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健康資本與產前檢查:以 SARS 對孕婦影響為例(第 2 年)

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中文摘要： 為了保障孕婦和胎兒健康，健保每年花費約十億，提供每位孕婦十次免費產前檢查。雖說過去研究均證實產前檢查能提升胎兒健康，但因產檢時間和數目均為內生決定，免費產檢成效仍為一個待回答的研究議題。本研究主要分析產檢和對產婦和嬰兒健康間的因果關係。為克服產檢的內生性，我們利用台灣於 2003 年所發生嚴重急性呼吸道疾病(即 SARS)疫情。基於 SARS 的不確定性，許多產婦被迫放棄或延後產檢，造成孕婦平均產檢數目由 2002 年的 9.5 次下降至 2004 年的 8.1 次，這個外生衝擊所產檢數目下降，提供了一個研究產檢對胎兒健康的機會。我們結果顯示產檢次數增加會減少早產機率，減少生產複雜性，但增加了剖腹產機率。

中文關鍵詞： 產前檢查，非典型肺炎，健康資本

英文摘要： In spite that number studies have shown the positive association between prenatal care and better birth outcomes, there is still scarce literature identifying the causal effect of prenatal care on birth outcomes. On the one hand, women who anticipate a poor birth outcome may be more likely to have prenatal care. On the other hand, women with a propensity to engage in a variety of healthy behaviors may be more likely to have prenatal care. In either case, the self-selected maternal care posits a challenge to identify the contribution of prenatal care on health outcome. In this study, we investigate the impact of prenatal visits on birth outcomes using the 2003 SARS epidemic in Taiwan as a source of exogenous variation on prenatal care. Our data are obtained from the NHID containing the complete outpatient records of prenatal visits. Our measures of birth outcomes include the incidence of cesarean section, preterm birth, preventable complications and obstetric trauma during delivery. Our first-stage estimates demonstrate that women pregnant at the time of the epidemic experienced a drastic decline in the prenatal care, approximately 1.8 (or 20%) out of the average 9.2 maternal visits. More importantly, the decline of maternity visits exhibits obvious geographic variations, indicating the presence of peer effect across areas. Using the average number of prenatal visits at the same hospitals as instrument, our IV results suggest that prenatal care visits significantly reduce the probability of having a preterm birth and the probability of having a birth complication as well as that of low birth weight, but increase the incidence of cesarean section.

英文關鍵詞： SARS，prenatal care, health capital

The Benefits of Prenatal Care: Evidence from the SARS Epidemic in Taiwan

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I. Introduction

As health expenditures continue to grow across the globe, understanding the productivity of health care plays a crucial role in allocating the scarce resources efficiently and effectively. However, to causally identify the productivity of medical care is challenging because patients' underlying health conditions are correlated with both medical inputs and ultimate health outcomes. The main innovation of this paper is to exploit the variation in medical inputs generated by an unpredicted infection epidemic that permits causal estimation of the marginal returns to medical care. Specifically, we use the SARS outbreak in 2002-2003 as a natural experiment to estimate the benefits of prenatal care in Taiwan.

Severe acute respiratory syndrome (SARS), caused by a novel virus belonging to the family *Coronaviridae* (SCoV, SARS-associated coronavirus), is the first severe and readily transmissible new disease emerging in the 21st century.[1,2] From its emergence in mid-November 2002 in China to its retreat in early-July 2003, SARS has resulted in more than 8,000 probable cases and nearly 800 deaths in more than 30 countries through airline routes in the globe (WHO, 2003a). Although the ultimate health impacts of SARS were not as substantial as initially feared, it caused widespread social disruption and economic losses. Schools, hospitals, and some borders were closed and public places such as

[1] SARS can spread by (1) droplet transmission when people are in close proximity (generally up to 3 feet) and virus travel on relatively large respiratory droplets from the sneeze, cough, drip or exhale; (2) direct contact with inanimate objects that carry SCoV (formites) and possibly (3) airborne virus. Source, CDC, 2004.

[2] SARS symptoms usually start off with a high fever (> 100.4°F), headaches, chills, myalgia, extreme fatigue, malaise, and diarrhea (10-20% of patients). From 3 to 7 days after exposure, respiratory symptoms develop as virus travels to the airways and lungs. Patients may experience dry and non-productive cough, hypoxia (gradual fall in blood-oxygen levels) and eventually develop pneumonia. Some patients (10-20%) may require mechanical ventilation to assist or replace spontaneous breathing. Source: CDC, 2004.

restaurants and shopping malls were empty. Thousands of people were placed in quarantine. Airlines were forced to cut 50-70% of the capacity to affected areas. People took heightened precautionary actions, such as wearing surgical masks, administering indigenous medicine and avoiding public transportation and congregation. Public panic was further exacerbated by psychological ripple effects.

How people respond to new epidemic depends on their risk perception that is influenced by factors such as perceived susceptibility, severity and understanding. The public perception about the threat of SARS to Taiwan in 2003 was 4.1 on a scale from 0 (no threat) to 5 (severe risk) with the perceived high case fatality as the primary concern (Liu et al., 2005). The relatively high risk perception explains abovementioned precautionary actions. Together with abundant but not necessarily perfect information transmitted instantaneously through modern communication technologies (Smith, 2006), individual precautionary actions may trigger widespread community responses. When information is not perfect, people respond to new threats through social learning, a process in which decision makers collect information by observing others in their social network.[3]

Based on the idea of social learning about SARS, we use the average number of prenatal visits in a relevant social network as the instrumental variable for the index mother's prenatal visit. Because the learning effects are stronger when people are at close proximity or have similar demographic backgrounds, we define a social group as those

[3] Social learning has been studied widely in a variety of contexts including, but not limited to, employer- sponsored health plan choices (Sorensen, 2006), retirement plan choices (Duflo and Saez, 2003), welfare program participation (Bertrand, Luttmer, and Mullainathan, 2000), health care utilization in Milan (Devillanova, 2008), consumption of movies (Moretti, 2008), and other examples, such as crime and labor market outcomes, which are cited in those studies.

who are at the same age, delivered in the same year and live in the same town as the index mother.

Examining the causal benefits of prenatal care has important policy implications as reducing neonatal mortality being an important goal of public health worldwide.[4] Low birth weight (LBW) is a predominant factor in the majority of the neonatal deaths. Moreover, LBW infants, if survived, are also more likely to have subsequent health problems, learning difficulties, and behavioral and psychological problems spanning from early childhood, adolescence to adulthood. Thus, early intervention to prevent low birth weight is of substantial public health relevance.

Prenatal care is a type of preventive care during pregnancy that includes regular screening and monitoring, education and intervention and vaccination and other prophylaxis. Our results suggest that prenatal care visits have important effects on birth outcomes.

II. Background for SARS Outbreak

a. Overview

The first SARS case, susceptibly due to zoonotic pathogens and retrospectively identified on November 16, emerged in the southern Chinese province of Guangdong in 2002. While additional cases occurred in other cities in the province, it was not until February 10, 2003 that the Chinese government officially reported to WHO that there had been an outbreak of acute respiratory syndrome involving 305 cases and 5 deaths (WHO, 2003b). On February 21, the first case outside China was reported, when a medical doctor who had treated patients in Guangdong and became ill in Hong Kong. This case turned

[4] Reducing child mortality (under age of five) by two thirds by 2015 is one of eight United Nations Millennium Development Goals.

out to be a superspreader that contributed greatly to the cross-border spread of the epidemic when twelve people staying on the same floor as this medical doctor in the Metropole Hotel in Hong Kong contracted SCoV. These twelve hotel guests subsequently carried the virus with them to advance the spread of the epidemic to Canada, Vietnam, Singapore and Hong Kong itself. According to WHO estimates, most of the probable SARS cases worldwide originated with this superspreader (WHO, 2003a).

On March 12, WHO issued the first global alert describing outbreaks of the yet-unnamed respiratory disease in Hong Kong and Vietnam and instituted worldwide surveillance (Knobler, et al. 2004). SARS was named and first travel advisory was declared in the second WHO global alert on March 15. The complete timeline is summarized in Table A1.

b. SARS in Taiwan

Despite having extensive business interactions with China and Hong-Kong, there were only sporadic SARS cases among business travelers reported in Taiwan in March and early April, largely due to rigorous port entry screening and success of early patient isolation, contact tracing and quarantine after the first case was reported on March 14, 2003. On April 22, a new cluster of seven infections in a major municipal hospital in Taipei was reported, initiating the spread of virus to other hospitals and communities that cumulated in 137 probable cases and 26 deaths in a month (CDC, 2003). The SARS outbreak was ignited by an unrecognized SCoV carrier who was a laundry worker at this hospital. To contain the explosive outbreak, more than 1,000 persons, including patients, staff, and visitors were quarantined in the hospital. Health authorities responded to this outbreak quickly by tightening surveillance, strengthening infection control measures, and launching a mass education campaign. As of May 22, a total of 483 probable cases had been reported (Figure 1), including 71% cases were from Taipei City and Taipei County. On July 5, Taiwan was removed from the WHO list of affected areas. The key dates of SARS in Taiwan are summarized in Figure 2. Based on the timeline, we define SARS period in Taiwan as from March 14, 2003 to July 5, 2003.

c. Impacts of SARS

SARS has a considerable economic impact on this highly connected and interdependent world. It is estimated that the potential economic losses of SARS for the world economy as a whole are about US$ 40 billion (World Bank, 2012; Lee and McKibbin, 2004). The unanticipated emergence of new virus, unpredictable but speedy outbreak, limited information about the disease and its control at that time and related containment strategies also exert a significant psychological impact on health care workers and the community at large (Nickell et al., 2004; Maunder et al., 2003). Comparing with other known microbial infection, such as influenza, SCoV has a relatively low transmission rate and is associated with a low number of death. However, SARS had a remarkably psychological impact on many societies worldwide. A Lexis Nexis Academic newspaper search of the phrase 'SARS fears' in 2003 results in about 840 articles (in English). Many newspaper headlines are illustrative for a global panic. For example, Business Times Singapore (April 5, 2003) wrote *"Weekend Trivia: To go, or not to go, that is the question. Go out, that is. With SARS hogging the headlines and threatening the very air we breathe, how are we to get through the daily grindstone that is life?"*

In addition to the health fears of SARS with an unknown cause and high case fatality rate, information and control measures also contribute to an unprecedented public panic. First, modern information technology, such as cellphone and internet, has facilitated instantaneous and borderless dissemination of information as well as false rumors.[5] How people change behaviors in an uncertain environment depends crucially on how the information changes their risk perceptions. When information is abundant but imperfect, people may form their risk perceptions through social learning which leads to herd behavior (Banerjee, 1992) or information cascade (Bikhchandani, Hirshleifer and Welch, 1992) that amplified public fears.

Second, "Middle Age" infection control techniques such as quarantine and isolation were key methods employed to control the spread of SARS. Public anxiety is further exacerbated by the fear of being stigmatized, marginalized or penalized by health authorities.

III. National Health Insurance and Prenatal Care

a. NHI and Prenatal Care

In March 1995, National Health Insurance (NHI), a single-payer system, was introduced to the entire population, about 22 million people, in Taiwan. Before its inception, health insurance was primarily provided through various social insurance programs that covered 12.3 million or 57% of the total population in 1994.[6] Since nearly

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[5] For example, according to Pomfret (2003), the SMS text message *"There is a fatal flu in Guangzhou"* was sent 126 million times from February 8 to 10 in Guangzhou city alone. According to Eysenbach (2003), as of June 30, 2003, PubMed lists 881 articles containing the key words "severe acute respiratory syndrome" or "SARS"; however, Google finds 358,000 pages in English with the phrase "severe acute respiratory syndrome" alone.

[6] Three social insurance programs include Labor Insurance for employees in the private sector, Government Employee Insurance for workers in the public sector, and Farmer Insurance for farmers. For details on health insurance provided by various social insurance programs prior to

half of the total population was still uninsured, of which the majority were children under fourteen or the elderly over sixty-five, universal health insurance was first discussed in 1992 and finally implemented in 1995. By the end of 1995, the insured rate jumped to 92%, and the rate has stayed above 97% since 1997. The NHI provides coverage for most medical services, including acute care, prescription drugs, dental care, and traditional Chinese medical care. Co-pays exist but are low,[7] and patients may seek care from virtually any of the clinics or hospitals under contract to the NHI.

For pregnant women, NHI provides coverage for ten prenatal care visits (see Table A2). There are two visits during the first trimester (week 0-16), two visits during the second trimester (week 17-28) and six visits during the third trimester (week 29-40). At the first visit (some time before week 12), pregnant woman's medical history and issues related to behavior and lifestyle (i.e. tobacco, alcohol and substance use) will be collected and discussed. Tests and screenings include regular urine tests, regular blood tests, blood type, Rh factor, VDRL (syphilis screening), Rubella immunity, and AIDS screening test.

In addition to the regular checkup (see details in Table A2) at each visit, an ultrasound examination will be given around the 20th week of pregnancy (3rd visit) and screening tests for hepatitis B, rubella and syphilis will be given around the 32th week of pregnancy (5th visit). The maternal serum screening, a blood test, to detect the risk of Down syndrome or neural tube defects will be given around the week 16-21. The gestational diabetes screening, also a blood test, will be performed around the week of

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national health insurance, see Chou et. al. (2003).

[7] For example, outpatients pay approximately $5 for visits to clinics and $8 for visits to hospitals, while inpatients pay 10% of the cost of their care, but with a maximum payment of 10% of the average national income per person. Further, indigenous people (about 2% of the population) qualify for exemption from all cost sharing (Department of Health, Taiwan).

24-28.

b. Literature Review on Benefits of Prenatal Care

There is a myriad literature examining the benefits of prenatal care in terms of improvement on birth outcomes. However, most existing literature using cross-section variations of prenatal care visits finds mixed results. To cite some examples, Fiscella (1995) conducted a critical review of published studies with the MEDLINE database 1966-1994, and concluded that although there was no conclusive evidence that prenatal care improved birth outcomes, policy makers must consider these findings in the context of prenatal care's overall benefits and potential cost-effectiveness. He also suggested that those studies may lack statistical power to detect cost-effectiveness of reduction in low birth weight. Krueger and Scholl (2000) studied 1771 patients enrolled in an ongoing study of maternal growth in young gravidas and confirmed that inadequate prenatal care, measured by both the Kessner index and the Kotelchuck index, was associated with higher incidence of preterm birth. Debiec et al. (2010) utilized a random sample of women under age 20 in Washington State from 1995-2006 and found similar results.

Partridge et al. (2012) conducted a retrospective analysis to evaluate the association between utilization of prenatal care and fetal/neonatal mortality using 28,729,765 births from 1995 to 2002 in US with the Center for Disease Control and Prevention's Linked Birth-Infant Death and Fetal Death data. They found that reduction of prenatal care was associated with higher likelihood of preterm birth, still births, early/late neonatal death and infant death.

The inconclusive evidence derived from cross-sectional studies with regard to the benefits of prenatal care is probably not surprising. On one hand, pregnant women who are more precautious are more likely to abide to the prenatal care guidelines and have healthier life style that lead to positive selection. On the other hand, pregnant women who expect to have worse birth outcomes will have more prenatal care visits that lead to usual negative selection when evaluating the productivity of medical care.

Evans and Lien (2005) is the only study that we are aware of that also uses a natural experiment to form the identification strategy. They used the 1992 Port Authority Transit strike in the Allegheny County in PA as an exogenous shock to identify the impact of prenatal visits on birth outcomes. They found that prenatal care visits decreased among black-inner city pregnant women, but only suggestive evidence that reducing prenatal care visits may adversely affect birth outcomes.

IV. Data and Sample

a. Data and Sample

The data are from four sources: (1) the National Health Insurance Database, administrated by the National Health Research Institutes (NHRI), that covers health care utilization by all NHI enrollees in Taiwan; (2) hospital basic files, also administered by the NHRI; (3) annual birth certificates and (4) annual death certificates, administered by the Department of Health. Our principal data are derived from the longitudinal inpatient and outpatient claims of 20 million people between 2001 and 2006 in Taiwan. Each inpatient and outpatient record includes information about a patient's diagnosis codes, DRG codes, admission and discharge dates, as well as a unique but scrambled identifier that allows us to link the patient's inpatient and outpatient records over time.

We selected all cases of vaginal birth or Cesarean section in the inpatient data from November 1, 2001 to 2006 based on DRG codes, giving us a sample of pregnant women. Starting from November 1, 2001 allows us enough data to trace back prenatal visits for 40 weeks prior to the delivery. We then link a pregnant woman's ID to her outpatient records to identify her prenatal care visits based on ICD9 codes as well as a variable indicating free visits. We eliminate women who had less than three free visits to exclude records such as ectopic or molar pregnancies, pregnancies with abortive outcomes, and pregnancies with intrauterine death.

We then link the sample of pregnant women with birth certificates using scrambled mothers' ID. In addition to birthweight (reported in grams) and gestational age (calculated from the date of the last menstrual period and reported in completed weeks), we also obtain maternal age, mother's schooling and father's schooling from the birth certificates. Using unique personal ID, we match birth files to death certificates that contain date of death to identify one month and three month mortality.

Finally, we eliminated all women who had gave birth to multiple children in one delivery, as well as those younger than 15 or order than 45. We also eliminated women who gave birth outside the mainland (Kinmen and Mazu) and who were foreign brides. Our final sample consists of 849,325 unique births from November 1, 2001 to December 31, 2006. We also use a post-SARS sample consisting of 404,166 unique births from May 1, 2004 to December 31, 2006. This sample only includes births that were not exposed to SARS during gestation.

a. Outcomes and Sample Statistics

We consider the following outcomes to examine the benefits of prenatal care: the incidences of preterm delivery, having a low birth weight infant, a very low birth weight infant, an infant died within 1 month after delivery, an infant died within three months after delivery and any preventable complication during delivery. Summary statistics of outcome variables for whole and post-SARS samples are in Table 1.

Preterm births include infants born before 37 weeks gestation. Low birth weight (LBW) is defined as birth weight < 2500 grams, and very low birth weight (VLBW) is defined as birth weight < 1500 grams. Preventable complications are complications, such as prolonged labor or excessive bleeding, which in many cases may be avoided with better care (Currie & MacLeod, 2008).[8] We also include one month and three month mortality rates of newborns as outcomes. The outcomes are very similar for both samples: about 18% are pre-term births, 5% are low birth weight infants, 0.2% are very low birth weight infants, 0.1% infants died within one month after delivery and 0.2% infants died within three months after delivery. About 15% of mothers experiences at least one preventable birth complication.

Low birth weight, suggested by substantive studies, is associated with higher risks of perinatal, neonatal and post-neonatal mortality and childhood morbidities such as cerebral palsy, hearing and visual impairments and other neurosensory, behavioral or learning difficulties. Small thin babies are also more susceptible to a wide spectrum of chronic diseases in adult life, such as hypertension, ischemic heart disease, stroke,

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[8] Preventable complications are: maternal fever, excessive bleeding, maternal seizure, precipitous labor, prolonged labor, dysfunction labor, anesthetic complications, fetal distress, rupture of the uterus during labor, and choriamnionitis (an inflammation of fetal membranes most often occurring with prolonged labor).

metabolic syndrome, diabetes, malignancies, osteoarthritis and dementia, and to adverse long-term outcomes in terms of educational attainment and earnings. Obviously, infants born at low birth weight not only impose substantial costs on family but also on society.

V. Empirical Specification

a. Empirical Setup

Our main specification is

$$Outcome_{ijkt} = \alpha PC_{ijkt} + \beta_1 X_{ijkt} + \beta_2 H_{jt} + \eta_k + \eta_k \times \tau_t + \varepsilon_{ijkt}, \quad (1)$$

where $Outcome_{ijkt}$ is the birth outcome for patient i, who delivers in hospital j in NHI region k in year t, η_k and τ_t are fixed effects for the NHI region (Taipei, Northern Area, Middle Area, Southern Area, Gao-Pin Area and Eastern Area) where the patient delivers and for the year of delivery (2001-2006). PC_{ijkt} measures the prenatal care visits. X_{ijkt} represents variables we include to control for characteristics of a mother that might affect her prenatal care visits as well as birth outcomes. These include gender of infant, five maternal age dummies (20-25, 25-30, 30-35, 35-40, and 40+) and mother's and father's three education dummies (high school, college and beyond college). We also include three dummies indicating whether a mother experiences SARS (3/14/2003 – 7/5/2003) in the first, second or third trimester of pregnancy[9] to capture unobserved maternal stress caused by SARS during pregnancy. To measure mother's unobserved health conditions, we include dummies indicating whether a mother has at least one non-preventable complication, that is, a birth complication unlikely to have been caused by a doctor at the

[9] We use the same definitions as NHI pregnant women handbook: the first trimester is defined as week 0 to week 16, the second trimester is defined as week 17 to week 28 and the third trimester is defined as week 29 to week 40.

time of delivery,[10] or at least one pre-existing condition, defined as conditions that are not directly caused by pregnancy but that may affect the delivery outcomes[11], or whether the delivery is a C-section. Finally, H_{jt} is a set of variables included to control for the possible effects of hospital characteristics on patient outcomes. These variables include ownership dummies (nonprofit and for-profit) and teach status (major teaching, minor teaching and community). Sample statistics of explanatory variables for whole and post samples are in Table 1.

If equation (1) is obtained by ordinary least squares, the coefficient α is likely to be inconsistent because error term may be correlated with both outcomes and prenatal care visits. On one hand, those who are more risk averse are more likely to abide the guideline for prenatal visits and have healthier behaviors that are associated with better birth outcomes. On the other hand, those who expect to have poor birth outcomes will have more prenatal visits. In the former case, the benefit of prenatal visits is overestimated, and in the second case, it is underestimated.

To identify causal effects of prenatal care birth outcomes, we employ the 2002-2003 SARS epidemic to form instruments for prenatal care. When information is not perfect, people may react to new epidemic through social learning (Bennett, Chiang and

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[10] Non-preventable complications are: a breech delivery, cephalopelvic disproportion (the baby's head is too big for the mother's pelvis), cord prolapse (the umbilical cord is delivered prior to the baby), placenta previa (the placenta is implanted too close to the cervical opening), abruption placenta (a premature separation of the placenta from the uterus), and a premature rupture of membranes.

[11] Pre-existing conditions are: anemia, herpes, eclampsia, incompetent cervix, Rhesus (anti-D) iso- immunization, uterine bleeding, hypertensive disorder, oligohydramnios, abnormality of vagina (congenItal or acquired), diabetes mellitus/abnormal glucose tolerance, and habitual aborter.

Malani, 2011). We use the average number of prenatal care visits in the relevant social group as an instrumental variable and estimate the first-stage equation as follows:

$$PC_{ijkt} = \gamma\overline{PC}_{-ijkt} + b_1 X_{ijkt} + b_2 H_{jt} + \eta_k + \eta_k \times \tau_t + \epsilon_{ijkt}, \quad (1)$$

where PC_{ijkt} is the total prenatal care visits for patient i, who delivers in hospital j in NHI region k in year t, η_k and τ_t are fixed effects for the NHI region where the patient delivers and for the year of delivery.

$\overline{PC}_{-ijkt}$ represents our instrumental variable. We define the social group for pregnant woman *i* as those pregnant women who were at the same age, delivered in the same year and lived in the same town.[12] We then calculate the average number of prenatal visits within each social group to form the instrumental variable. Thus, γ is capturing the social learning effect. Finally, we estimate equation (1) by 2SLS, with standard errors clustered at the age and town level.

b. Graphical Evidence

Figure 3 shows the average number of prenatal visits from 2001-2006. The average number of visits before November 16, 2002 was about 9.3. The size of reduction (from the level prior to SARS to the bottom of the dip) is about 2 visits (roughly 20%) of the average number of prenatal visits. The number remained low even after Taiwan was removed from the SARS-affected areas (July 2013). It takes more than 2 years after July 2013 for the number of prenatal visits to rebound to the level prior to SARS.

[12] There are 359 towns in Taiwan. In the whole sample (2001-2006), there are 165 unique towns. In theory, our definition of social group will give us 165 (towns)×31 (ages)×6 (years) =30,690 cells. However, if a cell only contains one mother, this observation will be dropped, because we will not be able to generate a value for the instrumental variable. We have 19,935 unique social groups at the end.

Figure 4 shows the average number of prenatal visits by NHI region. The general trend is similar to Figure 3, except the trend in the East Region. Despite the fact that the majority of SARS cases were reported in Taipei Area, the decreases of prenatal care visits were observed in all regions in the west coast. This figure suggests that psychological ripple effects spread rapidly even without the actual infection. This figure also suggests that we cannot use the SARS cases for the identification.

Instead, we exploit the variation of average prenatal visits at the same age group as the instrumental variable. For the purpose of exposition, Figure 5 shows the trend of prenatal visits by six age groups, not by each age. Overall the patterns are similar to Figure 3 for all age groups. This has two important implications to support our IV strategy. First, it suggests that the major source of our variation comes from the exogenous shock of SARS for all age groups. We do not rely on the limit variations across age groups. Second, the variations across age groups do not change significantly over time. It suggests that unobserved factors due to SARS, such as maternal stress or precautionary behaviors that also affect birth outcomes, do not systematically affect a particular age group.

VI. Results

a. Main Results

Table 2 shows the results of number of total prenatal visits on birth outcomes. Using OLS (top panel), total number of prenatal visits is associated with lower incidence of preterm birth, low birth weight, very low birth weight, one month and three month mortality rates. The IV results as well as the first stage results are shown on the top panel of Table 2. All results are statistically significant at the 1% level. As mentioned above, OLS is likely to yield biased results due to selection. Using IV estimations (bottom panel), our results suggest that total number of prenatal visits significantly lowers the incidence of low birth weight and very low birth weight at the 1% level and lowers the 1 month and 3 month mortality rates at the 5% level. The estimate on preterm is negative but is not statistically significant. While the signs are the same under both OLS and IV estimations, the magnitudes are 3-6 times smaller and less significant under IV estimations. The IV results suggest that the OLS estimates tend to overestimate the benefits of prenatal care in terms of improving birth outcomes.

The less significant IV results are not due to the problem of weak instrumental variables, because we have a very strong first stage results (column 1 of Table 2). The magnitude of coefficients also indicates a strong ripple effect. The index woman will increase roughly 0.8 visits if the average number of visits of her social group increases by one. The F-ratio is above the critical value of 10 (Cameron and Trivedi, 2005).

b. Unobserved Confounding Factors

One confounding factor that may drive our results is the effect of maternal stress and anxiety due to SARS epidemic and/or precautionary behaviors during epidemic. Stress and anxiety may trigger the release of stress hormones and lead to fetal overexposure to the cortisol and adrenaline. Maternal stress and anxiety may also cause changes in the blood flow to the fetus, making it difficult to supply oxygen and nutrients to the fetal growth and development. Nevertheless, during SARS epidemic, pregnant women may take extra precaution to maintain healthy pregnancy. Maternal stress and precautionary behaviors may affect both our instrumental variables and birth outcomes. Thus, the first unobserved factor (maternal stress) may lead us to overestimate the benefits of prenatal care, and the second unobserved factor (precautionary behaviors) may lead us to underestimate them.

While we cannot completely rule out the possibility that our results are driven by those unobserved confounders, we provide extra analyses to show that prenatal visits do in fact improve birth outcomes. First, in addition to three dummies indicating whether a mother experiences SARS during first, second or third trimester, we include interactions between these three dummies and maternal characteristics (3 education dummies or 5 age group dummies). Table 3 shows that our estimates are not affected by the inclusions of additional interactions, suggesting that there is no systematic bias due to differential responses by observable characteristics.

Second, we run the same regressions using only the post-SARS sample (2004-2006). While maternal stress or precautionary actions may continue after the end of SARS epidemic, the reactions should diminish afterwards. If our results are totally driven by unobserved factors during SARS, estimates should differ using the post sample. However, we find that results are similar (Table 4) using either whole sample or post-SARS sample.

c. Different Measures of Prenatal Care

To test the robustness of our results, we also experiment with two different measures of prenatal care: Kessner's Adequacy of Prenatal Care index (Kessner et al., 1973) and a binary variable indicating whether the total number of visits is at least ten times. Based on the timing of the first prenatal visit and total number of visits, the Kessner's Index groups the prenatal visits into three categories: adequate, intermediate, and inadequate. We define a dummy indicating whether the prenatal visits are adequate based on the Kessner's Index. In these two analyses, the instrumental variables will be the percentage of pregnant women who have adequate prenatal visits or who have at least ten prenatal visits. Our results (Table 5) suggest that having adequate prenatal visits is significantly associated with better birth outcomes in terms of lower incidences of birth complication, low birth weight and very low birth weight. Having recommended numbers of prenatal visits is further associated with lower one month and three mortality rates.

VII. Conclusions

In this paper, we use the variation of prenatal care visits within a given social group generated by the 2003 SARS epidemic to examine the impact of prenatal care on birth outcomes. Combining several administrative data from Taiwan, our first stage results show that the contagion effects are strong during SARS epidemic. Our IV results also show that prenatal care visits play important roles in lowering the probability of having birth complication, incidences of low birth weight and very low birth weight and one month and three month mortality rates.

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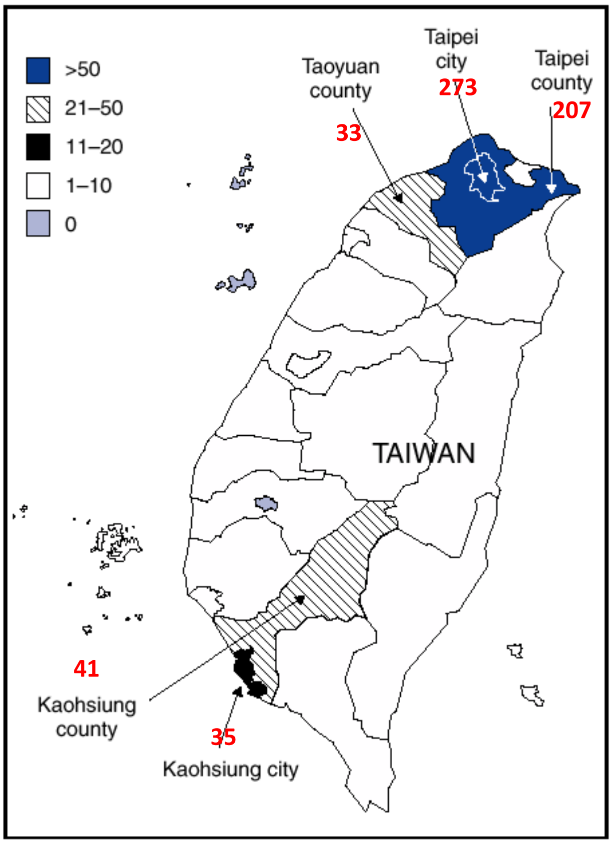
Figure 1: Geographic Distribution of Probable Case of SARS in Taiwan



N= 483. As of May 22.
Source: Severe Acute Respiratory Syndrome --- Taiwan, 2003, CDC MMWR, May 23, 2003, 52(20); 461-466.
Accessed from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5220a1.html

Figure 2: Important SARS Timeline in Taiwan

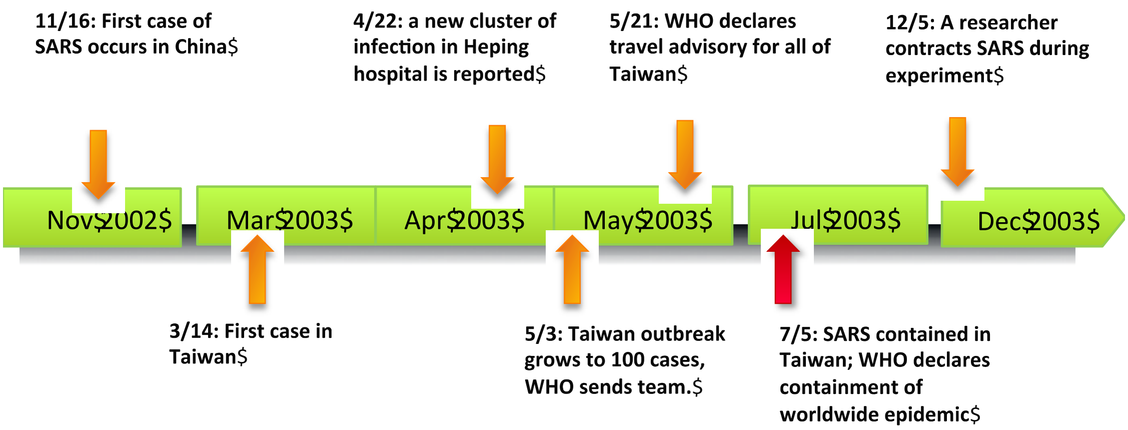


Figure 3: Average Number of Prenatal Visits (2001-2006)

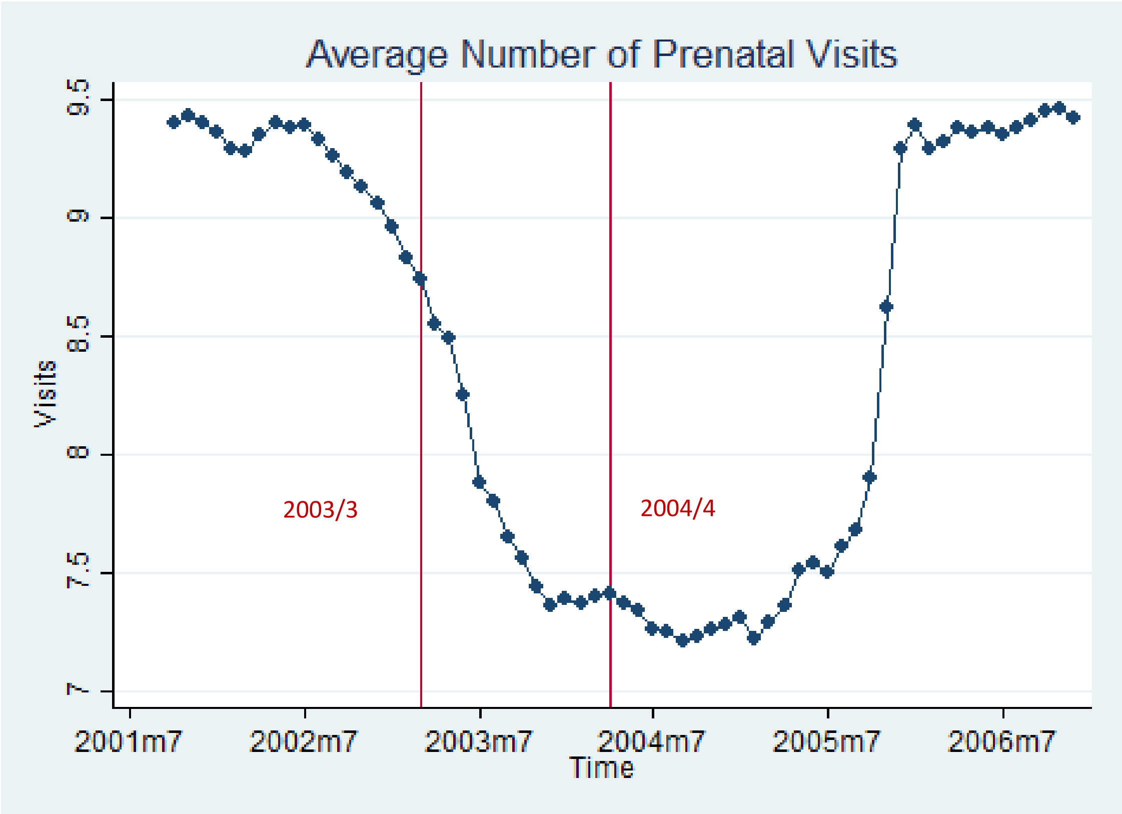


Figure 4: Average Number of Prenatal Care Visits by NHI Region

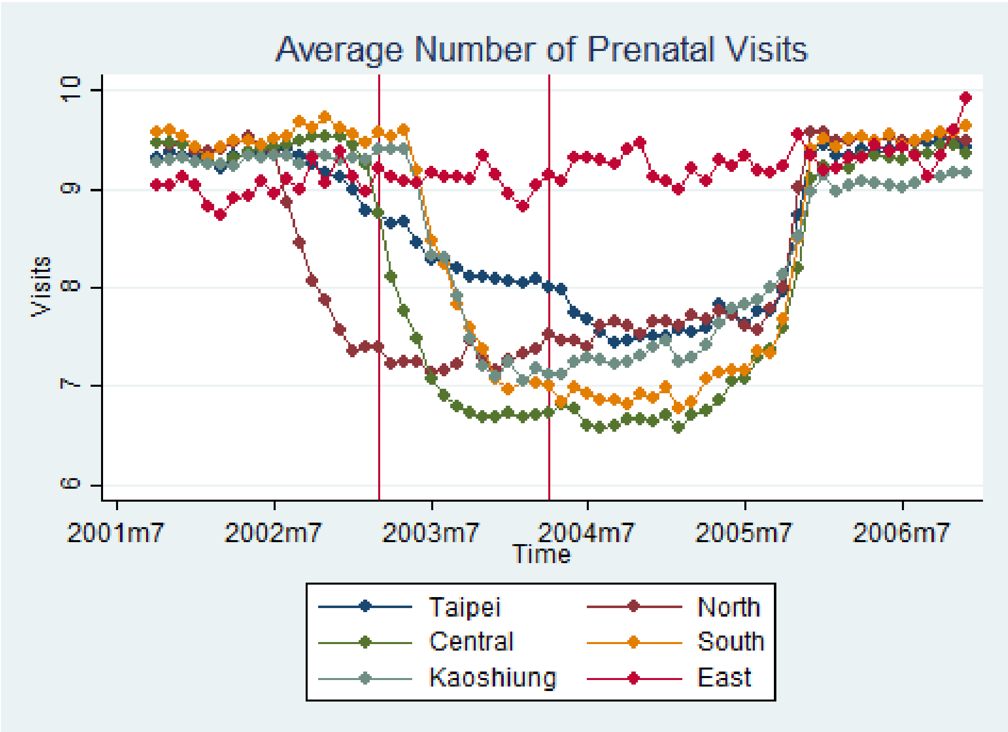


Figure 5: Average Number of Prenatal Care Visits by Age Group

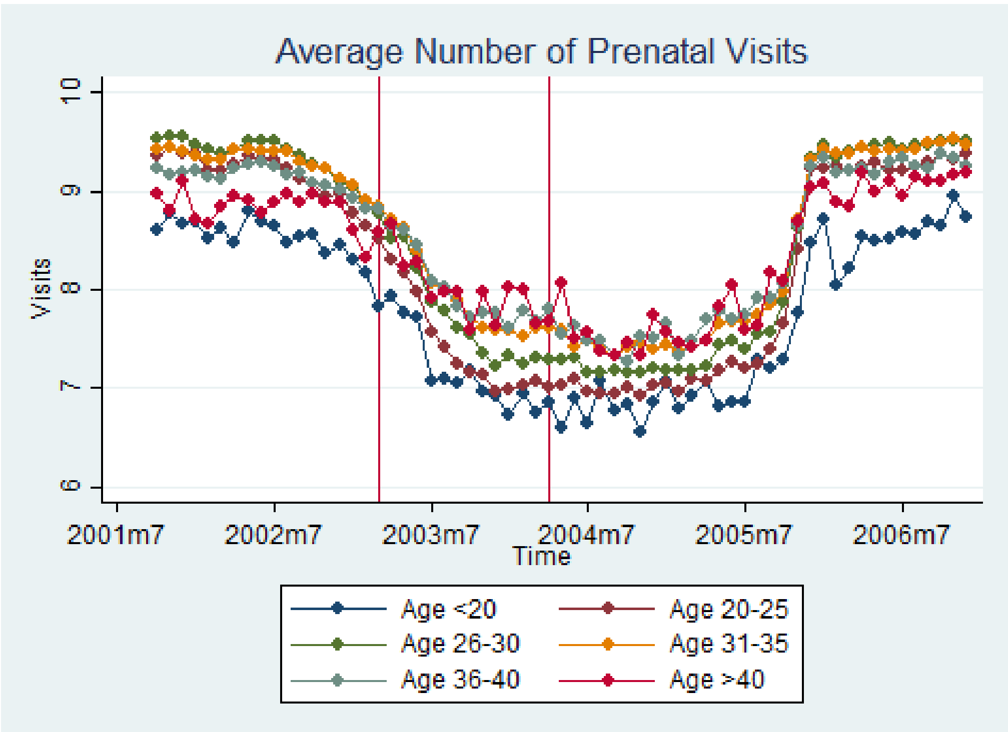


Table 1: Summary Statistics of Outcome and Explanatory Variables

	Whole Sample (2001Q4-2006)	Post Sample (2004Q2-2006)
Outcomes		
Preterm Delivery (<37 weeks)	5.99%	6.01%
Birth Complication	15.22%	15.02%
Low Birth Weight (<2500 Gram)	4.87%	4.91%
Very Low Birth Weight (<1500 Gram)	0.17%	0.17%
One Month Mortality	0.13%	0.13%
Three Month Mortality	0.19%	0.18%
Number of Prenatal Care Visits		
Total Number	8.46	8.24
Numbers during 1st Trimester	1.96	1.94
Numbers during 2nd Trimester	2.38	2.28
Numbers during 3rd Trimester	4.13	4.01
Total Number>=10 (Binary)	44.63%	39.20%
Provider Type		
Not-for-profit	29.91%	31.21%
For-Profit	59.13%	58.49%
Teaching Status		
Major Teaching Hospital	17.04%	17.42%
Minor Teaching Hospital	26.46%	26.31%
Community Hospital	23.94%	24.17%
Hospital Area		
Northern Area	17.76%	18.21%
Middle Area	21.89%	21.80%
Southern Area	14.35%	14.28%
Gao Pin Area	14.78%	14.96%
Eastern Area	29.06%	28.75%
Age at Delivery		
20-25	15.72%	13.93%
25-30	37.42%	37.15%
30-35	32.47%	33.80%
35-40	10.94%	11.89%
40+	1.45%	1.60%
Education Level (Mother)		
High School	43.41%	41.16%
College	42.31%	47.30%
Beyond College	2.92%	3.61%
Education Level (Father)		
High School	38.89%	37.56%
College	31.96%	34.60%

Beyond College	6.36%	7.55%
Maternal and Infant Characteristics		
Experiences SARS during 1st trimester	11.78%	0.00%
Experiences SARS during 2nd trimester	10.36%	0.00%
Experiences SARS during 3rd trimester	9.14%	0.00%
Infant Gender: Male	52.33%	52.30%
Non-Preventable Birth Complications	19.54%	20.09%
Pre-existing Conditions	4.90%	5.31%
C-Section Delivery	33.71%	33.22%
Sample size	849,325	404,166

Table 2: Results of Health Outcomes with IV and OLS Regressions (Whole Sample)

		OLS Estimation					
		Preterm	Birth Complication	Low Birth Weight	Very Low Birth Weight	One Month Mortality	Three Month Mortality
Number of Total Visits		-0.0190***	0.0036***	-0.0112***	-0.0011***	-0.0003***	-0.0003***
		[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]
	First Stage	IV Estimation					
	Number of Total Visits	Preterm	Birth Complication	Low Birth Weight	Very Low Birth Weight	One Month Mortality	Three Month Mortality
Number of Total Visits in the Social Group	0.7834*** [0.005]						
Number of Total Visits		-0.0004	-0.0053**	-0.0019***	-0.0003***	-0.0001**	-0.0001**
		[0.000]	[0.002]	[0.000]	[0.000]	[0.000]	[0.000]
F value	696.9						
Reject the Null?	Yes						
Observations	849,325	849,325	849,325	849,325	849,325	849,325	849,325

Note: ***, **, * Significance at the 1%, 5% and 10% level (two-tail test), respectively. All regressions include five maternal age dummies (20-25, 25-30, 30-35, 35-40 and 40+), mother's and father's three education dummies (high school, college and beyond college), dummies indicating whether a mother experiences SARS during 1st trimester, 2nd trimester or 3rd trimester, whether a mother has any non-preventable birth complications or any pre-existing conditions, and whether a mother has a C-section delivery, hospital ownership indicators (for-profit and not-for-profit), hospital teaching status (major teaching, minor teaching and community), five NHI regions, and interactions between NHI regions and year dummies.

Table 3: Robustness Checks

	Preterm		Birth Complication	
	IV	IV	IV	IV
Number of Total Prenatal Visits	-0.0004	-0.0004	-0.0054**	-0.0054**
	[0.000]	[0.000]	[0.002]	[0.002]
SARS Experiences×Maternal Education	Yes	No	Yes	No
SARS Experiences×Maternal Age	No	Yes	No	Yes

	Low Birth Weight		Very Low Birth Weight	
	IV	IV	IV	IV
Number of Total Prenatal Visits	-0.0019***	-0.0019***	-0.0003***	-0.0003***
	[0.000]	[0.000]	[0.000]	[0.000]
SARS Experiences×Maternal Education	Yes	No	Yes	No
SARS Experiences×Maternal Age	No	Yes	No	Yes

	One Month Mortality		Three Month Mortality	
	IV	IV	IV	IV
Number of Total Prenatal Visits	-0.0001**	-0.0001**	-0.0001**	-0.0001**
	[0.000]	[0.000]	[0.000]	[0.000]
SARS Experiences×Maternal Education	Yes	No	Yes	No
SARS Experiences×Maternal Age	No	Yes	No	Yes

Note: ***, **, * Significance at the 1%, 5% and 10% level (two-tail test), respectively. All regressions include five maternal age dummies (20-25, 25-30, 30-35, 35-40 and 40+), mother's and father's three education dummies (high school, college and beyond college), dummies indicating whether a mother experiences SARS during 1st trimester, 2nd trimester or 3rd trimester, whether a mother has any non-preventable birth complications or any pre-existing conditions, and whether a mother has a C-section delivery, hospital ownership indicators (for-profit and not-for-profit), hospital teaching status (major teaching, minor teaching and community), five NHI regions, and interactions between NHI regions and year dummies.

Table 4: IV Results for Whole and Post-SARS Samples

	Whole Sample	Post Sample
Preterm	-0.0004	0.0004
	[0.000]	[0.001]
Birth Complication	-0.0053**	-0.0069***
	[0.002]	[0.003]
Low Birth Weight	-0.0019***	-0.0015***
	[0.000]	[0.001]
Very Low Birth Weight	-0.0003***	-0.0003***
	[0.000]	[0.000]
One Month Mortality	-0.0001**	-0.0002**
	[0.000]	[0.000]
Three Month Mortality	-0.0001**	-0.0002*
	[0.000]	[0.000]
Observations	849,325	404,166

Note: ***, **, * Significance at the 1%, 5% and 10% level (two-tail test), respectively. All regressions include five maternal age dummies (20-25, 25-30, 30-35, 35-40 and 40+), mother's and father's three education dummies (high school, college and beyond college), dummies indicating whether a mother experiences SARS during 1st trimester, 2nd trimester or 3rd trimester, whether a mother has any non-preventable birth complications or any pre-existing conditions, and whether a mother has a C-section delivery, hospital ownership indicators (for-profit and not-for-profit), hospital teaching status (major teaching, minor teaching and community), five NHI regions, and interactions between NHI regions and year dummies.

Table 5: Different Measures of Prenatal Care

	Kessner Index=3		Number of Visits >=10	
	Whole Sample	Post-SARS Sample	Whole Sample	Post-SARS Sample
Preterm	0.0038	0.0018	-0.0048	-0.0045
	[0.003]	[0.004]	[0.003]	[0.004]
Birth Complication	-0.0659***	-0.0447**	-0.0351**	-0.0328*
	[0.016]	[0.018]	[0.016]	[0.017]
Low Birth Weight	-0.0062***	-0.0107***	-0.0128***	-0.0134***
	[0.002]	[0.003]	[0.003]	[0.004]
Very Low Birth Weight	-0.0008*	-0.0014**	-0.0015***	-0.0021***
	[0.000]	[0.001]	[0.000]	[0.001]
One Month Mortality	0.0001	-0.0005	-0.0007*	-0.0013**
	[0.000]	[0.001]	[0.000]	[0.001]
Three Month Mortality	-0.0003	-0.0005	-0.0009*	-0.0013*
	[0.000]	[0.001]	[0.000]	[0.001]
Observations	849,325	404,166	849,325	404,166

Note: ***, **, * Significance at the 1%, 5% and 10% level (two-tail test), respectively. All regressions include five maternal age dummies (20-25, 25-30, 30-35, 35-40 and 40+), mother's and father's three education dummies (high school, college and beyond college), dummies indicating whether a mother experiences SARS during 1st trimester, 2nd trimester or 3rd trimester, whether a mother has any non-preventable birth complications or any pre-existing conditions, and whether a mother has a C-section delivery, hospital ownership indicators (for-profit and not-for-profit), hospital teaching status (major teaching, minor teaching and community), five NHI regions, and interactions between NHI regions and year dummies.

Table A1: Chronology of SARS

Date	Event
2002	
November 16	First case of SARS occurs in Guangdong Province, China.
2003	
January 21	Guangdong provincial investigators report on “atypical” pneumonia.
January 31	First super-spreading SARS patient.
February 11	Chinese Ministry of health reports to WHO on respiratory disease in Guangdong.
February 18	Senior microbiologist at Chinese Center for Disease Control announces he suspects the disease is Chlamydia.
February 21	Worldwide epidemic begins at Metropole Hotel, Hong Kong.
February 28	Atypical pneumonia reported in Hanoi, Vietnam.
March 7	Son of Toronto index patient enters Scarborough Grace Hospital, initiating outbreak.
March 10	WHO teams arrive in Hong Kong and Hanoi.
March 12	First WHO global alert issued on yet-unnamed disease.
March 15	Second WHO global alert names SARS; first travel advisory declared.
March 17	WHO establishes laboratory network to seek cause of SARS.
March 20	United States reports first cases of SARS.
March 26	Ontario declares provincial emergency.
March 27	WHO instructs airlines to screen passengers in SARS-affected areas.
March 28	Chinese officials share details of first SARS cases.
March 30	Amoy Gardens, Hong Kong, outbreak announced.
March 31	Hong Kong health authorities issue quarantine order requiring some residents of the Amoy Gardens apartment complex to remain in their homes until April 9.
April 2	WHO declares travel advisory for Hong Kong and Guangdong Province.
April 4	Role of Metropole Hotel in global epidemic identified.
April 16	SARS coronavirus identified; WHO accuses Chinese government of underreporting SARS cases.
April 20	Mayor of Beijing and Chinese Minister of Health fired.
April 23	WHO declares travel advisory for Beijing, Shanxi Province, and Toronto.

April 28	SARS contained in Vietnam.□
April 30	WHO lifts Toronto travel advisory.
May 3	Taiwan outbreak grows to 100 cases; WHO sends team.□
May 8	WHO declares travel advisory for Tianjin, Inner Mongolia, and Taipei.
May 21	WHO declares travel advisory for all of Taiwan.
May 22	Second wave of SARS begins in Toronto.
May 23	SARS linked to masked palm civet and raccoon-dog; Hong Kong and Guangdong travel advisories lifted.
May 31	SARS contained in Singapore.
June 13	SARS contained in China, except Beijing.
June 23	SARS contained in Beijing.
July 2	SARS contained in Toronto.
July 5	SARS contained in Taiwan; WHO declares containment of worldwide epidemic.
September 8	Isolated case of SARS occurs in Singapore due to laboratory accident.
December 5	Taiwanese researcher contracts SARS during experiment.
December 7-10	Infected researcher attends conference in Singapore.
December 17	Singapore authorities quarantine 70 individuals.
January 5	China and WHO confirm SARS case in Guangdong Province.

Data Source: Summarized from "Summary and Assessment" in Learning from SARS: Preparing for the Next Disease Outbreak – Workshop Summary, edited by Knobler et al., National Academies Press, Washington, D.C., 2004.

Table A2: Time Schedule and Service Items for Prenatal Care Visit

Trimester	Prenatal visit	Recommended weeks of pregnancy to be examined	Service items
1st Trimester (week 1-16)	First	<= week 12	• Health survey[1], physical checkup[2], and laboratory tests[3] • Regular checkup[4]
	Second	Week 16	• Regular checkup[4]
2nd Trimester (week 17-28)	Third	Week 20	• Regular checkup[4] • Ultrasound exam • Preterm labor education and prevention
	Fourth	Week 28	• Regular checkup[4]
3rd Trimester (week 29-40)	Fifth	Week 32	• Regular checkup[4] • Screening tests on Hepatitis B, rubella and syphilis
	Sixth	Week 34	• Regular checkup[4]
	Seventh	Week 36	• Regular checkup[4]
	Eighth	Week 38	• Regular checkup[4]
	Ninth	Week 39	• Regular checkup[4]
	Tenth	Week 40	• Regular checkup[4]

Note:

[1] Health survey includes family disease history, pregnant woman's past disease history, pregnancy history and unpleasant symptoms during current pregnancy.

[2] Physical checkup at the first visit includes weight, height, blood pressure, thyroids, breasts, pelvic exam, chest and abdomen exams.

[3] Laboratory tests at the first visit include regular blood tests (white blood cells, red blood cells, platelets, hematocrit, hemoglobin, mean corpuscular volume), blood type, Rh factor, VDRL (syphilis screening), Rubella lgG (German measles antibody), AIDS test (ELISA or PA), and regular urine tests. Mean corpuscular volume is an important basis of thalassemia testing.

[4] Regular checkup consists of three parts: (1) diagnostic questions: doctors will ask about symptoms of discomfort such as bleeding, GI upset, headache, cramps; (2) physical checkup: weight, blood pressure, abdomen circumference and fundal height, fetal heart monitoring, fetal position, edema, varicosis; and (3) laboratory exam: urine protein and glucose.

附件四

科技部補助專題研究計畫項下出席國際學術會議心得報告

日期：103 年 10 月 17 日

計畫編號	101-2410-H-004-020-MY2		
計畫名稱	健康資本與產前檢查:以 SARS 對孕婦影響為例		
出國人員姓名	連賢明	服務機構及職稱	政大財政系教授
會議時間	103 年 7 月 18 日至 103 年 7 月 22 日	會議地點	日本橫濱大學
會議名稱	(中文) (英文) Global and Sustainable Supply Chain in the 2010s "Yokohama, Japan 2014"		
發表論文題目	(中文) (英文) Patient Cost-Sharing and Healthcare Utilization in Early Childhood: Evidence from a Regression Discontinuity Design		

一、參加會議經過

今年參與在日本的橫濱大學，由亞太地區決策科學研究所（Asia-Pacific Region of the Decision Sciences Institute, APDSI），供應鏈和運營管理（Association of Supply Chain and Operations Management, ASCOM）協會，日本運營管理和戰略協會（Japanese Operations Management and Strategy Association, JOMSA）共同舉辦的年度國際會議，此會議為針對各類經濟學的重要熱門議題做討論，為期四天，共舉行三天會議，每天約有 14 個子題，每個子題有 2~3 篇文章。藉由這次的國際性研討會，讓我有上台報告及擔任主持人的機會，並且與他國學者進行學術交流，使我收穫頗豐。不僅如

此，三天下來，會議的內容更是相當的豐富且充實，對我在研究當前議題時，可以使用不同的角度來切入，在做實證研究上的技巧和對議題的敏感度，皆有相當程度的收穫。

二、與會心得

這次會議能夠和許多不同領域的學者有近身接觸的經驗，除了學習當前熱門的研究議題，也同時學習各個知名學者在論文發表的技巧，亦可藉這次的機會跟他們請教，實在是機不可失。在簡短的論文發表中，讓我對於不同領域的研究方向、趨勢及方法皆有清楚的認識，在會後休息的片段，也讓我有機會與各領域的學者，針對彼此的想法做互動與分享，使我在討論的過程中，擴展我未來研究方向的深度與廣度。

報告題目是臺灣針對 3 歲以下兒童的幼兒醫療補助計畫。這補助計畫使得兒童在 3 歲以前免除健保的部份負擔，但 3 歲後則需負擔部分負擔，這差異使得平均門診醫療自負額增加一倍（從 60 元到 120 元），住院成本從 0 元跳到 1300 元。此種門診和住院部分負擔費用變化，很適合 Regression Discontinuity Design。在研究中我使用 RD 這個估計方法，分析醫療費用和醫療次數間因果關係。研究發現免除 3 歲以下兒童的健保費用，增加醫療次數約 4%，但增加醫療費用約 6%，主因是免除部分負擔誘使父母將兒童選擇於較高層級醫院就醫。另外，今年亦有擔任主持人的角色，主持的子題目為 Healthcare Management，宜共有三篇論文的發表： 除了自己的文章外，還有兩篇為 Han, H.W. 發表的 Determinants of the cross-region Health Care Utilization，以及 Lin, Y.J. 發表的 Applying the Two Stages Least Square to Explore the Impact of Income on Health。這幾篇文章都在討論台灣的醫療制度。

三、建議

這次會議中認識了不少國外的學者，希望國內也能類似本次會議多邀請知名的學者，無論是做短期且密集講演，或是舉辦大型國際間的交流研討會，皆能讓我們更清楚的了解目前研究的主流，並且增加國內學者和知名學者直接接觸的機會，更精進國內學者的學術研究，亦能更豐富國內的研究內容，並有國際的視野，讓國內的學術研究能夠更加豐富及多元化。

四、攜回資料名稱及內容

研討會的文章，以及一些交換資料。

六、其他：

參加橫濱大學舉辦會議的照片

國科會補助計畫衍生研發成果推廣資料表

日期:2013/09/02

國科會補助計畫	計畫名稱: 健康資本與產前檢查:以SARS對孕婦影響為例
	計畫主持人: 連賢明
	計畫編號: 101-2410-H-004-020-MY2　　學門領域: 健康、教育與福利

無研發成果推廣資料

101 年度專題研究計畫研究成果彙整表

計畫主持人：連賢明			計畫編號：101-2410-H-004-020-MY2				
計畫名稱：健康資本與產前檢查:以 SARS 對孕婦影響為例							
成果項目			量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
			實際已達成數（被接受或已發表）	預期總達成數(含實際已達成數)	本計畫實際貢獻百分比		
國內	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%		
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	0	2	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	1	100%		

其他成果 (無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)	無

	成果項目	量化	名稱或內容性質簡述
科教處計畫加填項目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與（閱聽）人數	0	

科技部補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

   ■達成目標

   □未達成目標（請說明，以 100 字為限）

   　　□實驗失敗

   　　□因故實驗中斷

   　　□其他原因

   說明：

2. 研究成果在學術期刊發表或申請專利等情形：

   論文：□已發表 ■未發表之文稿 □撰寫中 □無

   專利：□已獲得 □申請中 ■無

   技轉：□已技轉 □洽談中 ■無

   其他：（以 100 字為限）

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以 500 字為限）

   學術成就：這篇討論健康資本和產前檢查關係，估計結果發現產前檢查的確能改善嬰兒出生健康，包含減少生產時不順利比例，降低剖腹產比例，並增加嬰兒出生體重。這篇文章預計發表於國際期刊。

   社會影響：這估計結果，可提供國民健康局參考，作為提供和修正孕婦健康檢查內容的依據。