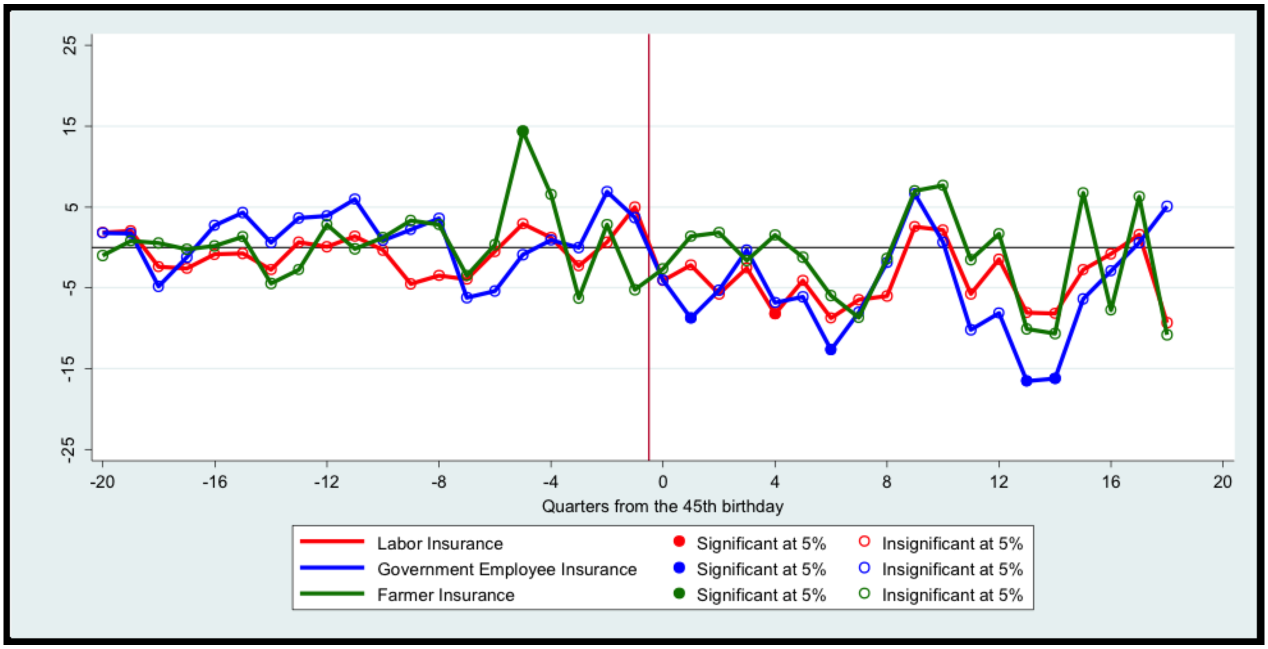

Figure 8: Difference-in-difference estimates $\widehat{\rho}_q$ for oophorectomy

We now turn to regression results of the other three surgeries: total oophorectomy, partial oophorectomy, and myomectomy. Almost all estimates of regression results for equation (1) for these three surgeries are insignificant. We present these in Tables A1, A2, and A3 in Appendix A (only estimates of $\widehat{\rho}_q$ for q between -10 and 7). In Figures 8, 9, and 10 we plot the entire set of estimates of $\widehat{\rho}_q$ for q between -20 and 19, and we use the same color convention for the three insurance groups. It is clear that the disability insurance program has not caused behavioral change.

For partial oophorectomy and myomectomy, these insignificant results are to be expected because they are not eligible for benefits. The insignificant result for total oophorectomy is important. Total oophorectomy and hysterectomy have the same eligibility requirement and benefits. However, the health risks and long-term morbidity of total oophorectomy are much more severe than hysterectomy. Our results indicate that the benefits are not enough to change enrollees' behavior.

5.2 Nonparametric estimation

Table 5 presents estimates $\widehat{\rho}_q$ in equation (2). Because the nonparametric approach does not rely on the existence of a control, we do an estimation for each of the three insured groups and the uninsured. The

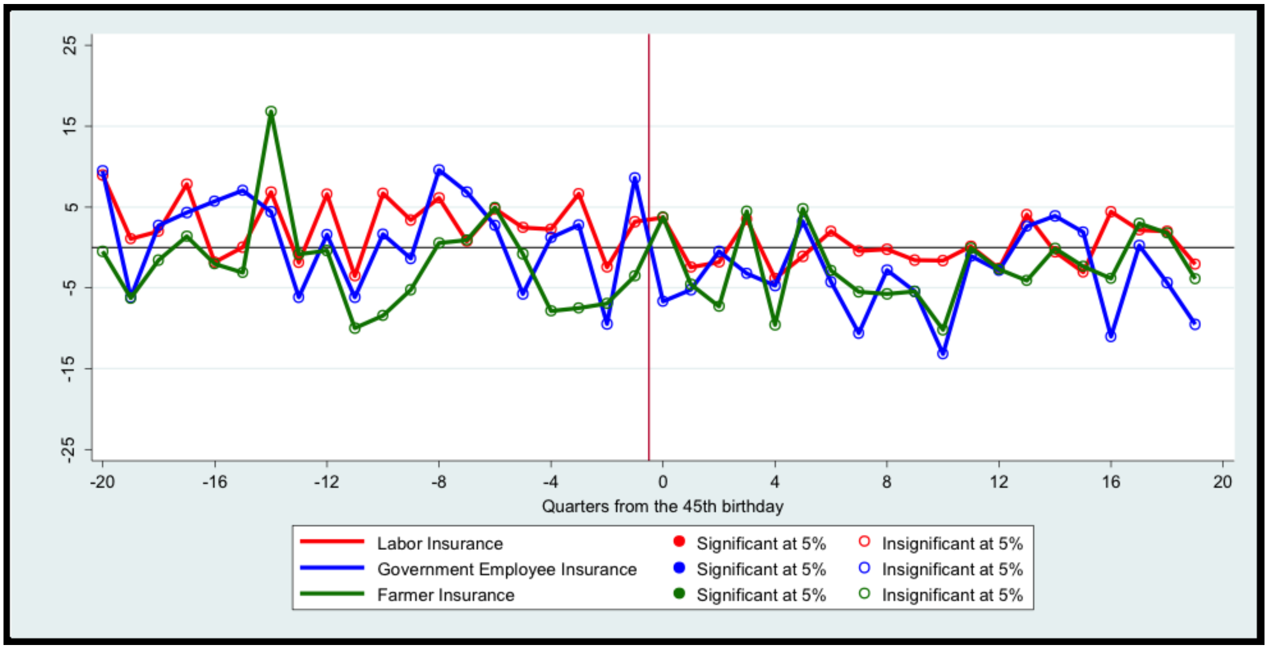

Figure 9: Difference-in-difference estimates $\widehat{\rho}_q$ for partial oophorectomy

number of observation is 4,498 for the Labor Insurance, and 4,474 and 4,481 for the Government Employee and Farmer samples, respectively. These are smaller than those from a complete and balanced sample (which would have 25 years × 4 seasons × 80 birth quarters, or 8,000 observations) in part because of censoring, and also because of more missing observations when the data are extended to 20 years. In Table 5, the four columns list the estimates $\widehat{\rho}_q$ for the uninsured, and the insured in different programs; the optimal bounds q_L and q_U, are at the bottom of each column. Because each group has its own optimal bounds, the number of estimated coefficients vary across different groups. The four sets of $\widehat{\rho}_q$ estimates are in Figure 11. The gray plots refer to those of the uninsured. The red, blue, and green plots refer to those estimates of enrollees of Labor Insurance, Government Employee Insurance, and Farmer Insurance, respectively.

From Figure 11, the gray line fluctuates minimally along the horizontal axis line, so the fifth-order polynomial fits the uninsured' hazard rates quite well. In fact, in Table 5, almost all estimates of $\widehat{\rho}_q$ of the uninsured are insignificant, and we cannot reject the hypothesis that estimates of $\widehat{\rho}_q$ are jointly zero (F statistics = 1.01). This serves to validate our nonparametric approach.

For enrollees in Labor Insurance, most estimates from $q = -11$ to $q = -1$ are significantly positive,

Table 5: Nonparametric estimates $\hat{\rho}_q$ for hysterectomy (nonswitching sample)

Quarters to age 45	(1) Uninsured	(2) Labor Insurance	(3) Government Employee Insurance	(4) Farmer Insurance
-18	14.61*			
	(6.95)			
-17	2.22			
	(7.32)			
-16	-10.15			
	(7.40)			
-15	-4.43	9.67		
	(7.73)	(7.33)		
-14	6.90	13.16		
	(7.40)	(7.00)		
-13	-15.66	13.75		
	(8.70)	(8.18)		
-12	-9.19	8.27		
	(8.50)	(8.14)		
-11	8.40	20.73*	19.20	
	(9.64)	(8.72)	(11.55)	
-10	1.27	27.13**	18.82	
	(8.82)	(9.36)	(13.07)	
-9	-7.15	33.64**	27.08	17.44
	(10.26)	(8.70)	(15.16)	(12.73)
-8	9.67	28.55**	16.82	-17.75
	(9.30)	(8.99)	(12.73)	(12.68)
-7	4.55	26.96**	44.99**	29.01*
	(7.95)	(8.24)	(16.03)	(12.63)
-6	-4.76	55.91**	22.92*	26.97*
	(9.29)	(10.25)	(10.78)	(12.59)
-5	-9.24	61.88**	39.84*	16.66
	(9.11)	(10.45)	(16.09)	(12.55)
-4	4.75	44.50**	55.15**	17.69
	(9.56)	(9.46)	(17.69)	(12.48)
-3	-6.23	65.06**	58.50**	19.13
	(10.70)	(10.77)	(15.43)	(12.41)
-2	-0.39	91.44**	86.19**	23.41
	(9.72)	(10.60)	(18.09)	(12.34)
-1	11.72	201.20**	187.31**	68.64**
	(10.25)	(17.53)	(22.06)	(12.29)
0	0.69	-47.24**	-40.39**	-27.49*
	(10.68)	(7.99)	(11.31)	(12.20)
1	-1.65	-20.55*	-28.25*	-19.43
	(10.44)	(9.11)	(12.27)	(12.12)
2	9.94	0.42	0.20	7.78
	(11.07)	(8.79)	(11.63)	(12.04)
3	3.71	-16.17*		
	(9.55)	(6.98)		
4	6.80	-18.57*		
	(10.86)	(8.66)		
5	13.15	-10.05		
	(10.45)	(8.11)		
6	11.91			
	(10.50)			
Optimal bounds (q_L, q_U)	(-18, 6)	(-15, 5)	(-11, 2)	(-9, 2)
Estimated inducement effect	–	4,842	756	280
Estimated timing effect	–	722	87	60
Observations	4,483	4,498	4,474	4,481

Note: Robust standard errors are in parentheses; ** p<0.01, * p<0.05.

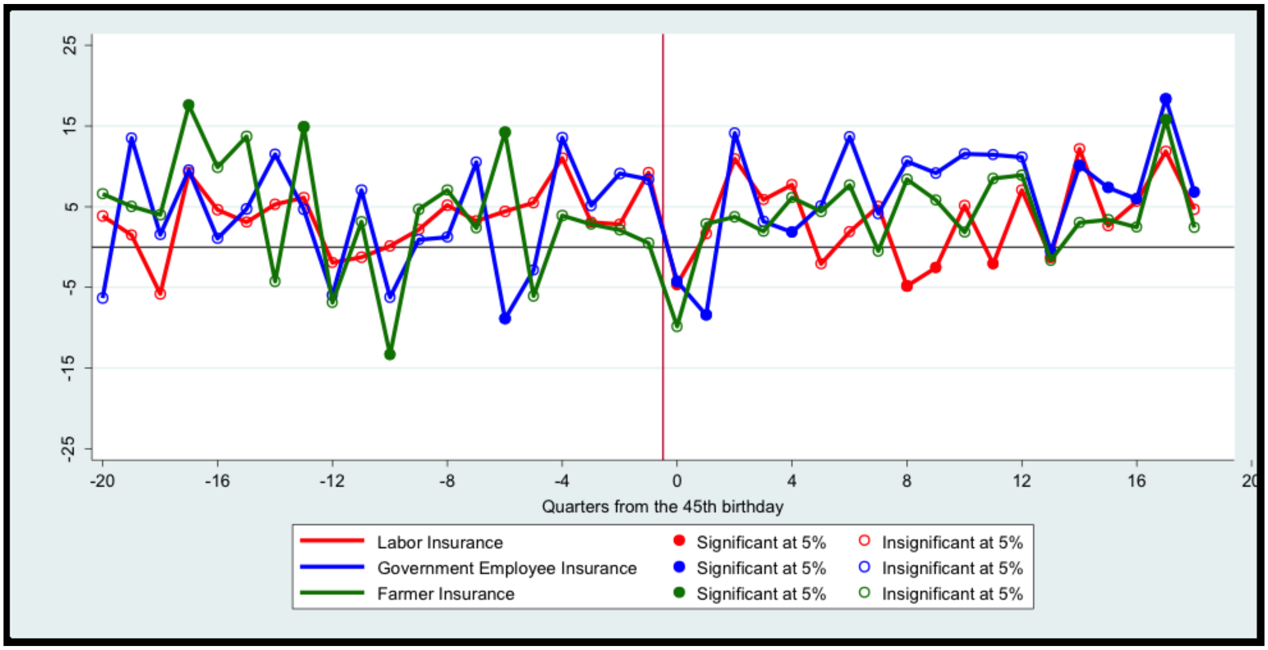

Figure 10: Difference-in-difference estimates $\widehat{\rho}_q$ for myomectomy

followed by significantly negative estimates from $q = 0$ to $q = 4$; see Table 5. The red plots in Figure 11 show the spike just before the 45th birthday, and then the drop. The pattern is similar to the corresponding difference-in-difference estimates. The estimated number of induced hysterectomies, $\sum_{q=q_L}^{q_U} \widehat{\rho}_q \cdot n_q$, is 4,842, which is about 11% of total hysterectomies (43,845) undertaken by Labor Insurance enrollees between 40 and 49 years old. Compared to the corresponding figures in the difference-in-difference method, the percentage is slightly smaller than the percentage (11.6%) estimated by the difference-in-difference method. The timing effect $\sum_{q=0}^{q_U} \widehat{\rho}_q \cdot n_q$ is 722 hysterectomies, about 14.9% of the total inducement effect; it is somewhat lower than the corresponding percentage in the difference-in-difference estimates. Nevertheless, the nonparametric method confirms the timing effect for Labor Insurance enrollees.

From Table 5, estimates $\widehat{\rho}_q$ for Government Employee Insurance enrollees are significantly positive for q between -7 and -1, but significantly negative at $q = 0$ and $q = 1$. The pattern can be seen in the blue plots in Figure 11. We obtain the estimated inducement and timing effects at 756 and 87 hysterectomies, respectively. These estimates are quite close to the corresponding difference-in-difference estimates (789 and 143 cases).

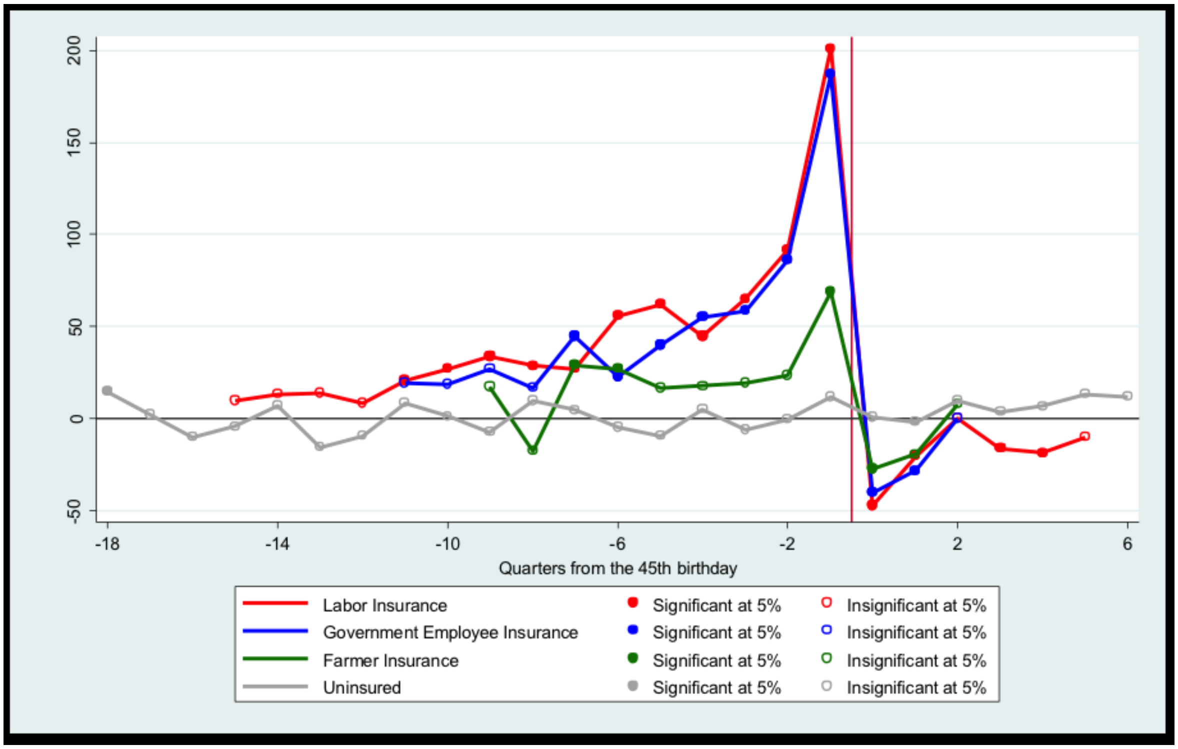

Figure 11: Nonparametric estimates $\widehat{\rho}_q$ for hysterectomy

Finally, in Table 5, for enrollees in Labor Insurance, $\widehat{\rho}_q$ is significantly positive at $q = -1$ and significantly negative at $q = 0$. In Figure 11, the green curve plots those estimates $\widehat{\rho}_q$ for Farmer Insurance enrollees. Compared to Table 4, the estimates for Farmer Insurance (the last column of Table 5) have fewer coefficients significantly different from zero before age 45. The estimated inducement effect is 280 hysterectomies, which is near the difference-in-difference value. However, the estimated timing effect is only 60 hysterectomies, much smaller than the difference-in-difference estimate (283).

From the nonparametric method, inducement and timing effects have larger impacts for Labor Insurances and the Government Employee Insurance enrollees, but less so for Farmer Insurance enrollees. However, compared to results of the difference-in-difference method, estimates of the nonparametric method show a smaller timing effect in the three insurance groups, whereas the inducements effects are similar.

We now report results of the nonparametric estimations for total oophorectomy, partial oophorectomy, and myomectomy. For partial oophorectomy and myomectomy, the fifth-order polynomial achieves a good fit, as most $\widehat{\rho}_q$ are insignificant, and the corresponding F-test (all coefficients) is insignificant for the uninsured

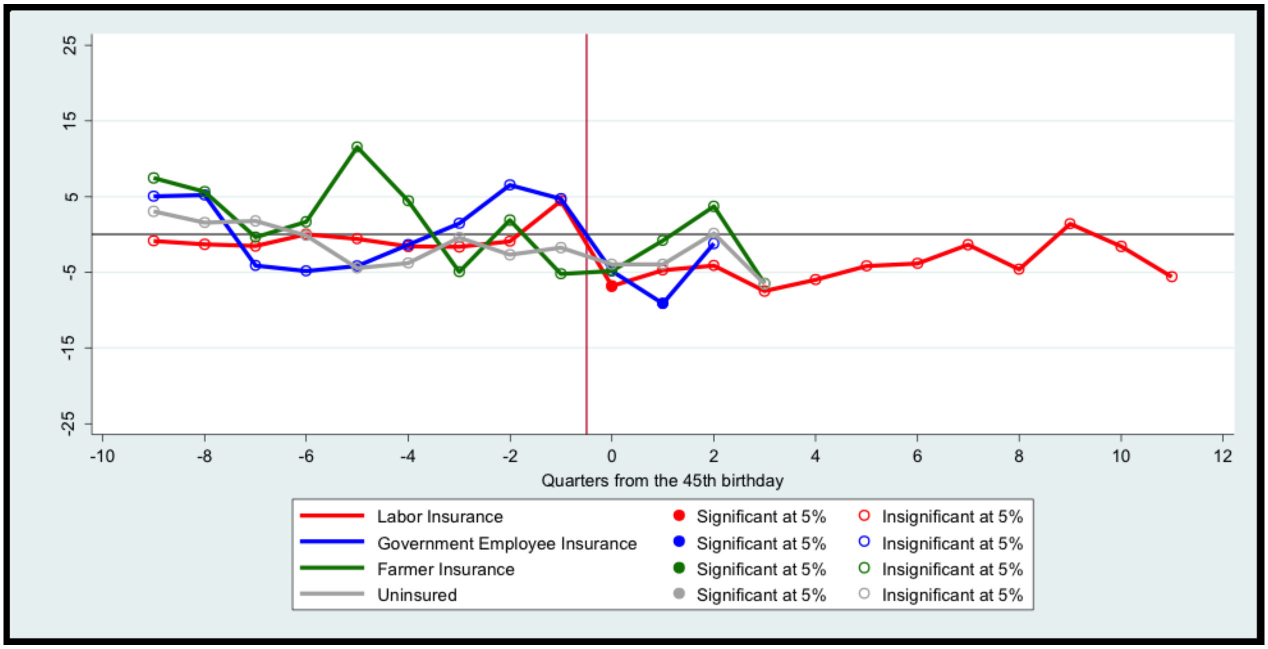

Figure 12: Nonparametric estimates $\widehat{\rho}_q$ for total oophorectomy

group. For total oophorectomy, however, the fifth-order polynomial fails the F test (F statistics = 11.22) and the sixth-order polynomial fits the function better and passes the F test (F statistics = 0.92). Hence, we present the results from estimating the sixth-order polynomial function. We present the estimates of $\widehat{\rho}_q$ for q from optimal q_L to q_U in Tables A4, A5, and A6 in Appendix A and plot the entire set of estimates in Figures 12, 13, and 14. In Appendix B, we also plot actual (corresponding colors) and estimated counterfactual (dark gray) distributions for the four surgeries.

The two estimation methods yield very similar findings. First, for total oophorectomy, which qualifies for insurance benefits, Figure 12 shows that very few $\widehat{\rho}_q$ are significantly different from zero in all insurance groups. Second, almost all the plots in Figures 13 and 14 (for partial oophorectomy and myomectomy, respectively) are insignificant for every insurance group. Third, the inducement and the timing effects are negligible.

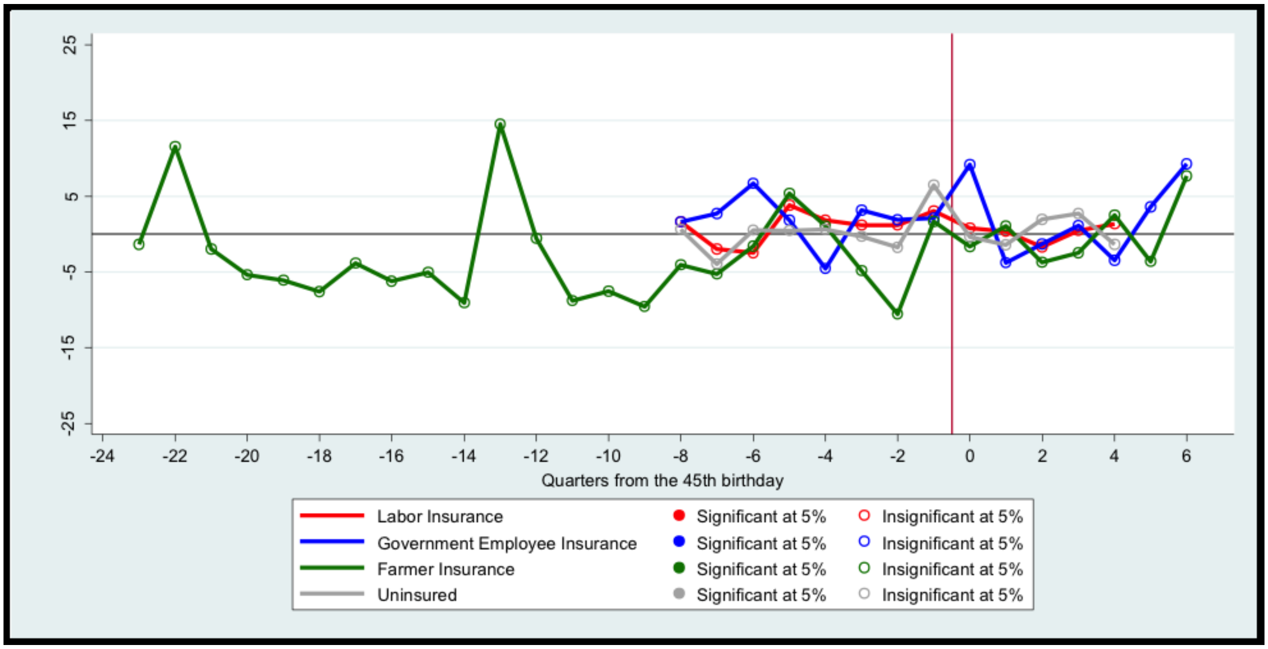

Figure 13: Nonparametric estimates $\widehat{\rho}_q$ for partial oophorectomy

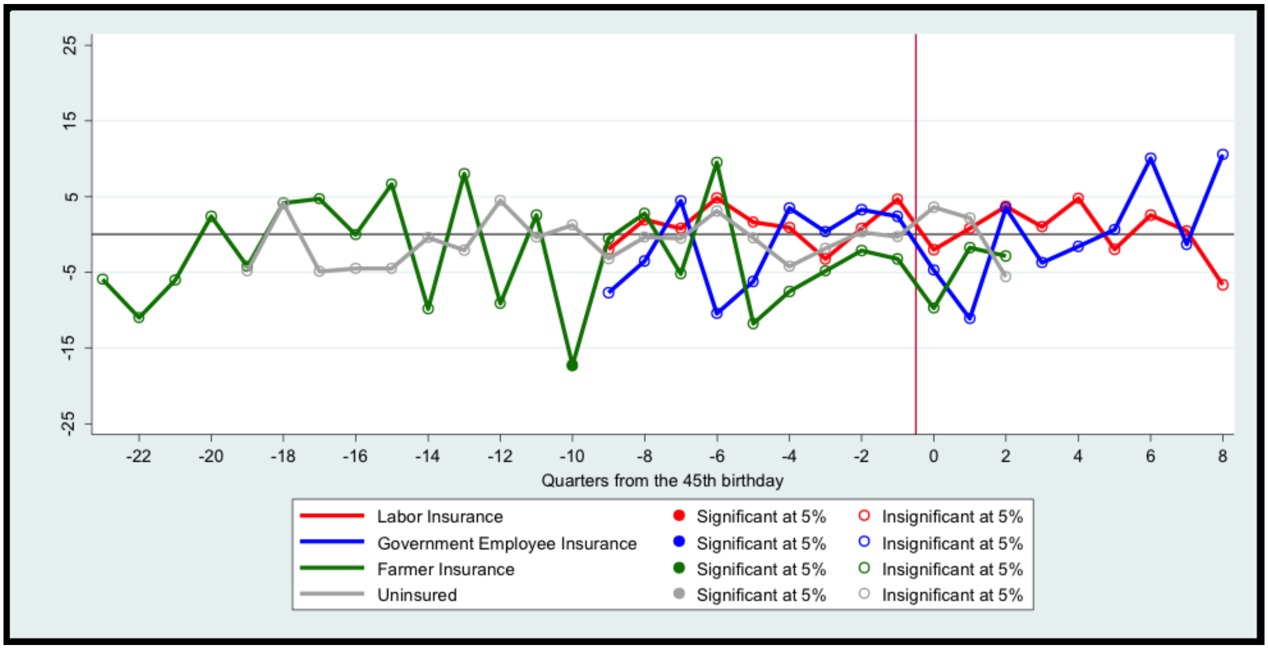

Figure 14: Nonparametric estimates $\widehat{\rho}_q$ for myomectomy

Table 6: Comparisons between nonswitching, general, and balanced samples in 2005

Insurance programs	(1) Nonswitching sample	(2) General sample sample	(3) (2)/(1)	(4) Balanced sample	(5) (4)/(1)
Government Employee Insurance	100,745	107,696	1.07	43,577	0.43
Labor Insurance	522,462	758,909	1.45	218,357	0.42
Farmer Insurance	88,782	111,550	1.26	41,295	0.47
Uninsured	279,963	499,791	1.79	121,014	0.43
	991,952	1,477,946	1.49	424,243	0.43

6 Robustness checks, benefit effects, and social costs

In this section, we investigate inducement and timing effects in more or less restrictive samples, and in subsamples stratified by different insurance benefit levels. Then in the last subsection, we estimate the social costs due to the disability programs.

6.1 Sample without nonswitching restriction and sample without censoring

In this subsection, we use two different samples. First, we use a bigger, "general sample" consisting of all enrollees between the ages of 39 and 49, whether they have switched insurance programs or not. The general sample allows us to detect bias due to program switches. Our data only allow us to identify an enrollee's insurance status at the end of a calendar year, so we use the end-of-year insurance status for all quarters in that year. Then, we calculate the hazard rates for the enrollees in each insurance group for each quarter in the year. Second, we use a smaller, "balanced sample" consisting of all enrollees born between 1958 and 1962 (see Table 2). These enrollees have had complete medical records between 39 and 49 in the 1997-2011 sample period, so the data are uncensored.

Table 6 lists the total numbers of observations by insurance groups in the general and balanced samples in 2005. For comparison, we also provide the corresponding numbers in the nonswitching sample. In Table 6, in 2005, there are a little less than 1 million subjects in the nonswitching sample, but there are more than 1.47 million in the general sample. In other words, the general sample is about 49% larger than the nonswitching sample. By contrast, there are just over 0.42 million in the balanced sample, about 40% of the nonswitching sample.

Among the four groups, the ratios of general sample size to nonswitching sample size is the lowest for Government Employee Insurance, at 1.07. Government employees appear to have higher job stability. By contrast, the corresponding ratios of Labor Insurance and the uninsured are higher, at 1.45 and 1.79, respectively. Enrollees switching in and out of being employed and being unemployed is more common among those in Labor Insurance than those in either Government Employee Insurance or Farmer Insurance. The balanced sample consists of enrollees in the nonswitching sample born between 1958 and 1962, so naturally the corresponding ratios between sample sizes are stable, at about 40% of all insurance groups.[15]

Table 7 presents the inducement and timing effects from difference-in-difference estimations of the general and balanced samples. Only effects for hysterectomy are included;[16] the effects for all the other three surgeries are negligible.[17] We include results of the nonswitching sample for easy comparison. From the first three rows in Table 7 for Labor Insurance, the inducement effect in the general sample is measured at 7,172 hysterectomies out of 61,692; this is about 11.3%. The inducement effect in the balanced sample is measured at 1,537 out of 13,609, about 11.7%. The corresponding percentage for the nonswitching sample is 11.6% (5,076/43,845). Induced hysterectomies as percentages of total hysterectomies remain stable in these three samples. The estimated timing effects in the three samples of Labor Insurance are in column (4) of Table 7. We tabulate the timing effect as a percentage of the inducement effect in column (5). The ratios of timing to inducement effects for the general and balanced samples are 16.8% and 25.2%, respectively; these compare with 19.9% of the nonswitching sample. Overall, the timing effects across the three samples are similar.

For Government Insurance enrollees, from Table 7, the total inducement effect is measured at 11.2% of total hysterectomy, and the timing effect at 17.6%, whereas the corresponding percentages in the nonswitching

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[15] It is possible that an individual contributes to the numerator or denominator for the hazard rate of one insurance group, say, Government Employee Insurance, in one year, but will contribute to that of another insurance group, say, Labor Insurance, in the next year.

[16] We present the difference-in-difference estimates of $\widehat{\rho}_q$ of the general sample for hysterectomy, total oophorectomy, partial oophorectomy, and myomectomy, in Tables A7 to A10 of Appendix A, respectively.

[17] Tables A11 to A14, respectively, present the difference-in-difference estimates of $\widehat{\rho}_q$ for hysterectomy, total oophorectomy, partial oophorectomy, and myomectomy for the balanced sample. The results are similar to those in Tables A7 to A10 of Appendix A.

Table 7: Hysterectomy inducement and timing effects from difference-in-difference estimates

Insurance types	Sample	(1) Total hysterectomies from 40 to 49	(2) Total Inducement Effect	(3) (2)/(1)	(4) Timing effect	(5) (4)/(2)
Labor Insurance	Nonswitching sample	43,845	5,076	11.6%	1,008	19.9%
	General sample	61,692	7,172	11.6%	1,202	16.8%
	Balanced sample	13,609	1,537	11.3%	387	25.2%
Government	Nonswitching sample	7,262	789	10.9%	143	18.1%
Employee Insurance	General sample	7,888	885	11.2%	156	17.6%
Farmer Insurance	Nonswitching sample	9,100	347	3.8%	283	81.6%
	General sample	10,987	241	2.2%	241	100.0%

sample are 10.9% and 18.1%. These estimates confirm that results in the general and nonswitching samples are stable. We do not include the results of the balanced samples for Government Employee Insurance and Farmer Insurance because the explanatory variables in these small samples exhibit very limited variations.

The last two rows in Table 7 are the summaries of the estimations of Farmer Insurance. The total inducement effect in the general sample is small, at 241 hysterectomies, or 2.2% of total hysterectomies. Although the number is even smaller than the total inducement effect of 347 in the nonswitching sample, the results may be driven by the imprecise estimates of coefficients after age 45. For enrollees in Farmer Insurance, the inducement effect in the general sample is 2.2% of total hysterectomies, and it is lower than the 3.8% in the nonswitching sample. For the timing effect, the general sample is about 20 percentage points higher than the 81.6% (of the inducement effect) of the nonswitching sample.

Next, we turn to the nonparametric estimates. We only compare the results of the general and the nonswitching samples because no balanced sample can be constructed due to the 20-year sample window for nonparametric estimation. Table 8 summarizes the inducement and timing effects from the nonparametric estimates.[18] For Labor Insurance, the inducement effect is measured at around 11% of total hysterectomy for both nonswitching and general samples. The timing effects are, respectively, 14.9% and 15.6% of the corresponding inducement effects for the general and nonswitching samples. These measures indicate robustness of estimates for the general and nonswitching samples.

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[18] Nonparametric estimates of $\widehat{\rho}_q$ for the general sample for hysterectomy, oophorectomy, partial oophorectomy, and myomectomy are in Tables A15 to A18 of Appendix A, respectively.

Table 8: Hysterectomy inducement and timing effects from nonparametric estimates

Insurance types	Sample	(1) Total hysterectomies from 40 to 49	(2) Total Inducement Effect	(3) (2)/(1)	(4) Timing effect	(5) (4)/(2)
Labor Insurance	Nonswitching sample	43,845	4,842	11.0%	722	14.9%
	General sample	61,692	6,736	10.9%	1,053	15.6%
Government Employee Insurance	Nonswitching sample	7,262	756	10.4%	87	11.5%
	General sample	7,888	864	11.0%	135	15.6%
Farmer Insurance	Nonswitching sample	9,100	280	3.1%	60	21.4%
	General sample	10,987	319	2.9%	84	26.3%

For Government Employee Insurance, the inducement effects in the general sample and nonswitching sample are, respectively, 10.4% and 11% of corresponding total hysterectomies. The timing effects in the general and nonswitching samples are 11.5% and 15.6%, respectively, of inducement effects. These results indicate robustness. Likewise, for Farmer Insurance, the total inducement effects in the general and non-switching samples are quite similar, measured at 3.1% and 2.9% of the corresponding hysterectomy, with the timing effect being 21.4% and 26.3%, respectively, of inducement. A smaller timing effect is obtained from the nonparametric estimation, especially for Farmer Insurance.

6.2 Inducement and insurance benefit

We now investigate the relationship between benefit levels and the inducement and timing effects. This is an issue pertinent to current policy discussions because the Taiwanese government has been considering reducing fertility disability benefits. We stratify our sample into 5 groups of increasing insurance salaries with roughly equal numbers of observations in each group.

The stratification analysis is only on enrollees of Labor Insurance, for two reasons. First, from Table 3, the sample size of Labor Insurance is at least 5 times larger than Government Employee Insurance, and 4 times larger than Farmer Insurance. The large sample size allows us to obtain more reliable estimates. Second, in contrast with other insurance groups, we have more accurate benefit information from Labor Insurance. We have data of an enrollee's (mandated) National Health Insurance premium. Because the premium is a fixed percentage of salaries, we therefore can infer enrollees' salaries. This inference is accurate for those in the Labor Insurance program. However, public employees often receive stipends, which do not count as salaries,

Table 9: Hysterectomy inducement effects of stratified nonswitching Labor Insurance enrollees

Subgroup	(1) Average insurance benefits	(2) Total hysterectomies between 40 and 49 years old	(3) Induced hysterectomies	(4) Inducement rate (3)/(2)
Difference-in-difference				
1	NT$84,592	8,280	739	8.93%
2	NT$100,425	9,145	1,060	11.60%
3	NT$133,435	8,722	949	10.88%
4	NT$185,197	9,049	1,319	14.58%
5	NT$219,500	8,631	1,356	15.71%
Nonparametric				
1	NT$84,592	8,280	589	7.11%
2	NT$100,425	9,145	903	9.88%
3	NT$133,435	8,722	848	9.72%
4	NT$185,197	9,049	1,520	16.80%
5	NT$219,500	8,631	1,247	14.45%

so the inference from National Health Insurance premium can be biased. In Labor Insurance the disability benefit is equal to 160 days or about 5.3 months of insurance salary, capped at NT$43,900.

For each of the 5 groups of increasing salaries, we use the difference-in-difference and nonparametric methods to estimate the number of induced hysterectomies and the inducement rate, the ratio of induced hysterectomies to total hysterectomies of enrollees between the ages of 40 and 49. Table 9 presents the results, with the difference-in-difference and nonparametric results in the upper and lower panels, respectively. Column (1) lists the average insurance benefits for the 5 groups. The average insurance benefit of group 1 is around NT$84,000, nearly one third of the average benefit of the highest group 5 which has an average of almost NT$220,000. The maximum allowed disability benefit is approximately NT$232,600 (5.3 $\times$ NT$43,900), but the average insurance benefits of group 5 is only a little lower than this maximum, so a sizable proportion of enrollees in this group have actual salaries above the cap.

Columns (2) and (3), respectively, present the total number of hysterectomies undertaken by enrollees between ages 40 and 49, and the estimated induced hysterectomies. Total hysterectomies of each group are similar, with the percentage difference between the highest and the lowest group at less than 10%. By contrast, the variation of induced hysterectomies is quite large among different benefit groups: induced hysterectomies of highest-benefit group 5 are about twice that of the lowest-benefit group 1.

The estimated inducement rates are in Column (4). The inducement rate increases with average insurance benefit: the rate ratio of induced hysterectomy increases modestly when moving from group 1 to group 3 (from about 9% to11%), but accelerates when moving from group 3 to group 5 (from about 11% to 15%). In total, in the difference-in-difference estimates, the highest benefit group's inducement rate is about 75% larger than the lowest income group (15.71% versus 8.93%). The corresponding results in the nonparametric estimates are stronger, with group 5's inducement rate being more than twice that of group 1 (14.45% versus 7.11%).

Stratification analysis shows that benefits have a strong and positive effect on inducement. Results in Table 9 shed some light on the possible impact of a policy change.[19] The current discussion may recommend reducing half of the benefit. If this were to happen, for group 5 the average benefit would drop from NT$220,000 to NT$110,000, falling between the average benefit of group 3 and group 2. At a projected inducement effect at 11%, this would result in a reduction of more than 4.5 percentage points from the current inducement effect of 15.71%. If the benefit is paid at a fixed price, say at the current third tier, we predict that inducement effects will become stronger among low-income enrollees, and weaker among high-income enrollees.

6.3 Social costs due to disability insurance

We now estimate social costs due to induced surgeries and insurance benefit payments. Each induced hysterectomy qualifies an enrollee for benefit that would not have been paid. One can plausibly argue that the benefit is a transfer, and we can be agnostic about the desirability or efficiency of the benefit transfers due to inducement. Each induced hysterectomy is a surgery which uses real resources. Admittedly a hysterectomy may yield some short-term and long-term health gains, but we are not in a position to estimate them.[20] Here, we calculate separately the inducement costs due to benefit payments and surgeries.

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[19] Our results are different from those in Ho et al. (2017). They find that the hysterectomy rate declines as the benefits increase. We suspect three reasons for this discrepancy. First, our setting differentiates the inducement and timing effects. Second, Ho et al. (2017) miscalculate the insured salary of public employees (whose insurance salary was only a fraction of the full salary due to stipends). Third, women in the farmer insurance also were entitled to infertility benefits and therefore should not be included in the control group.

[20] Taiwanese enjoy national health insurance, and presumably women would have assessed hysterectomy health gains irrespective of whether infertility insurance is available. Hence, induced hysterectomies likely lead to deadweight loss.

Table 10: Estimated social costs of disability insurance (balanced sample)

Insurance programs	Total number of enrollees	Monthly insurance salary	Total number of hysterectomies	Inducement disability benefit payment	Inducement surgical expenditure
Government Employee Insurance	43,577	NT\$33,786	2,740	NT\$60,543,000	NT\$15,322,000
Labor Insurance	218,357	NT\$31,578	14,946	NT\$306,577,000	NT\$89,732,000
Farmer Insurance	41,295	NT\$10,200	2,740	NT\$60,543,000	NT\$15,322,000
Total for three programs	303,229		20,426	NT\$427,663,000	NT\$120,376,000

We assess inducement costs over enrollees' lifetime. Most hysterectomies happen when females are between 40 and 50 years old, so our estimation results are suitable for lifetime cost assessment. We use the balanced sample (those born between 1958 and 1962) because all enrollees' experiences from their 40th to 50th birthdays happen within the data period of 1997 to 2011. We estimate the social costs of the three programs separately. Inducement effects have only been estimated for the Labor Insurance balanced sample. However, from Table 7, for Labor Insurance, the inducement effects for the nonswitching and balanced samples are similar. We believe that the same would hold for the nonswitching and balanced samples in Government Employee Insurance and Farmer Insurance. Hence, we simply use the inducement effect percentages in the nonswitching sample.

We estimate the hysterectomy reimbursements from National Health Insurance as follows. In Taiwan hysterectomies are classified by three broad surgical intensities (total, subtotal, and laparoscopic), as well as by three levels of teaching hospital characteristics (major teaching, minor teaching, and community). National Health Administration sets a separate reimbursement rate for each of these 9 hysterectomy classes. We pick the mid-point, year 2005, for the reimbursement rates. We multiply the number of hysterectomies in each of the 9 classes by the corresponding reimbursement rate; hysterectomy cost is the sum of these 9 products.[21]

Table 10 presents the aggregated data summary and the inducement costs. The first column lists the numbers of enrollees in the 1958-1962-cohort balanced sample. There are 303,229 enrollees in all three programs. The second column lists the average monthly insurance salary by programs. For Government

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[21] Details for the disaggregated numbers of hysterectomies and the 2005 reimbursement rates are in Table A19 of Appendix A.

Employee Insurance, the insurance salary is the lower of an enrollee's base monthly salary and NT$53,900. However, National Health Insurance records include base salary and stipends. For insurance benefit estimation, we use the average base salary for those who have worked for 10 years. This is NT$33,786 in the 2005 reports of Government Employee Insurance. For Labor Insurance, the insurance salary is defined to be the lower of an enrollee's actual monthly salary and NT$43,900. Based on the insurance salaries of female enrollees who underwent hysterectomies, we obtain the average insurance salary per month, NT$31,578. For Farmer Insurance, the insurance salary is fixed at NT$10,200 per month, so it is the average insurance salary.

The third column lists the numbers of hysterectomies and the total in all programs. Estimates of induced disability benefit payment and surgical costs are in the next two columns. Recall the benefit is 6 months of insurance salary for Government Insurance and 5.3 months for Labor Insurance and Farmer Insurance, so total payment is equal to the monthly amount multiplied by the corresponding month in the program. Then we multiply the total payment by the inducement rates in each insurance program in Table 7 to obtain the induced benefit payment. We follow a similar procedure to estimate the surgery costs due to inducement.

For the total of over 303 thousand enrollees, we estimate a lifetime cost of over NT$427 millions of induced benefit payment, so the lifetime induced benefit payment is NT$1,410 per insured enrollee. We estimate a lifetime cost due to induced hysterectomies over NT$120 millions. This corresponds to a lifetime cost of just under NT$400 per insured enrollee. To give a sense of the magnitude of these numbers, we find that the 2016 reimbursement rates for mammogram and pap smear are, respectively, NT$1,245 and NT$80. Hence, the induced benefit payment would be more than enough to fund 1 mammogram, and the surgery cost due to induced hysterectomy would fund 5 pap smears, over each enrollee's lifetime.

7 Conclusions

We have studied enrollees' response to the infertility coverage in three Taiwanese disability insurance programs. Enrollees having hysterectomy or complete oophorectomy qualify for benefit, but the eligibility ends at the 45th birthday. This program arguably can be likened to a natural experiment of putting a price on the removal of a human organ. Compared to the uninsured, enrollees have about 11% more hysterectomies, and about 20% of the induced hysterectomies could be classified as those expedited to beat the deadline. Disability insurance has not led to any increase in oophorectomy.

The contrast between the different responses in hysterectomy and oophorectomy is striking. The plausible explanation behind the difference is a cost-benefit calculus. Because organ removal is a discrete choice, economic principle dictates that such an operation is undertaken if and only if the net reward is above a threshold. If a policy goal is an amount of insurance that would not result in induced operations, then our results indicate that, in the Taiwanese case, the benefit is above the threshold for hysterectomy, but below for oophorectomy. A policy implication, therefore, is that insurance coverage for infertility should depend on whether the infertility is due to hysterectomy or oophorectomy.

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Appendix A

Table A1: Difference-in-difference estimates $\hat{\rho}_q$ for total oophorectomy: nonswitching sample

	(1) Labor Insurance	(2) Government Employee Insurance	(3) Farmer Insurance
Quarter to 45th birthday x Insurance group dummy (ρ_q)			
-10	1.322	1.253	1.097
	(2.332)	(3.223)	(3.903)
-9	-3.002	2.434	3.219
	(2.618)	(3.894)	(4.645)
-8	-2.147	3.661	2.748
	(2.297)	(4.424)	(3.968)
-7	-2.621	-6.168	-3.441
	(2.201)	(3.430)	(3.911)
-6	0.848	-5.396	0.444
	(2.890)	(3.815)	(4.955)
-5	4.258	-0.894	14.55*
	(3.069)	(3.592)	(5.769)
-4	2.538	0.874	6.783
	(2.453)	(4.557)	(5.359)
-3	-0.706	0.315	-6.207
	(2.728)	(4.615)	(3.719)
-2	2.469	7.489	2.752
	(3.162)	(5.301)	(4.239)
-1	7.006	4.597	-5.469
	(3.617)	(4.361)	(4.949)
0	-1.808	-2.760	-2.991
	(2.910)	(4.783)	(4.956)
1	-0.407	-7.569*	0.913
	(3.246)	(3.791)	(4.776)
2	-4.463	-4.166	1.299
	(4.402)	(5.232)	(5.667)
3	-1.682	0.717	-2.245
	-3.391	(5.211)	(4.900)
4	-7.928*	-5.818	0.771
	(3.890)	(5.175)	(6.893)
5	-3.677	-5.301	-1.771
	(4.141)	(6.050)	(7.327)
6	-8.167	-11.98*	-6.345
	(4.210)	(5.907)	(6.240)
7	-5.776	-7.501	-8.922
	(5.318)	(6.522)	(5.574)
Insurance group dummy	-5.394**	-6.718**	5.132*
	(1.171)	(1.527)	(2.229)
Logged household income	5.885**	3.654	3.984
	(2.197)	(1.976)	(3.205)
Total number of children	-38.27**	-29.59**	-26.52**
	(4.063)	(4.037)	(3.581)
Number of sons	-11.41*	-11.22*	-0.206
	(5.170)	(4.796)	(4.067)
Married	20.60	30.74**	31.15**
	(11.16)	(8.725)	(10.58)
Observations	5,280	5,280	5,280

Note: The dependent variable is quarterly hazard of total oophorectomy. Uninsured are used as baseline in each regression. Robust errors clustered at the birth cohort level are in parentheses. $^{**}, p < 0.01$; $^{*}, p < 0.05$.

Table A2: Difference-in-difference estimates $\hat{\rho}_q$ for partial oophorectomy: nonswitching sample

	(1) Labor Insurance	(2) Government Employee Insurance	(3) Farmer Insurance
Quarter to 45th birthday x Insurance group dummy (ρ_q)			
-10	6.664	1.650	-8.454
	(4.098)	(5.974)	(5.362)
-9	3.377	-1.380	-5.248
	(3.827)	(6.287)	(6.936)
-8	6.101	9.577	0.529
	(4.223)	(5.634)	(5.606)
-7	0.775	6.849	0.920
	(4.459)	(6.323)	(6.117)
-6	4.781	2.719	4.938
	(4.148)	(7.696)	(6.284)
-5	2.480	-5.745	-0.803
	(4.200)	(5.337)	(7.039)
-4	2.270	1.219	-7.867
	(3.806)	(5.776)	(6.671)
-3	6.616	2.759	-7.514
	(3.715)	(6.021)	(6.135)
-2	-2.445	-9.461	-6.953
	(4.228)	(6.822)	(7.480)
-1	3.166	8.600	-3.529
	(3.692)	(5.339)	(6.099)
0	3.692	-6.660	3.732
	(4.042)	(5.372)	(5.971)
1	-2.439	-5.250	-4.569
	(3.797)	(5.829)	(5.561)
2	-1.826	-0.479	-7.287
	(3.964)	(7.889)	(6.496)
3	3.501	-3.201	4.472
	(3.821)	(4.598)	(5.777)
4	-3.862	-4.727	-9.538
	(3.103)	(6.147)	(5.517)
5	-1.111	3.223	4.769
	(3.741)	(5.105)	(6.102)
6	1.998	-4.227	-2.845
	(3.953)	(5.197)	(5.475)
7	-0.423	-10.58	-5.510
	(3.699)	(5.833)	(5.346)
Insurance group dummy	1.842	5.965*	3.738
	(2.321)	(2.674)	(3.771)
Logged household income	-0.304	-0.506	-2.106
	(2.292)	(2.287)	(2.127)
Total number of children	-1.212	-5.141	0.164
	(3.018)	(3.242)	(3.115)
Number of sons	-8.945*	-1.790	-9.200*
	(3.924)	(4.159)	(4.554)
Married	4.850	5.437	0.431
	(8.194)	(9.247)	(9.423)
Observations	5,280	5,280	5,280

Note: The dependent variable is quarterly hazard of partial oophorectomy. Uninsured are used as baseline in each regression. Other covariates are full sets of quarter dummies and data year fixed-effects. Robust errors clustered at the birth cohort level are in parentheses. $^{**}, p < 0.01$; $^{*}, p < 0.05$.

Table A3: Difference-in-difference estimates $\hat{\rho}_q$ for myomectomy: non-switching sample

	(1) Labor Insurance	(2) Government Employee Insurance	(3) Farmer Insurance
Quarter to 45th birthday x Insurance group dummy (ρ_q)			
-10	-2.707	-13.42	-13.21*
	(4.773)	(7.971)	(5.562)
-9	-0.920	-6.991	4.795
	(4.202)	(8.056)	(8.625)
-8	1.841	-7.324	7.179
	(5.931)	(6.125)	(8.156)
-7	-0.389	1.275	2.511
	(5.059)	(7.940)	(6.294)
-6	0.540	-18.75*	14.35*
	(5.052)	(7.451)	(6.754)
-5	1.383	-13.39	-5.908
	(6.076)	(7.015)	(5.798)
-4	6.662	2.396	4.048
	(7.010)	(7.328)	(5.869)
-3	-1.561	-6.716	3.010
	(5.944)	(7.130)	(5.723)
-2	-2.097	-3.403	2.261
	(5.007)	(7.583)	(7.174)
-1	4.064	-4.757	0.711
	(4.142)	(7.650)	(7.501)
0	-10.04*	-18.03*	-9.618
	(4.023)	(7.562)	(5.125)
1	-4.035	-22.87**	3.083
	(4.356)	(6.532)	(6.545)
2	5.007	-1.012	3.958
	(4.101)	(8.110)	(6.661)
3	-0.337	-12.59	2.179
	(4.635)	(7.817)	(5.598)
4	1.259	-14.63*	6.333
	(4.890)	(7.351)	(7.447)
5	-8.786	-12.01	4.681
	(4.864)	(7.539)	(5.937)
6	-5.069	-4.082	7.939
	(4.293)	(8.640)	(6.306)
7	-2.199	-14.25*	-0.199
	(5.436)	(6.991)	(6.915)
Insurance group dummy	9.877**	17.12**	-7.212*
	(2.325)	(3.442)	(3.313)
Logged household income	-1.722	2.319	3.010
	(3.046)	(2.974)	(3.218)
Total number of children	-6.398	-6.563	-2.253
	(4.462)	(4.613)	(4.037)
Number of sons	2.239	9.824	1.919
	(6.077)	(5.448)	(5.756)
Married	-5.427	-1.203	4.644
	(12.48)	(12.35)	(11.60)
Observations	5,280	5,280	5,280

Note: he dependent variable is quarterly hazard of myomectomy. Uninsured are used as baseline in each regression. Other covariates are full sets of quarter dummies and data year fixed-effects. Robust errors clustered at the birth cohort level are in parentheses. $^{**}, p < 0.01$; $^{*}, p < 0.05$.

Table A4: Nonparametric estimates $\hat{\rho}_q$ for total oophorectomy; nonswitching sample

Quarters to age 45	(1) Uninsured	(2) Labor Insurance	(3) Government Employee Insurance	(4) Farmer Insurance
-9	3.08	-0.87	5.01	7.47
	(2.94)	(1.66)	(3.52)	(5.33)
-8	1.59	-1.28	5.22	5.62
	(2.40)	(1.82)	(3.92)	(5.32)
-7	1.76	-1.50	-4.09	-0.34
	(2.74)	(2.18)	(2.94)	(5.32)
-6	-0.15	0.01	-4.83	1.68
	(2.74)	(2.37)	(3.02)	(5.32)
-5	-4.42	-0.61	-4.17	11.56*
	(2.87)	(2.45)	(3.02)	(5.32)
-4	-3.76	-1.59	-1.33	4.46
	(2.70)	(2.34)	(4.07)	(5.31)
-3	-0.41	-1.66	1.48	-4.95
	(3.35)	(2.51)	(4.22)	(5.29)
-2	-2.69	-0.92	6.53	1.92
	(3.26)	(2.81)	(5.35)	(5.27)
-1	-1.73	4.44	4.73	-5.21
	(4.08)	(3.60)	(4.66)	(5.25)
0	-3.98	-6.80**	-4.82	-4.84
	(3.07)	(2.50)	(4.65)	(5.21)
1	-3.93	-4.71	-9.12**	-0.82
	(3.25)	(3.01)	(3.31)	(5.18)
2	0.14	-4.13	-1.19	3.72
	(4.06)	(3.48)	(4.90)	(5.13)
3	-6.52	-7.48*		-6.50
	(3.99)	(2.99)		(5.09)
4		-6.00		
		(3.40)		
5		-4.17		
		(3.48)		
6		-3.81		
		(4.44)		
7		-1.36		
		(4.76)		
8		-4.62		
		(4.13)		
9		1.39		
		(4.44)		
10		-1.61		
		(4.54)		
11		-5.60		
		(4.23)		
Optimal bounds (q_L, q_U)	(-9, 3)	(-9, 11)	(-9, 2)	(-9, 3)
Observations	4,483	4,498	4,474	4,481

Note: The dependent variable is quarterly hazard of total oophorectomy. The covariates are 6th order polynomial terms of quarterly ages. Robust errors are in parentheses. $^{**}, p < 0.01$; $^{*}, p < 0.05$.

Table A5: Nonparametric estimates $\hat{\rho}_q$ for partial oophorectomy: nonswitching sample

Quarters to age 45	(1) Uninsured	(2) Labor Insurance	(3) Government Employee Insurance	(4) Farmer Insurance
-18				-3.85
				(6.33)
-17				-6.23
				(6.46)
-16				-5.07
				(6.57)
-15				-9.10
				(6.66)
-14				14.51*
				(6.73)
-13				-0.60
				(6.78)
-12				-8.77
				(6.80)
-11				-7.55
				(6.80)
-10				-9.55
				(6.78)
-9	0.65	1.61	1.64	-4.08
	(3.58)	(2.77)	(5.58)	(6.73)
-8	-3.93	-1.99	2.71	-5.27
	(2.59)	(2.80)	(4.73)	(6.66)
-7	0.51	-2.48	6.71	-1.56
	(3.29)	(2.43)	(6.35)	(6.57)
-6	0.44	3.83	1.87	5.35
	(3.67)	(3.10)	(5.77)	(6.46)
-5	0.62	1.81	-4.57	1.08
	(2.92)	(2.49)	(4.53)	(6.34)
-4	-0.29	1.15	3.16	-4.83
	(3.22)	(2.65)	(5.39)	(6.19)
-3	-1.77	1.15	1.89	-10.57
	(2.80)	(2.93)	(5.27)	(6.04)
-2	6.49*	3.04	2.10	1.65
	(2.86)	(2.77)	(5.41)	(5.88)
-1	-0.35	0.78	9.16	-1.66
	(2.87)	(2.46)	(5.99)	(5.71)
0	-1.40	0.36	-3.76	1.07
	(2.90)	(2.80)	(4.90)	(5.54)
1	1.94	-1.67	-1.32	-3.70
	(3.18)	(2.61)	(5.05)	(5.38)
2	2.71	0.44	1.11	-2.45
	(3.14)	(2.77)	(4.59)	(5.21)
3	-1.38	1.33	-3.48	2.50
	(2.40)	(2.65)	(3.94)	(5.06)
4			3.63	-3.60
			(5.18)	(4.91)
5			9.26	7.68
			(5.45)	(4.79)
Optimal bounds (q_L, q_U)	(-9, 3)	(-9, 3)	(-9, 5)	(-24, 5)
Observations	4,483	4,498	4,474	4,481

Note: The dependent variable is quarterly hazard of partial oophorectomy. The covariates are 5th order polynomial terms of quarterly ages. For brevity, we only present estimates of q between -18 and 5. Robust errors are in parentheses. $^{**}, p < 0.01$; $^{*}, p < 0.05$.

Table A6: Nonparametric estimates $\hat{\rho}_q$ for myomectomy; nonswitching sample

Quarters to age 45	(1) Uninsured	(2) Labor Insurance	(3) Government Employee Insurance	(4) Farmer Insurance
-14	-4.53			6.63
	(4.20)			(6.34)
-13	-0.40			-9.84
	(4.23)			(6.38)
-12	-2.10			8.03
	(4.52)			(6.40)
-11	4.50			-9.11
	(4.39)			(6.39)
-10	-0.38			2.57
	(4.28)			(6.38)
-9	1.25			-17.30**
	(4.59)			(6.35)
-8	-3.16	-1.95	-7.71	-0.55
	(3.59)	(3.62)	(6.72)	(6.30)
-7	-0.36	1.94	-3.52	2.80
	(3.56)	(3.61)	(5.25)	(6.24)
-6	-0.54	0.81	4.42	-5.20
	(4.12)	(3.83)	(7.32)	(6.16)
-5	3.13	4.84	-10.47	9.52
	(3.88)	(3.60)	(6.30)	(6.07)
-4	-0.50	1.61	-6.19	-11.77*
	(4.24)	(3.91)	(5.87)	(5.98)
-3	-4.23	0.89	3.47	-7.51
	(3.88)	(3.80)	(5.98)	(5.86)
-2	-1.87	-3.22	0.35	-4.83
	(3.72)	(3.42)	(6.76)	(5.75)
-1	0.32	0.79	3.29	-2.12
	(3.93)	(3.45)	(6.17)	(5.63)
0	-0.30	4.67	2.41	-3.23
	(3.52)	(3.88)	(6.60)	(5.51)
1	3.59	-1.99	-4.73	-9.74
	(3.65)	(3.34)	(5.83)	(5.39)
2	2.20	0.79	-11.09*	-1.75
	(3.40)	(3.33)	(4.89)	(5.28)
3	-5.59	3.72	3.48	-2.84
	(2.95)	(3.49)	(6.44)	(5.16)
4		1.03	-3.73	
		(3.35)	(6.29)	
5		4.75	-1.58	
		(3.58)	(5.87)	
6		-1.98	0.64	
		(3.26)	(6.91)	
7		2.58	10.05	
		(3.23)	(6.62)	
8		0.45	-1.29	
		(3.30)	(5.79)	
9		-6.65*	10.56	
		(2.75)	(7.31)	
Optimal bounds (q_L, q_U)	(-18 3)	(-8, 9)	(-8, 9)	(-22, 3)
Observations	4,483	4,498	4,474	4,481

Note: The dependent variable is quarterly hazard of myomectomy. The covariates are 5th order polynomial terms of quarterly ages. For brevity, we only present estimates of q between -14 and 9. Robust errors are in parentheses. $^{**}, p < 0.01$; $^{*}, p < 0.05$.

Table A7: Difference-in-difference estimates $\hat{\rho}_q$ for hysterectomy: general sample

	(1) Labor Insurance	(2) Government Employee Insurance	(3) Farmer Insurance
Quarter to 45th birthday x Insurance group dummy (ρ_q)			
-10	30.77**	18.61	12.61
	(6.452)	(12.03)	(13.28)
-9	45.51**	41.27**	38.51**
	(6.228)	(12.50)	(14.23)
-8	23.36**	11.62	-10.93
	(7.672)	(11.18)	(12.51)
-7	35.16**	48.62**	30.80*
	(6.353)	(14.56)	(13.81)
-6	49.09**	19.10	19.14
	(7.600)	(10.12)	(14.81)
-5	71.88**	45.71**	38.61**
	(6.571)	(12.85)	(12.82)
-4	41.86**	57.94**	19.41
	(7.140)	(15.60)	(13.66)
-3	70.79**	66.97**	26.85*
	(9.377)	(12.11)	(11.16)
-2	84.47**	85.95**	34.00*
	(8.862)	(14.72)	(14.48)
-1	180.6**	164.5**	37.67**
	(12.10)	(19.31)	(13.45)
0	-41.08**	-35.35**	-28.57*
	(7.792)	(11.27)	(13.10)
1	-20.09*	-22.88	-14.39
	(7.979)	(13.02)	(14.03)
2	-12.46	-4.111	-1.821
	(7.720)	(10.75)	(14.54)
3	-20.43**	3.021	-3.919
	(7.122)	(12.76)	(14.14)
4	-22.43**	-14.00	1.716
	(6.908)	(12.47)	(12.58)
5	-17.43*	0.313	-6.784
	(7.353)	(13.60)	(13.22)
6	-14.53	-11.94	-0.213
	(9.009)	(10.98)	(14.23)
7	-3.877	5.524	-15.94
	(6.551)	(13.75)	(12.06)
Insurance group dummy	10.53**	-19.27**	35.96**
	(3.189)	(3.888)	(5.471)
Logged household income	-13.98**	-10.13*	-23.37**
	(4.740)	(4.198)	(5.643)
Total number of children	-20.83**	-18.02*	-19.74**
	(7.698)	(7.790)	(6.969)
Number of sons	6.555	2.188	-0.166
	(10.12)	(9.886)	(8.980)
Married	33.16*	42.33*	20.06
	(15.92)	(18.37)	(18.62)
Observations	5,280	5,280	5,280

Note: The dependent variable is quarterly hazard of hystereomy. Uninsured are used as baseline in each regression. Other covariates are full sets of quarter dummies and data year fixed-effects. Robust errors clustered at the birth cohort level are in parentheses. $^{**}, p < 0.01$; $^{*}, p < 0.05$.

Table A8: Difference-in-difference estimates $\hat{\rho}_q$ for total oophorectomy: general sample

	(1) Labor Insurance	(2) Government Employee Insurance	(3) Farmer Insurance
Quarter to 45th birthday x Insurance group dummy (ρ_q)			
-10	0.117	0.323	-0.0534
	(2.235)	(3.277)	(3.908)
-9	-1.196	7.012	4.218
	(2.421)	(4.726)	(4.828)
-8	-1.979	4.016	3.181
	(2.470)	(4.459)	(4.852)
-7	-0.0735	-2.244	-0.151
	(2.395)	(3.636)	(4.194)
-6	-0.866	-4.103	-2.317
	(2.840)	(4.538)	(4.984)
-5	2.744	2.801	9.398
	(2.962)	(3.530)	(5.461)
-4	2.438	5.172	1.506
	(2.789)	(5.145)	(5.170)
-3	-0.178	2.336	-5.931
	(3.296)	(5.112)	(4.535)
-2	3.192	13.41*	0.729
	(3.527)	(6.694)	(4.541)
-1	6.570	10.55*	-6.958
	(3.900)	(4.374)	(4.917)
0	-2.120	-1.610	-5.461
	(3.461)	(6.117)	(6.323)
1	-2.723	-5.318	-0.0806
	(3.555)	(4.872)	(5.717)
2	-7.557	-1.015	-3.826
	(4.602)	(6.252)	(6.089)
3	-5.766	6.469	-7.940
	(4.197)	(5.606)	(5.453)
4	-10.58*	-0.807	-6.592
	(4.784)	(6.253)	(6.753)
5	-9.506	-0.0366	-11.26
	(4.917)	(6.660)	(7.430)
6	-12.25**	-6.582	-8.896
	(4.650)	(7.214)	(7.253)
7	-8.147	1.831	-10.26
	(5.982)	(7.252)	(6.934)
Insurance group dummy	-4.941**	-6.798**	4.602*
	(1.003)	(1.335)	(1.960)
Logged household income	5.588**	3.117	4.691
	(2.065)	(1.930)	(2.775)
Total number of children	-34.38**	-29.60**	-26.38**
	(3.756)	(3.692)	(3.215)
Number of sons	-14.77**	-13.87**	-3.313
	(4.417)	(4.402)	(3.368)
Married	23.81**	36.69**	34.54**
	(8.901)	(7.815)	(8.594)
Observations	5,280	5,280	5,280

Note: The dependent variable is quarterly hazard of total oophorectomy. Uninsured are used as baseline in each regression. Other covariates are full sets of quarter dummies and data year fixed-effects. Robust errors clustered at the birth cohort level are in parentheses. $^{**}, p < 0.01$; $^{*}, p < 0.05$.

Table A9: Difference-in-difference estimates $\hat{\rho}_q$ for partial oophorectomy: general sample

	(1) Labor Insurance	(2) Government Employee Insurance	(3) Farmer Insurance
Quarter to 45th birthday x Insurance group dummy (ρ_q)			
-10	4.772	1.584	-3.888
	(3.216)	(5.970)	(5.010)
-9	3.867	-0.270	1.442
	(2.649)	(5.348)	(5.969)
-8	2.405	6.499	-0.544
	(3.360)	(5.342)	(4.816)
-7	1.866	7.671	2.814
	(3.068)	(5.941)	(5.416)
-6	4.936	4.734	8.155
	(3.428)	(7.231)	(5.716)
-5	2.352	-3.932	-0.387
	(3.037)	(5.189)	(5.586)
-4	0.565	2.040	-6.526
	(2.870)	(5.581)	(5.670)
-3	8.421**	5.423	-3.199
	(3.039)	(5.519)	(5.272)
-2	1.012	-4.386	-0.177
	(3.066)	(6.006)	(5.965)
-1	2.420	9.904	0.402
	(3.032)	(5.690)	(5.275)
0	3.130	-5.179	5.597
	(2.914)	(4.716)	(5.452)
1	-4.414	-5.585	-2.095
	(3.192)	(5.440)	(5.394)
2	0.294	2.279	0.658
	(3.108)	(7.578)	(5.524)
3	4.215	-1.124	4.391
	(2.953)	(4.703)	(5.059)
4	-0.122	-2.535	-2.095
	(2.506)	(5.369)	(4.201)
5	1.832	6.290	11.47*
	(3.137)	(4.953)	(5.731)
6	0.615	-6.217	-1.340
	(2.809)	(4.790)	(5.338)
7	1.809	-5.028	1.545
	(3.049)	(5.742)	(4.743)
Insurance group dummy	0.759	3.966	0.565
	(1.728)	(2.400)	(3.228)
Logged household income	-0.606	-0.816	-2.803
	(1.879)	(1.985)	(2.095)
Total number of children	-2.857	-4.910	-1.648
	(2.863)	(3.007)	(2.750)
Number of sons	-6.615	-2.940	-8.579*
	(3.721)	(3.897)	(3.585)
Married	4.684	8.703	5.615
	(6.874)	(8.669)	(8.506)
Observations	5,280	5,280	5,280

Note: The dependent variable is quarterly hazard of partial oophorectomy. Uninsured are used as baseline in each regression. Other covariates are full sets of quarter dummies and data year fixed-effects. Robust errors clustered at the birth cohort level are in parentheses. $^{**}, p < 0.01$; $^{*}, p < 0.05$.

Table A10: Difference-in-difference estimates $\hat{\rho}_q$ for myomectomy: general sample

	(1) Labor Insurance	(2) Government Employee Insurance	(3) Farmer Insurance
Quarter to 45th birthday x Insurance group dummy (ρ_q)			
-10	0.618	-3.451	-14.19**
	(3.813)	(6.864)	(4.487)
-9	4.566	0.550	5.865
	(2.933)	(7.664)	(7.189)
-8	-0.346	1.986	0.291
	(4.425)	(5.976)	(7.137)
-7	-2.572	5.536	0.0176
	(4.165)	(7.402)	(5.991)
-6	0.598	-10.35	7.467
	(3.303)	(6.384)	(5.427)
-5	5.221	-0.481	-6.664
	(4.626)	(5.535)	(5.364)
-4	9.053	13.14	-3.094
	(4.841)	(6.652)	(4.398)
-3	2.962	4.995	0.701
	(4.212)	(7.125)	(5.176)
-2	0.731	8.834	-0.807
	(3.945)	(7.230)	(6.463)
-1	4.472	7.988	-7.022
	(3.725)	(7.177)	(6.016)
0	-6.444*	-1.536	-9.801*
	(3.067)	(6.292)	(4.753)
1	3.126	-2.779	-3.409
	(3.677)	(5.794)	(5.673)
2	7.406*	14.29*	-2.699
	(2.958)	(6.657)	(5.236)
3	2.833	1.625	-3.860
	(3.400)	(6.892)	(4.635)
4	4.923	2.770	-1.352
	(4.106)	(6.320)	(6.087)
5	-2.012	4.152	1.516
	(4.017)	(6.721)	(5.244)
6	2.865	18.38*	4.581
	(3.435)	(8.541)	(6.406)
7	4.608	7.466	-1.436
	(4.388)	(6.397)	(6.129)
Insurance group dummy	9.021**	15.55**	-5.065
	(1.748)	(3.191)	(3.140)
Logged household income	-1.971	1.893	1.746
	(2.367)	(2.669)	(2.589)
Total number of children	-4.862	-5.062	-2.254
	(3.850)	(4.027)	(3.447)
Number of sons	-1.996	5.733	-2.839
	(5.532)	(4.813)	(4.556)
Married	-2.160	1.764	4.204
	(9.922)	(10.83)	(11.20)
Observations	5,280	5,280	5,280

Note: The dependent variable is quarterly hazard of myomectomy. Uninsured are used as baseline in each regression. Other covariates are full sets of quarter dummies and data year fixed-effects. Robust errors clustered at the birth cohort level are in parentheses. $^{**}, p < 0.01$; $^{*}, p < 0.05$.

Table A11: Difference-in-difference estimates $\hat{\rho}_q$ for hysterectomy: balanced sample

	(1) Labor Insurance	(2) Government Employee Insurance	(3) Farmer Insurance
Quarter to 45th birthday x Insurance group dummy (ρ_q)			
-10	51.91**	55.68*	43.84
	(12.14)	(25.78)	(28.55)
-9	57.93**	75.65*	43.39
	(15.57)	(32.79)	(33.94)
-8	42.49*	31.02	-3.186
	(19.52)	(19.82)	(29.17)
-7	30.30**	59.60*	33.97
	(10.15)	(23.33)	(26.26)
-6	79.01**	30.08	57.59*
	(21.04)	(17.78)	(20.60)
-5	84.01**	51.24	38.06
	(18.02)	(33.14)	(31.29)
-4	47.56**	64.20	52.19
	(12.83)	(37.15)	(26.74)
-3	80.12**	75.88**	57.44**
	(16.24)	(20.95)	(17.49)
-2	75.21**	117.0**	23.98
	(18.13)	(31.53)	(24.07)
-1	195.4**	207.6**	63.14*
	(26.08)	(39.41)	(28.38)
0	-55.98**	-10.68	-11.75
	(17.02)	(21.16)	(20.95)
1	-18.70	-10.48	13.71
	(20.57)	(29.62)	(33.18)
2	5.616	-4.302	23.17
	(15.24)	(28.45)	(21.30)
3	-28.53	-19.56	16.28
	(16.10)	(24.81)	(35.00)
4	-27.86	-14.57	28.13
	(19.00)	(25.20)	(25.03)
5	-8.301	18.70	19.33
	(11.78)	(28.23)	(20.58)
6	-13.92	8.849	27.29
	(26.70)	(35.25)	(31.42)
7	-2.159	5.176	25.24
	(17.98)	(30.72)	(42.76)
Insurance group dummy	-10.58	-38.91**	38.13**
	(8.762)	(10.71)	(11.26)
Logged household income	-39.00**	-0.555	-16.18
	(8.617)	(8.792)	(12.62)
Total number of children	-80.07**	-55.39**	-43.98
	(17.97)	(18.93)	(21.23)
Number of sons	1.063	22.42	-5.374
	(24.54)	(20.95)	(23.45)
Married	41.89	46.65	6.762
	(30.84)	(28.45)	(54.48)
Observations	1,748	1,748	1,748

Note: The dependent variable is quarterly hazard of hystereomy. Uninsured are used as baseline in each regression. Other covariates are full sets of quarter dummies and data year fixed-effects. Robust errors clustered at the birth cohort level are in parentheses. $^{**}, p < 0.01$; $^{*}, p < 0.05$.

Table A12: Difference-in-difference estimates $\hat{\rho}_q$ for total oophorectomy: balanced sample

	(1) Labor Insurance	(2) Government Employee Insurance	(3) Farmer Insurance
Quarter to 45th birthday x Insurance group dummy (ρ_q)			
-10	-5.650	11.18	3.675
	(4.556)	(7.272)	(7.512)
-9	-1.475	3.704	4.138
	(5.160)	(6.279)	(10.83)
-8	-3.832	10.32	-0.151
	(4.706)	(8.231)	(7.744)
-7	-9.690	-7.723	-9.808
	(5.668)	(6.135)	(7.193)
-6	-4.681	7.627	-3.881
	(5.080)	(9.442)	(6.421)
-5	1.070	-0.637	1.311
	(6.337)	(4.667)	(6.602)
-4	-1.000	5.319	4.716
	(4.953)	(7.819)	(7.664)
-3	-5.007	-2.793	-12.08*
	(4.258)	(5.841)	(5.412)
-2	-7.218	-0.791	-1.340
	(6.962)	(8.485)	(8.490)
-1	4.848	7.717	-5.884
	(4.222)	(6.465)	(7.117)
0	-10.81*	-0.572	-0.843
	(5.154)	(9.595)	(8.885)
1	0.737	-7.652	15.01
	(5.059)	(7.577)	(8.964)
2	-9.098	-7.208	0.633
	(5.890)	(10.42)	(9.106)
3	-4.432	8.154	-0.662
	(6.401)	(9.199)	(7.568)
4	-15.97*	-7.762	-5.511
	(6.032)	(8.568)	(6.919)
5	1.533	7.671	5.541
	(5.693)	(10.23)	(11.37)
6	-8.633	-2.236	-1.734
	(7.083)	(11.18)	(10.39)
7	-12.35	15.11	-14.61
	(8.378)	(14.96)	(11.09)
Insurance group dummy	-1.907	-5.519	7.219
	(1.160)	(3.466)	(4.345)
Logged household income	-4.070	3.679	0.119
	(3.843)	(3.079)	(4.373)
Total number of children	-12.42**	-12.99*	-15.59*
	(4.144)	(4.541)	(5.597)
Number of sons	-12.83	-6.228	1.723
	(6.615)	(8.517)	(8.205)
Married	10.05	0.255	21.29
	(11.50)	(13.41)	(15.78)
Observations	1,748	1,748	1,748

Note: The dependent variable is quarterly hazard of total oophorectomy. Uninsured are used as baseline in each regression. Other covariates are full sets of quarter dummies and data year fixed-effects. Robust errors clustered at the birth cohort level are in parentheses. $^{**}, p < 0.01$; $^{*}, p < 0.05$.

Table A13: Difference-in-difference estimates $\hat{\rho}_q$ for partial oophorectomy: balanced sample

	(1) Labor Insurance	(2) Government Employee Insurance	(3) Farmer Insurance
Quarter to 45th birthday x Insurance group dummy (ρ_q)			
-10	-7.409	-13.94	-4.319
	(4.558)	(9.426)	(6.439)
-9	-5.338	-14.31	-0.124
	(6.572)	(8.882)	(12.37)
-8	-5.177	2.971	3.346
	(5.253)	(12.40)	(8.457)
-7	-13.01	-5.867	1.374
	(6.762)	(11.59)	(9.889)
-6	-3.400	-0.0364	6.498
	(8.941)	(11.75)	(11.16)
-5	-13.98	-22.62**	13.76
	(7.851)	(7.807)	(12.20)
-4	-6.259	8.917	0.0910
	(6.168)	(11.78)	(9.774)
-3	-5.817	-7.127	-16.50
	(6.035)	(14.25)	(10.21)
-2	-20.32*	-21.60*	-21.24
	(8.300)	(8.230)	(10.45)
-1	-5.937	0.665	-5.350
	(6.214)	(9.347)	(10.68)
0	-6.426	3.375	4.791
	(6.251)	(12.61)	(7.412)
1	-15.82	-25.86*	-17.79
	(8.133)	(11.82)	(9.731)
2	-10.52	-23.71	-3.099
	(6.362)	(12.23)	(12.28)
3	-7.768	-11.71	12.33
	(6.865)	(9.434)	(11.43)
4	-8.221	4.308	-2.026
	(6.545)	(11.30)	(10.11)
5	-7.120	8.433	11.56
	(6.906)	(10.71)	(11.40)
6	-5.474	-18.62	-7.881
	(7.057)	(12.84)	(10.50)
7	-10.26	-31.49**	-7.237
	(8.033)	(8.895)	(10.51)
Insurance group dummy	9.160*	15.91*	5.960
	(3.273)	(5.630)	(4.264)
Logged household income	-12.26**	-3.915	-2.945
	(3.643)	(5.607)	(4.119)
Total number of children	12.10	1.957	5.194
	(7.683)	(9.661)	(7.676)
Number of sons	-15.27	5.649	-16.41
	(12.59)	(11.17)	(11.94)
Married	-21.84	-20.85	-21.22
	(17.26)	(17.00)	(17.33)
Observations	1,748	1,748	1,748

Note: The dependent variable is quarterly hazard of partial oophorectomy. Uninsured are used as baseline in each regression. Other covariates are full sets of quarter dummies and data year fixed-effects. Robust errors clustered at the birth cohort level are in parentheses. $**, p < 0.01$; $*, p < 0.05$.

Table A14: Difference-in-difference estimates $\hat{\rho}_q$ for myomectomy: balanced sample

	(1) Labor Insurance	(2) Government Employee Insurance	(3) Farmer Insurance
Quarter to 45th birthday x Insurance group dummy (ρ_q)			
-10	14.48	-3.865	-1.985
	(7.250)	(10.85)	(7.843)
-9	4.051	7.061	4.020
	(7.229)	(14.74)	(9.278)
-8	5.595	4.096	20.78
	(7.256)	(9.837)	(11.56)
-7	-4.243	22.07	5.355
	(8.143)	(14.79)	(11.35)
-6	1.940	3.839	14.70
	(7.386)	(10.65)	(12.71)
-5	5.760	-8.830	-8.254
	(8.640)	(11.16)	(13.47)
-4	-2.833	14.73	-19.82*
	(9.166)	(10.46)	(9.442)
-3	-7.076	1.873	-4.594
	(7.541)	(12.22)	(10.33)
-2	-9.740	22.23	3.810
	(6.781)	(16.96)	(12.96)
-1	-1.070	5.050	7.194
	(7.304)	(12.68)	(14.86)
0	-1.676	8.449	-18.04
	(8.232)	(11.57)	(10.39)
1	-9.163	-2.584	-5.473
	(7.855)	(8.811)	(12.95)
2	7.441	31.17	0.522
	(7.450)	(16.05)	(11.02)
3	-3.469	12.59	2.930
	(10.13)	(13.92)	(12.04)
4	7.520	7.536	-8.274
	(8.144)	(14.60)	(10.58)
5	-10.11	23.52	5.543
	(10.44)	(15.29)	(13.99)
6	-2.768	19.24	7.536
	(7.453)	(17.51)	(13.03)
7	3.457	26.40	13.84
	(11.39)	(16.30)	(18.83)
Insurance group dummy	9.804**	13.90*	-9.394
	(3.400)	(6.634)	(4.732)
Logged household income	-19.68**	8.231	-6.702
	(5.614)	(5.565)	(4.978)
Total number of children	-12.08	8.602	13.89
	(8.927)	(6.816)	(6.697)
Number of sons	25.84*	7.858	-8.823
	(11.73)	(10.61)	(8.445)
Married	12.29	-36.02	-26.67
	(19.62)	(19.98)	(18.91)
Observations	1,748	1,748	1,748

Note: The dependent variable is quarterly hazard of myomectomy. Uninsured are used as baseline in each regression. Other covariates are full sets of quarter dummies and data year fixed-effects. Robust errors clustered at the birth cohort level are in parentheses. $^{**}, p < 0.01$; $^{*}, p < 0.05$.

Table A15: Nonparametric estimates $\hat{\rho}_q$ for hysterectomy: general sample

Quarters to age 45	(1) Uninsured	(2) Labor Insurance	(3) Government Employee Insurance	(4) Farmer Insurance
-16	-12.19			
	(6.460)			
-15	-4.250	7.065		
	(6.862)	(6.779)		
-14	-1.199	13.10		
	(6.271)	(7.628)		
-13	-12.39	15.49		
	(7.873)	(8.123)		
-12	-12.94	7.431		
	(7.535)	(8.214)		
-11	1.618	20.44*	17.34	
	(7.939)	(8.449)	(11.76)	
-10	-2.270	26.97**	18.70	
	(7.508)	(9.219)	(13.84)	
-9	-15.01	29.40**	28.02	17.84
	(8.370)	(8.423)	(14.55)	(11.73)
-8	5.283	27.18**	17.61	-12.60
	(8.138)	(8.455)	(12.56)	(11.69)
-7	-6.594	27.76**	42.70**	19.12
	(7.430)	(8.224)	(15.44)	(11.66)
-6	3.140	51.85**	22.24*	18.38
	(9.094)	(9.447)	(10.72)	(11.62)
-5	-11.30	60.90**	34.21*	24.91*
	(8.425)	(9.677)	(15.48)	(11.60)
-4	-2.245	40.42**	55.11**	16.10
	(9.002)	(8.923)	(16.82)	(11.54)
-3	-8.338	64.51**	58.94**	18.00
	(9.569)	(10.55)	(14.73)	(11.50)
-2	3.611	90.91**	90.07**	37.14**
	(8.968)	(10.29)	(18.29)	(11.46)
-1	18.67	204.7**	185.4**	55.96**
	(10.34)	(16.76)	(21.79)	(11.42)
0	-8.864	-45.79**	-43.35**	-37.59**
	(9.030)	(7.549)	(11.64)	(11.35)
1	-4.724	-20.11*	-26.97*	-17.92
	(8.702)	(7.969)	(13.02)	(11.30)
2	1.883	-5.561	-2.852	2.154
	(9.664)	(8.004)	(12.23)	(11.24)
3		-16.93*	1.141	
		(6.963)	(13.21)	
4		-18.19*	-15.96	
		(7.829)	(12.88)	
5		-8.814	1.858	
		(7.400)	(14.20)	
6			-7.622	
			(13.36)	
Optimal bounds (q_L, q_U)	(-16, 2)	(-15, 5)	(-11, 9)	(-9, 2)
Observations	4,483	4,498	4,474	4,481

Note: The dependent variable is quarterly hazard of hysterectomy. The covariates are 5th order polynomial terms of quarterly ages. For brevity, we only present estimates of q between -16 and 6. Robust errors are in parentheses. $^{**}, p < 0.01$; $^{*}, p < 0.05$.

Table A16: Nonparametric estimates $\hat{\rho}_q$ for total oophorectomy: general sample

Quarters to age 45	(1) Uninsured	(2) Labor Insurance	(3) Government Employee Insurance	(4) Farmer Insurance
-7	0.35	-0.95	3.61	3.61
	(1.97)	(1.53)	(3.67)	(4.87)
-6	-1.10	-0.46	-4.46	-0.09
	(2.05)	(2.10)	(2.83)	(4.87)
-5	-0.27	-0.01	-5.26	0.10
	(2.20)	(2.02)	(3.06)	(4.88)
-4	-4.40*	-1.12	-3.38	8.64
	(2.15)	(1.96)	(3.28)	(4.88)
-3	-4.53*	-1.49	-1.53	1.40
	(2.24)	(2.14)	(3.97)	(4.87)
-2	-0.87	0.21	0.30	-1.95
	(2.84)	(2.27)	(4.18)	(4.86)
-1	-4.47	0.27	8.37	0.98
	(2.61)	(2.39)	(5.88)	(4.85)
0	-3.30	4.94	5.97	-5.02
	(3.17)	(3.09)	(4.61)	(4.84)
1	-4.00	-3.95	-6.43	-4.26
	(2.71)	(2.17)	(4.58)	(4.81)
2	-3.86	-2.51	-9.02**	2.03
	(2.70)	(2.50)	(3.34)	(4.78)
3	-0.93	-3.63	-2.43	1.95
	(3.48)	(2.88)	(4.66)	(4.74)
4	-6.13*	-6.10*		-5.43
	(3.05)	(2.48)		(4.71)
5		-4.03		
		(2.88)		
6		-2.92		
		(2.92)		
7		-2.91		
		(3.78)		
Optimal bounds (q_L, q_U)	(-7, 4)	(-7, 7)	(-7, 3)	(-7, 4)
Observations	4,483	4,498	4,474	4,481

Note: The dependent variable is quarterly hazard of total oophorectomy. The covariates are 6th order polynomial terms of quarterly ages. Robust errors are in parentheses. $^{**}, p < 0.01$; $^{*}, p < 0.05$.

Table A17: Nonparametric estimates $\hat{\rho}_q$ for partial oophorectomy: general sample

Quarters to age 45	(1) Uninsured	(2) Labor Insurance	(3) Government Employee Insurance	(4) Farmer Insurance
-13				17.46**
				(4.64)
-12		0.09	-5.59	1.81
		(2.70)	(4.92)	(4.66)
-11	-3.85	0.61	-4.05	-4.72
	(2.65)	(2.57)	(5.45)	(4.66)
-10	2.82	-0.54	-0.50	-0.90
	(2.91)	(2.62)	(4.79)	(4.66)
-9	0.36	2.97	-1.45	-1.80
	(2.56)	(2.85)	(5.24)	(4.66)
-8	-0.93	1.80	-1.16	3.32
	(2.73)	(2.62)	(5.41)	(4.65)
-7	-1.33	-2.08	0.51	-1.69
	(2.58)	(2.49)	(4.65)	(4.64)
-6	-0.77	-1.53	4.94	1.96
	(2.63)	(2.38)	(6.20)	(4.62)
-5	-0.83	3.53	1.19	9.51*
	(2.98)	(2.83)	(5.95)	(4.60)
-4	1.01	1.42	-5.39	2.69
	(2.54)	(2.46)	(4.47)	(4.58)
-3	-0.21	-0.45	1.82	-2.23
	(2.66)	(2.40)	(5.33)	(4.55)
-2	-2.88	2.35	1.43	-7.02
	(2.41)	(2.65)	(5.56)	(4.51)
-1	2.65	2.31	0.30	4.78
	(2.52)	(2.40)	(5.35)	(4.48)
0	-0.08	-0.06	6.93	1.91
	(2.41)	(2.34)	(5.90)	(4.45)
1	-1.58	-0.62	-4.92	3.34
	(2.67)	(2.33)	(4.70)	(4.40)
2	4.03	-2.18	-2.55	-0.14
	(2.63)	(2.47)	(4.92)	(4.37)
3	2.07	0.15	0.53	3.16
	(2.40)	(2.20)	(4.91)	(4.33)
4			-2.88	2.78
			(4.28)	(4.29)
5			1.65	-0.67
			(4.86)	(4.25)
6			7.75	10.37*
			(5.19)	(4.21)
	(2.626)	(2.091)	(4.598)	(4.316)
Optimal bounds (q_L, q_U)	(-11, 3)	(-12, 3)	(-12, 7)	(-12, 7)
Observations	4,483	4,498	4,474	4,481

Note: The dependent variable is quarterly hazard of partial oophorectomy. The covariates are 5th order polynomial terms of quarterly ages. Robust errors are in parentheses. $^{**}, p < 0.01$; $^{*}, p < 0.05$.

Table A18: Nonparametric estimates $\hat{\rho}_q$ for myomectomy: general sample

	(1)	(2)	(3)	(4)
Quarters to age 45	Uninsured	Labor Insurance	Government Employee Insurance	Farmer Insurance
-12	-2.85			13.40*
	(3.34)			(5.23)
-11	2.22			-1.31
	(3.27)			(5.24)
-10	-2.02			5.40
	(3.53)			(5.23)
-9	2.20	3.10		-14.16**
	(3.56)	(3.61)		(5.22)
-8	-3.31	0.72	-9.08	5.47
	(2.80)	(3.18)	(6.51)	(5.21)
-7	1.08	0.23	-1.13	4.78
	(3.08)	(2.97)	(5.64)	(5.17)
-6	2.62	-0.65	2.23	0.21
	(3.29)	(3.47)	(6.91)	(5.14)
-5	4.56	3.78	-10.83	10.85*
	(2.86)	(3.17)	(6.04)	(5.10)
-4	-0.94	2.06	-5.41	-7.83
	(3.11)	(3.42)	(5.56)	(5.05)
-3	-3.51	1.82	2.90	-6.34
	(2.97)	(3.29)	(5.82)	(4.99)
-2	-2.36	-1.69	-0.60	-0.30
	(3.10)	(3.06)	(6.42)	(4.94)
-1	1.25	1.82	3.60	2.54
	(3.55)	(3.35)	(6.15)	(4.88)
0	3.12	5.26	5.03	-1.57
	(3.10)	(3.62)	(6.90)	(4.82)
1	1.67	-4.78	-5.02	-5.71
	(2.75)	(2.82)	(5.45)	(4.76)
2	0.16	1.01	-9.36	-2.86
	(2.74)	(2.78)	(5.22)	(4.70)
3	-3.36	3.22	3.51	-2.53
	(2.49)	(3.07)	(6.22)	(4.64)
4		1.42	-5.22	
		(3.04)	(5.91)	
5		4.31	-0.95	
		(3.24)	(5.55)	
6		-1.62	-0.94	
		(2.70)	(6.67)	
7		3.27	12.37	
		(2.87)	(6.96)	
8		1.00	-0.26	
		(2.81)	(5.65)	
9		-6.24**	10.17	
		(2.40)	(7.07)	
Optimal bounds (q_L, q_U)	(-12, 3)	(-9, 9)	(-8, 9)	(-16, 3)
Observations	4,483	4,498	4,474	4,481

Note: The dependent variable is quarterly hazard of myomectomy. The covariates are 5th order polynomial terms of quarterly ages. For brevity, we only present estimates of q between -12 and 9. Robust errors are in parentheses. $^{**}, p < 0.01$; $^{*}, p < 0.05$.

Table A19: Disaggregated surgical expenditures due to inducement: balanced sample*

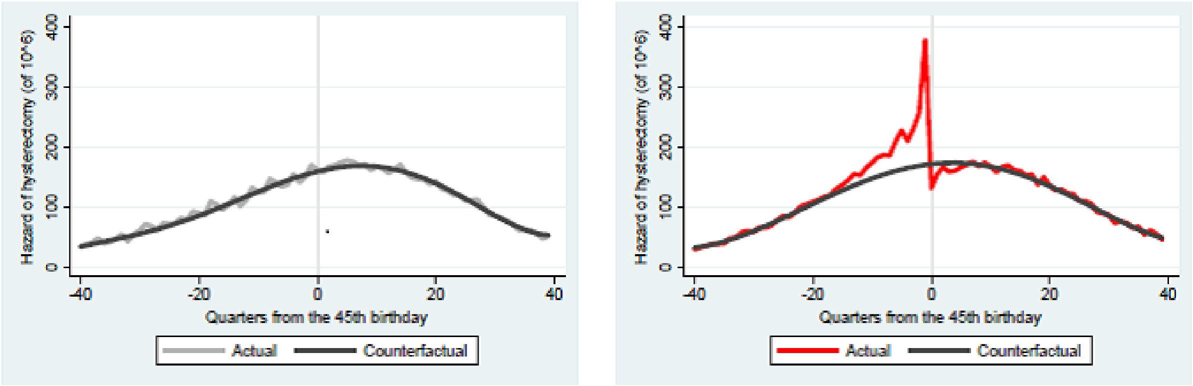
Reimbursement of surgery type by teaching status (Unit: NT$)	Total Hysetectomy			Subtotal Hysetectomy			Laparoscopic hysterectomy		
	Major Teaching	Minor Teaching	Community	Major Teaching	Minor Teaching	Community	Major Teaching	Minor Teaching	Community
	44,332	42,412	41,055	40,334	38,414	37,057	63,260	61,510	60,305
Government Insurance	831	436	138	61	73	28	713	352	108
Labor Insurance	4,077	2,379	913	262	326	165	3,653	2,415	756
Farmer Insurance	502	553	200	24	35	22	646	802	189
	5,410	1,911	1,251	347	434	215	118	3,569	1,053

*We use the reimbursement rates of nine surgeries in year 2005.

Appendix B

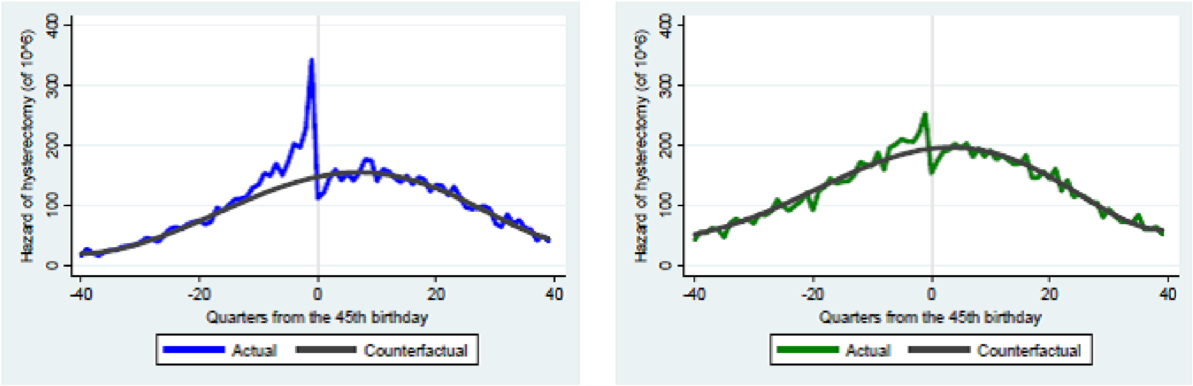
In each panel, the black curve plots the counterfactual hazard distribution; the grey or colored curves are the actual hazard distributions. The counterfactual is constructed by fitting a fifth-order polynomial (except sixth-order for total oophorectomy) of quarterly ages on hazard data outside the lower threshold q_L and the upper threshold q_U. The values of q_L and q_U are selected by a grid search over the ranges of $q_L \in [-18, -9]$ and $q_U \in [2, 12]$ to minimize the root mean squared error (RMSE) of the regression.

Figure B1: Actual and counterfactual hysterectomy hazards



(A) Uninsured

(B) Labor Insurance



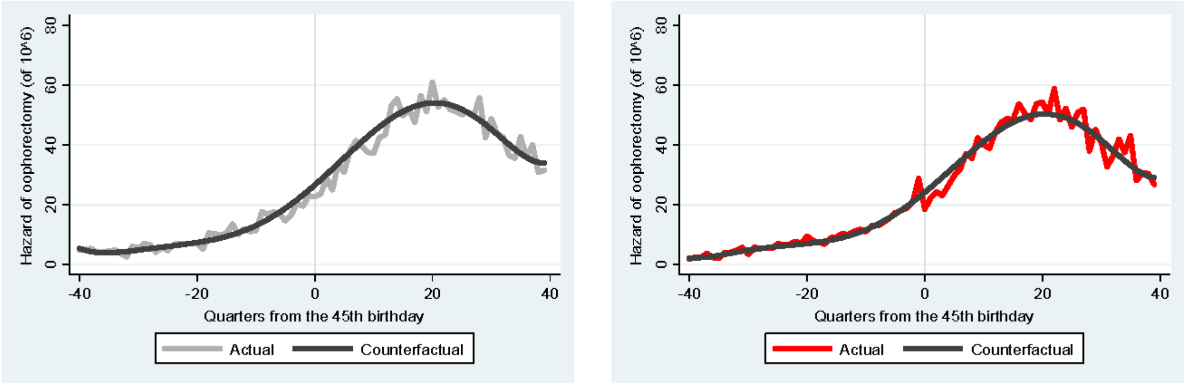
(C) Government Employee Insurance

(D) Farmer Insurance

Figure B2: Actual and counterfactual oophorectomy hazards

(A) Uninsured

(B) Labor Insurance enrollees



(C) Government Employee Insurance enrollees

(D) Farmer Insurance enrollees

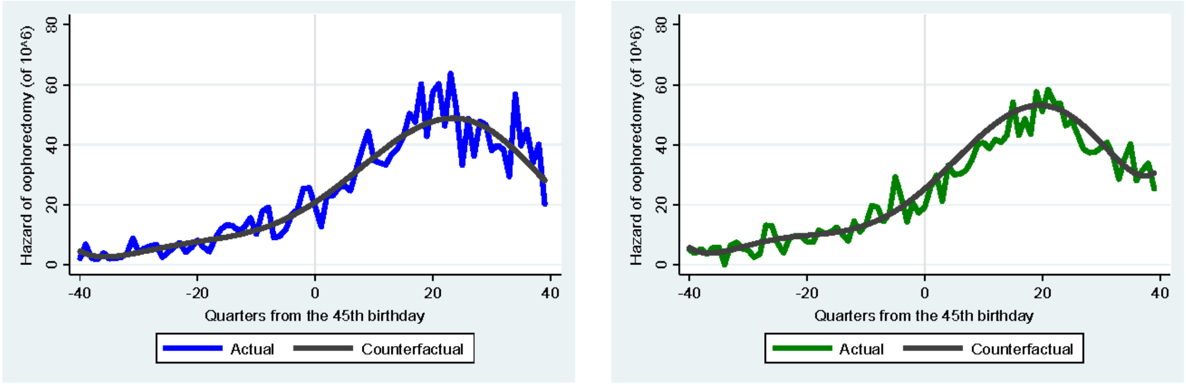


Figure B3: Actual and counterfactual partial oophorectomy hazards

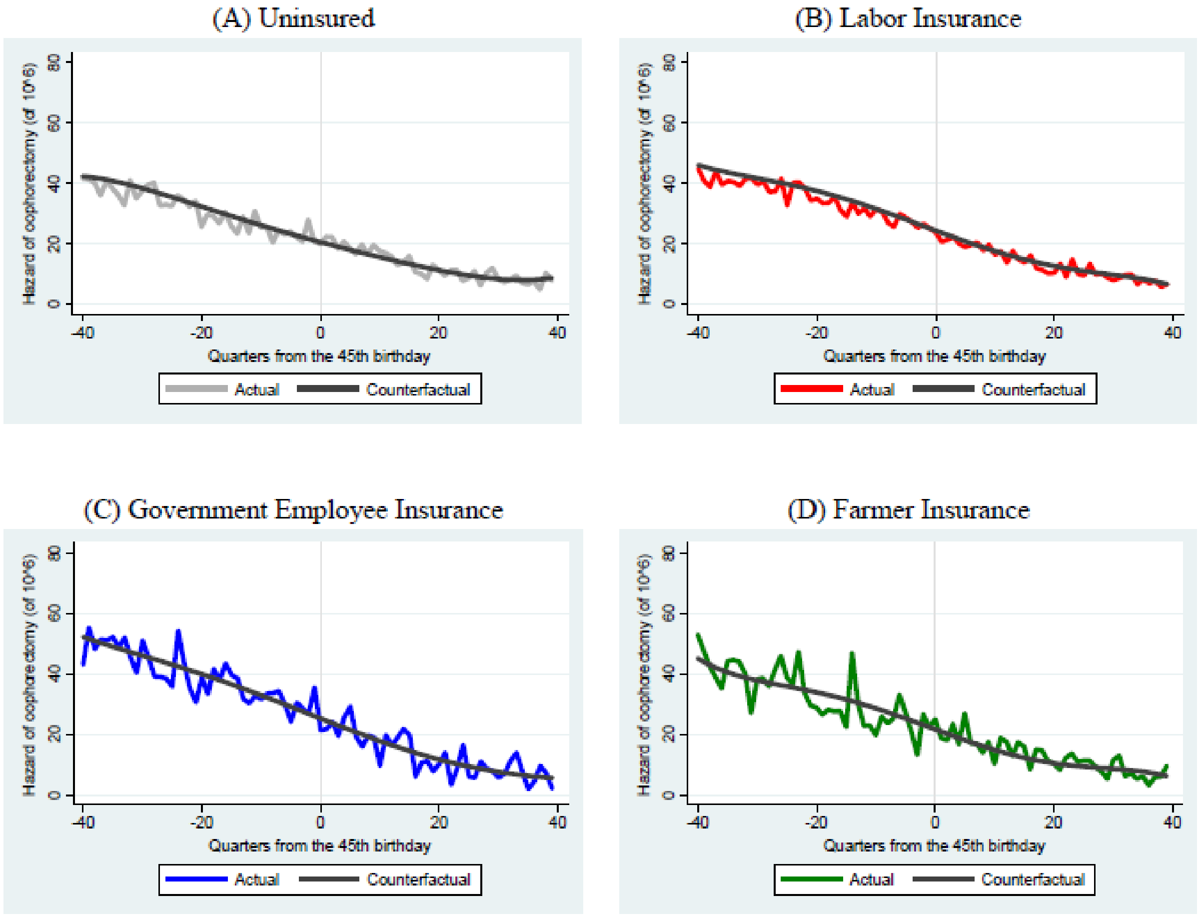
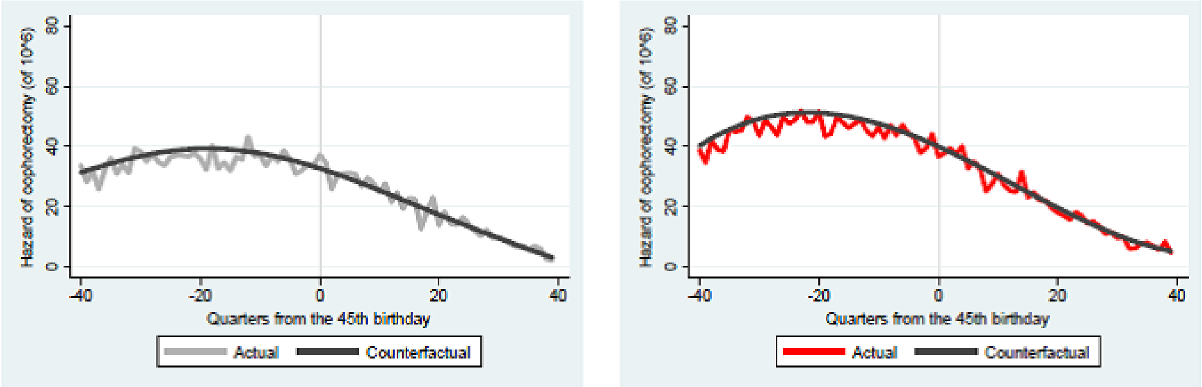


Figure B4: Actual and counterfactual myomectomy hazards

(A) Uninsured

(B) Labor Insurance



(C) Government Employee Insurance

(D) Farmer Insurance