PATIENT COST-SHARING AND HEALTHCARE UTILIZATION IN EARLY CHILDHOOD: EVIDENCE FROM A REGRESSION DISCONTINUITY DESIGN

Hsing-Wen Han, Hsien-Ming Lien, Tzu-Ting Yang


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Abstract

Healthcare for young children is highly subsidized in many public health insurance programs around the world. However, the existing literature lacks evidence on how the demand for young children’s healthcare reacts to these medical subsidy policies. This paper exploits a sharp increase in patient cost-sharing at age 3 in Taiwan that results from young children “aging out” of the cost sharing subsidy. This price shock on the 3rd birthday allows us to use a regression discontinuity design to examine the causal effect of cost sharing on the demand for young children’s healthcare by comparing the expenditure and utilization of healthcare for young children right before and after the 3rd birthday. Our results show that the increased patient cost sharing at the 3rd birthday significantly reduces total outpatient expenditure. The implied arc-elasticity of outpatient expenditure is around -0.10. However, the demand for inpatient care for young children does not respond to a change in cost sharing at the 3rd birthday even though the price variation is much larger. This result implies that the full coverage of inpatient care could improve the welfare of young children.

JEL Classification: G22; I12; I18; J13

Key words: patient cost-sharing, health insurance, children health

Corresponding Author:

Tzu-Ting Yang*
PhD candidate
Vancouver School of Economics
University of British Columbia
Email: nestofdata@gmail.com

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1 Introduction

Health conditions and medical treatments in early childhood are widely believed to have a substantial impact on health and labour outcomes in adulthood (Bharadwaj et al., 2013; Almond et al., 2011; Currie, 2009; Almond, 2006; Case et al., 2005; Currie and Madrian, 1999). On the other hand, young children also bring about sizeable medical costs to their parents since they are vulnerable to diseases. In line with this evidence, many public health insurance programs in the world subsidize medical care for young children through providing this age group with relatively low patient cost sharing. For example, the United States regulates the level of patient cost sharing in Medicaid and Children Health Insurance Program (CHIP) to ensure the children from middle and low income families can afford essential medical treatment. Recently, due to tight budgets, many state governments have considered raising the level of patient cost sharing for Medicaid and CHIP, which has led to many debates on the possible impact. Similarly, national health insurance in Japan and Korea offer children under six years of age lower patient cost sharing than those above age six to promote healthy investments in early childhood.

To evaluate the effectiveness of these subsidy policies and the impact of future reform in public health insurance for children, we need to understand healthcare expenditure elasticities for young children. That is, the response of healthcare demand to the change in out-of-pocket costs (referred to as ”price” from here on). If the children’s price elasticity of healthcare expenditures is zero or very small, then providing full insurance for children’s health care could be welfare improving because the lower patient cost sharing does not raise

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1Several recent studies (Bharadwaj et al., 2013; Almond et al., 2011) present convincing evidence to show early life medical treatments can reduce mortality and even result in better long-run academic achievement in school. That is, health intervention in early childhood could be an investment with high returns.

2The definition of a young children is an individual under age six (before elementary school enrolment).

3For example, in Taiwan, outpatient visits for children under three years of age is around 20 per year. Compared with adults (12 visits per year), this age group has especially high demand for healthcare

4That is, the share of healthcare cost paid out-of-pocket by the patient is lower.

5The federal requirement for Medicaid eligibility varies by children’s age. For children under age 6 (young children), Medicaid eligibility requires family incomes to be lower than 133% of the federal poverty level (FPL). For children ages 6-19 (older children), the Medicaid eligibility requires family incomes below 100% of FPL. Thus, the coverage of Medicaid for children under six is much higher than above six.

6After the passing of the Deficit Reduction Act (DRA) of 2005, states have the right to increase cost sharing of public health insurance programs, such as Medicaid and CHIP, for specific populations and medial services (Selden et al., 2009)

7National health insurance in Japan covers almost all medical service, such as outpatient and inpatient care, for all citizens. The patient cost sharing for children under age six (pre-school age) is 20% of original healthcare cost. For children above age six (school-age), patient cost sharing becomes 30% of medical cost. More details for Japanese national health insurance can be found at this web page. [http://www.shigakokuhu.or.jp/kokuho_sys/kokuho_en.pdf](http://www.shigakokuhu.or.jp/kokuho_sys/kokuho_en.pdf). In Korea, their national health insurance exempts cost sharing of inpatient service for the children under age six.
the cost from moral hazard of healthcare use\textsuperscript{8} but fully protects a household’s financial risk arising from out-of-pocket expenses. In addition, lower patient cost sharing can also benefit children’s health by increasing their access to necessary healthcare services. If children’s healthcare expenditures are sensitive to pricing, then higher patient cost sharing could substantially reduce the loss from moral hazard behaviour and allocate medical resources more efficiently.

To date, very little is known about how the healthcare demand of young children reacts to a change in patient cost sharing. Most estimates of price elasticity mainly focus on adults’ and the elderly’s healthcare demands (Cherkin et al., 1989; Selby et al., 1996; Rice and Matsuoka, 2004; Chandra et al., 2010\textsubscript{a}; Chandra et al., 2010\textsubscript{b}; Chandra et al., 2014; Shigeoka, 2014).\textsuperscript{9} However, these estimates might not be externally valid for the healthcare demand of young children for two reasons. First, the types of healthcare services (e.g., visit (admission) diagnoses) used by adults and children are quite different. Children’s outpatient visits are rarely for chronic diseases and most are for acute diseases, which need timely treatment and should not be sensitive to price change. In addition, the majority of children’s inpatient admissions do not require surgery but are treated with bed rest or medication. Shigeoka (2014) found that inpatient admissions for surgery, especially elective surgery (e.g., cataract surgery), are more price sensitive than ones for non-surgery. He also found admissions for the respiratory diseases typically treated with bed rest or medication do not respond to a change in cost sharing at age 70. Card et al. (2008) also had similar findings for Medicare eligibility at age 65 in the United States. Second, the healthcare intervention in early childhood could substantially benefit an individual’s later life, which is addressed by recent studies (Bharadwaj et al., 2013; Almond et al., 2011). Given such high returns, parents might not be willing to adjust their children’s medical care in response to price changes. Based on the above two reasons, we expect healthcare demand for young children should be less price sensitive than an older demographic group.

Credible estimates of price elasticity for children still rely on evidence from the RAND Health Insurance Experiment (RAND HIE)\textsuperscript{10}, which was an influential randomized social

\textsuperscript{8}Since insured people do not pay full cost of medical service, the optimal utilization of healthcare for individual would be larger than social optimum, which leads to loss of social welfare. Lower patient cost sharing could induce individuals to use more healthcare in inefficient way (moral hazard).

\textsuperscript{9}Shigeoka (2014) exploited sharp reduction in patient cost sharing at age 70 in Japan and apply regression discontinuity (RD) design to estimate price elasticity of outpatient and inpatient visits for the elderly. He found both health services respond to price change strongly, namely, have obvious drop at age 70. The estimated price elasticities are around -0.17 (outpatient) and -0.15 (inpatient). Chandra et al. (2014) used cost sharing reform in Massachusetts as an exogenous variation in price and obtained price elasticity of healthcare expenditure is around -0.15 for low-income adults.

\textsuperscript{10}Before passing the Deficit Reduction Act (DRA) of 2005, state governments had little right to adjust
experiment conducted in the mid 1970s. Its sample was of people 62 years of age or less and randomly assigned participating households to different levels of patient cost-sharing (ranging from free care to 95% cost-sharing). The RAND HIE provided estimates of price elasticity of healthcare demand for children under 14 years of age (Leibowitz et al., 1985; Manning et al., 1981). RAND HIE found higher patient payments significantly reduced children’s outpatient expenditures and utilization but obtain mixed evidence of cost sharing effect on children’s demand for inpatient care.\textsuperscript{11} The estimated arc-elasticity\textsuperscript{12} of the total medical expenses was around -0.12. However, the sample size for children in the RAND HIE was not big. Some estimates or subgroup analysis are not precise enough to confirm the presence or absence of a cost sharing response (Leibowitz et al., 1985).\textsuperscript{13} Additionally, the RAND HIE evidence is over 30 years old. Both medical technology and market structure has changed considerably during the past three decades. The varying healthcare environment could affect the way in which demand for healthcare changes in response to the difference in price. Therefore, our paper fills this gap by providing new evidence on the price elasticity of children’s healthcare demand.

In this paper, we exploit a sharp increase in patient cost-sharing at the 3rd birthday in Taiwan that results from young children ”aging out” of the cost sharing subsidy. On average, turning age three leads to an increase in price per outpatient visit (from 59 to 133 NT$) by more than 100 percent\textsuperscript{14} and price per inpatient admission dramatically rises from zero.

\textsuperscript{11}For children under age 4, the RAND HIE found that the inpatient care is price sensitive. Children assigned to a free plan had a significantly higher rate of inpatient admission than children assigned to 95% cost-sharing. For children between 5 to 13, they found no consistent pattern of a cost sharing effect on inpatient use (Leibowitz et al., 1985).

\textsuperscript{12}The health insurance contracts in RAND HIE adopted non-linear pricing, which cast some challenges of estimating a price elasticity. Specifically, the insurance plans required initial cost-sharing (free care, 25%, 50% and 95%) but have an annual stop-loss (Maximum Dollar Expenditure), namely, the total out-of-pocket medical expense per year cannot exceed 4000 US$. Thus, the patient cost-sharing would fall to zero when annual out-of-pocket medical expense reached 4000 US$. Such non-linear pricing makes patients face a different price for the same health care at different times of the year. To summarize the estimated price elasticity, RAND researchers define four kinds of price that patients respond to when making their health care decision: 1) the current ”spot” price; 2) the expected end-of-year price; 3) the realized end-of-year price; 4) weighted-average of the price paid over a year (Aron-Dine et al., 2013). The price elasticity of children’s health care mentioned here is calculated by defining price as definition 1).

\textsuperscript{13}As Leibowitz et al. (1985) comments: “Because hospitalizations for children are infrequent, our estimates of hospital use have wide confidence intervals and we can be less certain than for outpatient care about the presence or absence of a cost sharing response”

\textsuperscript{14}1 US$ is equal to 32.5 NT$ in 2006.
to 1300 NT$. The change in out-of-pocket expenses at the 3rd birthday allows us to use a regression discontinuity (RD) design to examine the causal effect of patient cost sharing on young children’s healthcare demand by comparing the expenditure (utilization) of healthcare for young children just before and after the 3rd birthday.

We obtain three key findings. First, the increase in out-of-pocket cost at the 3rd birthday significantly reduces outpatient expenditure by 6.9%. The implied arc-elasticity of outpatient expenditure is around $-0.10$. Second, the sharp price increase at age 3 not only results in fewer outpatient visits (extensive margin) but also reduces the medical cost per visit, namely, induces patients to switch from high to low quality providers (intensive margin, e.g., substitute teaching hospitals with clinics or community hospitals). We find losing cost sharing subsidy reduces visits to teaching hospitals by 50%. Further investigating possible heterogeneous effects in detail, we also find preventive care and mental health services have larger price responses than acute respiratory diseases. Third, in sharp contrast to outpatient service, the demand for inpatient services does not respond to price change at the 3rd birthday. The estimated arc-elasticity of inpatient expenditure is close to zero. This finding is a surprising result because the variation in the inpatient price at age 3 is much larger than the outpatient price in terms of its level and percentage change. The above findings suggest that the level of patient cost sharing for young children should be different depending on healthcare service. For example, our results imply that full coverage of the medical costs (no cost sharing) of inpatient services for young children could be optimal because the elasticity of the inpatient expenditure is close to zero. Providing full insurance coverage might not stimulate excessive hospital use (moral hazard) but it might substantially reduces financial risk for households.

Our paper contributes to the research on patient cost sharing in three areas. Firstly, our paper provides new evidence on the causal effect of patient cost sharing on the healthcare demand of young children. In particular, many public health insurance programs in developed countries (e.g., the United States, Japan, and Korea) tend to provide relatively low patient cost sharing for young children. However, the literature lacks knowledge about how the healthcare demand of young children reacts to these medical subsidy policies. Our elasticity estimates fill this gap and provides evidence on the price responsiveness of young children’s healthcare demand, which could have important implications for evaluating current cost sharing policies and possible reforms in the future. Furthermore, our identification strategy of a regression discontinuity design provides an unique opportunity of getting esti-\footnote{This result is due to differential copayment for health providers in Taiwan. We will discuss this issue in more detail in section 2 and 5.}
mates in a local randomized experiment. The comparison at the 3rd birthday convincingly isolates the impact of patient cost sharing on healthcare demand from other factors because children right after and before their 3rd birthday should have similar healthcare demands if there is no change in patient cost sharing at age 3.\(^{16}\) Therefore, our research design gives us highly credible estimates of price elasticity of the healthcare demand of young children.

In addition, our estimates can also avoid the bias from a composition change of enrollees induced by the change in cost sharing. Several recent U.S. studies (Chandra et al., 2010a; Chandra et al., 2010b; Chandra et al., 2014) use a quasi-experimental design by exploiting the change in the copayment of one health insurance plan and use unchanged insurance plans as a control group. However, the change in cost sharing could also affect people’s decision to enroll in insurance plans. Such self-selection behavior could bias the elasticity estimates. For example, a larger proportion of people with less price sensitivity could continue their enrolment after the cost-sharing increase, which may “downward” bias the elasticity estimates in absolute value. However, the Taiwanese National Health Insurance (NHI) is a single payer scheme and every citizen is mandated to join this program.\(^{17}\) Thus, our elasticity estimates are free of bias from any composition change in enrollees after the cost-sharing change.

Finally, the data we use in this paper is administrative insurance claim data, that contains all NHI records of healthcare payments and use for the children under four years of age in Taiwan\(^{18}\) during our sample period. Compared with survey data, the administrative data have a number of advantages, such as much less measurement error and a larger sample sizes. These features allow us to get precise estimates of the heterogeneity in the cost sharing effect across different subgroups or types of healthcare (diagnoses) that could not be analysed precisely in the RAND HIE because of its limited sample of children.

The rest of the paper is organized as follows. Section 2 has a brief overview of the institutional background. In Section 3, we discuss our data and sample selection. Section 4 describes our empirical strategy. In section 5, we analyze the main results. Section 6 gives concluding remarks.

\(^{16}\)In Taiwan, turning age 3 does not coincide with any confounding factors, such as, school starting age or recommended immunization schedule. We will discuss this issue in Section 4.

\(^{17}\)The only exceptions are citizens who lose their citizenship, die or missing for more than six months.

\(^{18}\)99% of Taiwanese population is covered by NHI. Furthermore, NHI covers almost all medical services. We will discuss this issue in more detail later.
2 Policy Background

2.1 National Health Insurance in Taiwan

In March 1995, Taiwan established the NHI. The National Health Insurance is a government-run, single-payer scheme administered by the Bureau of National Health Insurance. Prior to the NHI, health insurance was provided through three main occupational forms – labour insurance for private-sector workers, government employee insurance, and farmer’s insurance – and these systems accounted for only 57% of the Taiwanese population (Lien et al., 2008). The remainder of the population were people not employed: people over 65, children under 14, and unemployed workers. The implementation of the NHI raised the coverage rate of health insurance sharply to 92% by the end of 1995, and since 2000, it has stayed above 99%.

Under universal insurance coverage, patients received almost all of the medical services covered by NHI, such as outpatient, inpatient, dental, mental health, prescription drug, and even traditional Chinese medicine. The NHI classifies healthcare providers into four categories based on accreditation: major teaching hospital, minor teaching hospital, community hospital, and clinic. Like most Asian countries, enrollees are free to choose their care providers and do not need to go through a general practitioner (family physician) to obtain a referral. For example, patients can directly access specialists in a major teaching hospital without a referral. In other words, NHI does not adopt a gatekeeper system.

2.2 Patient Cost-Sharing

Patient cost sharing in Taiwan is determined by two parts: 1) NHI copayment (coinsurance); 2) Other NHI “uncovered” medical expense (e.g., registration fee for outpatient visit).

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19 The clinic is similar to physician office in Canada and the U.S.
20 Most of the hospitals and clinics (97%) have had contracts with NHI.
21 For example, National Health Service (NHS) in the United Kingdom adopts a gatekeeper system. Patients can not directly obtain outpatient service at hospitals. Instead, they need get referral from general practitioners. Provincial Health insurance in Canada also adopt the similar systems.
22 Copayment is a fixed fee paid by the insurance enrollee each time a medical service is accessed. Coinsurance is a percentage medical payment that the insured person has to pay. NHI adopts copayment for outpatient care and coinsurance for outpatient prescription drug and inpatient care.
23 More discretionary healthcare, such as plastic surgery, sex reassignment surgery and assisted reproductive technology, etc., are not covered by NHI. Patients have to pay full cost for these services.
2.2.1 Cost-Sharing for Outpatient Service

With respect to outpatient care, a patient pays a NHI copayment plus a registration fee for each visit.\textsuperscript{24} If a physician prescribes drug at a visit and a drug cost is above 100 NT$, a patient also needs to pay the cost-sharing of prescription drug, which is 20\% of total drug cost.\textsuperscript{25} While, compared with NHI copayment, average out-of-pocket cost for outpatient prescription drug (at age 2) is quite small, only 2.5 NT$ per visit.\textsuperscript{26}

The NHI copayments are based on a national fee schedule. In general, a higher copayment is set for the health providers that have higher accreditation.\textsuperscript{27} The first rows of Panel A in Table 1 summarize NHI copayment of four types of providers during our sample period (2005 to 2008). A major teaching hospital can charge a patient a copayment of 360 NT$ (12 US$) per outpatient visit, which accounts for 29\% of the total medical cost per visit. However, the NHI copayment for one clinic visit is only 50 NT$ (1.7 US$) and covers 13\% of the total medical cost of each visit.\textsuperscript{28} In other words, the copayments for outpatient services at teaching hospitals are much higher than those for clinics/community hospitals in terms of both their level and their share of the cost.

The spirit of this design is to use the differential copayments to guide patients to properly choose their health providers based on the severity of an illness to better allocate medical resources to the patients who need it most. This design is needed because patients in Taiwan (or other Asian countries) have no restriction on the choice of their healthcare providers. If there is no difference in patient cost sharing between hospitals and clinics, patients might abuse the limited medical resources of the hospitals\textsuperscript{29} and crowd out other patients whose illness only can be treated at hospitals.

In addition to the NHI copayment, a patient also needs to pay a registration fee for each outpatient visit, which is not covered by the NHI. The registration fee reflects the health provider’s administrative costs and is determined by the provider.\textsuperscript{30}

\textsuperscript{24}Both are fixed amount.
\textsuperscript{25}If drug cost is under 100 NT$, a patient has no out-of-pocket cost.
\textsuperscript{26}The average drug cost per visit is only 61 NT$, which is under 100 NT$. Thus, patients do not pay any out-of-pocket cost at most visits.
\textsuperscript{27}NHI in Korea also has similar cost sharing policy. Patients have to pay 40-50\% of total medical cost when visiting hospitals but only pay 15-30\% when visiting clinics.
\textsuperscript{28}For more detailed information about NHI copay schedule, please see Note in Table 1. A reimbursement is also paid according to the provider’s accreditation. That is, major teaching hospitals can obtain the highest reimbursement for their medical services even though they provide the similar health services as clinics.
\textsuperscript{29}For example, patients use hospital outpatient services for the diseases which could be cured in clinic (e.g., cold).
\textsuperscript{30}Our main dataset lacks this information. But the NHI has another database that provides information about the registration fees of all health providers during our sample period (2005-2008). Major teaching hospitals usually charge 150 NT$, minor and community hospitals usually charge 100 NT$, and clinics
2.2.2 Cost-Sharing for Inpatient Service

For inpatient admissions, the patient cost sharing takes place through coinsurance. Depending on the length of the stay and the type of admission (acute or chronic admission), the coinsurance rate is 10% to 30% of the total medical expense per admission. For example, a patient must pay 10% of the hospitalization costs when they stay in acute admission units for the first 30 days and 20% if they stay an extra 30 days (i.e., 31–60 days). Almost all inpatient admissions for young children (99.5%) are acute admissions and the length of a stay is within 30 days\(^{31}\). Thus, coinsurance rates for most admissions are around 10%. Panel B in Table 1 lists the coinsurance rates for inpatient services.

Because inpatient care usually results in larger financial risks than outpatient care, the NHI has a stop-loss policy (maximum out-of-pocket expense) for inpatient admissions. The out-of-pocket cost is up to the stop-loss, which is calculated annually as 10% of the gross domestic product per capita in Taiwan. The NHI covers all expenses above the stop-loss. According to NHI statistics, very few patients (less than 1%)\(^{32}\) reach this stop-loss, so the non-linearity imposed by the stop-loss should not seriously bias our estimates of price elasticity. Moreover, in contrast to health insurance plans in the United States and other countries, the NHI does not require patients to pay deductibles\(^{33}\) before insurance coverage begins. The above two features substantially simplifies our computation of price elasticities.

2.3 Change in Patient Cost Sharing at 3rd Birthday

To reduce the financial burden on parents and ensure that every child obtains essential medical treatment in his/her early childhood, in March 2002, the Taiwan government enacted the Taiwan Children’s Medical Subsidy Program (TWCMS). This program, through subsidies, exempts all NHI copayments and coinsurance for outpatient visits, outpatient prescription drugs, inpatient admissions, and emergency room visits for children under the age of three. A patient would lose eligibility for subsidies at his/her 3rd birthday. After the implementation of TWCMS, a patient under three years of age only pays the medical costs not covered by NHI (e.g., registration fee for outpatient care and other uncovered medical services).\(^{34}\)

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\(^{31}\)In our empirical analysis, we limit our estimated sample for inpatient service to the cases with acute admissions and inpatient days within 30 days.

\(^{32}\)This is because NHI waives the cost-sharing for patients with catastrophic illness (e.g., cancer). These people had a greater probability of reaching the stop-loss if their cost sharing were not waived.

\(^{33}\)In health insurance, the deductible is the amount that a insured person has to pay before an insurer (e.g., insurance company) starts to pay the expense.

\(^{34}\)If they use medical services not covered by NHI, they will have to pay all expenses. However, NHI has already covered most of health services. As mentioned before, very few services are not covered by NHI. Most
Figure 1 plots the observed age profile of average out-of-pocket cost per outpatient visit\textsuperscript{35} and inpatient admission (180 days before and after the 3rd birthday). Figures 1a and 1b reveal that patients would experience sharp increase in price for both outpatient and inpatient service at the 3rd birthday. Especially for inpatient service, the out-of-pocket expense per admission suddenly rises from zero to almost 1300 NT$, which could bring about sizeable financial risk to a household with young children turning three years old.

Note that the observed price changes per visit/admission at the 3rd birthday are endogenous. Especially for outpatient services, the price change at the 3rd birthday is larger for the visits to a teaching hospital than to a clinic or community hospital. For example, the price per visit for major teaching hospital at 3rd birthday increase by 240% (from 150 to 510 NT$) and price for minor teaching hospital rises by 240% (from 100 to 340 NT$). However, the visit price for clinic only increase by 100% (from 50 to 100 NT$). In other words, TWCMS indeed subsidizes outpatient services in teaching hospitals much more than those in clinic or community hospitals. Therefore, patients might also change their choices of providers at the 3rd birthday, which could make the observed out-of-pocket cost per visit after the 3rd birthday endogenous (i.e., already reflect the change in choices of providers). To obtain the exogenous price change at the 3rd birthday, we need to fix the utilization of each type of provider.

Table 2 presents the weighted average out-of-pocket cost per visit/admission before and after the 3rd birthday.\textsuperscript{36} The weights are the average daily utilization of each type of providers 90 days before the 3rd birthday. Thus, the numbers in the first row are actual weighted average out-of-pocket costs per visit/admission before the 3rd birthday and the numbers in the second row are counterfactual weighted average out-of-pocket costs per visit/admission after the 3rd birthday, which uses the share of utilization of providers at age 2 (i.e., 90 days before the 3rd birthday) as weights. In this way, we can compute the difference between rows (1) and (2) to obtain the exogenous change in out-of-pocket costs per visit/admission at the 3rd birthday. Table 2 shows that the average price of outpatient visits rise by more than 100% (from 58.9 to 132.7 NT$) at the 3rd birthday, and the average price of inpatient admission sharply jumps from zero to 1296 NT$. To sum up, in terms of both the level and the percentage change, the out-of-pocket cost for each inpatient admission of them are quite discretionary healthcare, such as plastic surgery, sex reassignment surgery and assisted reproductive technology, etc. Patients have to pay full cost for these services.

\textsuperscript{35}Each dot represents the mean (10-day cells) of outpatient (inpatient) price at given age (measure in day). The line is from fitting a linear regression on age variables fully interacted with a dummy indicating age 3 or older.

\textsuperscript{36}The bandwidth is 90 days. Thus, we use out-of-pocket cost per visit/admission within 90 days before and after the 3rd birthday to obtain the estimates in Table 2.
has a much larger increase than for each outpatient visit.

3 Data and Sample

3.1 Data

To implement our empirical analysis, we need the following information: 1) the enrollee’s exact age to the day at the time of a visit\textsuperscript{37}; 2) the utilization of the outpatient or inpatient services; 3) the medical expenses of the outpatient or inpatient services. We use unique claims data from Taiwan’s National Health Insurance Research Database (NHIRD), which contains detailed information about out-of-pocket costs, total medical costs and healthcare use for all NHI enrollees in Taiwan.\textsuperscript{38} In addition, NHIRD also includes the exact date of outpatient visits (inpatient admissions) and exact birth date of enrollees, which allows us to precisely measure children’s age in days for our RD design.

For our purposes, we linked information from four types of files in NHIRD: outpatient claims files, inpatient claims files, enrolment files, and provider files. First, outpatient (inpatient) claims files record the information about payments and medical treatments for each visit. These files contain the enrollee’s ID and birth date, hospital/clinic ID, date of visit, total medical expenses, total out-of-pocket costs, diagnosis\textsuperscript{39}, and the medical treatment.\textsuperscript{40} Second, we use enrollee ID to merge the enrolment files to get each enrollee’s demographic information, such as enrollee’s gender, household monthly income, number of siblings, and town of residence. Finally, we use hospital/clinic ID to link information (e.g., provider’s accreditation) in the provider files.

3.2 Sample

To avoid the effect of the variation in the cohort size on our estimation, we focus on the healthcare use from the same cohort (fixed panel). Our original sample is all NHI enrollees born between 2003 and 2004. The original sample size is 435,206 (see Table 3).\textsuperscript{41} We further restrict our sample to the enrollee who continuously register in NHI at age 2 and 3, which

\begin{itemize}
\item\textsuperscript{37}That is, we measure age in days.
\item\textsuperscript{38}Due to privacy concern, NHIRD only allows at most 10% sampling for each research application. Thus, we only use claims data of sample with age 2 and 3 during 2005-2008 and 1997-2001.
\item\textsuperscript{39}Diagnoses are recorded in five digits of ICD9 (International Classification of Diseases, Ninth Revision, Clinical Modification)
\item\textsuperscript{40}Inpatient claims files also have information about length of stay
\item\textsuperscript{41}Since 99% of Taiwanese are covered by NHI, these samples represent nearly the entire population of children born between 2003 and 2004 in Taiwan.
\end{itemize}
reduces the sample size by 8,619. In addition, we eliminate the sample with cost sharing waivers, such as, children with catastrophic illness and children from very low income families since these children do not experience any price change when turning three. The above sample selection reduces our original sample by 5.7% and the final sample size for estimation becomes 410,517. Table 3 provides summary statistics of the characteristics of enrollees at age 3 before and after the sample selection. We find that the selected characteristics are quite similar between the original sample and the final samples used in our empirical analysis.

We use 2005–2008 NHIRD data to obtain all records of outpatient visits and inpatient admissions when these children are age 2 and 3. Following Lien et al. (2008), we also excluded visits of dental services, Chinese medicine, and health check up with copay waiver.

Table 4 provides the descriptive statistics of outpatient visits and inpatient admissions and compares their characteristics within 90 days before and after the 3rd birthday. We can find children before their 3rd birthday use more outpatient and inpatient care. Most young children visit clinics for outpatient services. However, they tend to visit teaching hospitals more frequently before their 3rd birthday.

4 Empirical Specification

Our identification strategy is similar to the recent studies utilizing ”age discontinuity” to identify the insurance coverage effect (Card et al., 2008; Card et al., 2009; Anderson et al., 2012 ) or patient cost-sharing effect (Shigeoka, 2014) on medical utilization for adults or elderly. We are the first applying RD design to study the impact of patient cost sharing on healthcare utilization and expenditures for young children. The general form of our RD regression is as follows:

\[ Y_i = \beta_0 + \beta_1 \text{Age3}_i + f(a_i; \gamma) + \epsilon_i \]  

(1)

where \( Y_i \) is the outcome of interest for the child \( i \), such as 1) the number of outpatient visits or inpatient admissions; 2) total medical cost of outpatient or inpatient care at a given age. The variable \( a_i \) is children \( i \)'s age and is measured in days from her or his 3rd birthday, which is the 1096th day after birth. The \( \text{Age3}_i \) is a treatment dummy that captures the

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43NHI provides nine health check up with copay waiver for the children under age 7. Since patient cost sharing for these visits will not change at 3rd birthday, we eliminate these visits to avoid biased estimation.
44This choice is because our main results use 90-day as bandwidth.
45The calculation is 365 x 3 + 1 = 1096. We need to plus one due to lunar year.
higher cost patient sharing (losing cost sharing subsidy) at the 3rd birthday and is equal
to one if child $i$ is age 3 or older ($a_i \geq 1096$). The key assumption of RD design is that
the age profile of the healthcare demand is smooth (continuous). Thus, we assume $f(a_i; \gamma)$
is a smooth function of age with parameter vector $\gamma$ that accommodates the age profile
of outcome variables. The $\varepsilon_i$ is an error term that reflects all of the other factors that
affect outcome variables. Our primary interest is $\beta_1$, that measures any deviation from the
continuous relation between age and outcomes $Y_i$ at child $i$’s 3rd birthday (the treatment
variable switches from 0 to 1). If no other factors also change discontinuously around child’s
3rd birthday, that is, $E[\varepsilon_i|a_i]$ is continuous at age 3, $\beta_1$ can represent causal effect of higher
patient cost sharing on expenditure and utilization of young children’s healthcare. In general,
there are two ways to estimate $\beta_1$, typically referred to as the global polynomial approach
and the local linear approach (Lee and Lemieux, 2010).

In the global polynomial approach, we can use all available data\textsuperscript{46} to capture age profile
of healthcare demand $f(a_i; \gamma)$ by using a flexible parametric function (e.g., a third order
polynomial of age used in our analysis). One caveat of this approach is that an incorrect
regression functional form could create a biased estimate of $\beta_1$. To avoid a misspecification
bias, we adopt a local linear regression as our main specification and present the global
polynomial estimates for comparison.

In the local linear approach, we capture the age trend of the healthcare use $f(a_i; \gamma)$
by estimating a linear function over a specific narrow range of data on either side of the
threshold (3rd birthday). The local linear estimates of the treatment effect are differences
between the estimated limits of the outcome variables on each side of the discontinuity. Our
baseline specification is the following local linear regression:

$$Y_i = \beta_0 + \beta_1 \text{Age}_3 + \gamma_1 (a_i - 1096) + \gamma_2 \text{Age}_3 (a_i - 1096) + \varepsilon_i$$ (2)

In practice, we obtain the estimated treatment effect $\beta_1$ by allowing that the slope of the
age profile to be different on either side of the 3rd birthday by interacting the age variable
fully with $\text{Age}_3$, and estimating (2) via weighted least squares using a triangular kernel (i.e.,
giving more weight for the sample (data point) close to 3rd birthday).\textsuperscript{47} We restrict our
sample within 90 days before and after the 3rd birthday. The choice of bandwidth and the
computation of standard errors of discontinuity estimates are important issues for local linear

\textsuperscript{46}We have all NHI records of medical utilization within 365 days before and after individual’s 3rd birthday
(2nd birthday to 4th birthday).
\textsuperscript{47}As mentioned before, the 1096th day is the children’s 3rd birthday.
estimation. In Table A3, we will show that our main estimates are robust to the various choices of bandwidth and different methods of calculating standard errors.\footnote{Deciding how ”narrow” range of data, namely, choice of bandwidth, is critical to local linear estimation. If bandwidth is too wide, local linear estimate $\beta_1$ could be bias due to misspecification. That is, linear function is unable to capture age profile over such ”wide” range of data. If bandwidth is too narrow, there is not enough data for estimation to get precise local linear estimate. Thus, the optimal bandwidth needs to balance bias and precision (variance) for the estimates of $\beta_1$. This is a quite active filed in nonparametrics literature and there are many competing methods to select optimal bandwidth, such as, plug-in approach \cite{imbens2012plug},\cite{cattaneo2013semiparametric} and cross-validation approach \cite{ludwig2007large}. In Table A3, we will show that our main estimates are robust across various optimal bandwidth selectors. In addition, standard error of discontinuity estimate is also an important issue for local linear estimation since the available bandwidth selectors tend to give a ”large” bandwidth and lead to biased local linear estimates. One solution is to use bias-correction estimates, however, the conventional standard error of bias-correction estimates fail to consider variability of additional second order bias estimates, which result in too small standard error and makes false conclusion of statistical inference. Cattaneo et al. (2013) proposes a method to account for this variability to obtain the robust standard error and confidence interval. In Table A3, we will show the statistical inference of our main estimates are still valid even we take this conservative way to compute our standard error.}

Following Card et al. (2009), Anderson et al. (2012) and Lemieux and Milligan (2008), we collapse the individual level data into age cells(measured in day), which gives us the same estimates as the results from the individual level data, but substantially reduces computational burden. Therefore, our regressions are estimated on day level means at each day of age:

$$Y_a = \beta_0 + \beta_1 \text{Age}^3 + \gamma_1 (a - 1096) + \gamma_2 \text{Age}^3 (a - 1096) + \varepsilon_a$$ (3)

We also take the log of our dependent variables to allow $\beta_1$ to be interpreted as a percentage change in the dependent variables. That is, the dependent variables for RD estimation are the log of total outpatient (inpatient) expenditure, total number of outpatient visits (inpatient admissions), and outpatient (inpatient) expense per visit at each day of age.

The most important assumption for our RD estimation is that except for the higher patient cost sharing, there is no change in any other confounding factors that affect the healthcare demand at the 3rd birthday. For this age group, the potential confounding factors could be take-up of vaccines and pre-school attendance. The recommended immunization schedule could mechanically increase the healthcare spending and use of young children at age 3. However, this concern could be alleviated since children in Taiwan do not need to take vaccines while age 3 and indeed take most vaccines before two years-of-age\cite{center2013immunization}.\footnote{http://www.cdc.gov.tw/professional/page.aspx?treeid=5B0231BE894EDFFC&nowtreeid=1B4BACAO0D1FDDB84} On the other hand, entering preschool could increase the chance of

\footnote{http://www.cdc.gov.tw/professional/page.aspx?treeid=5B0231BE894EDFFC&nowtreeid=1B4BACAO0D1FDDB84}
getting diseases (e.g., the flu) for young children and then affect children’s healthcare use. This factor might not confound with the cost sharing change at age 3 because the age of entry for “public” preschool is four years-of-age and government does not enact statutory attendance age for “private” kindergartens. Most importantly, we measure children’s age at a daily level, so our RD design will be invalid only if these factors also change abruptly within one or two days of the 3rd birthday. This fact substantially alleviates the concern that our estimates would be biased by other factors. We will conduct several placebo tests to further confirm the validity of our RD design (e.g., using pre-reform data).

5 Results

In this section, we examine the impact of the children’s 3rd birthday (higher cost-sharing) on the healthcare expenditure and utilization. As mentioned above, our sample are the children born between 2003 and 2004 and continuously enrolled in NHI at age two and three. We follow this fixed panel of sample across their 3rd birthday to estimate the change in healthcare demand at age three. We will examine outpatient care first and then impatient care.

5.1 Outpatient Visits and Expenditures

From Section 2, we know the average out-of-pocket cost for each outpatient visit increases more than 100% when children pass their 3rd birthday. Our main question is how children’s healthcare demand respond to this exogenous price change. We begin with a graphical analysis.

5.1.1 Graphical Analysis

Figure 2a shows the actual and fitted age profiles of total outpatient expenditure for children born between 2003 and 2004. The dots in the figure represent total outpatient expenditure per 10,000 person years by patient’s age (measured in days) at visit. The solid line gives the fitted values from a local linear regression that interacts age variables fully with a dummy indicating after 3rd birthday. Corresponding to a sharp increase in patient cost expenditure at a particular age by the number of the enrollees born between 2003 and 2004 and then times 10,000. This is a common way to present data in the health economics and the public health literatures and can help us compare the estimated results across different sample period and subgroups.

We compute the total outpatient expenditure per 10,000 person years by dividing the total outpatient expenditure at a particular age by the number of the enrollees born between 2003 and 2004 and then times 10,000. This is a common way to present data in the health economics and the public health literatures and can help us compare the estimated results across different sample period and subgroups.

The dots represent means of the dependent variable for 10-day cells.

We use 90 days as our bandwidth.
sharing at the 3rd birthday (treatment), there is an obvious discrete reduction in outpatient expenditure when children turn three. The change in total outpatient expenditure could decompose into the change in the number of visits and outpatient expenditures per visit. Figures 2c and 2e represent actual and fitted age profiles of outpatient visits per 10,000 person years\textsuperscript{53} and outpatient expenditures per visit, respectively. We find both variables also suddenly jumping down right after the children’s 3rd birthday. On the other hand, we use pre-reform period data (1997-2001) to plot the related outcome variables in Figure 2b, 2d and 2f. In sharp contrast to the graphs presented above, We do not find any visible discontinuity at the 3rd birthday.

5.1.2 Main Results

Table 5 presents the estimated impact of the 3rd birthday on outpatient expense and visits before (1997-2001) and after (2005-2008) introducing TWCMS. Each panel (row) displays results for a different dependent variables of interest. Odd numbered columns present RD estimates from a nonparametric local linear regression and even numbered present RD estimates from a parametric OLS regression (cubic spline). Column (1) of Table 5 is our main results for outpatient services and displays the estimates from a local linear regression with a triangular kernel function and a bandwidth of 90 days of age.\textsuperscript{54} Corresponding to the sharp drop in outpatient expenditure at the 3rd birthday in Figure 2a, Panel A shows that higher patient cost-sharing at the 3rd birthday causes overall outpatient expenditures to significantly decrease by 6.9%. The implied arc-elasticity of outpatient expenditure is around -0.10.\textsuperscript{55}

The change in total outpatient expenditure comes from two margins: 1) the number of visits (extensive margin); 2) the outpatient expense per visit (intensive margin). Panel B reveals the number of outpatient visits decreases by 4.7% at the 3rd birthday, which is smaller than the change in total expenditure. The remaining change comes from change in medical cost per visit. Panel C reveals outpatient expense per visit significantly decrease

\textsuperscript{53}Again, each dot represents outpatient visits per 10,000 person years at given age and then take 10 days average.

\textsuperscript{54}restricting estimated sample within 90 days before and after 3rd birthday

\textsuperscript{55}The standard formula for price elasticity of demand is \(\frac{(Q_2 - Q_1)/Q_1}{(P_2 - P_1)/P_1}\), where \(Q_1\) and \(P_1\) denote the baseline healthcare demand and patient cost sharing, respectively and \(Q_2\) and \(P_2\) are the healthcare demand and patient cost sharing after change in cost sharing. However, in the health economics literature, many studies (Leibowitz et al., 1985; Manning et al., 1981; Chandra et al., 2010a) also use arc-elasticity, which defines percent change is relative to the average, since \(P_1\) could be zero in some cases (e.g., free plan in Rand HIE or this paper: zero out-of-pocket cost for inpatient care ) and the denominator of price elasticity is undefined in this case. That is, elasticity is calculated as \(\frac{(Q_2 - Q_1)/((Q_1 + Q_2)/2))/(P_2 - P_1))/((P_1 + P_2)/2)\)
by 2.2% at the 3rd birthday. In fact, this result is a combination of two forces. First, higher cost sharing at 3rd birthday could change the composition of patients and results in higher outpatient expense per visit at age 3. Assuming that the marginal patients are not as sick as those who enter hospitals/clinics regardless of cost sharing subsidy eligibility, the average health of patients may drop discretely at the 3rd birthday, which leads to higher medical costs per visit. Second, losing the cost sharing subsidy at the 3rd birthday could also affect patients’ choices of providers (quality of each visit) and causes lower outpatient expense per visit at age 3. As mentioned in section 2, TWCMS indeed subsidizes more out-of-pocket costs for teaching hospital patients than clinic/community hospital patients and would encourage patients to use outpatient services in teaching hospitals before the 3rd birthday. By doing so, patients not only can extract more subsidies but also receive the better quality of medical service. Therefore, when patients lose their eligibility for the cost sharing subsidy at the 3rd birthday, they would reduce the visits to teaching hospitals, which results in lower medical cost per visit. Our estimates in Panel C imply the latter force dominates the former one, which causes the outpatient expenditures per visit to exhibit a discrete drop at the 3rd birthday. In the section 5.1.4, we will discuss this issue in more detail.

5.1.3 Validity and Robustness Checks

Columns (3) and (4) in Table 5 display a placebo test using pre-reform data (1997-2001). The results reveal there is no discontinuity of our outcome variables at the 3rd birthday before 2002 (introducing TWCMS). The point estimates are insignificant and close to zero, which substantially reduces concerns about the impact of other confounding factors on our estimates. In Table A1, we conduct another placebo test by examining any discontinuity at other age cut-offs. We find our outcome variables (log of outpatient expenditure and number of visits) are smooth across selected age cut-offs, except 3rd birthday (1096 age of days).

For the robustness checks of our main specification, we use an alternative way (global polynomial approach) to estimate the discontinuity of outcome variables at 3rd birthday using all available data (365 days before and after 3rd birthday) and the third order poly-

56 Assuming that healthcare providers spend more costs on treating less healthy patients.
57 Every three to four year, Ministry of Health and Welfare evaluates every NHI contracted hospitals/clinics to determine the accreditation of the evaluated providers. The category of major teaching hospital is seen as the best quality among the providers.
58 Because the teaching hospitals may provide more medical service at each visit, such as health checks or medical treatments, it would cost more for each visit.
59 There are several "significant" discontinuities at other age cut-offs. However, their magnitudes are quite small.
nominal age function with different slopes on the either side of the 3rd birthday. The results in column (2) present very similar estimates as our main results. In Table A2, we systematically examine the sensitivity of our RD estimates to different bandwidth and order of polynomial. The estimates are quite stable across different specifications. In Table A3, we presents various local linear estimates from three different bandwidth selectors and kernel functions to show our main results are robust to these choices.

One caveat could threaten the validity of our RD design. Because every child eventually "ages out" of his/her cost sharing subsidy, parents may anticipate the sharp increase in medical price after children’s 3rd birthday and "stock up" on children’s outpatient care. This behavioural response represents inter-temporal substitution of health care (i.e., substitute future health care with current health care) and does not indicates “real” change (increase) in demand for healthcare induced by cost sharing subsidy, which is our main interest. Thus, such behavioural response tends to bias upward our estimates of change in healthcare demand at 3rd birthday (i.e., price elasticity of healthcare demand). From Figures 2a and 2c, we indeed find outpatient expenditures and visits suddenly rise at 20 days before the 3rd birthday. In order to account for the possible anticipation effect, we conduct a "donut" RD (Barreca et al., 2011; Shigeoka, 2014) by systematically excluding the outpatient expenditures and visits within 3-21 days before/after 3rd birthday (see Table A4 in appendix). Although there is no consensus for optimal size of a donut hole and eliminating the sample around threshold seems to contrast with the spirit of RD design, this type of estimation still can give us some sense of the "stock-up" effect on our estimates. The estimates from different "size" of donut hole give us very similar results as our main RD estimates.

5.1.4 Change in Choice of Providers at 3rd birthday

NHI in Taiwan (or other Asian countries) does not adopt a gatekeeper system to restrict patient’s choices of providers. Instead, NHI sets different cost sharing (copayment) for four types of providers to lead patients to choose the suitable provider according to their understanding of the seriousness of illness and then rectify possible moral hazard behaviors of choosing providers. As mentioned before, TWCMS exempts all NHI copayment for children under age 3, which gives us an unique opportunity to examine the impact of differential copayment on patient’s choice of providers by comparing the choice right before the 3rd birthday.

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60 Although most of outpatient visits for young children are acute diseases (e.g., 74% of visits are for respiratory diseases), it is hard to believe parents can substitute children’s outpatient care for the care after one month. However, it is possible to substitute outpatient care within few days.
birthday (uniform copayment\textsuperscript{61}) and right after the 3rd birthday (differential copayment).

Figures 3a to 3d present age profiles of outpatient visits by type of providers. We find outpatient visits for major and minor teaching hospitals have the strikingly discrete reductions just after the 3rd birthday. However, the number of visits for community hospitals has the opposite pattern, namely, jumps at the 3rd birthday and there is a little and less obvious drop in visits to clinic after the 3rd birthday. Most decline in the overall outpatient visits indeed comes from teaching hospitals. The visual evidence suggests the change in relative prices at the 3rd birthday results in a significant redistribution of caseloads across different types of providers.

Coinciding with the graphical evidence, the RD estimates in Panel A of Table 6 show that turning age 3 substantially reduces outpatient visits to major and minor teaching hospitals by 59% and 44%, respectively. But outpatient visits to community hospitals increases by 18% and caseloads of clinics decrease slightly by 2%. This result indicates patients are quite sensitive to the relative price (cost sharing) between different types of providers and can switch their providers easily. The following question is what kind of healthcare can substitute easily between teaching hospitals and clinics (community hospitals) ?

In Panel B of Table 6, we use outpatient expense per visit as a proxy for severity of illness.\textsuperscript{62} The estimates in Panel B reveal that turning age 3 substantially increase medical cost per visit for major and minor teaching hospitals by 20% and 6%, respectively. This result implies that most of the reduced visits to teaching hospitals at the 3rd birthday are actually for less severe diseases. Since patients reduce their utilization of teaching hospitals right after the 3rd birthday, we suspect these missing visits are not necessary to be cured at teaching hospitals but could also be treated at clinics/community hospitals, which implies substantial moral hazard of abusing outpatient services in teaching hospitals before the 3rd birthday. The above results suggest the relative level of copayment is an important factor to determine patient’s choice of providers. Maintaining differential copayment between different types of providers could be a powerful tool to allocate medical resources efficiently.

### 5.2 Inpatient Admissions and Expenditures

For young children, inpatient admissions are much less common than outpatient visits. Among our sample at age 2, the average annual number of outpatient visits is 19.8 but average annual inpatient admission is only 0.14. Nevertheless, the expense of one inpatient

\textsuperscript{61}Before the 3rd birthday, patients still need to pay registration fee. However, registration fee does not vary a lot across different providers.

\textsuperscript{62}Assuming more severe diseases would require more costs for each visit.
admission is 29 times more expense per outpatient visit (the expenditure of one inpatient admission is equal to the expense of 29 outpatient visits) and 17 percent of healthcare spending for young children is attributed to inpatient care. More importantly, patient cost sharing for inpatient admission at the 3rd birthday experiences a much larger increase than the one for outpatient visits in terms of both level and percentage change. That is, inpatient care could have substantial impacts on overall healthcare spending and individual’s out-of-pocket medical expense. Hence, understanding how young children’s demand for inpatient care responds to cost sharing has important policy and welfare implications.

However, the effect of turning age 3 (losing cost sharing subsidy) on the utilization of inpatient care is theoretically ambiguous. On one hand, children may have fewer inpatient admissions and expenditures when they turn three since patient cost sharing for inpatient care also increases sharply at the 3rd birthday. On the other hand, the type of inpatient care that young children usually use could be less price sensitive. Most admission diagnoses in early childhood, such as pneumonia and acute gastroenteritis, can be treated with medication or bed rest. Previous studies (Card et al., 2008; Shigeoka, 2014) found patient cost sharing (or insurance coverage) has less impact on this type of diagnosis for the elderly. In addition, for the admissions requiring surgery, such hospital stays for young children are seldom selective (e.g., osteoarthritis, hip and knee replacement) but could be life threatening and necessary (e.g., congenital heart disease). Thus, we should expect inpatient care for young children should be less sensitive to price changes at the 3rd birthday.

5.2.1 Graphical Analysis

Figure 5a shows the actual and fitted age profiles of inpatient admissions for children born between 2003 and 2004. Similar to the graphs for outpatient care (Figure 2), The markers represent total inpatient expenditure per 10,000 person years at given age, which is measured in days from the 3rd birthday. The solid line gives the predicted values from a local linear regression that interacts age variables fully with a dummy indicating ages after the 3rd birthday. Surprisingly, in contrast to the sharp drop in outpatient expenditure, Figure 5a shows that inpatient expenditure exhibits no change at the 3rd birthday. Similarly, Figures 5c and 5e represent actual and predicted age profiles of inpatient admissions and inpatient expenses per admission. We also find there is little visual evidence of any discontinuity in inpatient admissions and inpatient expenses per admission at the 3rd birthday. Compared with the graphs plotted by using pre-reform data (1997-2001), we find the outcome variables

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63 Average patient cost sharing for one inpatient admission increases by 1296 NT$ at 3rd birthday. However, average price for one outpatient visit only rise by 74 NT$. 

19
during pre/post period have quite similar age profiles.

5.2.2 Main Results

Table 7 presents the estimated effect of the 3rd birthday on inpatient expenditures and admissions before (1997-2001) and after (2005-2008) introducing TWCMS. Like Table 5 for outpatient service, each panel (row) displays results for a different dependent variables of interest. Odd numbered columns presents RD estimates from nonparametric local linear regression and even numbered present RD estimates from parametric OLS regression (cubic spline). Consistent with graphical evidence in Figure 5, all RD specifications in Table 7 suggest there is no statistically significant impact of turning age three on inpatient expenditures and utilization. The point estimates in column (1) of Table 7 (our baseline estimation) is close to zero and insignificant. It reveals losing cost sharing subsidy reduces the total inpatient expenditure by only 0.89% and the number of inpatient admissions by 0.18%. The implied arc elasticity of inpatient expenditure is close to 0.

There is little evidence on the impact of patient cost sharing on the demand of inpatient service. Our results are consistent with the findings in previous literatures. Shigeoka (2014) found the demand for inpatient admissions treated with bed rest and medication do not respond to price change at age 70 in Japan. Card et al. (2008) also have similar findings for Medicare receipts in US. Since most admissions for young children are belong to these types of inpatient care, our results suggest utilization of inpatient care for young children could have very limited response to patient cost sharing, which implies young children’s demand for inpatient care may not be discretionary but necessary. According to our estimates, providing full insurance coverage of young children’s inpatient service should be welfare improving since it will not cause moral hazard but substantially reduce financial risk brought by inpatient admissions.

6 Conclusion

Many developed countries subsidize young children’s healthcare by providing this demographic group relatively low patient cost sharing in their public insurance programs. The rationale of these medical subsidy policies is that young children are heavy user of healthcare, which might bring sizeable financial risk to young households. More importantly, these early life health interventions are widely believed to be beneficial to individual’s future life. To assess the efficacy of these subsidy policies, understanding how young children’s healthcare demand respond to patient cost sharing is essential. Yet the existing literature is very little
known about this issue.

In this paper, we provide the convincing evidence on the price response of healthcare for young children. We exploit a sharp increase in patient cost-sharing at age 3 in Taiwan that occurs when young children "aging out" of the cost sharing subsidy, which results in higher patient cost sharing for the children just after their 3rd birthday than the ones just before their 3rd birthday, and apply an RD design to estimate the impact of cost sharing on healthcare demand in early childhood. We reach three conclusions. First, the demand for outpatient service significantly respond to copayments change, but the estimated are elasticity of outpatient expenditure is modest (around -0.10). Second, differential copayments of outpatient service between hospitals and clinics is a powerful policy tool to allocate patients to the suitable providers based on their seriousness of illness. According to our estimates, due to the differential copayments, the number of visits for teaching hospitals is reduced by 50% and most of decreased visits are for less server diseases. Finally, the demand for inpatient service does not respond to price change. The implied arc elasticity of inpatient expenditure is close to zero. Rand HIE found mixed evidence on this issue and cannot strongly draw conclusion from them. Our results largely support the view that inpatient service for young children is not price sensitive. Taken together, theses results suggest the level of patient cost sharing for young children should be different by healthcare service (providers). For example, NHI should fully cover the medical cost of inpatient care for young children since it will not generate excess spending induced by moral hazard but fully protect patient’s risk from out-of-pocket expenses. On the other hand, NHI should set higher patient cost sharing for outpatient service at teaching hospital to reduce possible moral hazard behavior when patients choose providers.

Several important questions have not been analysed in this paper, such as the long-run health impact of this cost sharing subsidy program. Future research could focus on this issue and will give us more complete picture of the effect of similar programs in the world.
References


*Vaccination Schedule in Taiwan* (2013). Center of Disease and Control.
7 Tables and Figure

Table 1:
PATIENT COST-SHARING IN TAIWAN NHI

<table>
<thead>
<tr>
<th>Panel A:</th>
<th>Outpatient service: copayment (NT$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Patient Cost-Sharing</td>
</tr>
<tr>
<td></td>
<td>Major Teaching Hospital</td>
</tr>
<tr>
<td>NHI copayment</td>
<td>360</td>
</tr>
<tr>
<td>Average register Fee</td>
<td>150</td>
</tr>
</tbody>
</table>

Panel B:
Inpatient service: coinsurance

<table>
<thead>
<tr>
<th></th>
<th>1-30 days</th>
<th>31-60 days</th>
<th>after 61 days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
</tr>
</tbody>
</table>

Note: 1 US$ is 32.5 NT$ in 2006. For outpatient service, patient cost-sharing is through copayment. A patient pays NHI copayment plus registration fee for each visit. Information about NHI Copay is from National Health Insurance Research Database codebook (2012). NHI implements this fee schedule since July 2005. Since our sample period is from January 1st 2005 to December 31st 2008, most of our outpatient visits in our sample, except visits on January 1st 2005 to June 30th 2005, are based on the above fee schedule. Before July 1st 2005, NHI Copay for outpatient service is according to the following fee scheme: 210 NT$ for major teaching hospital, 140 NT$ for minor teaching hospital, 50 NT$ for community hospital, and 50 NT$ for clinic. Information about registration Fee is from an online database of NHI registration fee survey: [http://www.nhi.gov.tw/amountinfo/](http://www.nhi.gov.tw/amountinfo/) For inpatient care, patient cost-sharing takes place through coinsurance. Depending on the days of stay and the type of admission (acute or chronic admission), a patient is required to pay 10% to 30% of the total medical expense per admission. The above fee schedule is only for acute admission since we eliminate all chronic admissions, which only accounts for 0.3% of inpatient admissions.

Table 2:
WEIGHTED AVERAGE OUT-OF-POCKET COST PER VISIT/ADMISSION

<table>
<thead>
<tr>
<th>Type of Service</th>
<th>Before 3rd birthday</th>
<th>After 3rd birthday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outpatient service</td>
<td>58.9</td>
<td>132.7</td>
</tr>
<tr>
<td>Inpatient service</td>
<td>0</td>
<td>1296</td>
</tr>
</tbody>
</table>

Note: Data are pooled NHI claims records 2005-2008. Weighted average out-of-pocket costs per visit/admission are reported in New Taiwan Dollar (NT$). 1 US$ is 32.5 NT$ in 2006.
Table 3:
SELECTED CHARACTERISTICS AT AGE THREE BEFORE AND AFTER SAMPLE SELECTION

<table>
<thead>
<tr>
<th></th>
<th>(1) Original Sample</th>
<th>(2) Continuous enrollment at age two and three</th>
<th>(3) Eliminating cost-sharing waiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>0.525</td>
<td>0.525</td>
<td>0.524</td>
</tr>
<tr>
<td>Birth year: 2003</td>
<td>0.510</td>
<td>0.509</td>
<td>0.509</td>
</tr>
<tr>
<td>Birth year: 2004</td>
<td>0.490</td>
<td>0.491</td>
<td>0.491</td>
</tr>
<tr>
<td>1st birth</td>
<td>0.519</td>
<td>0.520</td>
<td>0.520</td>
</tr>
<tr>
<td>2nd birth</td>
<td>0.368</td>
<td>0.370</td>
<td>0.370</td>
</tr>
<tr>
<td>3rd birth (above)</td>
<td>0.113</td>
<td>0.112</td>
<td>0.110</td>
</tr>
<tr>
<td>Number of siblings</td>
<td>1.761</td>
<td>1.760</td>
<td>1.759</td>
</tr>
<tr>
<td></td>
<td>(0.671)</td>
<td>(0.671)</td>
<td>(0.669)</td>
</tr>
<tr>
<td>Number of children</td>
<td>435,206</td>
<td>426,587</td>
<td>410,517</td>
</tr>
</tbody>
</table>

Note: Column (1) presents the selected characteristics for original sample: all NHI enrollee born in 2003 and 2004. Column (2) restrict sample to enrollee who continuously register in NHI at age 2 and 3. Column (3) eliminates sample with cost-sharing waiver, such as, children with catastrophic illness (e.g., cancer) and children from very low income families since these children do not experience any price change when turning three.

Table 4:
DESCRIPTIVE STATISTICS

<table>
<thead>
<tr>
<th></th>
<th>Outpatient Service</th>
<th>Inpatient Service</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before 3rd birthday</td>
<td>After 3rd birthday</td>
</tr>
<tr>
<td><strong>Utilization</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average annual visits</td>
<td>19.8</td>
<td>19.0</td>
</tr>
<tr>
<td>Average out-of-pocket cost per visit (NT$)</td>
<td>58.9</td>
<td>123.1</td>
</tr>
<tr>
<td>Average medical expenditure per visit (NT$)</td>
<td>443.5</td>
<td>438.7</td>
</tr>
<tr>
<td><strong>Choice of providers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major Teaching Hospital</td>
<td>4.1%</td>
<td>2.3%</td>
</tr>
<tr>
<td>Minor Teaching Hospital</td>
<td>5.6%</td>
<td>3.7%</td>
</tr>
<tr>
<td>Community Hospital</td>
<td>3.8%</td>
<td>4.6%</td>
</tr>
<tr>
<td>Clinic</td>
<td>86.5%</td>
<td>89.4%</td>
</tr>
<tr>
<td>Number of children (visits &gt; 0)</td>
<td>375,493</td>
<td>364,075</td>
</tr>
<tr>
<td>Number of children-visit</td>
<td>2,003,097</td>
<td>1,954,591</td>
</tr>
</tbody>
</table>

Note: Data are pooled NHI claims records 2005-2008. The above descriptive statistics is based on records about outpatient (inpatient) service happened within 90 days before 3rd birthday and 90 days after 3rd birthday. For inpatient care, bandwidth is 238 days and we use all inpatient admissions happened within 238 days before and after 3rd birthday. Average annual visits is calculated by average visits at each age (measured in day) times 365. Average out-of-pocket costs and medical expenditures are reported in New Taiwan Dollar (NT$). 1 US$ is 32.5 NT$ in 2006.
Table 5: Change at 3rd birthday in Outpatient Expenditure and Visits: before and after reform

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Specification</td>
<td>Nonparametric</td>
<td>Parametric</td>
</tr>
<tr>
<td></td>
<td>Local linear</td>
<td>Cubic spline</td>
</tr>
</tbody>
</table>

| | (per 10,000 person-years) | |
| Visits rate at age 2 | 542 | 568 |
| Bandwidth (days) | 90 | 365 | 90 | 365 |

Panel A: Log(outpatient expenses)

| After 3rd birthday (X100) | -6.90*** | -6.99*** | 0.09 | 0.29 |
| | [0.49] | [0.46] | [0.24] | [0.22] |

Panel B: Log(number of visits)

| After 3rd birthday (X100) | -4.73*** | -4.77*** | 0.22 | 0.20 |
| | [0.31] | [0.32] | [0.17] | [0.16] |

Panel C: Log(outpatient expenses per visit)

| After 3rd birthday (X100) | -2.17*** | -2.22*** | -0.12 | 0.09 |
| | [0.29] | [0.27] | [0.13] | [0.13] |

Note: Our RD estimation is based on age cells rather than individual level. Age is measured in days. Each observation (age cell) represents outpatient utilization from 410,517 children. Odded column use data within 90 days before and after 3rd birthday (bandwidth is 90 days) and report the difference in local linear regression estimates just before and after 3rd birthday by using a triangular kernel, which gives higher weight on the data close to 3rd birthday. Asymptotic standard errors in parentheses. Evened columns present estimated regression discontinuities by using all available data (365 days before and after 3rd birthday) and flexible polynomial regression (cubic spline), allowing different slope on the either side of 3rd birthday. We use the same selection criteria to create pre-reform sample: enrollee born between 1995 and 1997 (when they are age 2 and 3). Therefore, we use 1997-2001 NHI data to obtain the above estimated results. Robust standard error in parentheses. *** significant at the 1 percent level, ** significant at the 5 percent level, and * significant at the 10 percent level.
Table 6:
CHANGES AT 3RD BIRTHDAY IN OUTPATIENT VISITS AND SPENDING: BY CHOICE OF PROVIDERS

<table>
<thead>
<tr>
<th>Providers</th>
<th>(1) Major teaching hospital</th>
<th>(2) Minor teaching hospital</th>
<th>(3) Community hospital</th>
<th>(4) Clinic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visits rate at age 2</td>
<td>22</td>
<td>30</td>
<td>20</td>
<td>469</td>
</tr>
<tr>
<td>(per 10,000 person-years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panel A:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log(number of visits)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After 3rd birthday (X100)</td>
<td>-59.29***</td>
<td>-43.89***</td>
<td>17.71***</td>
<td>-1.73***</td>
</tr>
<tr>
<td>[1.96]</td>
<td>[1.65]</td>
<td>[1.64]</td>
<td>[0.32]</td>
<td></td>
</tr>
<tr>
<td>Panel B:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log(outpatient expense per visit)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After 3rd birthday (X100)</td>
<td>19.85***</td>
<td>5.76***</td>
<td>0.05</td>
<td>-0.19*</td>
</tr>
<tr>
<td>[2.24]</td>
<td>[1.77]</td>
<td>[1.67]</td>
<td>[0.10]</td>
<td></td>
</tr>
</tbody>
</table>

Note: Our RD estimation is based on age cells rather than individual level. Age is measured in days. Each observation (age cell) represent outpatient utilization from 410,517 children. Column (1)-(4) present estimated regression discontinuities of each interested outcome for four types of health providers by using data within 90 days before and after 3rd birthday and report the difference in local linear regression estimates just before and after 3rd birthday by using a triangular kernel, which gives higher weight on the data close to 3rd birthday. Asymptotic standard errors in parentheses. *** significant at the 1 percent level, ** significant at the 5 percent level, and * significant at the 10 percent level.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td>Nonparametric</td>
<td>Parametric</td>
</tr>
<tr>
<td></td>
<td>Local linear</td>
<td>Cubic spline</td>
</tr>
<tr>
<td>Visits rate at age 2 (per 10,000 person-years)</td>
<td>3.9</td>
<td>2.3</td>
</tr>
<tr>
<td>Bandwidth (days)</td>
<td>90</td>
<td>365</td>
</tr>
</tbody>
</table>

### Panel A:

**Log(inpatient expense)**

After 3rd birthday (X100)

- **Nonparametric Local linear**: -0.89, [4.85]
- **Parametric Cubic spline**: 0.46, [4.31]
- **Nonparametric Local linear**: 0.39, [3.06]
- **Parametric Cubic spline**: 1.94, [3.14]

### Panel B:

**Log(number of admission)**

After 3rd birthday (X100)

- **Nonparametric Local linear**: -0.18, [2.82]
- **Parametric Cubic spline**: -1.26, [2.56]
- **Nonparametric Local linear**: 0.72, [2.06]
- **Parametric Cubic spline**: 2.60, [2.05]

### Panel C:

**Log(inpatient expense per admission)**

After 3rd birthday (X100)

- **Nonparametric Local linear**: -0.71, [3.49]
- **Parametric Cubic spline**: 1.72, [3.21]
- **Nonparametric Local linear**: -0.33, [2.96]
- **Parametric Cubic spline**: -0.66, [2.69]

**Note:** Our RD estimation is based on age cells rather than individual level. Age is measured in days. Each observation (age cell) represents inpatient utilization from 410,517 children. Odded column uses data within 90 days before and after 3rd birthday (bandwidth is 90 days) and report the difference in local linear regression estimates just before and after 3rd birthday by using a triangular kernel, which gives higher weight on the data close to 3rd birthday. Asymptotic standard errors in parentheses. Evened columns present estimated regression discontinuities by using all available data (365 days before and after 3rd birthday) and flexible polynomial regression (cubic spline), allowing different slope on the either side of 3rd birthday. We use the same selection criteria to create pre-reform sample: enrollee born between 1995 and 1997 (when they are age 2 and 3). Therefore, we use 1997-2001 NHI data to obtain the above estimated results. Robust standard error in parentheses. *** significant at the 1 percent level, ** significant at the 5 percent level, and * significant at the 10 percent level.
Table A1: Placebo Test for Other Age Cutoff

<table>
<thead>
<tr>
<th>Cutoff Age (days)</th>
<th>Coefficient on Cutoff Age</th>
<th>Cutoff Age (days)</th>
<th>Coefficient on Cutoff Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>886</td>
<td>0.66</td>
<td>1186</td>
<td>-0.63</td>
</tr>
<tr>
<td></td>
<td>[0.42]</td>
<td></td>
<td>[0.39]</td>
</tr>
<tr>
<td>916</td>
<td>0.09</td>
<td>1216</td>
<td>-0.31</td>
</tr>
<tr>
<td></td>
<td>[0.37]</td>
<td></td>
<td>[0.42]</td>
</tr>
<tr>
<td>946</td>
<td>-0.55</td>
<td>1246</td>
<td>0.85*</td>
</tr>
<tr>
<td></td>
<td>[0.39]</td>
<td></td>
<td>[0.50]</td>
</tr>
<tr>
<td>976</td>
<td>-0.46</td>
<td>1276</td>
<td>-0.59</td>
</tr>
<tr>
<td></td>
<td>[0.38]</td>
<td></td>
<td>[0.42]</td>
</tr>
<tr>
<td>1006</td>
<td>0.01</td>
<td>1306</td>
<td>-0.22</td>
</tr>
<tr>
<td></td>
<td>[0.38]</td>
<td></td>
<td>[0.42]</td>
</tr>
<tr>
<td>1096</td>
<td>-6.64***</td>
<td>1336</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>[0.44]</td>
<td></td>
<td>[0.44]</td>
</tr>
</tbody>
</table>

Log(outpatient visits)

<table>
<thead>
<tr>
<th>Cutoff Age (days)</th>
<th>Coefficient on Cutoff Age</th>
<th>Cutoff Age (days)</th>
<th>Coefficient on Cutoff Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>886</td>
<td>0.24</td>
<td>1186</td>
<td>-0.80***</td>
</tr>
<tr>
<td></td>
<td>[0.25]</td>
<td></td>
<td>[0.30]</td>
</tr>
<tr>
<td>916</td>
<td>-0.21</td>
<td>1216</td>
<td>-0.23</td>
</tr>
<tr>
<td></td>
<td>[0.29]</td>
<td></td>
<td>[0.27]</td>
</tr>
<tr>
<td>946</td>
<td>-0.21</td>
<td>1246</td>
<td>0.59*</td>
</tr>
<tr>
<td></td>
<td>[0.27]</td>
<td></td>
<td>[0.30]</td>
</tr>
<tr>
<td>976</td>
<td>-0.26</td>
<td>1276</td>
<td>-0.60**</td>
</tr>
<tr>
<td></td>
<td>[0.25]</td>
<td></td>
<td>[0.26]</td>
</tr>
<tr>
<td>1006</td>
<td>-0.26</td>
<td>1306</td>
<td>-0.12</td>
</tr>
<tr>
<td></td>
<td>[0.22]</td>
<td></td>
<td>[0.31]</td>
</tr>
<tr>
<td>1096</td>
<td>-4.54***</td>
<td>1336</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>[0.32]</td>
<td></td>
<td>[0.31]</td>
</tr>
</tbody>
</table>

Note: Our RD estimation is based on age cells rather than individual level. Age is measured in days. Each observation (age cell) represent outpatient utilization from 410,517 children. Column (1) and (3) indicates different cutoff age (measured in days) used in RD estimation. Note that 1096th age day is 3rd birthday and its estimate is corresponding to our main result in Table 5. Column (2) and (4) present estimated regression discontinuities of each interested outcome using data within 90 days before and after 3rd birthday and report the difference in local linear regression estimates just before and after 3rd birthday by using a triangular kernel, which gives higher weight on the data close to 3rd birthday. Asymptotic standard errors in parentheses. *** significant at the 1 percent level, ** significant at the 5 percent level, and * significant at the 10 percent level.
<table>
<thead>
<tr>
<th>Bandwidth (days)</th>
<th>60</th>
<th>120</th>
<th>180</th>
<th>240</th>
<th>300</th>
<th>360</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log(outpatient expenditure)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polynomial 1</td>
<td>-6.69***</td>
<td>-6.19***</td>
<td>-5.54***</td>
<td>-5.10***</td>
<td>-4.54***</td>
<td>-4.65***</td>
</tr>
<tr>
<td></td>
<td>[0.48]</td>
<td>[0.33]</td>
<td>[0.28]</td>
<td>[0.24]</td>
<td>[0.23]</td>
<td>[0.20]</td>
</tr>
<tr>
<td>Polynomial 2</td>
<td>-6.58***</td>
<td>-6.90***</td>
<td>-6.61***</td>
<td>-6.24***</td>
<td>-6.06***</td>
<td>-5.29***</td>
</tr>
<tr>
<td></td>
<td>[0.74]</td>
<td>[0.51]</td>
<td>[0.40]</td>
<td>[0.37]</td>
<td>[0.32]</td>
<td>[0.30]</td>
</tr>
<tr>
<td>Polynomial 3</td>
<td>-7.07***</td>
<td>-6.68***</td>
<td>-7.04***</td>
<td>-6.98***</td>
<td>-6.85***</td>
<td>-6.94***</td>
</tr>
<tr>
<td></td>
<td>[1.11]</td>
<td>[0.70]</td>
<td>[0.56]</td>
<td>[0.47]</td>
<td>[0.42]</td>
<td>[0.40]</td>
</tr>
<tr>
<td>Log(outpatient visits)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polynomial 1</td>
<td>-4.55***</td>
<td>-3.92***</td>
<td>-3.39***</td>
<td>-2.88***</td>
<td>-2.35***</td>
<td>-2.52***</td>
</tr>
<tr>
<td></td>
<td>[0.34]</td>
<td>[0.24]</td>
<td>[0.20]</td>
<td>[0.18]</td>
<td>[0.17]</td>
<td>[0.15]</td>
</tr>
<tr>
<td>Polynomial 2</td>
<td>-4.33***</td>
<td>-4.97***</td>
<td>-4.36***</td>
<td>-4.12***</td>
<td>-3.89***</td>
<td>-3.04***</td>
</tr>
<tr>
<td></td>
<td>[0.53]</td>
<td>[0.37]</td>
<td>[0.29]</td>
<td>[0.26]</td>
<td>[0.23]</td>
<td>[0.23]</td>
</tr>
<tr>
<td>Polynomial 3</td>
<td>-4.86***</td>
<td>-4.41***</td>
<td>-5.07***</td>
<td>-4.72***</td>
<td>-4.68***</td>
<td>-4.84***</td>
</tr>
<tr>
<td></td>
<td>[0.83]</td>
<td>[0.49]</td>
<td>[0.41]</td>
<td>[0.33]</td>
<td>[0.30]</td>
<td>[0.29]</td>
</tr>
</tbody>
</table>

Note: Our RD estimation is based on age cell rather than individual level. Age is measured in days. Each observation (age cell) represent outpatient utilization from 410,517 children. Each row indicates different order of polynomials used in RD estimation and each column denotes various bandwidth choice. We obtain RD estimates using OLS regression with uniform kernel function (similar to the parametric estimation in Table 5) Robust standard error in parentheses. *** significant at the 1 percent level, ** significant at the 5 percent level, and * significant at the 10 percent level.
Table A3:
SENSITIVITY TO BANDWIDTH SELECTOR AND KERNEL FUNCTION SELECTION IN NONPARAMETRIC RD REGRESSIONS

<table>
<thead>
<tr>
<th>Bandwidth selector</th>
<th>Log(outpatient expenditure)</th>
<th>Log(outpatient visits)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CCT</td>
<td>IK</td>
</tr>
<tr>
<td>Kernel function</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triangular</td>
<td>-6.64***</td>
<td>-6.63***</td>
</tr>
<tr>
<td></td>
<td>[0.48]</td>
<td>[0.44]</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>81</td>
<td>89</td>
</tr>
<tr>
<td>Uniform</td>
<td>-6.68***</td>
<td>-6.69***</td>
</tr>
<tr>
<td></td>
<td>[0.47]</td>
<td>[0.46]</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>65</td>
<td>66</td>
</tr>
<tr>
<td>Epanechnikov</td>
<td>-6.64***</td>
<td>-6.64***</td>
</tr>
<tr>
<td></td>
<td>[0.47]</td>
<td>[0.44]</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>75</td>
<td>82</td>
</tr>
</tbody>
</table>

Note: Our RD estimation is based on age cells rather than individual level. Age is measured in days. Each observation (age cell) represent outpatient utilization from 410,517 children. Each row indicates the specific kernel function used in nonparametric RD estimation and each column denotes the optimal bandwidth selector for choosing bandwidth. CCT is an optimal bandwidth selection method proposed by Matias D. Cattaneo, Sebastian Calonico and Rocio Titiunik (2013). IK is an optimal bandwidth selection procedure proposed by imbens and kalyanaraman (2012). LM is an optimal bandwidth selection procedure proposed by Ludwig and Miller (2007). The above table present estimated regression discontinuities of each interested outcome using data within specific bandwidth before and after 3rd birthday and report the difference in local linear regression estimates just before and after 3rd birthday by using a triangular kernel, which gives higher weight on the data close to 3rd birthday. Asymptotic standard errors in parentheses *** significant at the 1 percent level, ** significant at the 5 percent level, and * significant at the 10 percent level.
Table A4:  
**Donut RD for Outpatient Expenditure and Visits**

<table>
<thead>
<tr>
<th>Size of Donut around 3rd birthday</th>
<th>Log(outpatient expenditure)</th>
<th>Log(outpatient visits)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>After 3rd birthday (X100)</td>
<td>-6.90***</td>
<td>-6.67***</td>
</tr>
<tr>
<td></td>
<td>[0.54]</td>
<td>[0.48]</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>After 3rd birthday (X100)</td>
<td>-4.73***</td>
<td>-4.43***</td>
</tr>
<tr>
<td></td>
<td>[0.38]</td>
<td>[0.27]</td>
</tr>
</tbody>
</table>

Note: Our RD estimation is based on age cells rather than individual level. Age is measured in days. Each observation (age cell) represent outpatient utilization from 410,517 children. *** significant at the 1 percent level, ** significant at the 5 percent level, and * significant at the 10 percent level.
Figure 1: Age profile of out-of-pocket cost

(a) Average price per outpatient visit (NT$)  
(b) Average price per inpatient admission (NT$)

Notes: The line is from fitted a linear regression on age variables fully interacted with Age3, a dummy indicating after 3rd birthday. The dependent variable are average price per outpatient visit (inpatient admission) by patient’s age at visit (measured in days, 180 days before and after 3rd birthday). Each dot represents the mean (10-day cells) of the dependent variable.
Figure 2: Age profile of outpatient expenditure and visits

(a) Outpatient expenses per 10,000 person-years: 2005-2008

(b) Outpatient expenses per 10,000 person-years: 1997-2001

(c) Outpatient visits per 10,000 person-years: 2005-2008

(d) Outpatient visits per 10,000 person-years: 1997-2001

(e) Outpatient expenses per visit: 2005-2008

(f) Outpatient expenses per visit: 1997-2001

Notes: The line is from fitted a linear regression on age variables fully interacted with $Age_{3i}$, a dummy indicating after 3rd birthday (90 days bandwidth). The dependent variables are outpatient expenditure and visits per 10,000 person years, outpatient expenditure per visit by patient’s age at visit (measured in days, 180 days before and after 3rd birthday). Each dot represents the mean (10-day cells) of the dependent variables.
Figure 3: Age profile of outpatient visits per 10,000 person-years by type of provider

(a) Major Teaching Hospital

(b) Minor Teaching Hospital

(c) Community Hospital

(d) Clinic

Notes: Please see Notes under Figure 2
Figure 4: Age profile of outpatient visits per 10,000 person-years by diagnosis

(a) Acute upper respiratory infection
(b) Bronchitis

(c) Sinusitis
(d) Diseases of the skin

(e) Mental diseases
(f) Preventive care

Notes: Please see Notes under Figure 2
Figure 5: Age profile of inpatient expenditure and visits

(a) Inpatient expenses per 10,000 person-years: 2005-2008

(b) Inpatient expenses per 10,000 person-years: 1997-2001

(c) Inpatient admissions per 10,000 person-years: 2005-2008

(d) Inpatient admissions per 10,000 person years: 1997-2001

(e) Inpatient expenses per admission: 2005-2008

(f) Inpatient expenses per admission: 1997-2001

Notes: Please see Notes under Figure 2