Unintended Consequences of Health Care Reform in South Korea: Evidence from a Regression Discontinuity in Time Design

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Abstract

In June 2007, the South Korean government, hoping to reduce the state's share of health care costs, passed an amendment to the state-run health care system to transition from a copay system to a coinsurance system for outpatient services. This new policy effectively increased the out-of-pocket health care costs of outpatient services to South Koreans from 22 percent to 30 percent. This paper estimates the impact of the health insurance reform on outpatient health care utilization. Using a regression discontinuity in time design, I find that the abolition of the copayment program significantly increased system-wide outpatient health care utilization by up to 90 percent and reduced medical expenditures by 23 percent per visit. The copayment abolition incentivized beneficiaries to obtain more medical treatments during the grace period and enroll in supplemental private health insurance covering patient-sharing medical costs, allowing access to more medical services with lower marginal costs. Therefore, the abolition of the copayment and emergence of supplemental private insurance caused moral hazard and adverse selection problems, leading South Korea to become the country with the highest per capita utilization of outpatient health services worldwide since 2012.

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Keywords: health care utilization, copayment, regression discontinuity in time, adverse selection, moral hazard, supplemental private health insurance

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1 Introduction

South Korea has been ranked at the top of OECD countries for per capita outpatient health care utilization (OECD, 2019). The annual number of doctor consultations per capita in South Korea in 2017 was 16.6, which is approximately six more visits than the number observed for countries in the second tier, namely, Hungary and Slovakia. The higher number of outpatient visits reduces the level of health care quality in the short run when the supply of health care remains constant by increasing patient waiting time and shortening each patients consultation time. Furthermore, consulting more patients in a limited time is likely to make a doctor more physically tired, implying less attention given to each patient. In fact, the health care quality indicator for South Korea has exhibited a decreasing trend since 2008 (115 in 2008, 108.1 in 2009, 101.5 in 2010, 98.9 in 2011, 105 in 2012, 94.7 in 2013, 91.4 in 2014, and 94.5 in 2015; OECD, 2019).

The more serious problem faced by the South Korean government is the rapid increase in the difference in per capita annual outpatient visits compared to that in the second-tier countries. Based on the OECD Health Statistics (OECD, 2019), Japan was the country with the highest per capita outpatient visits until 2009, while South Korea ranked third in 2002. However, due to the sharp increase in the annual average number of outpatients per capita, South Korea ranked second beginning in 2005, becoming the top country in 2010. Except in 2011, when Japan once again was ranked first, South Korea has been the top country among OECD countries from 2012 to the present. The problem is that the gap between South Korea and the second-tier countries has increased dramatically every year: 1.4 (vs. Japan in 2012), 1.8 (vs. Japan in 2013), 3.6 (vs. Japan in 2014), 3.2 (vs. Japan in 2015), 4 (vs. Japan in 2016), and 5.7 (vs. Hungary and Slovakia in 2017).

To deliver better–quality health care services and reduce the financial burdens associated with the governments health care spending, it is important to find out which factors have contributed to the recent dramatic changes in the outpatient health care utilization

rate in South Korea. Many studies have pointed out that supplemental private health insurance that covers all (or most) patient sharing of medical bills for both outpatient and inpatient health care services is one of the main factors (Kim, 2014; Kim, 2011; Park and Jeong, 2011). However, no study has successfully determined why people became interested in supplemental health insurance even with low health expenditure (7.34%), as a share of the nation's GDP, compared to that in other OECD countries (12.59%), the United States (17.07%) or the EU (9.93%) as of 2016 (WHO, 2019).

This paper applies a regression discontinuity in time (RDiT) design to estimate the effect of the abolition of a copayment program on outpatient health care utilization in South Korea. In the early 2000s, the Korean government expressed concerns that the copayment program may result in excessive medical use at low cost and therefore threaten the financial stability of the National Health Insurance (NHI) program. Thus, in 2007, a medical amendment was passed to abolish the copayment program in order to increase patients' financial share of health care costs and reduce medical care overuse. This nationwide health care policy change demonstrates several benefits when the RDiT design is applied. First, this policy change was implemented for everyone living in Korea, thereby preventing self-selection problems. Second, the policy could not have been anticipated, and therefore, its implementation and timing can be thought of as random. People had little incentive to manipulate hospital visits before the amendment was enacted. Even though the amendment was expected to pass, people knew that there would be a grace period in which they could still benefit from the copayment program.

I obtained rich data on hospitalization for NHI beneficiaries from the Korean National Health Insurance Service (NHIS). As of 2018, approximately 97 percent of the total population was covered by NHI, and the remaining 3 percent was covered by the Medical Aid program[1]. NHIS tracks all of the medical records for all recipients and randomly selects

1. The Medical Aid program is similar to the Medicaid program in the United States, which provides support for low-income households that have difficulty covering health care costs.

one million beneficiaries nationwide each year to provide data for public access.

This paper estimates the local average treatment effect (LATE) of the abolition of the copayment program on outpatient use by focusing on the changes in overall outpatient visits, average health care cost per outpatient visit, and total outpatient health care expenditures using an RDiT. In contrast to theory, I find that as soon as a medical amendment to abolish the copayment was passed, unexpectedly, total outpatient utilization increased, and health care spending per visit decreased. In particular, monthly hospitalization increased by up to 90 percent while one-time health service use increased by 110 percent, and the number of patients who visit the hospital multiple times for the same condition decreased by 56 percent. In contrast, health care spending per visit decreased by 23 percent, with NHI sharing decreasing by 24 percent and patient sharing decreasing by 21 percent, showing that outpatients treated for relatively mild symptoms increased.

Why did this policy change, which aimed to increase patients' economic burden, increase the use of health care services? First, there was a two-month grace period between when the amendment was passed (June 2007) and when the amendment was implemented (August 2007), and NHI subscribers increased their demand for medical care services before the cost of health care increased. Although NHI subscribers may have felt only slightly uncomfortable due to minor symptoms, they sought to visit their doctors more frequently during the grace period to avoid additional higher costs in the future.

Second, the patient-sharing burden decreased after the policy was implemented due to the emergence of supplemental private insurance and the new coinsurance program. As the supplemental private insurance reimburses the patient share of copayment or coinsurance, the increased cost sharing of NHI subscribers due to the abolition of the copayment program resulted in a rapid increase in private insurance enrollment. As a result, the marginal cost for medical services became almost zero, making it considerably cheaper for outpatients to access medical services. Furthermore, outpatients with private insurance

pay a monthly premium of 8,000 South Korean won (KRW) for supplemental insurance, or approximately US$7 for, for example, a 40-year-old man in 2007, which leads to the abuse of medical services to compensate for monthly premium payments[2].

Furthermore, under the new coinsurance program, patient sharing per visit became even less expensive for some minor symptoms. Under the previous copayment program, patients paid 3,000 KRW (US$2.73) if the total bill was equal to or less than 15,000 KRW (US$13.64). After the copayment program was abolished, patients paid 30 percent of the full price of the total bill, meaning that if the bill was less than 10,000 KRW (US$9.10), the patient's share was less than 3,000 KRW (US$2.73), which is lower than the share under the copayment program. Therefore, reduced patient sharing due to private insurance and coinsurance made medical care services more affordable, particularly for mild symptom treatments such as colds and flu.

This paper contributes to the literature in three dimensions. First, the unexpected decision on nationwide health care reform allows us to use a quasi-experimental design to estimate how people respond to changes in health care cost-sharing plans. This unique research environment permits us to derive a causal relationship between health care costs and utilization.

Second, the findings of this study suggest that increased patient cost-sharing does not necessarily reduce health care utilization, in contrast to the existing literature (Newhouse 1993; Fendrick et al., 2001; Rosen et al., 2005). This result does not imply that demand for health care does not respond to a change in price. Rather, people seek alternative options to reduce the increased cost-sharing and may possibly use more health care services if an alternative financial service ultimately reduces the patient share. Although cost sharing did not increase significantly when switching from copayment to coinsurance, supplemental private health insurance, which effectively created a "zero–price" effect, led to an increase in

2. The average exchange rate for the study period (2002-2015) is approximately 1,100 KRW per USD. This exchange rate is used throughout the study.

demand for outpatient services (Iizuka and Shigeoka, 2018; Shampanier et al., 2007; Douven et al., 2017).

Lastly, this paper examines the factor that encouraged the enrollment in supplemental private insurance and the subsequent increase in low–value outpatient health care utilization. Research has shown that supplemental private health insurance may increase the use of health care services due to moral hazard and adverse selection problems (Coulson et al., 1995; Keane and Stavrunova, 2016; Heung-Sik Kim, 2003). To our knowledge, there is little discussion about the policy interventions that cause existing health insurance beneficiaries to have supplemental private health insurance.

This study has significant policy implications. First, the use of supplemental private health insurance should be limited to mid- or high-value health care services, and the copayment should be reintroduced for low-value health care services. The effects of the copayment on health care utilization have been well documented (Vincenzo Carrieri, 2010; Jens Holst, 2010; Katherine Swartz, 2010), and the copayment program can still be useful in increasing patient burdens for low-value medical services. Second, the abolition of the copayment program unintentionally induces private insurance enrollment, and private insurance causes marginal health care costs to approach zero, resulting in excessive health care utilization by private insurance subscribers. This finding suggests that changes to existing policy or the introduction of new policy should be managed carefully. All potential impacts must be considered before implementing policy changes; otherwise, interaction effects between related policies may cause unexpected results.

2 Background

2.1 Korean health care system and copayment program

The NHIS is a single compulsory national insurance system in South Korea under the Ministry of Health and Welfare. The NHIS covers the entire population residing within the country including overseas Koreans and foreign residents. As of February 2018, the NHI insures 97.1 percent of the population, and the remaining 2.9 percent, which is classified as low-income households, is supported by the Medical Aid program[3].

Since 1963, the National Health Insurance Corporation (NHIC) has mandated coinsurance for inpatient care (20 percent) and doctor visits (30 percent). However, the NHIC was concerned about excessive medical use due to low patient sharing of coinsurance. Thus, in 1987, the NHIC implemented a copayment policy that was aimed at increasing patient sharing by up to 50 percent. If medical expenses are less than 10,000 KRW (US$9.10), 2,000 KRW (US$1.82) will be paid according to the copayment policy. Because the average medical cost was approximately 4,000 KRW (US$3.64), which means that patient sharing is greater than 30 percent, the copayment policy was effective enough to reduce health care utilization (Kim, 2007).

The copayment policy was revised for many years but not adequately adjusted for economic development and inflation. As a result, patient shares gradually decreased to 22 percent in 2001. In addition, in 2001, the NHI fixed the copayment as 3,000 KRW for medical bills equal to or under 15,000 KRW and announced that the copayment rate would no longer be adjusted in the future. Column 1 in Table 1 shows the amount of patient sharing under copayment depending on the medical bill range. Under the copayment program, patients pay 3,000 KRW if their medical bills are equal to or less than 15,000 KRW. Because the copayment program was only applied to outpatient bills less than 15,000 KRW, the patient share of a bill above 15,000 KRW was 20–30 percent of the final medical bill depending

3. https://www.nhis.or.kr/menu/retriveMenuSet.xx?menuId=B2220 (in Korean)

on the examination and treatment each beneficiary received (Table 1), which is the same before and after the health care reform.

Due to the low patient–sharing cost per outpatient visit, the outpatient utilization rate has consistently increased since 2001 (Figure 1). According to the 2007 OECD Health Data[4], South Korea ranked 3rd among OECD countries using 11.8 outpatient health care services per capita per year. Therefore, the copayment policy was criticized for the continued increase in total medical costs due to the overuse of medical services. Therefore, on June 7, 2007, the government passed medical reforms to abolish copayments and return to the coinsurance system to prevent the excessive use of medical services and promote the financial stability of the NHI. Since August 2007, beneficiaries have been responsible for 30 percent of the total outpatient care as shown in column 2 in Table 1. However, outpatients who are seniors aged 65 years and older can continue to use the existing copayment program, and the copayment for children younger than six years is only 70 percent of the copayment for adults.

2.2 Supplemental private health insurance

Many countries have introduced private health insurance to complement the NHI system. In Germany, for example, since 2009, people have been mandated to enroll in private insurance if they do not have NHI. This requirement was implemented because more people would be able to benefit from medical insurance, putting additional resources into the medical system and broadening patient choices.

In October 2003, the Korean government allowed private insurance to enter the health insurance market to minimize financial problems at the NHIS due to the excessive use of medical services and to reduce the economic burden of patients suffering from diseases that the NHI does not cover. Supplemental private insurance covers the patient's share of

4. http://www.oecd.org/els/health-systems/health-data.htm

both inpatient and outpatient medical costs. Inpatient medical treatment can be covered up to 50 million KRW (US$44,000) per day, and outpatient treatments are covered to up to 250,000 KRW (US$230) per visit. The monthly premium varies based on each subscriber's condition, such as age, sex, and chronic disease; in 2007, the cost was 8,000 KRW (US$7) for a 40-year-old man.

Medigap, a form of private supplemental insurance in the U.S., has similar characteristics to the private insurance sold in South Korea. Medigap was introduced to supplement Medicare, the primary health insurance for most elderly people introduced in 1965. If a senior 65 years or older has paid Medicare taxes for more than 40 quarters, he or she qualifies for Medicare. Even if they have Medicare, however, elderly people spend approximately 22 percent of their average income on medical expenses because Medicare only covers approximately 45 percent of medical expenses (Kaiser Family Foundation, 2005). Private insurance companies introduced Medigap policies to the market to cover some uncovered costs by Medicare, including copayments and deductibles (Fang et al., 2008).

Some argue that Medigap increases Medicare spending due to the presence of moral hazard and adverse selection. Individual supplemental health insurance, such as Medigap, reduces the marginal cost of patient sharing, sometimes even close to zero, which results in excessive medical use because of a moral hazard (Coulson et al., 1995). For adverse selection, Keane and Stavrunova (2016) show that a healthier individual with Medigap tends to use more health care services and that Medicare spending therefore increases by approximately 24 percent. Kim (2003) argues that U.S. Medigap case studies suggest that supplemental private insurance may have negative impacts on the NHI and that the Korean government should focus on minimizing the impact on the market rather than promoting supplemental private insurance.

3 Data

The study is based on national hospitalization data for NHI beneficiaries from 2002 to 2015. Because the NHI consists of a compulsory single health insurer in the country, it tracks all medical records for both inpatients and outpatients covered by NHI. To publicly disclose data, the NHI randomly selects one million beneficiaries each year from among the beneficiaries who visited hospitals at least once during the year[5]; the data include all their hospitalization records for that year.

This study focuses on national outpatient health care utilization, and this approach is motivated by the following considerations. First, the copayment policy was implemented only for outpatient medical costs equal to or less than 15,000 KRW (US$13.64). Furthermore, the change in health care policy impacts outpatient health care services for overall diseases covered by the NHI. Since estimating the average treatment effect on a daily basis is difficult, the data are aggregated by month to examine the changes in the hospitalization rate. Finally, this paper uses outpatient visits of all age groups. Although children (0–5 years) and seniors (65+ years) are excluded from the copayment abolishment, this paper aims to investigate the effects of supplemental private health insurance that were triggered by the abolition of the copayment and the vulnerable groups of the population, such as children and the elderly, who are likely to have supplemental private health insurance supported by their guardian.

The data used for this analysis cover all the cities and provinces in Korea for the 14-year period from 2002 to 2015. To examine the changes in outpatient utilization, I exclude inpatient hospitalization data and those observations for which the sum of patient sharing and NHI sharing does not equal the total health care cost due to errors in data collection. The total number of outpatient observations is 105 million. Because the average

5. OECD Health Data (2007) show that the per capita outpatient utilization rate in a year is 11.8 in Korea, implying that using sample data based on beneficiaries who use outpatient health care services at least once a year is not problematic.

treatment effect is difficult to estimate using daily hospital outpatient visit data, the data are aggregated temporally by month to focus on the monthly variation in hospitalization. Therefore, I construct panel data using monthly average hospitalization data from 16 cities and provinces[6].

Table 2 shows the summary statistics for the key variables used in this study. *Monthly hospitalization* is approximately 40,000, but this does not provide much information because it is from the sample data. Instead, I use a natural logarithm transformation to determine the percentage of changes in health care utilization. *Age* is the monthly average age of outpatients. The NHIS provides age group data, and I use the mean number of each age group for each beneficiary. For example, one beneficiary is in the age group between 20 and 24 years old, and 22 is used for the subscriber's age. *Sex* is a dummy variable that equals one if the beneficiary is female and zero otherwise. An average sex ratio of 0.58 implies that women visit physicians more frequently than men. The medical cost per visit is 19,839 KRW (US$18) per patient, of which the patient pays 6,011 KRW (US$5.47), and the remaining 13,804 KRW (US$13) is paid by the NHI. Patients share approximately 30 percent of the per-visit medical cost, and the NHI pays 70 percent.

4 Empirical Strategy

To evaluate the causal effect of the new policy or its changes, a randomized controlled trial (RCT) or other quasi-experimental methodologies are preferred for establishing treatment and control groups and estimating the differences in outcomes. However, the change in the national program in this study was applied to all NHI beneficiaries, who account for approximately 97 percent of the total Korean population, and it is difficult to estimate the causal effect of health care reform due to the lack of a clean control group.

6. Sejong is a new city separated from Chungnam in 2012. For simplicity, Sejong is included with Chungnam Province.

To address this challenge, I apply an RDiT to analyze changes in outpatient health care utilization before and after the abolition of the copayment program. First, a parametric RD design is implemented to assess the treatment effects of eliminating the copayment program on health care utilization and expenditures. Second, I estimate the average treatment effect using a local linear regression at the cutoff τ, following Calonico et al. (2017) and Roh (2017). Then, I repeat the RD regression using various alternatives, such as including covariates and different bandwidths above and below the cutoff.

4.1 Regression discontinuity in time to estimate LATE

For identification purposes, I consider that the outpatient hospital utilization and expenditures changed as soon as the medical amendment was passed in June 2007, not in August 2007, when the policy actually went in effect. NHI beneficiaries responded as soon as the health insurance reform was confirmed. The running variable is time t, and treatment status is defined as:

$$D_{ct} = \begin{cases} 1 & \text{if } t \geq \tau \\ 0 & \text{if } t < \tau \end{cases} \tag{1}$$

where D_{ct} is a dummy for the abolition of the copayment, τ is a cutoff (June 2007), and c and t indicate city and time, respectively.

The baseline parametric RD specification to estimate the causal effects of health care reform on health care utilization and expenditure is as follows:

$$Y_{ct} = \alpha + \beta_1 \cdot D_{ct} + \beta_2 \cdot \psi(Z_{ct}) + \beta_3 \cdot X_{ct} + \eta_c + \epsilon_{ct} \tag{2}$$

where β_1, the coefficient of interest, measures the causal effect of copayment abolition. X includes control variables (average age and sex ratio). The city fixed effect η_c is included to control for unobserved heterogeneity between cities and provinces. $\psi(Z_{ct})$ is a continuous

function of the running variable T with a polynomial of degree two.

I use cluster-robust standard errors at the city/province level to control for within–cluster serial autocorrelation. Clustering allows consideration of the within-cluster correlation of standard errors and prevents the standard errors from being too small, which leads to narrower confidence intervals, larger t-statistics, and lower p-values (Cameron and Miller, 2015).

Second, a nonparametric RD model is used to estimate discontinuity in the conditional expectation $E[Y_{ct}|Z_{ct}]$ at the cutoff. A local polynomial model uses only observations within a given bandwidth around the cutoff and is preferred over the global approach because including observations far from the threshold can lead to bias in estimating LATE (Gelman and Imbens, 2017). For the polynomial order, I use a polynomial of order one, as recommended by Gelman and Imbens (2017). High-order polynomials can cause significant approximation errors, such as noisy estimates, results sensitive to the degree of the polynomial, and poor coverage of confidence intervals. Skovron and Titiunik (2016) also argued that a lower order of polynomial is preferred when using an optimal bandwidth selector, allowing it to flexibly adjust the bandwidth size for better approximation in a given polynomial order. The preferred local linear RD estimator in this study is defined as follows:

$$\hat{\beta}_{RD} = \hat{\alpha}_+ - \hat{\alpha}_- \tag{3}$$

where $\hat{\alpha}_+, \hat{\alpha}_-$ are defined through

$$\hat{\phi}_Y = \underset{\hat{\alpha}_+,\hat{\alpha}_-,\hat{\lambda}}{\operatorname{argmin}} \sum \{Y_{it} - D_{it}(\alpha_+ + \lambda_+ Z_{it}) - (1 - D_{it})(\alpha_- + \lambda_- Z_{it})\}^2 \cdot K(\frac{Z_{it}}{b}) \tag{4}$$

where $\hat{\phi}_Y = [\hat{\alpha}_+, \hat{\alpha}_-, \hat{\lambda}_+, \hat{\lambda}_-]$, $K(\cdot)$ is a kernel function, and b is its bandwidth.

The local linear RD estimator $\hat{\beta_{RD}}$ can be estimated by the vertical distance between

the estimated intercepts of the weighted linear regression $[\hat{\alpha}_+, \hat{\alpha}_-]$ applied separately to the left and right of the cutoff (Roh, 2017). The weighting is determined by the kernel function $K(Z_{it}/b)$ in equation 4; in particular, I use a triangular kernel function, where $K(u) = 1\{|u| \leq 1\} \cdot (1 - |u|)$, which assigns zero weight to all of the observations outside the bandwidth interval $[x_0 - b, x_0 + b]$ and positive linear down-weighting to the observations in the interval. This approach leads to a point estimator with optimal variance and bias properties (Roh, 2017; Calonico et al., 2017; Skovron and Titiunik, 2016).

For the bandwidth, I apply a data-driven mean squared error (MSE) optimal bandwidth selection proposed by Calonico et al. (2017). This up-to-date version of the optimal bandwidth selector provides the different MSE optimal bandwidths above and below the threshold, while employing the same kernel function for units in each bandwidth.

5 Results

In addition to regression analyses, graphical evidence provides important information for estimating the effects of the program using an RD in time design. Therefore, this paper first analyzes the graphical evidence and then discusses the regression results. Figure 2 displays the monthly average outpatient hospital visits from January 2002 to December 2015. I fit a local linear regression to estimate $\hat{\alpha}$ for each side of the cutoff month, June 2007 when the amendment was passed. On the left-hand side of the cutoff, before June 2007, it shows an increasing trend of health care utilization. The Korean government was concerned about this increasing trend, which could threaten the sustainability of the NHI in the future, and thus decided to terminate the copayment program that was suspected to be the main cause of health care overuse. If the abolition of the copayment program has a significant effect, the hospital visits at the cutoff point must sharply decrease.

In contrast to expectations, Figure 3 (a) shows that the number of outpatient visits increased sharply as soon as the health care policy amendment passed in June 2007,

providing evidence that the abolition of the copayment program has had a significant impact on outpatient health care utilization growth. Outpatient visits clearly increase at the cutoff and visually, the monthly outpatient health care use increases by approximately 100 percent. In contrast, Figure 2 (b) shows the total health care spending during the study period. Despite the discontinuous increase in the use of health care at the threshold, there is no graphical evidence of significant changes in total health care expenditures, suggesting a trade-off between the number of hospitalizations and the cost of each medical care use.

Figure 2 (c) shows the changes in medical expenses per visit. Per-visit health care costs decrease sharply in the cutoff month, providing some evidence for why total medical expenditure does not change in the cutoff month despite the significant increase in health care utilization. Due to an increase in hospital visits with more minor symptoms, the average health care costs per visit can decrease; thus, I find no graphical evidence of changes in overall health care spending.

The results of regression analysis, however, differ slightly from the graphical results. Columns 1-3 in Table 3 display the results from the fixed effects model with different bandwidths manually applied. The first column shows the results of the entire study period, while the results shown in the second and third columns are based on 6-month and 3-month intervals before and after the cutoff point, respectively. As the bandwidth decreases, the magnitude of the effect decreases from approximately 60 percent to 30 percent, while the estimates remain statistically significant. Columns 4 and 5 are estimates based on the parametric and local linear model using equations 2 and 4, respectively. Although the estimates of the parameter models are statistically significant, and their magnitudes are also similar to the estimates of the fixed effects model in Columns 1-3, the estimates of the local linear model are positive but statistically non-significant.

To investigate the difference in graphical evidence and insignificant regression results, I return to examining the cause of the increase in hospital utilization. As mentioned earlier,

the abolition of copayment caused health care subscribers to become more fearful of higher hospital expenses, which motivated the use of private health insurance as a defense against this expense increase. If private insurance subscribers were responsible for the increase in outpatient services due to moral hazard, which implies the excessive use of medical services that have a marginal cost approaching zero, there would be some changes in the characteristics of outpatient users that lead to an endogenous effect on outpatient health care utilization.

Two variables can be used to examine changes in the characteristics of outpatient medical users using a given dataset: *Age* and *Sex ratio*. Figure 3 shows the monthly average age and sex ratio of outpatient medical users throughout the study period. As shown in Figure 3 (a), the average age of outpatients has an upward curve due to aging, but there is no significant difference in the increase or decrease at the threshold. Conversely, in the graph of average sex ratio in Figure 3 (b), a very clear increase can be seen based on the cutoff point. Considering that the sex ratio is composed of indicator variables with 0 for males and 1 for females, it can be seen that the outpatient utilization of women has increased rapidly after the amendment of the medical law passed. This result can be interpreted in various ways, but the most realistic interpretation concerns the gender differences in the utilization of health care services.

Studies over the last several decades have shown that women use more health care services than men (Bertakis et al., 2000; Cleary et al., 1982; Cylus et al., 2011; Verbrugge et al., 1987) and that this difference is mainly due to biological and behavioral differences (Regitz-Zagrosek, 2012), socio-economic and socio-demographic status differences (Cherepanov et al. 2010), and differences in the perceptions of illness (Hibbard and Pope, 1983; Richardson and Mitchell, 2010). Noh et al. (2017) confirm that women use more health care services than men in Korea.

Due to the lack of information regarding private health insurance subscribers, ar-

riving at an accurate conclusion is difficult, but based on the results above, abolishing the copayment program promoted private health insurance as a defense mechanism against the increase in medical costs, and South Korean women, who are likely to use more health care services, are more active in accessing private health insurance. In addition, the marginal cost of using additional medical services after joining private insurance became almost zero, and the use of medical services increased sharply due to the moral hazard caused by private insurance subscribers.

If the rapid increase in the use of medical services is attributable to private insurance and if the participants in this private insurance are mainly women, a fuzzy RD in time design can be used by assuming that health care subscribers are partially enrolled in private insurance; thus, the assignment to treatment (enrolling private insurance) depends on the sex ratio. Column 1 in Panel A in Table 4 shows the results of the regression analysis using fuzzy RD in time, and the average number of outpatient users per month increased by approximately 90 percent due to the elimination of the copayment program. However, even after controlling for endogeneity, the estimates are positive but still not statistically significant. The total health care cost shows no significant change, and the per-visit health care cost is significantly reduced by approximately 23 percent. Thus, as with the previous results, a significant decrease in per-visit health care costs made it difficult to find a significant change in total health care costs despite the increased use of health care services, as shown in Panel B.

What does it mean when health care costs per-visit decline significantly? Per visit health care costs are related to the severity of a patient's illness. In general, outpatients are charged for quality of care, consultation hours, and additional medical care (injections, bandages, etc.). Therefore, if the illness is minor or if additional medical care is not required, the per-visit medical treatment charge will be low in cost. Therefore, the lowered cost of per-visit medical services implies that the illness of visiting patients is mild. This can be

attributed to the abovementioned moral hazard, which is characteristic of private insurance subscribers who want to use hospital services to the fullest extent for mild illnesses because of the reduced marginal cost of hospital visits.

Changes in illness severity can be identified using the number of times that the health care service is used for the same condition. If the illness is mild, doctors are not likely to recommend more than visit for medical treatment for the same illness. Since Korea is one of the countries with the highest number of medical services per capita in the world, doctors do not recommend the use of additional medical services for relatively minor illnesses. However, if the condition is severe or chronic, the patient may use more than one outpatient service for the same condition. Therefore, this study is divided into two cases: 1) one-time visits to outpatient services for the same condition; and 2) multiple visits for the same condition.

Figure 4 shows the average number of visits per month for patients using the outpatient service for the same disorder once and for those using it more than once. As shown in (a), a single outpatient visit for a condition has significantly increased the number of outpatient patients per month since the revised medical law passed and the number of patients using medical services by more than twice due to the same condition decreasing sharply (3 (b)). Column 2 in Panel A in Table 2 shows that the use of a single outpatient service for patients increases by approximately 110 percent, while the use of multiple visits shows a reduction of approximately 56 percent; both estimates are statistically significant. This result suggests that the increased use of health care services for mild symptoms leads to an increase in total health care utilization, and the decrease in the number of multiple uses of health care services results from an adverse selection problem, in which relatively healthy people use more health care services.

Accordingly, the abrupt increase in outpatient utilization caused by the abolition of the copayment program is due to the new coinsurance program and private insurance subscribers. Since the increase in medical expenses was expected to further increase the

economic burden of national health insurers, private insurance began to be actively used as a defense mechanism. Participation in private insurance is dominated by women, who are more sensitive to changes in market prices, and privately insured people have found it easier to access health care services, even for mild illnesses, due to the lower marginal cost. The increased use of one-time hospital services is evidence of moral hazard, but it can also be evidence of adverse selection in which the use of health services by relatively healthy people increases, while the number of multiservice users decreases.

6 Robustness Checks and Validity Tests

In this section, I perform robustness and validity checks to address potential confounding factors in the RDiT estimation. First, I examine the placebo effects by examining different subgroups that are not supposed to be affected by the health care reform. Then, I address particular concerns related to the regression discontinuity in time (RDiT) approach.

6.1 Placebo tests

Because the health care reform of patient sharing was only applied to the population aged above 6 and below 65, the elderly group aged above 65 was still eligible for the copayment program, and the children group aged below 6 pays 70 percent of the cost paid by adults. Thus, outpatient utilization by children and the elderly should be independent and should not be impacted by the abolition of the copayment program. To test for placebo effects, I replicate the RDiT regressions by focusing on the following two age groups: children aged between 0–4 and seniors aged above 65. If the discontinuity of outpatient visits is solely driven by an increase in patient burden in the population aged below 65, no discontinuity should exist in outpatient utilization among the elderly aged above 65 at the cutoff. However, if private health insurance flourished due to the abolition of copayment, the health care utilization of other age groups is expected to be affected.

Table 5 shows the regression results of the placebo tests. Column 1 shows the overall health care utilization rate by age group. Interestingly, a significant increase in health care utilization was found in the age groups 5 and under and 65 and older, representing individuals who were not affected by the abolition of copayment, but I do not find any significant changes in health care utilization in the target age group between 5–64. This finding offers two important implications. First, the policy intervention to increase the economic burden of patients through the abolition of the copayment program was unsuccessful. Second, this intervention incentivized NHI beneficiaries to have more interests in private insurance covering all patient–sharing costs, causing moral hazard and adverse selection problems among vulnerable populations.

6.2 Validity tests of RDiT

While it is assumed that the assignment of treatment is as good as random near the cutoff, many cross-sectional RD studies have required various validity tests to examine potential biases, such as the data sorting effect or anticipating effect. However, these standard validity tests are not relevant or applicable to RD studies using time as a running variable. For example, the density test of sorting behavior proposed by McCrary (2008) cannot be applied because the density of the time running variable is uniform and therefore has no discontinuity in the density of the running variable at the cutoff.

Hausman and Rapson (2018) discussed the difference between the cross-sectional RD and RD in time designs, and, due to the unique characteristics of RD in time, which depends on time-series variation for identification, the authors suggest that a checklist should be reviewed by researchers using RD in time. In the context of this paper, I carefully review each concern on the list as follows.

Unobservables correlated with time. In a cross-sectional RD model, a covariate may be included to reduce the noise and increase the accuracy of the estimates, but such a

covariate is optional and not required (Lee and Lemieux, 2010). However, in the RD in time setting, including a covariate in the regression model is strongly recommended due to a potential correlation with the discontinuity of the running variable. In this study, the age of the beneficiaries, which is mostly related to health status, is included as a control variable. The age variable could control for the increase in outpatient health care use patterns during the study period. Second, the fixed effects model and clustered standard errors consider not only heterogeneity but also the time trends of the unobservables in each cluster, which might be correlated with the discontinuity around the cutoff.

Time-varying treatment effects. The treatment effect in RD in time specifications might not be constant and vary over time, and current RD in time settings do not support testing for the time–varying effect. Previous studies used difference–in–differences or qualitatively estimated the short- and long-run impacts to discuss time-varying treatment effects in RD in time setting. In this paper, I assume that the treatment effect is smooth and constant throughout the post-period for two reasons. First, as shown in Figure 2 (a), outpatient hospital utilization consistently increased after the increase at the cutoff. Second, this consistent and parallel increase in health care utilization could be explained by the effects of the grace period, supplemental private insurance, and coinsurance program as discussed in the results section.

Autoregressive properties. Since RD in time relies on time-series variation, the following two concerns regarding autoregression are proposed: serial correlation in residuals and lagged dependent variables. First, the serial dependence in the residuals is controlled for by clustering the standard errors in both the parametric and local linear specifications, allowing for dependency within the clusters while maintaining independence between the clusters. Second, outpatient health care services are used every two or three days after a first visit and generally do not last longer than three or four weeks. Thus, monthly aggre-

gated hospitalization data are used in this study to control for the lagged effects on the dependent variable.

Selection and strategic behavior. In many cross-sectional RD models, data manipulation near the cutoff by sorting behavior or anticipation effects are examined by the McCrary (2008) test. However, because the running variable is time in RD in time specifications, the discontinuity of the running variable is not testable. Instead, I investigate for events that might impact the discontinuity of the outcome variable near the threshold. Table A.1 shows the trends of supply for health care services from 2006 to 2015, and the blue dashed line represents the year 2007. At approximately the time of interest, I do not find any discontinuous changes either in the number of medical doctors (A.1.a) or the number of medical facilities (A.1.b). Furthermore, Table A.2 shows the monthly trends of the meteorological conditions during the study period, and the blue dashed line displays June 2007. Again, there were no significant changes in relative humidity (A.2.a), precipitation (A.2.b), temperature (A.2.c), and wind speed (A.2.d) around June 2007. In addition, no other changes in health care policy or epidemic disease events were found at the time of interest, June 2007[7].

7 Conclusions

This paper is the first to argue that Korea's extraordinary outpatient health care utilization is due to the abolition of the copayment program and the emergence of private insurance in 2007. First, people anticipated higher health care expenditures after the copayment program ended. This incentivized individuals to visit doctors in the two-month grace period between June and July 2007. Second, the policy change caused individuals to sign up for supplemental private health insurance. When the government passed the amendment to

7. There was another health care reform for medical aid beneficiaries, but this study focuses only on changes in outpatient health care use by NHI policyholders.

abolish the copayment program in June 2007, private insurance companies actively promoted supplemental health insurance policies, and people were encouraged to purchase one or more policies to reduce their economic burden for medical treatments. Finally, when the copayment program was suspended in August 2007, people found that the patient-sharing burden became even less expensive for low-cost medical treatments under 10,000 KRW (US$9.10).

This paper shows that controlling excessive health care demand by increasing the patient burden through the abolition of the copayment program failed to achieve its original policy goal and actually worsened the situation due to moral hazard, adverse selection, and the impacts of interactions with a related policy. Therefore, this paper argues that government attempts to change a current policy or introduce a new policy should be carefully considered to avoid unintended consequences.

Although this paper covers many robustness checks and sensitivity analyses, three caveats must be mentioned. First, there is a lack of information about the beneficiaries of supplemental private health insurance and changes in their enrollment rates near the cutoff. Furthermore, this paper assumes that the increase in health care utilization was primarily due to supplemental private insurance beneficiaries, while outpatient visits could still increase due to lower patient sharing under the new coinsurance program. Finally, as described in the validation section, the validity tests for the conventional RD design cannot be applied in this setting due to the time running variable. This paper uses the guidelines proposed by Hausman and Rapson (2018) to address the issue of the validity of RDiT designs, but further research is needed to validate the regression discontinuity design with a time running variable.

References

Bertakis, Klea D., Rahman Azari, Jay L. Helms, Edward J. Callahan, and John A. Robbins. 2000. "Gender differences in the utilization of health care services." *Journal of Family Practice* 49 (2): 147–152.

Calonico, Sebastian, Matias D. Cattaneo, Max H. Farrell, and Rocio Titiunik. 2017. "Rdrobust: Software for regression-discontinuity designs." *The Stata Journal* 17 (2): 372–404.

Cameron, A. Colin, and Douglas L. Miller. 2015. "A Practitioner's Guide to Cluster-Robust Inference." *The Journal of Human Resources* 50 (2): 317–372.

Carrieri, Vincenzo. 2010. "The Effects Of Cost-Sharing In Health Care: What Do We Know From Empirical Evidence?" *Economia politica, Journal of Analytical and Institutional Economics* 2:351–374. doi:10.1428/32543.

Cherepanov, Dasha, Mari Palta, Dennis G Fryback, and Stephanie A. Robert. 2010. "Gender differences in health-related quality-of-life are partly explained by sociodemographic and socioeconomic variation between adult men and women in the US: evidence from four US nationally representative data sets." *Quality of Life Research* 19 (8): 1115–1124. doi:10.1007/s11136-010-9673-x.

Cleary, Paul D., David Mechanic, and James R. Greenley. 1982. "Sex Differences in Medical Care Utilization: An Empirical Investigation." *Journal of Health and Social Behavior* 23 (2): 106–119. ISSN: 00221465. http://www.jstor.org/stable/2136508.

Cubanski, Juliette, Molly Voris, Michelle Kitchman, Tricia Neuman, and Lisa Potetz. 2005. *Medicare Chart Book 2005.* 3rd. The Henry J. Kaiser Family Foundation.

Cylus, Jonathan, Micah Hartman, Benjamin Washington, Kimberly Andrews, and Aaron Catlin. 2011. "Pronounced Gender And Age Differences Are Evident In Personal Health Care Spending Per Person." *Health Affairs* 30 (1). doi:10.1377/hlthaff.2010.0216.

Fang, Hanming, Michael P. Keane, and Daniel Silverman. 2008. "Sources of advantageous selection: Evidence from the medigap insurance market." *Journal of Political Economy* 116 (2): 303–350. doi:10.1086/587623.

Fendrick, A. Mark, Dean G. Smith, Michael E. Chernew, and Sonali N. Shah. 2001. "A Benefit-Based Copay for Prescription Drugs: Patient Contribution Based on Total Benefits, Not Drug Acquisition Cost." *American Journal of Managed Care* 7 (9): 861–867.

Gelman, Andrew, and Guido Imbens. 2018. "Why High-Order Polynomials Should Not Be Used in Regression Discontinuity Designs." *Journal of Business & Economic Statistics.* doi:10.1080/07350015.2017.1366909.

Hausman, Catherine, and David S. Rapson. 2018. "Regression Discontinuity in Time: Considerations for Empirical Applications." *Annual Review of Resource Economics* 10 (1): 533–552. doi:10.1146/annurev-resource-121517-033306.

Hibbard, Judith H., and Christopher R. Pope. 1987. "Sex and gender differences in health." *Social Science & Medicine* 17 (3): 129–137.

Holst, Jens. 2010. "Patient cost sharing: Reforms without evidence." *Social Science Research Centre, Berlin:* 1–146.

Iizuka, Toshiaki, and Hitoshi Shigeoka. 2018. "Free for Children? Patient Cost-sharing and Healthcare Utilization." *NBER Working Paper No. 25306.*

Keane, Michael, and Olena Stavrunova. 2016. "Adverse selection, moral hazard and the demand for Medigap insurance." *Journal of Econometrics* 190 (1): 62–78. doi:10.1016/j.jeconom.2015.08.002.

Kim, Dae Hwan. 2014. "Effects of Fee-For-Service Health Insurance on Medical Consumption." *Korean Journal of Insurance* 98:61–90.

Kim, Heung-Sik. 2003. "Development of Medigap in the United States and Policy Implications for an Utilization of Private Health Insurance in Korea" [in Korean]. *Korean Policy Studies Review* 12 (2): 33–58.

Kim, Jung-Hee. 2007. "Introduction to Co-insurance Policy for Outpatient health care Utilization" [in Korean]. *Health Insurance Forum* 6 (3): 6–31.

Lee, David S., and Thomas Lemieux. 2010. "Regression Discontinuity designs in economics." *Journal of Economic Literature* 48 (2): 281–355. doi:10.1257/jel.48.2.281.

McCrary, Justin. 2008. "Manipulation of the running variable in the regression discontinuity design: A density test." *Journal of Economic Literature* 142 (2): 698–714. doi:10.1016/j.jeconom.2007.05.005.

Newhouse, Joseph P. 1993. "Free for All? Lessons from the RAND Health Insurance Experiment." Cambridge, MA: Harvard University Press (CB-199). doi:10.7249/CB199.

Noh, Jin-Won, Kyoung-Beom Kim, Hyunchun Park, and Young Dae Kwon. 2017. "Gender Differences in Outpatient Utilization: A Pooled Analysis of Data from the Korea Health Panel." *Journal of Women's Health* 26 (2). doi:10.1089/jwh.2016.5771.

OECD. 2019. *OECD Health Statistics 2019*. http://www.oecd.org/health/health-data.htm.

Park, Sung Bok, and Ki Ho Jeong. 2011. "The Determinants of Private Health Insurance and Its Effects on Medical Utilization in Korea." *Korean Journal of Insurance* 88:23–49.

Regitz-Zagrosek, Vera. 2012. "Sex and gender differences in health." *EMBO reports* 13 (7): 596–603. doi:10.1038/embor.2012.87.

Richardson, Elizabeth A., and Richard Mitchell. 2010. "Gender differences in relationships between urban green space and health in the United Kingdom." *Social Science & Medicine* 71 (3): 568–575. doi:10.1016/j.socscimed.2010.04.015.

Roh, Jungho. 2017. "The incumbency disadvantage in South Korean National Assembly elections: Evidence from a regression discontinuity approach." *The Electoral Studies* 46:112–122. doi:10.1016/j.electstud.2017.02.003.

Rosen, Allison B., Mary Beth Hamel, Milton C. Weinstein, David M. Cutler, A. Mark Fendrick, and Sandeep Vijan. 2005. "Cost-Effectiveness of Full Medicare Coverage of Angiotensin Converting Enzyme Inhibitors for Beneficiaries with Diabetes." *Annals of Internal Medicine* 143 (2): 89–99. doi:10.7326/0003-4819-143-2-200507190-00007.

Shampanier, Krstinia, Nina Mazar, and Dan Ariely. 2007. "Zero as a Special Price: The True Value of Free Products." *Marketing Science* 26 (6): 742–757.

Skovron, Christopher, and Rocio Titiun. 2015. "A Practical Guide to Regression Discontinuity Designs in Political Science." *Conference Proceedings.*

Swartz, Katherine. 2010. "Cost–sharing: effects on spending and outcomes." *The Synthesis project. Research synthesis report* 20:1–36.

Verbrugge, Lois M., Deborah L. Wingard, and Haworth Continuing Features Submission. 1987. "Sex Differentials in Health and Mortality." *Women & Health* 12 (2): 103–145. doi:10.1300/J013v12n02_07.

WHO. 2019. *World Health Organization Global Health Expenditure database.* apps.who.int/nha/database.

Figures

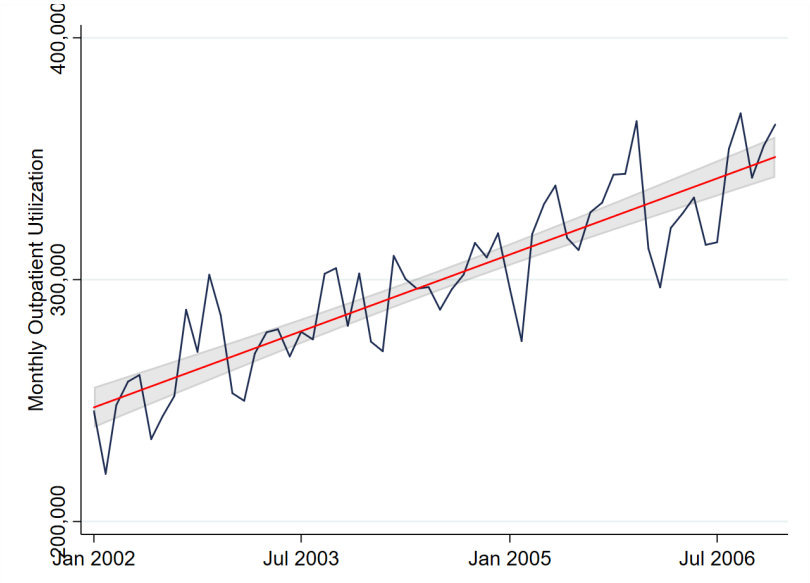
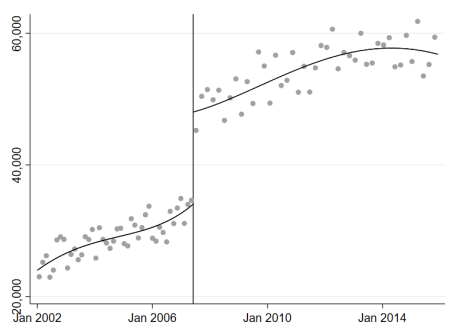
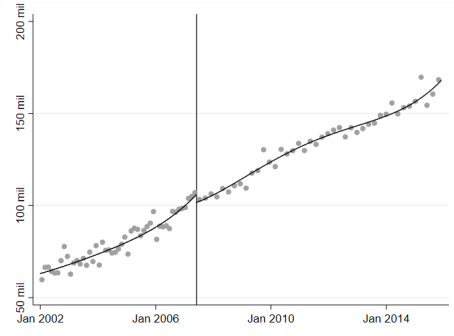


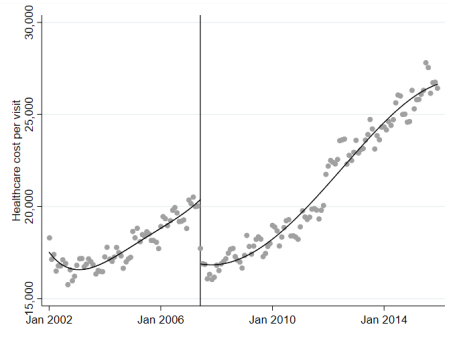
Figure 1: Outpatient health care utilization between 2002 and 2006



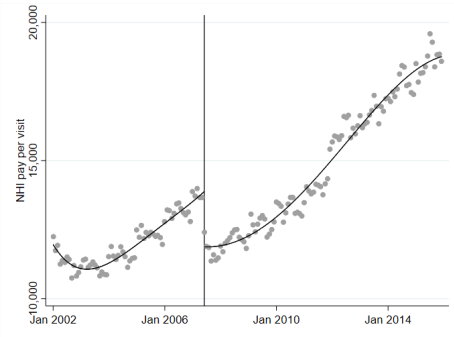
(a) Total outpatient visit



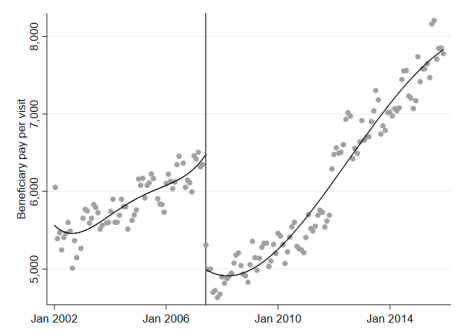
(b) Total outpatient health care cost



(c) Health care cost per outpatient visit

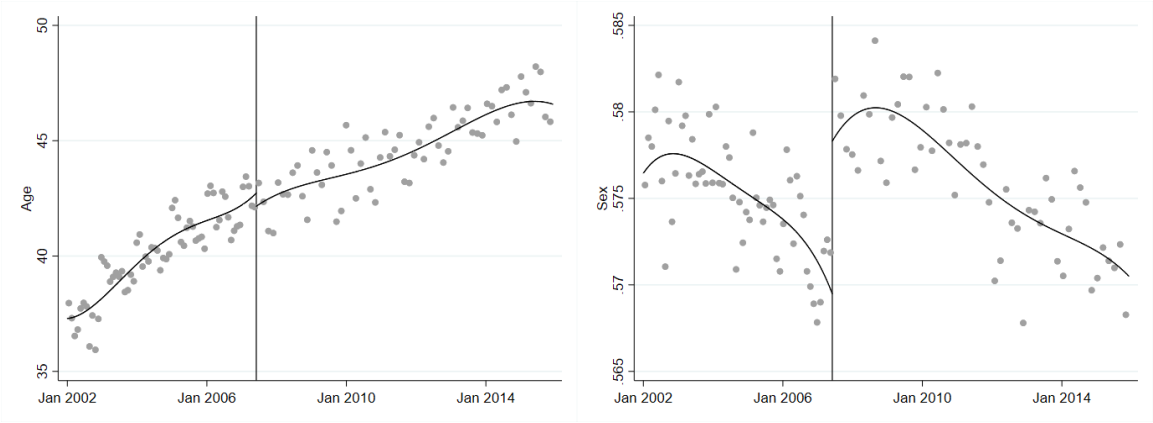


(d) NHI-sharing per outpatient visit



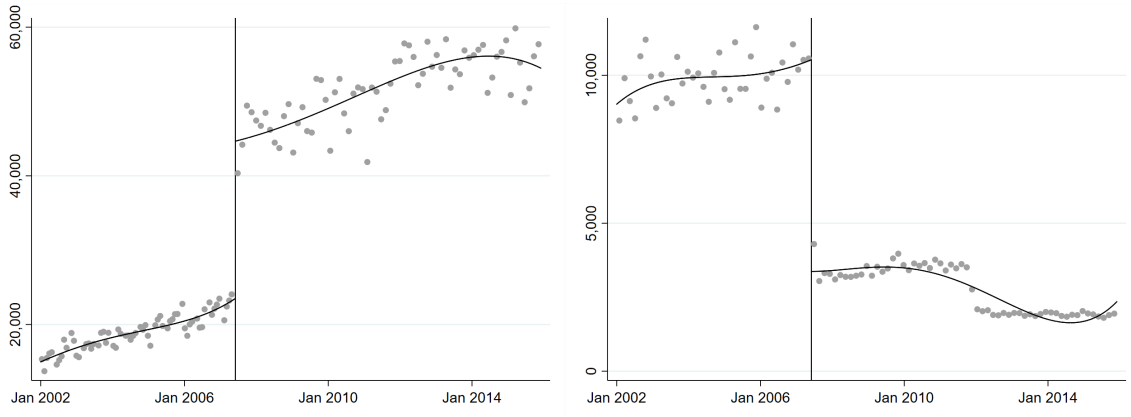
(e) Patient-sharing per outpatient visit

Figure 2: Discontinuity in health care utilization



(a) Age (b) Sex ratio

Figure 3: Discontinuity in covariates



(a) One-time visit

(b) Multiple visits

Figure 4: Outpatient visit comparison between one-time visit and multiple visits

Tables

Table 1: Patient-sharing rate change due to the health care reform in 2007

	Patient-sharing	
Medical bill	Before	After
	Copayment	Coinsurance
$\leq$ 15,000 KRW	3,000 KRW	30 %
$>$ 15,000 KRW	20-30 %	20-30 %

Notes: Prior to 2007, patients paid 3,000 KRW if a medical bill was equal or less than 15,000 KRW and 20–30 percent of coinsurance if a medical bill was greater than 15,000 KRW under the copayment program. Effective August 1, 2007, patients pay 20–30 percent coinsurance for all outpatient health care services.

Table 2: Summary statistics

	N	Mean	SD	Min	Max
Monthly hospitalization	2,688	39,193	43,926	2,796	228,693
Age	2,688	42.86	3.75	31.64	55.49
Sex	2,688	0.58	0.01	0.53	0.61
Spending per-visit	2,688	19,839	3,260	14,821	29,815
		(US$18)	(US$3)	(US$14)	(US$27)
- Patient-sharing	2,688	6,011	888	4,176	8,993
		(US$6)	(US$1)	(US$4)	(US$8)
- NHI-sharing	2,688	13,804	2,454	10,108	21,267
		(US$13)	(US$2)	(US$9)	(US$19)

Notes: This table presents the number of observations (N), and the mean, standard deviation (SD), minimum, and maximum values for the key variables used in this paper. The number of outpatients is based on the monthly average outpatients in each city and province of South Korea. Sex is the ratio of female patients to male patients.

Table 3: Regression discontinuity regression results

	1	2	3	4	5
	All	[-6m,+6m]	[-3m,+3m]	Parametric	Local linear
Panel A: Total outpatient visit					
Copayment abolition	0.471***	0.404***	0.247***	0.383***	0.322
	(0.013)	(0.014)	(0.010)	(0.020)	(0.258)
	[60.16%]	[49.78%]	[28.12%]	[46.67%]	[37.99%]
R^2	0.955	0.975	0.973	0.964	
Panel B: Total health care cost					
Copayment abolition	0.215***	0.031	-0.103***	0.021	-0.045
	(0.013)	(0.018)	(0.016)	(0.021)	(0.266)
	[23.99%]	[3.15%]	[-9.79%]	[2.12%]	[-4.40%]
R^2	0.892	0.770	0.650	0.964	
Panel C: Health care cost per-visit					
Copayment abolition	-0.255***	-0.373***	-0.350***	-0.363***	-0.264***
	(0.015)	(0.012)	(0.013)	(0.008)	(0.018)
	[-22.51%]	[-31.13%]	-29.53%]	[-30.44%]	[-23.20%]
R^2	0.653	0.984	0.984	0.964	
Panel C-1: Health care cost per visit (NHI-sharing)					
Copayment abolition	-0.233***	-0.364***	-0.357***	-0.352***	-0.273***
	(0.015)	(0.013)	(0.015)	(0.009)	(0.018)
	[-20.78%]	[-30.51%]	[-30.02%]	[-29.67%]	[-23.89%]
R^2	0.567	0.982	0.981	0.964	
Panel C-2: Health care cost per visit (Patient-sharing)					
Copayment abolition	-0.306***	-0.392***	-0.332***	-0.386***	-0.246***
	(0.014)	(0.011)	(0.011)	(0.010)	(0.021)
	[-26.36%]	[-32.43%]	[-28.25%]	[-32.02%]	[-21.81%]
R^2	0.808	0.986	0.985	0.964	
Observations	2,688	192	96	2,688	2,688

Notes: Columns 1-3 show the regression results from a fixed effects model. The regression results from a parametric model and a local linear model are presented in Columns 4-5. The average age variable is included as a covariate.

Table 4: Local linear RD regression results

	1	2	3
Panel A: Total outpatient visit			
Copayment abolition	0.633	0.744**	-0.816**
	(0.479)	(0.309)	(0.253)
	[88.30%]	[110.47%]	[-55.77%]
RDD	Fuzzy	Fuzzy	Fuzzy
Panel B: Total health care costs			
Copayment abolition	-0.045	0.475*	-0.625**
	(0.266)	(0.261)	(0.289)
	[-4.40%]	[60.80%]	[-46.47%]
RDD	Sharp	Sharp	Sharp
Panel C: Health care costs per visit			
Copayment abolition	-0.264***	-0.099***	0.364***
	(0.018)	(0.011)	(0.035)
	[-23.20%]	[-9.43%]	[43.91%]
RDD	Sharp	Sharp	Sharp
Observations	2,688	2,688	2,688

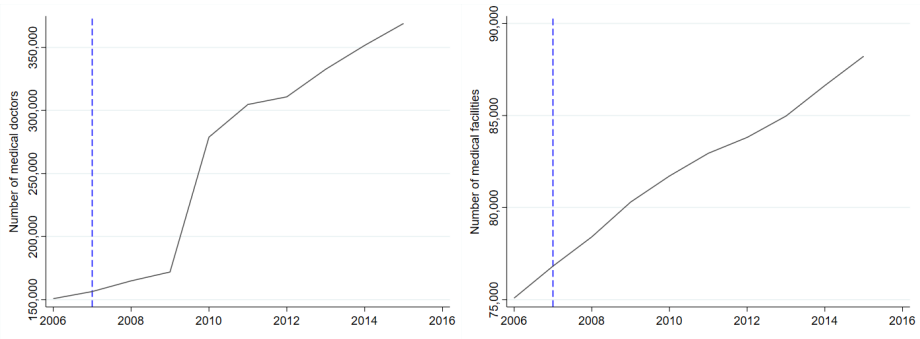
Notes: Column 1 includes all outpatient visits. Columns 2 and 3 only include one-time visits and multiple visits, respectively. Covariate variables are included in the regression. A cluster–adjusted standard error is used to account for the within-cluster correlation. I use a polynomial of order one and a triangular kernel function. A data-driven mean squared error optimal bandwidth selection is applied.

Table 5: Placebo tests

	1 Total	2 Single	3 Multiple
Panel A: Age 0–4			
Copayment abolition	0.488***	0.985***	-1.637***
	(0.230)	(0.242)	(0.254)
	[62.91%]	[167.78%]	[-80.54%]
RDD	Sharp	Sharp	Sharp
Panel B: Age 5–64			
Copayment abolition	0.272	0.681**	-0.927***
	(0.265)	(0.293)	(0.269)
	[31.26%]	[97.59%]	[-60.43%]
RDD	Sharp	Fuzzy	Sharp
Panel C: Age 65+			
Copayment abolition	0.437*	0.491*	-0.437***
	(0.241)	(0.261)	(0.157)
	[54.81%]	[63.39%]	[-35.40%]
RDD	Sharp	Fuzzy	Fuzzy
Observations	2,688	2,688	2,688

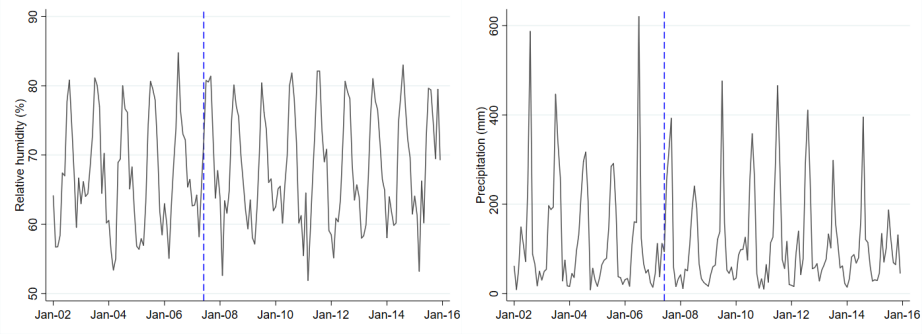
Notes: Column 1 includes all outpatient visits. Columns 2 and 3 only include one-time visits and multiple visits, respectively. Covariate variables are included in the regression. A cluster–adjusted standard error is used to account for within-cluster correlation. I use a polynomial of order one and a triangular kernel function. A data-driven mean squared error optimal bandwidth selection is applied.

Appendices



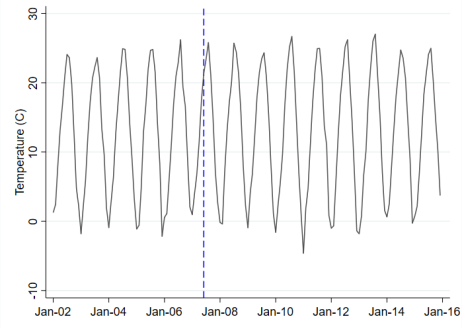
(a) Number of medical doctors (b) Number of medical facilities

Figure A.1: Health care supply trends between 2006 and 2015

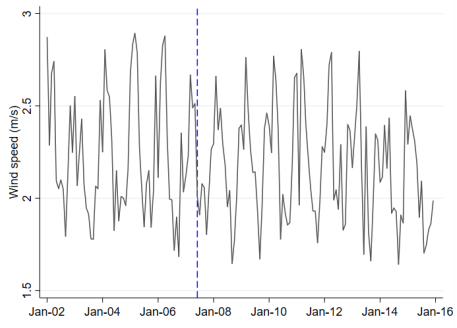


(a) Relative humidity

(b) Precipitation



(c) Temperature



(d) Wind speed

Figure A.2: Weather trends between 2002 and 2015