Three Essays on Health Economics and Policy

BY

HANSOO KO
M.D., Chung-Ang University, 2008
M.P.H., Seoul National University, 2012

THESIS

Submitted as partial fulfillment of the requirements
for the degree of Doctor of Philosophy in Public Health Sciences
in the Graduate College of the
University of Illinois at Chicago, 2019

Chicago, Illinois

Defense Committee:

Anthony Lo Sasso, Chair and Advisor
Darren Lubotsky, Economics
Lisa Powell, Health Policy & Administration
Emily Stiehl, Health Policy & Administration
Nicholas Tilipman, Health Policy & Administration

If this work is a success, it would have been impossible without my best friend and wife, Yukyung Kwon. Nobody has been more important to me in the pursuit of this research than you. I've felt sorry to keep asking you to have an uneasy future together. All my love to you, for knowing what I don't know in the past, present, and future.

ACKNOWLEDGMENTS

I would like to thank my advisor and dissertation chair, Anthony Lo Sasso, for his support, enthusiasm, and encouragement during my time at UIC. I am also grateful to my dissertation committee – Darren Lubotsky, Lisa Powell, Emily Stiehl, and Nicholas Tilipman – for being wonderful mentors. I am also thankful for the support of my comrades I fortunately have gained at UIC and the city of Chicago.

Hansoo

SUMMARY

My research focuses on a variety of topics on individual behavioral changes to external changes. By exploring how individual responses to policy interventions and environmental shocks, I aim to provide policy implications on how to promote health behavior and how to mitigate negative health impacts at an individual level.

In my first chapter, I explore the effects of supplemental private health insurance in Korea. Despite having a mandatory social health insurance program, Koreans have the highest rates of out-of-pocket payment for health care among OECD nations. As a result, private supplemental health insurance has gained popularity. Private insurance supplements the social insurance program by covering co-pays and services not covered by social insurance. Using longitudinal microdata from the Korea Health Panel, I find evidence of favorable selection into private insurance. Sources of favorable selection include age, health status, income, education, and risk aversion. Results from fixed-effects estimation show that private supplemental insurance increases outpatient and hospitalization utilization (price elasticity of demand is estimated at around -0.18~-0.2). This moral hazard effect is primarily driven by increases in the use and intensity of discretionary care. In general, private supplemental health insurance generates welfare benefits when social insurance's benefits coverage is not deep enough.

In my second chapter, I investigate the causal effects on individual smoking behavior of the city-level outdoor smoking ban in Korea. To address the highly prevalent secondhand smoke exposure in Korea, local governments have implemented smoking bans at open public places (parks, bust stops, and school zones) since 2011. Exploiting temporal and spatial variation in implementation dates of bans, this study estimates the causal effects on individual smoking behavior. The individual-level longitudinal data from the 2009-2015 Korean Labor and Income Panel Study are linked to the smoking ban legislation information from the National Law Information Center. I find robust evidence that outdoor smoking bans increase the probability of making a quit attempt by 16%. This effect immediately appears when the ban goes into effect and lasts for 3 or more years with an increasing effect size. Persons who spend more time outdoors are more likely to change smoking behavior. I also find heterogeneity in effects across the amount of monetary penalty. Whereas the policy change does not reduce the prevalence of smoking, a higher penalty has stronger impacts on reducing the intensity of smoking and increasing the propensity to try to quit. These results suggest that outdoor smoke-free policy affects individual smoking behavior through two mechanisms. The outdoor smoking ban raises awareness about the harmful effects of smoking and it leads to an increase in quit attempts – though not enough to reduce the demand for cigarettes. This effect is stronger and more significant among persons who spend more time outdoors, indicating that socially active persons are more likely to be exposed to changes in social norms regarding tobacco use in public places. In addition, the amount of penalty has differential impacts on quit attempts and the intensity of smoking, suggesting that the outdoor smoking ban also changes individual smoking behavior through monetary costs of smoking.

The final study in my dissertation explore the impact of the 2015 MERS epidemic in Korea on individual health behavior. Negative impacts of external shocks on health and human capital have been established by a growing body of research across different disciplines. Meanwhile, it has been relatively less studied how individuals react to health shocks to mitigate the anticipated negative impacts. This study investigates the impacts of the 2015 Middle Ease Respiratory Syndrome Coronavirus (MERS-CoV) epidemic in Korea on health behaviors. My main estimation relies on the finding that distance from the origin of the epidemic is strongly associated with the city-level incidence rates and is not directly related to individual-level health behaviors. Results from instrumental variables estimation indicate that individuals react to higher risks by stopping drinking and attempting to quit smoking. I also find heterogenous effects of the epidemic. Worse-off persons and individuals with weak social interactions are less likely to change their harmful behavior. The MERS epidemic positively affects health behaviors among all workers, though workers in precarious employment are in fact more likely to stop, not just try to do, risky behaviors. These findings suggest that private self-protection should be accompanied by public mitigation efforts to fully deal with negative impacts of public health emergencies and to narrow the health investment gap.

How individual responses to external shocks such as policy changes and environmental shocks has been less studied in the health economics and health policy literature. My research questions are important as a matter of informing implications for policy especially when the impacts of policy changes or environmental shocks on health are unclear.

TABLE OF CONTENTS

CHAPTER **PAGE**

LIST OF TABLES

LIST OF TABLES (CONTINUED)

LIST OF FIGURES

FIGURE **PAGE**

LIST OF ABBREVIATIONS

ACSC	Ambulatory Care Sensitive Condition
AQI	Air Quality Index
DALYs	Disability Adjusted Life Years
ER	Emergency Room
FCTC	Framework Convention on Tobacco Control
GDP	Gross Domestic Product
GRDP	Gross Regional Domestic Product
IV	Instrumental Variables
LATE	Local Average Treatment Effect
MERS	Middle Ease Respiratory Syndrome
MLR	Medical Loss Ratio
MRI	Magnetic Resonance Imaging
NHI	National Health Insurance
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
OOP	Out-of-pocket
PHI	Private Health Insurance
$PM_{2.5}$	Particulate Matter<2.5 micrometers
R_0	Basic reproduction number
SHI	Social Health Insurance
2SLS	Two-Stage Least Squares
WHO	World Health Organization

1. MORAL HAZARD EFFECTS OF SUPPLEMENTAL PRIVATE HEALTH INSURANCE IN KOREA

1.1. Introduction

Private health insurance (PHI) becomes more important in financing healthcare as governments struggle to keep up with rising costs of social health insurance (SHI). In particular, governments increasingly have relied on supplemental private insurance which provides coverage for services not included in the basic benefits package to address financial gaps left by SHI (Wasem et al., 2004). Having PHI can provide opportunities for financial protection from large out-of-pocket (OOP) spending, adding consumer choices, and injecting more resources into health systems (Colombo, Tapay, 2004).

International experiences, however, indicate that PHI can exacerbate inequities in access to care if inappropriately managed (Sekhri, Savedoff, 2005). A review of European PHI markets find that access issues are common among less educated or ill persons (Wasem et al., 2004). A study of PHI in 11 European countries documents that impacts of PHI on cost containment are ambiguous (Paccagnella et al., 2013). Also, a review of the relationship of Medicare and private supplemental insurance in the U.S. finds a consistent evidence suggesting that supplemental policy is significantly related with an increase in Medicare spending (Atherly, 2001).

Korea, where healthcare is financed through SHI covering the whole population, has witnessed an increasing role of PHI, which supplements SHI by covering full payments for services excluded by SHI and covering copayments for covered services. In 2007, the government aimed to strengthen the healthcare industry’s competitiveness by expanding the individual PHI market. Until 2007, private insurers had only sold policies reimbursing fixed cash benefits for a limited range of severe conditions. However, instead of further expanding SHI’s benefits, the policy change allowed private insurers to sell supplemental private insurance reimbursing actual healthcare costs incurred.

Using a nationally representative individual-level longitudinal data set containing detailed information on private insurance coverage and healthcare utilization, I estimate adverse selection of PHI and its moral hazard effects and provide its welfare effects and equity implications. Moral hazard effects of supplemental private insurance is of particular interest to policy makers because increased utilization due to PHI can lead to increased SHI spending. In other words, this moral hazard represents “moral hazard subsidy” because the additional financial burden induced by supplemental insurance should be subsidized by the public insurance scheme (Finkelstein, 2004).

First, I find evidence of favorable selection, while evidence on adverse selection is weak. Asymmetric information has been thought to be a main source of adverse selection in the field of economics and public policy (de Meza, Webb, 2001; Fang et al., 2008; Buchmueller et al., 2013; Keane, Stavrunova, 2016). If persons have private information (unobserved by insurers) about their own risks of suffering loss, they are more likely to purchase comprehensive insurance policies, resulting in adverse selection. As both adverse selection and moral hazard lead to positive associations between insurance purchase and ex post realization of loss, failing to disentangle adverse selection from moral hazard would lead to unintended increases in healthcare expenditures when a policy aiming to deal with adverse selection (expanding population coverage) is implemented (Keane, Stavrunova, 2016). On the other hand, advantage selection predicts that private information is rather multidimensional (Fang et al., 2008) and that risk-averse persons not only put more effort to reduce the risk of illness but buy comprehensive insurance (de Meza, Webb, 2001). In this case, the positive correlation of insurance coverage with individual risks would not be found.

Results from individual-level fixed effects (FE) regression of PHI enrollment on sociodemographic factors, health status, and healthcare utilization (in the preceding period) show that annual healthcare visits before the supplemental health insurance purchase are not statistically associated with enrollment, suggesting that strict medical underwriting reduces the probability of information asymmetricity. Also, married or educated persons are more likely to enroll in PHI. Results also indicate that the use of primary prevention activity (vaccination) is positively associated the propensity of PHI enrollment among men. These results together indicate that privately-insured persons are risk averse.

In addition, following Fang et al. (2008), I present the coefficients on annual number of visits regressed by PHI holding status along with observable covariates which are expected to be correlated with both the enrollment status and healthcare utilization. Results of naïve regression (including only year dummies) show that persons with PHI visit healthcare facilities 1.4 times fewer than those without PHI. However, conditional on health status, the sign flips: Privately-insured persons use more healthcare services than persons without PHI. With all factors controlled for, persons with supplemental health insurance use healthcare services 1.1 times per year more than those without PHI. This sign reversal indicating advantage selection is closely in line with the studies of the U.S. Medigap market (Fang et al., 2008) and the Australian private insurance market (Buchmueller et al., 2013). Also, the result that omitting individual-level fixed effects leads to an underestimation of the impact of PHI on utilization suggests that unobservable time-invariant individual factors such as risk preferences play an important role in determining the demand for insurance and healthcare utilization.

My empirical estimation relies on within-person variation in PHI holding status. Results show that PHI is significantly associated with the use and intensity of care. Supplemental health insurance increases the number of annual outpatient visits and hospitalization utilization by 1.01 and 0.02, respectively. I also find that PHI significantly increases the use of discretionary health services (acute outpatient care), while there are no impacts on less discretionary care utilization (chronic care outpatient visits). Notably, persons holding private supplemental insurance significantly increases the likelihood of visiting outpatient care unit of hospital due to symptoms commonly treated in the primary care setting, indicating that supplemental PHI could be at odds with SHI’s differential cost-sharing policy (lower co-pays for primary physician visits).

Using Feldman and Dowd's (1991) solution to the value of insurance, which balances expected utility when insured by PHI and expected utility when uninsured, I estimate the welfare consequences of PHI. Results show that, in general, risk gains outweigh welfare costs. In particular, welfare gains from PHI are higher among the elderly, though the likelihood of enrolling in PHI is in fact the lowest for this age group.

In addition, there are substantial negative spillover effects due to a link between SHI and PHI. SHI's additional financial burden due to moral hazard of PHI is estimated as $929~3,180 million per year (1.9~6.6% of total SHI expenditures). To bear these additional costs incurred by PHI, social insurance may require every citizen to pay additional contributions as much as $18.2~62.3 per year.

1.2. Institutional background

Under the universal public health insurance scheme, every citizen is required to enroll in the National Health Insurance (NHI) in Korea. The contribution is set as the percentage of income and equally shared with the employer for employees with a ceiling. For the self-employed, premium rates are determined by income and the value of property (houses and vehicles). Benefits covered by SHI include most curative healthcare services (except new or costly care), some dental treatments, most prescription pharmaceuticals, medical check-ups, and cancer screening. The NHI collects premiums, negotiates fee schedules with provider associations, and provides health information to beneficiaries. The independent claims review agency (Health Insurance Review and Assessment) reviews and assesses appropriateness of medical claims.

Roughly 90% of providers are private practitioners. Provider reimbursement has been fee-for-service from the beginning of SHI in 1989 (Kwon, 2009). Providers claim reimbursements for services utilized to the NHI and require patients to pay statutory cost-sharing (Figure 1). Fees for covered services are determined by annual negotiations between provider groups and the NHI. Patients are required to pay a copayment, which is 20% of total costs incurred for covered inpatient services and 30~60% for covered outpatient services, depending on the level/type of facilities, for preventing excessive utilization (Table 1).

Under the National Health Insurance Act, all healthcare providers are obliged to treat SHI enrollees and are not able to opt out of the public insurance scheme (Chun et al., 2009). The social insurance scheme has mandatory contractual relationships with all providers and does have uniform reimbursement rates for both public and private providers. Thus, there is no competition for contract with SHI among providers.

The role of primary care in gatekeeping is weak in the Korean health system (Kwon et al., 2015). Patients can select first-contact providers without restriction and specialists in hospitals also can be freely chosen if referred. Most clinics, including specialists, accept walk-in patients.

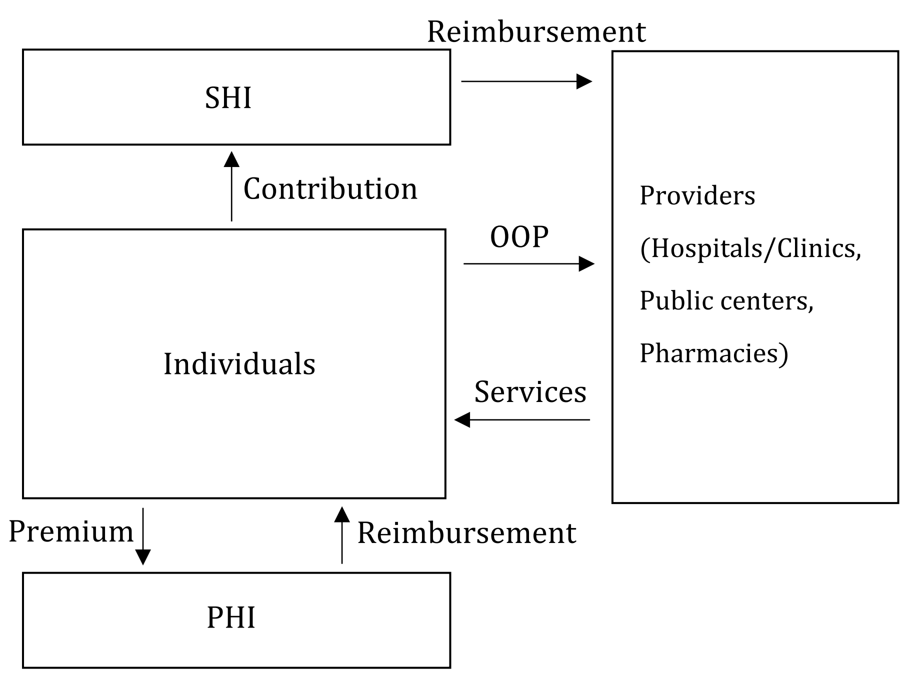

Figure 1. Healthcare financing in Korea (adapted from Kwon et al., 2015).
SHI, social health insurance; PHI, private health insurance; OOP, out-of-pocket spending

TABLE I
THE BENEFITS COVERAGE OF THE KOREAN NATIONAL HEALTH INSURANCE

Benefits package	
1. Social insurance covers all treatments, procedures, or materials except[a];	
1.1. Treatment for diseases not interfering with everyday activities	Example: Simple fatigue, snoring, urogenital or ophthalmologic diseases
1.2. Treatment not for improving critical body functions	Example: Cosmetic or plastic surgery, vision correction procedure
1.3. Treatment not for preventing diseases or injuries	Example: Simple scaling, smoking cessation aid, fetal genetic test
1.4. Cases not accorded with the value of insurance	Example: Upgraded hospital accommodation (single room), medical braces not prescribed to the disabled, assisted reproductive technology, new medical technology pending decision by the Evaluation Committee
2. Social insurance covers drugs only listed in the law[a]	
Coinsurance rates	
Outpatient service Clinic: 30% Hospital: 40% General hospital: 50% Tertiary general hospital: 60%	
Inpatient service: 20% (Hospital room: only 6-bed room is covered)[b]	
Emergency room visit: 20% (50% if not emergent)	
Prescription drug: 30%	

[a] Decided by the Evaluation Committee under the supervision of the Minister of Health and Welfare based on safety, effectiveness, cost-effectiveness, and related studies. As of January 1st, 2018, there are 3,784 uncovered services listed and 20,493 drugs listed for coverage.

[b] 4-bed room has been covered since September 2014.

The benefits package of SHI is determined by the government based on safety, effectiveness, and cost-effectiveness of treatments and procedures. The basic benefits include all medical services except several thousand items listed by the law (Table 1). Covered services must be provided at prices set by SHI and consumers are forbidden to purchase covered services OOP. Patients are also prohibited from purchasing a covered service for an indication not validated by the NHI.

Examples of uncovered services include chiropractic care, ultrasound, magnetic resonance imaging (MRI), upgraded hospital accommodation, conscious sedation, simple scaling, cosmetic surgeries, and other new, expensive, or less effective medical technologies. Because imaging (MRI/CT/Ultrasound) has been uncovered due to high costs, patients with severe conditions were responsible for the full costs of imaging. For instance, chronic carriers of hepatitis B virus (HBsAg carriers) have been required to pay out-of-pocket for regular ultrasound check-up even though it's medically necessary.

Services uncovered by SHI are not subject to the government's fee regulation and can be purchased OOP. In the mid-2000s, patients' OOP payments included a significant portion of health spending for uncovered services. Total OOP payments for inpatient care were, on average, 41% of the total costs (note that SHI's coinsurance rate is only 20%). Of those OOP amounts, more than a half (24% of the total costs) were expenses for uncovered services (Kwon, 2009). Extra payments for new technology and upgraded accommodation are the most commonly cited reasons for high OOP spending on hospitalization. In particular, payments for upgraded accommodation, which PHI covers, account for 25% of total OOP spending in 2011 (Kwon et al., 2015).

Private voluntary supplemental health insurance has gained popularity due to patient's financial burden in the nation. Patients are responsible for 43% of total healthcare costs on average, which is 3rd on the list of the highest financial burden among the OECD member countries (OECD, 2017). As Figure 2 shows, healthcare expenditure as the percentage of Gross Domestic Product (GDP) has gradually increased from 3.4% in 1995 to 7.4% in 2016. Also, the fraction of households experiencing catastrophic health expenditure (health spending exceeds 10% of total household expenditures) almost doubled since 2000 (10.6% to 19.3% in 2014). The World Health Organization (WHO) (2009) reports that, conditional on hospitalization, 30% of households experienced financial difficulties in 2007. In specific, Sohn et al. (2010) document that low-income households (whose earned incomes are less than 60% of the median household's earned income) are more likely than the whole households (19%) to experience financial difficulties due to healthcare (32%) in 2006 and that such catastrophic expenditures lead to impoverishment of households.

The government has tried to address the rise of OOP spending by expanding NHI's benefits package and setting annual OOP maximum, though their impacts have been limited. Specifically, services not covered by SHI have contributed to the growth of OOP because the NHI's stop loss is only applied to covered services. Uncovered services' prices, which are set by providers, are typically costlier than covered services because of the low reimbursement rates of SHI (Kwon et al., 2015).

In 2007, the government, specifically Ministry of Strategy and Finance , aimed to strengthen the healthcare industry's competitiveness by expanding the PHI market. Until 2007, private insurers only sold policies reimbursing fixed cash benefits for a limited range of severe conditions (for instance, cancer, stroke, and acute coronary syndrome). Because SHI benefits have continuously expanded, it has been difficult for private insurers to develop a sustainable policy on a yearly basis (WHO, 2009). However, the government, instead of further expanding SHI's benefits, allowed private insurers to sell supplemental insurance reimbursing actual healthcare costs incurred in 2007. This policy drove private insurance carriers to enter the supplemental health insurance market and was followed by a massive growth of advertising.

Figure 2. Spending on health in Korea, 1995-2016: OOP as the total health expenditures (left), household health expenditures (right)

Under the new administration's economic policy of promoting the private sector, the Korean PHI market has witnessed a rapid increase in the share of population holding supplemental PHI. Figure 3 shows that the share of study population enrolled in PHI has gradually increased from 0.9% in 2008 to 35% in 2014.

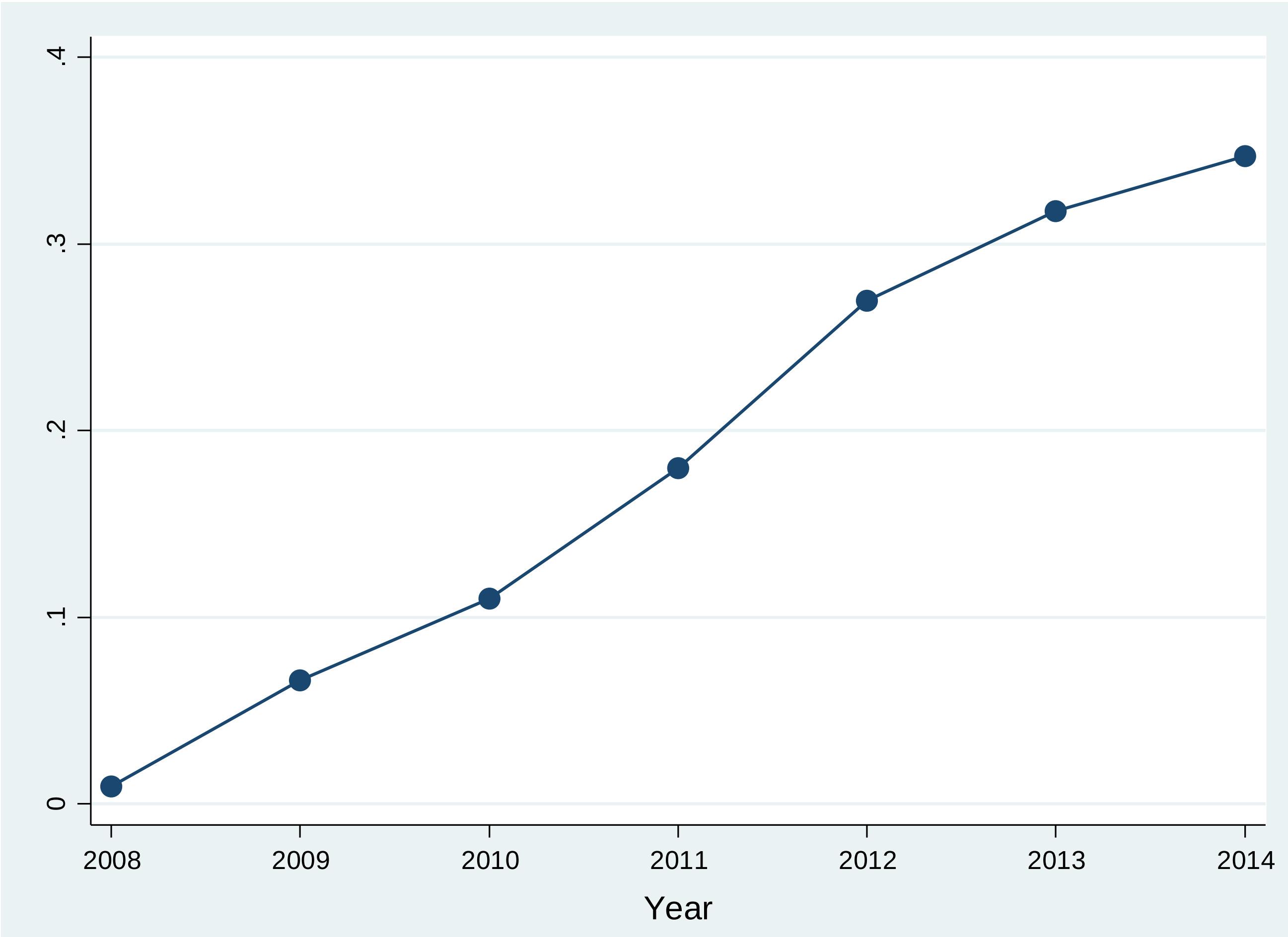

Figure 3. The share of the study population holding supplemental PHI, 2008-2014.

Supplemental PHI reimburses policyholders actual healthcare OOP spending incurred, including SHI's statutory cost-sharing and full payments for services uncovered by SHI. PHI covers most healthcare services except preventive care, delivery, and cosmetic surgeries (Table 2). The Korean supplemental PHI is considered as a traditional type given that it collects and pools funds but does not purchase services (Sekhri, Savedoff, 2006). Private insurers reimburse the actual OOP amounts spent by policyholders and are not able to negotiate the payment amounts with providers because, by the law, they do not have contractual relationships with healthcare providers.

TABLE II

CHARACTERISTICS OF KOREAN SUPPLEMENTAL PRIVATE HEALTH INSURANCE

Enrollment	Voluntary and individual-/household-based
Pricing	Experience rating
Management	Mostly for-profit commercial (# carriers offering policy in 2017: 25)
Guaranteed issue/renewal	No/No
Waiting period	No
Purchasing	No (insurers are not allowed to be directly involved with contractual relationships with providers)
Public subsidization	No
Monthly premium rates (for persons without chronic disorders)	\$10~15 (ages 40) \$15~25 (ages 50)
Benefits package	Most curative services (except cosmetic surgery, urologic disorders, sexually-transmitted diseases, congenital diseases, dietary supplements, normal spontaneous vaginal delivery, and dental/orthopedic braces)
Coverage	Whole out-of-pocket payments
Reimbursement mechanism	Policy holders pay out of pocket first and then claim back their expenses to private insurance carriers later.
Annual benefit limits	\$50,000
Deductibles	\$0
Coinsurance rates	0% (pre2009 plan) 10% (post2009 plan) 10/20% (post2013 plan)
Copayments [*]	\$10 (outpatient/urgent care) \$25 (inpatient care)
Share of total health expenditure	3.9% (in 2005) 5.4% (in 2010)

There is no guaranteed issue and guaranteed renewal. No deductibles and waiting period are required. However, it's been reported that persons with pre-existing conditions are driven out of the market because of medical underwriting (Jeon, Kwon, 2013). Also, premiums are rated by individual risks. There has been no regulatory limit on premium rates.

1.3. Theoretical framework

Economic theory shows that in the presence of demand response to health insurance (moral hazard), full first-dollar protection is not optimal (McGuire, 2012).[1] The McGuire model (2012) shows that the second-best insurance coverage[2] implies cost-sharing should be inversely related to demand elasticity because higher demand elasticity creates larger deadweight welfare loss. Thus, the existence and intensity of moral hazard are important empirical questions to determine the optimal level of insurance.

Though SHI provides basic mandatory coverage to all citizens with stop-loss, individuals still can face substantial financial risks when sick because they will be responsible for paying full costs for uncovered services. Since these items are not subject to SHI's stop-loss and fee regulation, expected financial risks with severe health conditions are open ended. Thus, consumer's choice between having PHI (additional to SHI) or not (having only SHI) is not much different from the choice between being insured or uninsured, though protection from SHI reduces the probability of catastrophic health spending to some extent.

Let me define utility U depends on consumption (x) and health status (h); $U(x, h)$. Assume that individuals fall sick with probability p and spend on healthcare (m) in the sick state. Also assume that no health services are used when healthy and that healthcare fully restores person's health ($h = H[d, m]$ and $H[0,0] = H[1, m]$ where d indicates sick $(d = 1)$ or healthy $(d = 0)$ state). With exogenous

---

[1] When the marginal utility of income is lower in the healthy state (the typical case), the first-order condition for the coinsurance is always negative unless coinsurance equals zero. In other words, full insurance is the first best optimal health insurance benchmark when there is no moral hazard (McGuire, 2012).

[2] $(1 - \mathrm{c}) = \frac{(1-p)(U_I^h - U_I^s)}{\varepsilon U_I^s (p U_I^s + (1-p) U_I^h)}$, where c is the demand-side cost-sharing, p is the probability of being sick, U_I^h and U_I^s are the marginal utility of income when healthy or sick, and ε is demand elasticity (McGuire, 2012).

income endowments y, which are left over after paying SHI contributions, individual's consumption after spending on health can be written as: $x = y - m$ when sick and $x = y$ when healthy for persons without supplemental insurance. With PHI, $x = y - \pi$ in either sick or healthy states, assuming that PHI fully covers OOP spending on health, where actuarially-fair premium $\pi = pm$. Then, individual's expected utility when having only SHI (V_{SHI}) and having both SHI and PHI (V_{PHI}) is:

$$\text{(1a)} \quad V_{SHI} = (1-p)U(y) + pU(y-m)$$

$$\text{(1b)} \quad V_{PHI} = U(y-\pi)$$

Following Cutler and Zeckhauser (2000), V_{SHI} can be expended as $V_{SHI} \approx U(y-\pi) + U'(\frac{U''}{2U'})\pi(m-\pi)$.[3] Thus, the value of PHI is the dollar amount which makes individual indifferent between V_{SHI} and V_{PHI}:

$$\text{(2)} \quad \frac{V_{PHI} - V_{SHI}}{U'} \approx \frac{1}{2}(-\frac{U''}{U'})\pi(m-\pi)$$

Equation (2) shows that the benefit of supplemental insurance (the right-hand side) is gains from risk pooling. This benefit consists of risk aversion $(-\frac{U''}{U'})$ and the variance of health spending $(\pi(m-\pi) = m^2p(1-p))$. Therefore, persons who are more risk averse or who face higher expected healthcare spending are willing to pay more for PHI to offset expected future spending on health by paying premiums up front.

Now suppose each person has a range of expected health risks s_i with a distribution of risks $f(s)$. This individual risk determines his expected costs of healthcare ($E[m(s_i)]$) and premium amount which is based on the mean risks among potential enrollees ($\pi(s) = \frac{1}{N}\sum_{i=1}^{N} E[m(s_i)]$) (Fleitas et al., 2018). Adverse selection makes mean risks among enrollees to be higher than the value of insurance for

[3] The Taylor series are used to expand equation (1a): $V_{SHI} \approx (1-p)\left[U(y-\pi) + U'\pi + \frac{1}{2}U''\pi^2\right] + p\left[U(y-\pi) - U'(m-\pi) + \frac{1}{2}U''(m-\pi)^2\right]$ (Cutler, Zeckhauser, 2000).

marginal consumer. It may cause him to forgo private coverage in the next period, causing the premium for PHI to rise because persons with higher risks will be increasingly concentrated in PHI (Cutler, Reber, 1998).

Now utility when enrolled in PHI can be written as a function of income, premium, and spending on health:

$$(3)\ \ U_{PHI} = \int U[y - \pi - c\big(m(s)\big), H[s, m(s)]]f(s)ds$$

where $c\big(m(s)\big)$ is consumer's copayment amount and $\pi = pE\left(m(s) - c\big(m(s)\big)\right) = \int m(s) - c\big(m(s)\big)\, f(s)ds$. Suppose there is no moral hazard (disease severity s is observable to insurers and consumers are fully aware of potential impacts of utilization on their premium). Then $c(m(s))$ can be simply written as $c(s)$ and individuals choose optimal health spending to maximize utility: $Max_{m(s)} \int U[y - (\int m(s) - c(s)\, f(s)ds) - c(s), H(s,m)]f(s)ds$. Cutler and Zeckhauser (2000) show the solution to this as:

$$(4)\ \ H_m U_H = E[U_x] = \int U[y - (\int m(s) - c(s)\, f(s)ds) - c(s), H(s,m)]f(s)ds$$

H_m is marginal gain in health from additional health spending (m) and U_H is the marginal effect of health on utility. Equation (4) shows that utility gains from additional unit of spending on health ($H_m U_H$) equal to the average of expected marginal utility of consumption in which is weighted by the density function $f(s)$. In other words, individuals are willing to pay more for health insurance if the future illnesses are expected to cause higher financial risks (Manning, Marquis, 1996). And the marginal condition for optimal health insurance is that gains from risk-pooling are balanced with deadweight loss (Petretto, 1999; McGuire, 2012).

This study aims to empirically test the four relevant hypotheses.

Hypothesis 1. Persons with PHI would use more healthcare services than persons without PHI.

Theory predicts consistent moral hazard effects of health insurance.[4] The influential RAND Health Insurance Experiment reveals the price responsiveness (elasticity of -0.2) of healthcare services (Newhouse, 1993). Supplemental insurance further lowers consumers' prices and incentivizes them to use more services (1st graph in Figure 4). As a result, a person can increase the treatment quantity until an additional unit of care does not produce sufficient marginal benefits (a point where marginal benefits equals to marginal costs) – an increase of utilization from Q_0 to Q_1. These changes make demand curves rotate clockwise (D to D_1) and make consumers less price elastic.[5]

However, empirical studies have provided conflicting evidence on moral hazard effect of supplemental PHI. While studies from the U.S. Medigap market (Ettner, 1997; Dardadoni and Donni 2012) and the French private insurance market (Buchmueller et al., 2004) find increased healthcare utilization, evidence from Belgium (Schokkaert et al., 2010) and Australia (Buchmueller et al., 2013) reveal null (or negative) impacts of private policy on the use of care.

Estimating the moral hazard effect of health insurance requires confronting the traditional endogeneity problem (Buchmueller et al., 2004). Specifically, individuals with high expected level of utilization are more likely to purchase policies. This adverse selection simply predicts that persons with higher healthcare needs or with worse health status are more likely to demand better protection. In this case, OLS estimates of moral hazard effect would be overestimated because unobserved demand ("private information") is positively correlated with both utilization and the demand for insurance (Ettner, 1997; Dardanoni, Donni, 2012).

4 "moral hazard irrefutably exists" (Einav, Finkelstein, 2017).

5 Due to non-monetary costs incurred, such as traveling and time costs, even free care keeps patients from increasing quantities indefinitely (Folland et al., 2007).

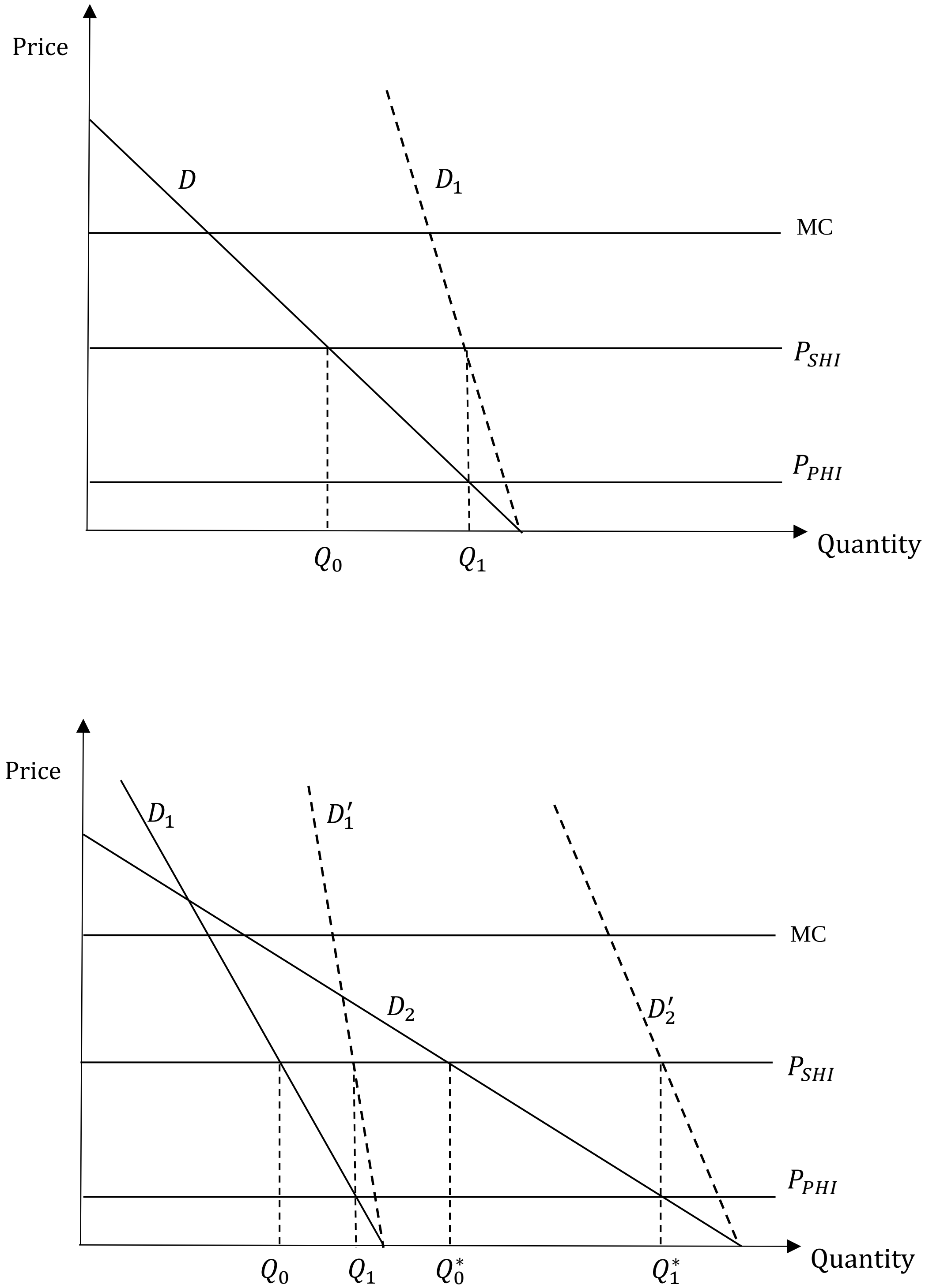

Figure 4. Moral hazard effects of supplemental private health insurance.
D, demand; P, price; MC, marginal cost; SHI, social health insurance; PHI, private health insurance.

Because purchasing private insurance is determined multidimensionally, identifying the moral hazard effect is an empirical challenge. Buchmueller and colleagues (2013) explain that there are two possible explanations for the null associations found in empirical studies. A first argument is that insurers are provided enough information on health status and utilization history so that they can better select consumers with lower probabilities of utilization. Second, omitting unobservable individual characteristics, which are negatively associated with the use of health services, would attenuate the bias induced by adverse selection. A notable example is risk aversion; persons who are risk averse tend to invest more in prevention and tend to enroll in private insurance. Advantageous selection, not adverse selection, can dominate the demand for private insurance because consumers with high opportunity costs (earnings loss in case of fatal illnesses), who are low risk, are more likely to demand private insurance (Buchmueller et al., 2013). Cohen and Siegelman (2010) report that a coverage-risk correlation varies across different settings/markets.

In addition, the differing nature of health systems around the world creates varying incentives (Paccagnella et al., 2013). Because Korean private insurers require policy holders to cover the costs out of pocket and then be reimbursed for expenses later, the insured could be discouraged from using services (Mossialos, Thomson, 2002). Also, unlike some European countries where supplemental PHI provide access to superior private services, there is no limit in Korea for the publicly-insured to get treatment from providers of any kind.

The aforementioned positive correlations can also be attenuated because of strict underwriting (risk rating) (Buchmueller et al., 2013). Korean private insurers have been free to charge higher premiums to persons with pre-existing conditions than healthy peers without guaranteed issue and guaranteed renewal of policies (Jeon, Kwon, 2013). In case of a person with certain pre-existing conditions such as cancers or cirrhosis, private insurers often accept applications conditional on a clause that such illnesses will not be covered.

In sum, I expect supplemental PHI leads to more healthcare utilization, but the size of moral hazard depends on the selection.

Hypothesis 2. Moral hazard effects will vary by the type of service.

When supplemental PHI decreases patient's price, the use of services with relatively elastic (discretionary) demands would increase ($Q_1^* - Q_0^*$) more than services with inelastic demands ($Q_1 - Q_0$) as drawn in the second graph in Figure 4. Ellis et al. (2017) find heterogeneity in price elasticity of demand across services; services with high price elasticities include pharmaceutical, chiropractic care, specialty visits, and diagnostic imaging (MRI, CT, or PET scan), while ER visit, prevention service, ambulance, dialysis, and surgical procedures have low price elasticities.

In particular, patients would face low marginal benefits of certain procedures which accompany the risk of discomfort, infection, additional care. In addition, individuals often face entry barriers because some medical decisions are made based on professional standards and patients with acute conditions do not have much autonomy in relate to decision-making.

Studies on determinants of health services utilization reveal that discretionary care utilization – for instance, emergent or acute care visits – is affected by enabling factors (income, insurance, or distance to facilities) of Andersen's health behavior model, while need factors (health status or number of illnesses diagnosed) play a more important role in determining the use of less discretionary care – for example, prevention or chronic care visits (Fernandez-Mayoralas et al., 2000; Arcury et al., 2005).

Thus, supplemental policies would increase the use of discretionary care, while less discretionary services utilization would not be affected.

Hypothesis 3. Supplemental PHI would induce the demand for low-value care.

Whether reduced cost-sharing induces more use of high- or low-value care is a policy-relevant question. Pauly and Blavin (2008) argue for value-based cost-sharing, which imposes lower coinsurance rates for services with high marginal benefits. When consumers systematically underestimate the true marginal medical benefit of high-value care (“negative behavioral hazard”) – for instance, diabetes medication, vaccination, or prenatal care – and when the true marginal benefit of low-value care – for example, the overuse of antibiotics or imaging, or emergency room visits for ACSCs – is overestimated (“positive behavioral hazard”) (Baicker et al., 2015), differential coinsurance rates can be used to address the underuse (overuse) of high- (low-) value care (Pauly, Blavin, 2008).

Baicker et al. (2015) explain that systematic under- or over-estimation can happen because costs appear now while the medical benefits often appear in the future (“present bias”), and people tend to overweight salient symptoms (for instance, pain) while underweight less salient symptoms (high blood pressure, for example) (“symptom salience”). A welfare-maximizing government can reduce cost-sharing for underutilized high-value care because welfare gains from an increased utilization may outweigh the deadweight loss from moral hazard when marginal benefits are systematically underestimated – if this is the case, the optimal copayment can even be negative though subsidies (Baicker et al., 2015). This directive has been implemented in the Patient Protection and Affordable Care Act, which requires preventive care be provided free of charge. An additional argument for generous coverage of preventive care is that it reduces the propensity to be sick and thus decreases the use of other costly curative services, which eventually would lower the average premiums (Ellis, Manning, 2007).

However, the prediction on moral hazard effect of PHI on the use of low-value care is rather ambiguous. Nyman (1999) predicts that more effective treatments are more price elastic than less effective treatments. Empirical studies, however, find little evidence supporting the differential price elasticities. The use of both high-value and low-value care changes similarly when cost-sharing for the both type of services identically changes, meaning that consumers do not tend to distinguish the true value of services provided (Einav, Finkelstein, 2017; Brot-Goldberg et al., 2017). Clinical studies suggest that the use of low-value care is mainly driven by the supply-side factors such as local norms or market competition (Charlesworth et al., 2016; Colla et al., 2017). Colla (2014) insists that, without enough information provided to patients, demand-side interventions would not affect low-value care utilization much.

1.4. Methods

This study uses the microdata from the Korea Health Panel, which includes information on demographic/socioeconomic characteristics, healthcare utilization/spending, and private insurance status. The survey data consist of the individual-level data set (containing demographic and socioeconomic variables) and the encounter-level utilization data set (containing timing, place, diagnosis, and costs of each encounter).[6] Most important, survey participants were asked to collect receipts (including diagnosis codes) of each encounter to minimize recall bias.

The panel has annually collected information from nationally-representative 7,009 households and 21,283 individuals randomly selected in 2008. I select 2008-2014 as the study period, which is the most recent data set available. I restrict study population to working-age individuals aged between 20 and 65 years old.[7] This age restriction results in an exclusion of 2,594 persons older than 65. Note that SHI waives user fees for childbirth and care for newborns younger than 4 weeks – the both cases are excluded from my study sample as well. In addition, I exclude 53 persons who enroll in more than one supplemental policy because I cannot determine which type of policy affects policyholders' behaviors.[8] As a result, the final sample consists of an unbalanced panel of 64,912 person-years (12,284 persons at baseline).

My empirical analysis relies on within-person variation in the PHI holding status:

$$(5)\ \ Utilization_{it} = \beta_1 PHI_{it} + \alpha_i + \varphi X_{it} + \theta_t + \varepsilon_{it}$$

---

[6] The panel does not contain information on the amounts reimbursed by PHI. Thus, my estimations do not show the impact of PHI on OOP spending.

[7] Due to strict underwriting, only 4.1% of persons older than 65 years ever enrolled in supplemental policies, while 24.9% of my study population (aged 25-65) ever held PHI. Including the elderly group, though, does not qualitatively change main results.

[8] The Insurance Business Act prohibits duplicated reimbursements.

The unit of analysis is a person-year. Utilization_{it} is defined as annual healthcare utilization (outpatient, inpatient, or emergency care) for person i in survey year t. Included covariates are individual fixed effects (α_i), year fixed effects (θ_t), Charlson comorbidity index, and a set of time-variant factors (educational attainment, marital status, employment status, and indicators whether disabled). Charlson comorbidity index is included for capturing health conditions requiring healthcare services and better coverage. This index is converted by using scoring system used in previous clinical studies in Korea (Chae et al., 2011; Kim et al., 2013) based on diagnosis codes (Korean Standard Classification of Diseases, Fourth Revision (KCD-4)) reported in the panel data. Standard errors are clustered at individual level.

Including individual fixed effects benefits the study design in that I can control for unobservable time-invariant individual factors – for instance, depreciated health shocks and investments which occurred in the past (Grossman, 2000) –, which can be correlated with both the demand for supplemental insurance and healthcare utilization. I also assume that other individual-level factors such as preferences for healthcare services, risk perception, symptom salience, or medication adherence do not substantially change over time, though it can be a threat to my identification if changes in these factors, which I cannot control for due to data limitation, are significantly related to the demand for PHI and the outcome measures.

In addition, I estimate the effect on low-value care utilization. First, the impact on hospitalization or ER visits due to ACSCs are estimated. The panel data include diagnoses which are coded based on Korean Standard Classification of Diseases, Fourth Revision (KCD-4). ACSCs – hypertension, congestive heart failure, angina, diabetes short-term or long-term complications, chronic obstructive pulmonary disease, bacterial pneumonia, and urinary tract infection – defined by the Agency for Healthcare Research and Quality (AHRQ, 2016), are matched with KCD-4 codes. Second, I check the association of having supplemental insurance with the use of CT/MRI imaging for unspecified low-back pain or headache, which are not recommended by medical professional groups (Shreibati, Baker, 2011; Charlesworth et al., 2016; Colla et al., 2017).

I also expect that heavy users increase their level of utilization more than light users after enrolling in supplemental private insurance. By running quantile treatment regressions with individual fixed effects (Powell, 2016), I investigate the relationship between the outcome measure (the number of annual visits) and regressors at different points in the conditional distribution of the outcome variable.

1.5. Results

Table III shows that, of all 12,284 study subjects at baseline (survey year 2008), 51% are women, 72% are married, and 42% finish secondary education. Mean age is 42.

Figure 5 presents fitted values of the propensity to enroll in supplemental PHI by demographics and by a health indicator. Persons with higher educational attainment and with higher household income are significantly more likely to be privately insured, suggesting selection on risk aversion because their opportunity costs of getting sick tend to be high.

Figure 5 also suggests favorable risk selection. Distributions by age show the pattern that older individuals are significantly less likely than younger groups to enroll in PHI. This finding is in stark contrast to a Belgian study which finds persons aged 50~70 are significantly more likely to enroll in PHI than persons in their 40s (Schokkaert et al., 2010).[9] In addition, persons with lower Charlson comorbidity index are more likely to purchase private policies. The fitted probabilities of being insured by PHI among persons with Charlson score higher than 4 or among persons 60 years or older are close to zero.

TABLE III
BASELINE CHARACTERISTICS (SURVEY YEAR 2008)

[9] The Belgian private insurers also apply individual risk rating (Stevens et al., 1998).

	Observations	Mean (std. dev)	Min.	Max.
Dependent variables (for the past year)				
Any visit	12284	0.699	0	1
Number of visits	12284	6.997 (11.750)	0	200
Outpatient visit	12284	0.692	0	1
Outpatient visit, clinic	12284	0.605	0	1
Outpatient visit, hospital	12284	0.317	0	1
Lab test, outpatient	12284	0.450	0	1
Medicine prescribed, outpatient	12284	0.648	0	1
Hospitalization	12284	0.083	0	1
Inpatient length of stay, sum	12284	1.221 (9.167)	0	365
ER visit	12284	0.055	0	1
Independent variables				
Survey year				
2008	12284	0.188		
2009	10208	0.156	0	1
2010	9456	0.145	0	1
2011	9149	0.140	0	1
2012	8619	0.132	0	1
2013	7993	0.122	0	1
2014	7623	0.117	0	1
Age	12284	42.319 (12.222)	20	65
Female	12284	0.513	0	1
Household income quintile [a]	12166			
Q1		0.099	0	1
Q2		0.189	0	1
Q3		0.223	0	1
Q4		0.246	0	1
Q5		0.243	0	1
Education	12284			
Primary schooling		0.116	0	1
Secondary schooling		0.468	0	1
College attendance		0.416	0	1
Married	12284	0.721	0	1
Employed	12283	0.641	0	1
Charlson comorbidity index	12284	0.589 (0.954)	0	7
Disabled	12284	0.039	0	1

ER, emergency room.

[a] Quintile of adjusted household annual income (earned + unearned) which was divided by square-rooted number of household members.

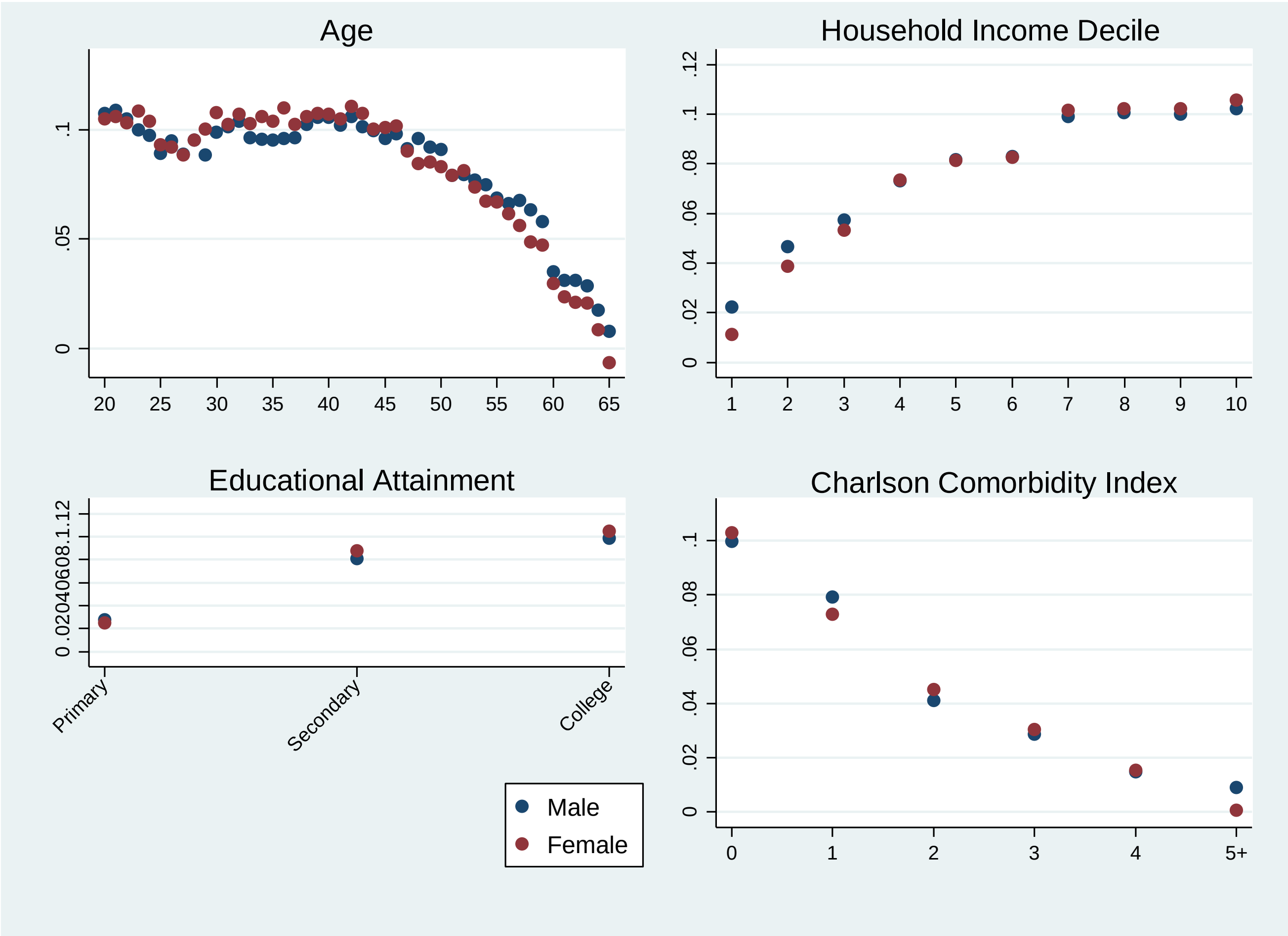

Figure 5. Fitted values of the propensity to enroll in PHI.

This advantageous selection can be driven either by private insurers (risk selection) or by individuals (risk aversion). To answer this question, I investigate determinants of PHI enrollment in Table IV, assuming that the purchase of private supplemental insurance is a function of sociodemographic factors, health status, and healthcare utilization in the preceding period (samples in the regression model exclude persons who had PHI in the preceding period). The positive correlation between the use of healthcare services in the preceding period and the purchase of PHI would indicate the presence of information asymmetricities, thus supporting scenario of adverse selection (Fang et al., 2008; Bardey, Buitrago, 2017).

TABLE IV

DETERMINANTS OF ENROLLING IN SUPPLEMENTAL PRIVATE HEALTH INSURANCE

	Male	Female
# outpatient visits$_{t-1}$	-0.0003** (0.0001)	0.00009 (0.0001)
# hospitalization$_{t-1}$	0.005 (0.003)	0.012*** (0.004)
# ER visits$_{t-1}$	0.007 (0.006)	0.004 (0.006)
Hospitalization due to ACSCs$_{t-1}$	-0.013 (0.020)	-0.0004 (0.024)
ER visit due to ACSCs$_{t-1}$	0.004 (0.038)	0.079 (0.048)
CT imaging$_{t-1}$	0.004 (0.010)	-0.001 (0.009)
MRI imaging$_{t-1}$	0.016 (0.014)	0.009 (0.012)
Ultrasound imaging$_{t-1}$	-0.0001 (0.008)	0.007 (0.005)
Vaccination$_{t-1}$	0.021*** (0.007)	0.002 (0.005)
Gastric cancer screening$_{t-1}$	-0.010 (0.007)	-0.008 (0.010)
Hepatic cancer screening$_{t-1}$	0.014 (0.013)	0.025 (0.016)
Colorectal cancer screening$_{t-1}$	-0.004 (0.021)	-0.003 (0.015)
Prostate cancer screening$_{t-1}$	-0.004 (0.021)	
Breast cancer screening$_{t-1}$		0.003 (0.011)
Cervical cancer screening$_{t-1}$		0.011 (0.010)
Positive result from cancer screening$_{t-1}$	0.023** (0.011)	0.028*** (0.011)
Education (ref=less than secondary schooling)		
Secondary schooling	0.006 (0.006)	0.020*** (0.005)
College attendance or more	-0.001 (0.006)	0.013* (0.007)
Married	0.029** (0.007)	0.048*** (0.007)
Employed	0.009* (0.005)	0.007* (0.004)
Disabled	-0.011** (0.005)	-0.024*** (0.007)
Household head	0.028*** (0.007)	0.056*** (0.009)
# household members	-0.007*** (0.002)	-0.007*** (0.002)
Charlson comorbidity index (ref=0)		
1	-0.001 (0.006)	0.0006 (0.007)
2	-0.018** (0.007)	-0.007 (0.008)
3+	-0.019** (0.008)	-0.028*** (0.007)
Dep. Var. Mean	0.064	0.080

* p-value <0.1, ** <0.05, and *** <0.001.

In particular, I add prevention activities (vaccination and cancer screening), which are not covered by PHI, to the model to test whether samples are selected on risk aversion or on moral hazard. Primary prevention (vaccination) reduces the risk of illness, thus it's positive correlation with PHI enrollment would provide evidence of advantageous selection. Secondary prevention (cancer screening), on the other hand, would indicate either risk aversion or individual's private information (adverse selection) (Bardey, Buitrago, 2017). If a person received a positive result from cancer screening, it would increase the propensity of consequent healthcare utilization, while private insurers would not have such information at the time of enrollment.

I also add unnecessary care (hospitalization/ER visit due to ACSCs) and uncovered discretionary care (MRI/CT/Ultrasound imaging) utilization indicators to the regression model to see if the sample is adversely selected. The positive correlation of these indicators with PHI enrollment would indicate selection on moral hazard in that individuals who used costly and discretionary healthcare services even before the purchase of PHI "exhibit a greater behavioral response to coverage" (Einav et al., 2013).

Results from pooled OLS estimation in Table IV show that persons enrolled in PHI are not necessarily heavy users. And the propensity of discretionary care utilization is not correlated with the purchase of PHI. Results indicate that, however, the use of primary prevention activity (vaccination) is associated with a 1.6~2.1 percentage point increase (25~33% of the mean) of the propensity of PHI enrollment among men, indicating that privately-insured persons are risk averse.

The uptake of cancer screening is not correlated with PHI enrollment. But any positive result from the screening, which is less than 20% of all screening cases, are significantly associated with the purchase of PHI policies (1.8~3.1 percentage points). This result indicates the presence of private information, which is unobserved by insurers, about individual's risk of suffering a financial loss.

Put together, these findings indicate that evidence on adverse selection is not strong in the Korean supplemental PHI market. As results show that individuals insured by PHI are not necessarily having more annual healthcare visits before the supplemental health insurance purchase, the medical underwriting practices seem to reduce the probability of information asymmetricity to some extent. Low probabilities of PHI enrollment among high-cost consumers (chronically ill or disabled persons) would be explained by risk selection by insurers, though I am not able to directly test this due to lack of data on pricing and application history.

In Table V, following Fang et al. (2008), I present the coefficients on annual number of visits regressed by PHI holding status along with controls which are expected to be correlated with both the enrollment status and healthcare utilization. When only year dummies are included in the model (naïve regression), persons with PHI visit healthcare facilities 1.4 times fewer than those without PHI. However, conditional on health status and individual fixed effects, I find a significantly positive relationship between the number of visits and PHI status. With all factors controlled for, persons with supplemental insurance visit 1.1 times more than those without PHI.

Results of Table V and Figure 5 together show that those in need of better coverage and more healthcare services (older or chronically-ill persons) are less likely to enroll in PHI, corroborating evidence of advantage selection. Also, result that omitting individual fixed effects leads to underestimation of the impact of PHI on utilization suggests that unobservable time-invariant individual factors such as risk preferences play an important role in determining the demand for supplemental health insurance and healthcare utilization.

TABLE V

SOURCES OF SELECTION: OLS REGRESSION OF ANNUAL NUMBER OF VISITS ON SUPPLEMENTAL PRIVATE INSURANCE

	(1)	(2)	(3)	(4)	(5)	(6)
Coefficient	-1.366*** (0.144)	-1.743*** (0.140)	0.256** (0.130)	0.315** (0.128)	2.038*** (0.150)	1.056*** (0.151)
Year FE	√	√	√	√	√	√
Female		√	√	√		
Married		√	√	√		√
Employed			√	√		√
Household income decile			√	√		√
Educational attainment			√	√		√
Age groups			√	√		√
Charlson comorbidity index				√		√
Disabled				√		√
Individual FE					√	√
(Adjusted) R^2	0.006	0.044	0.162	0.199	0.721	0.729

OLS, ordinary least squares; FE, fixed effects.

* p-value <0.1, ** <0.05, and *** <0.001.

Enrolling in PHI increases annual healthcare visits at the extensive margin (Table VI). Supplemental insurance increases the probability of any healthcare visit (including outpatient, inpatient, and ER visits) and any outpatient visit by 1.1~1.2 percentage points (1.5% of the mean), and any hospitalization by 1.5 percentage points (18.1% of the mean). The association of PHI with ER visit is not significant.

PHI also increases annual healthcare utilization at the intensive margin (Table VII). Supplemental insurance increases the number of annual outpatient visits by 1.01 (12% of the mean) and annual hospitalization utilization by 0.02 (18.8% of the mean).

TABLE VI

IMPACT OF SUPPLEMENTAL PRIVATE HEALTH INSURANCE ON ANNUAL HEALTHCARE UTILIZATION AT THE EXTENSIVE MARGIN

	Any visit	Any outpatient visit	Any hospitalization	Any ER visit
Supplemental insurance	0.011* (0.006)	0.012* (0.006)	0.015*** (0.005)	0.006 (0.004)
Year (ref: 2008)				
2009	0.024 *** (0.005)	0.023 *** (0.005)	0.008 ** (0.004)	0.007 ** (0.003)
2010	0.039 *** (0.005)	0.039 *** (0.005)	0.008 ** (0.004)	0.011 *** (0.003)
2011	0.040 *** (0.005)	0.042 *** (0.005)	0.005 (0.004)	0.004 (0.003)
2012	0.071 *** (0.007)	0.074 *** (0.006)	0.022 *** (0.005)	0.012 *** (0.004)
2013	0.080 *** (0.007)	0.085 *** (0.006)	0.017 *** (0.005)	0.018 *** (0.004)
2014	0.082 *** (0.007)	0.086 *** (0.006)	0.018 *** (0.005)	0.015 *** (0.004)
Educational attainment (ref: primary schooling or less)				
Secondary schooling	0.029 (0.041)	0.060 (0.042)	-0.021 (0.063)	-0.004 (0.052)
College attendance	0.037 (0.057)	0.082 (0.060)	0.009 (0.067)	0.007 (0.056)
Married	0.111 *** (0.019)	0.107 *** (0.019)	0.051 *** (0.015)	0.028 ** (0.012)
Employed	0.0009 (0.005)	0.002 (0.005)	-0.005 (0.005)	0.002 (0.004)
Disabled	0.020 (0.020)	0.016 (0.020)	-0.067 *** (0.026)	-0.010 (0.017)
Charlson comorbidity index (ref: 0)				
1	0.025 *** (0.007)	0.022 *** (0.007)	-0.010 * (0.006)	-0.001 (0.005)
2	0.063 *** (0.007)	0.066 *** (0.007)	0.064 *** (0.009)	0.022 *** (0.007)
3+	0.077 *** (0.007)	0.084 *** (0.007)	0.164 *** (0.015)	0.050 *** (0.011)
Dep. Var. Mean	0.741	0.735	0.083	0.064

* p-value <0.1, ** <0.05, and *** <0.001

TABLE VII

IMPACT OF SUPPLEMENTAL PRIVATE HEALTH INSURANCE ON ANNUAL HEALTHCARE UTILIZATION AT THE INTENSIVE MARGIN, 2008-2014

	# visits, any	# visits, outpatient	# visits, inpatient	# visits, ER
Supplemental insurance	1.056*** (0.151)	1.012*** (0.148)	0.024*** (0.009)	0.009 (0.006)
Year (ref: 2008)				
2009	0.958 *** (0.094)	0.932** (0.092)	0.016 *** (0.006)	0.010 ** (0.004)
2010	1.831 *** (0.119)	1.787* (0.117)	0.022 *** (0.006)	0.021 *** (0.005)
2011	2.596 *** (0.133)	2.598*** (0.131)	0.022 *** (0.007)	0.006 (0.005)
2012	3.307 *** (0.149)	3.231* (0.147)	0.056 *** (0.008)	0.020 *** (0.005)
2013	3.742 *** (0.159)	3.671* (0.156)	0.046 *** (0.008)	0.025 *** (0.006)
2014	3.771 *** (0.172)	3.695* (0.170)	0.052 *** (0.008)	0.025 *** (0.006)
Educational attainment (ref: primary schooling or less)				
Secondary schooling	-2.233 (2.806)	-2.376 (2.874)	0.149 (0.137)	-0.005 (0.052)
College attendance	-1.601 (2.753)	-1.832 (2.815)	0.215 (0.139)	0.017 (0.059)
Married	0.813 * (0.445)	0.734 (0.434)	0.050 * (0.029)	0.029 * (0.015)
Employed	-0.553 *** (0.162)	-0.529 *** (0.159)	-0.020 ** (0.009)	-0.004 (0.006)
Disabled	2.321 * (1.344)	2.406 * (1.331)	-0.100 * (0.057)	0.015 (0.031)
Charlson comorbidity index (ref: 0)				
1	-1.076 *** (0.211)	-1.060 *** (0.207)	-0.014 (0.009)	-0.002 (0.007)
2	-0.043 (0.337)	-0.155 (0.333)	0.094 *** (0.017)	0.018 * (0.010)
3+	4.153 *** (0.583)	3.726 *** (0.571)	0.355 *** (0.040)	0.071 *** (0.018)
Dep. Var. Mean	8.662	8.454	0.128	0.080

* p-value <0.1, ** <0.05, and *** <0.001.

Supplemental insurance increases the probability of outpatient prescription drug (+2%) and any lab test (+4%) (Table VIII). Impacts of PHI are higher for the number of hospital outpatient department visits (+18.4%) than the number of clinic outpatient visits (+9.8%). Also, PHI is positively associated with the probability of any hospital outpatient department visit (+7.1%), while the likelihood of clinic physician visit is not affected.

Supplemental PHI does not have uniform moral hazard effects across outpatient services. Table IX shows that individuals with PHI increase the use and intensity of care for conditions commonly treated in the primary care settings (acute upper respiratory tract infection, upper gastrointestinal tract infection, and musculoskeletal disorders). Notably, PHI significantly increases the propensity to visit outpatient care unit of hospital for these discretionary conditions, while the coefficients on outpatient clinic visit are not significant. This result indicates that supplemental PHI incapacitates SHI's differential cost-sharing policy. By contrast, PHI does not increase the use of less discretionary services – chronic care visits – (Panel D & E).

Table X shows that PHI increases the propensity of hospitalization not for surgery (for instance, diagnostic purposes, minor trauma, or medical treatments) (28.8% of the mean) more than the probability of hospitalization for surgery (+16.3%). PHI also increases the intensity of inpatient care: Hospital length of stay increases by 22.6%. The use of upgraded rooms (with fewer than 6 beds), which are not covered by SHI but covered by PHI, also increases by 19.3%.

TABLE VIII

IMPACT OF SUPPLEMENTAL PRIVATE HEALTH INSURANCE ON ANNUAL OUTPATIENT HEALTHCARE UTILIZATION, 2008-2014

	Any outpatient clinic visit	# visits, outpatient clinic	Any hospital outpatient visit	# visits, hospital outpatient	Any medicine prescribed	Any outpatient lab test
Supplemental insurance	0.006 (0.007)	0.620*** (0.129)	0.026*** (0.008)	0.392*** (0.071)	0.014** (0.007)	0.019** (0.008)
Year (ref: 2008)						
2009	0.024 *** (0.005)	0.748 *** (0.082)	0.023 *** (0.005)	0.184 *** (0.048)	0.029 *** (0.005)	0.034 *** (0.006)
2010	0.038 *** (0.005)	1.343 *** (0.099)	0.052 *** (0.006)	0.444 *** (0.065)	0.036 *** (0.005)	0.090 *** (0.006)
2011	0.051 *** (0.006)	2.030 *** (0.117)	0.050 *** (0.006)	0.538 *** (0.065)	0.049 *** (0.005)	0.097 *** (0.006)
2012	0.076 *** (0.006)	2.209 *** (0.123)	0.093 *** (0.007)	1.022 *** (0.081)	0.085 *** (0.006)	0.145 *** (0.007)
2013	0.083 *** (0.007)	2.575 *** (0.130)	0.102 *** (0.007)	1.095 *** (0.088)	0.092 *** (0.006)	0.155 *** (0.008)
2014	0.087 *** (0.007)	2.642 *** (0.143)	0.097 *** (0.007)	1.053 *** (0.089)	0.101 *** (0.007)	0.160 *** (0.008)
Educational attainment (ref: primary schooling or less)						
Secondary schooling	-0.023 (0.037)	-1.490 (1.273)	0.137 ** (0.063)	-0.886 (2.495)	0.045 (0.036)	0.006 (0.076)
College attendance	-0.055 (0.052)	-1.480 (1.300)	0.197 ** (0.079)	-0.353 (2.434)	0.069 (0.054)	0.029 (0.082)
Married	0.090 *** (0.020)	0.401 (0.394)	0.065 *** (0.021)	0.333 (0.245)	0.089 *** (0.019)	0.079 *** (0.021)
Employed	0.001 (0.006)	-0.239 * (0.135)	-0.007 (0.006)	-0.290 *** (0.083)	0.003 (0.006)	0.001 (0.007)
Disabled	0.038 (0.024)	2.024 * (1.215)	-0.002 (0.024)	0.382 (0.553)	0.011 (0.020)	-0.007 (0.026)
Charlson comorbidity index (ref: 0)						
1	0.012 * (0.007)	-0.903 *** (0.182)	0.007 (0.009)	-0.157 (0.096)	0.025 *** (0.007)	0.023 *** (0.008)
2	0.026 *** (0.008)	-1.014 *** (0.302)	0.102 *** (0.011)	0.859 *** (0.146)	0.067 *** (0.007)	0.113 *** (0.010)
3+	0.035 *** (0.011)	0.983 ** (0.463)	0.197 *** (0.014)	2.743 *** (0.349)	0.092 *** (0.008)	0.168 *** (0.011)
Dep. Var. Mean	0.649	6.328	0.365	2.126	0.695	0.450

* p-value <0.1, ** <0.05, and *** <0.001.

TABLE IX

IMPACT OF SUPPLEMENTAL PRIVATE HEALTH INSURANCE ON DISCRETIONARY OUTPATIENT CARE UTILIZATION, 2008-2014

	Any outpatient visit	Any outpatient visit, clinic	Any outpatient visit, hospital	Any medicine prescribed	Any outpatient lab test
Panel A. Visits due to acute upper respiratory tract infection[a]					
Supplemental insurance	0.015 *	0.010	0.010 ***	0.013 *	0.004
	(0.008)	(0.008)	(0.004)	(0.008)	(0.003)
Dep. Var. Mean	0.410	0.377	0.043	0.407	0.031
Panel B. Visits due to upper gastrointestinal tract infection[b]					
Supplemental insurance	0.010 *	0.003	0.006 *	0.008	0.0008
	(0.005)	(0.005)	(0.003)	(0.005)	(0.004)
Dep. Var. Mean	0.131	0.093	0.043	0.125	0.054
Panel C. Visits due to musculoskeletal pain[c]					
Supplemental insurance	-0.0006	0.003	0.011 **	0.012 *	-0.0001
	(0.001)	(0.006)	(0.004)	(0.006)	(0.0004)
Dep. Var. Mean	0.005	0.177	0.075	0.197	0.0008
Panel D. Visits due to hypertension					
Supplemental insurance	-0.007 **	-0.004	-0.002	-0.005 *	-0.004
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
Dep. Var. Mean	0.122	0.086	0.034	0.143	0.051
Panel E. Visits due to diabetes mellitus					
Supplemental insurance	-0.003	-0.003	-0.0007	-0.005 *	-0.0004
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
Dep. Var. Mean	0.048	0.030	0.019	0.143	0.043

[a] Acute pharyngitis, acute tonsillitis, common cold, acute bronchitis

[b] Dyspepsia, gastroesophageal reflux disease, acute gastritis, acute duodenitis, peptic ulcer

[c] Rheumatoid arthritis, osteoarthritis, unspecified low back pain, spinal stenosis, herniated disc, sprain

* p-value <0.1, ** <0.05, and *** <0.001.

TABLE X

IMPACT OF SUPPLEMENTAL PRIVATE HEALTH INSURANCE ON ANNUAL OUTPATIENT HEALTHCARE UTILIZATION, 2008-2014

	Hospitalization for surgery	Hospitalization not for surgery	Inpatient length of stay, sum	Upgraded accommodation[a]
Supplemental insurance	0.008** (0.004)	0.015*** (0.004)	0.329** (0.163)	0.011** (0.004)
Year (ref: 2008)				
2009	0.006 ** (0.003)	0.004 (0.003)	0.267** (0.115)	0.006* (0.003)
2010	0.005 * (0.003)	0.006 * (0.003)	0.353** (0.137)	0.012*** (0.003)
2011	0.005 * (0.003)	0.001 (0.003)	0.342** (0.151)	0.005 (0.003)
2012	0.019 *** (0.003)	0.010 *** (0.003)	0.613*** (0.181)	0.014*** (0.004)
2013	0.011 *** (0.004)	0.010 *** (0.004)	0.581*** (0.189)	0.010*** (0.004)
2014	0.015 *** (0.004)	0.009 ** (0.004)	0.597*** (0.195)	0.008** (0.004)
Educational attainment (ref: primary schooling or less)				
Secondary schooling	-0.037 (0.053)	0.023 (0.048)	2.628 (2.031)	-0.066 (0.055)
College attendance	-0.015 (0.057)	0.049 (0.050)	3.565* (2.033)	-0.035 (0.058)
Married	0.015 (0.013)	0.037 *** (0.012)	-0.554 (1.049)	0.050*** (0.012)
Employed	0.006 * (0.004)	-0.008 ** (0.004)	-0.510*** (0.182)	-0.0003 (0.004)
Disabled	-0.046 ** (0.020)	-0.046 ** (0.022)	-1.319 (2.587)	-0.039* (0.022)
Charlson comorbidity index (ref: 0)				
1	-0.0007 (0.004)	-0.009 ** (0.004)	0.008 (0.193)	-0.003 (0.004)
2	0.059 *** (0.008)	0.018 *** (0.006)	0.641** (0.320)	0.041*** (0.007)
3+	0.122 *** (0.012)	0.081 *** (0.012)	4.179*** (0.648)	0.103*** (0.012)
Dep. Var. Mean	0.049	0.052	1.458	0.057

a Rooms with fewer than 6 beds (until September 2014, only 6-bed rooms had been covered by SHI).

* p-value <0.1, ** <0.05, and *** <0.001.

In Figure 6 and Table XI, I present the annual healthcare utilization quantile treatment effects taken from quantile regressions. Results indicate heterogeneity in the impacts of PHI on the annual number of visits. Results show that, for quantiles below the median, the quantile treatment effects are not statistically significant and smaller than the mean treatment effect (1.056 with individual fixed effects). Results also show that the quantile treatment effects for quantiles 60~90th are significant and bigger than effects for quantiles below the median. In particular, quantile regression with individual fixed effects (Powell, 2016) shows that the biggest impact is found for the quantile 90th (Panel A), meaning that heavy users increase their healthcare utilization the most after enrolling in PHI.

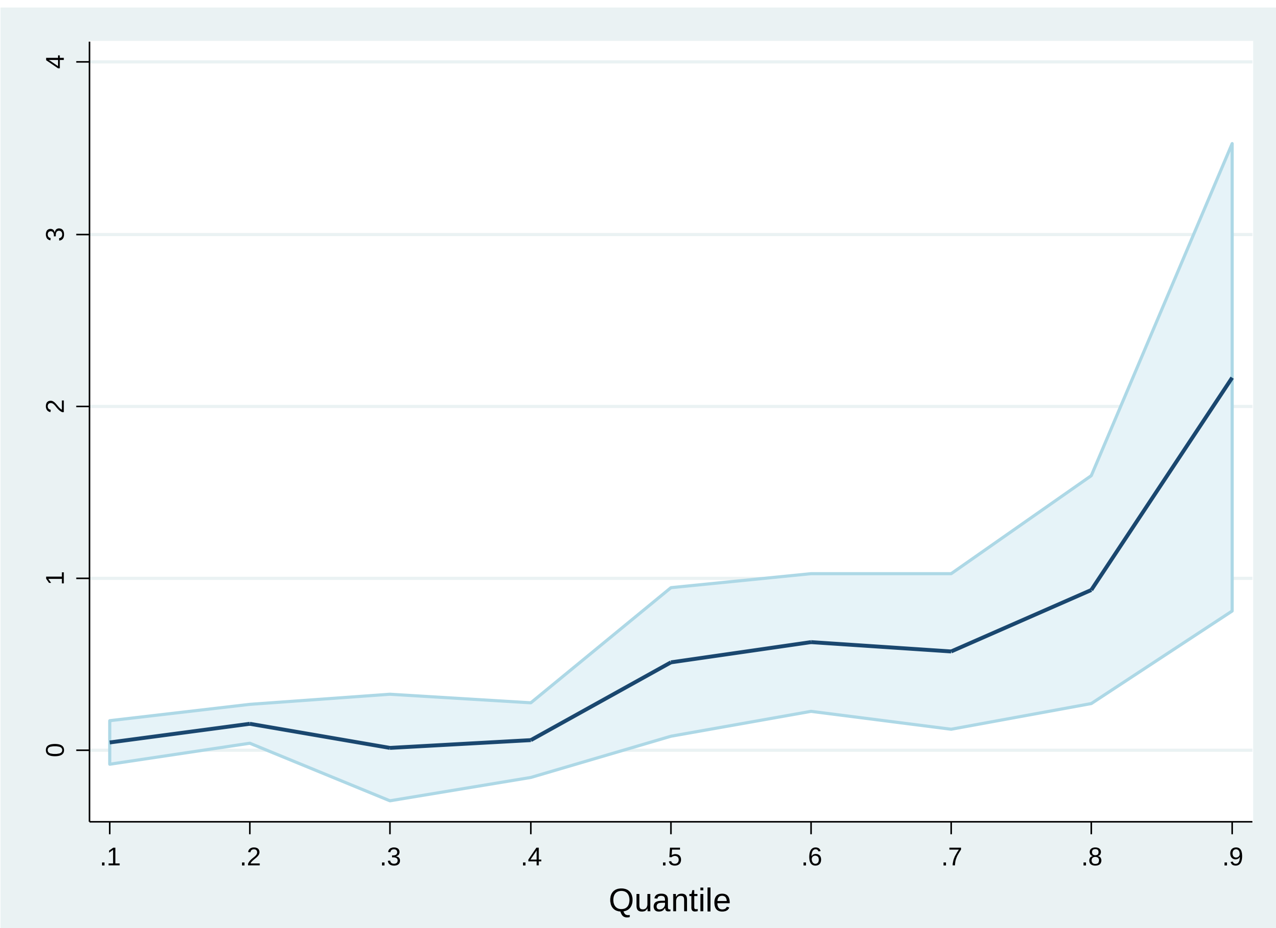

Figure 6. Quantile treatment effects of supplemental private health insurance on annual visits.

Also, the coefficient estimates from quantile regression with individual fixed effects are higher, especially for quantiles above median, than the coefficient estimates from quantile regression without individual fixed effects, meaning that omitting time-invariant individual factors such as preferences for healthcare services and risk preferences leads to underestimation of the impacts of PHI on healthcare utilization. This finding suggests that individuals who value frequent healthcare utilization are less likely to have private policies.

Results that supplemental insurance increases hospital outpatient visit, especially for conditions treatable in the primary setting, and hospitalization not for surgery raise the concern that PHI may lead to increases in the use of unnecessary healthcare services that would otherwise be not used without PHI.

TABLE XI
QUANTILE TREATMENT EFFECTS OF SUPPLEMENTAL PRIVATE HEALTH INSURANCE ON ANNUAL NUMBER OF VISITS, 2008-2014

	Quantile								
	10%	20%	30%	40%	50%	60%	70%	80%	90%
Panel A. Including individual fixed effects									
Coefficient	0.048 (0.065)	0.156 *** (0.057)	0.018 (0.159)	0.059 (0.111)	0.514 ** (0.220)	0.629 *** (0.205)	0.575 ** (0.231)	0.935 *** (0.338)	2.169 *** (0.692)
Panel B. Without individual fixed effects									
Coefficient	-0.0002 (0.015)	-0.0005 (0.015)	-0.0001 (0.028)	0.188 *** (0.038)	-0.0001 (0.033)	0.556 *** (0.086)	0.683 *** (0.100)	0.913 *** (0.161)	1.097 *** (0.252)

* p-value <0.1, ** <0.05, and *** <0.001.

Table XII shows that PHI does not affect the use of unnecessary inpatient or emergent care. Hospitalizations or emergency room visits due to ACSCs, which are preventable by proper care in outpatient setting, are not significantly associated with supplemental policy both conditional on and unconditional on any hospitalization or ER visit. There is also no evidence that persons holding free policies use more low-value care than persons with cost-sharing policies.

In addition, supplemental insurance does not affect low-value care in outpatient setting (Table XIII). Even though PHI effectively reduces patients' price from 100% (because CT and MRI imaging are not covered by SHI for most cases) to 0% (free policy) or 10/20% (cost-sharing policy), I find a null association of PHI with imaging due to unspecified low-back pain or unspecified headache (it is possible, however, that PHI's associations with unnecessary imaging are not found due to the fact that only 2~4% of study population use such services).

Note that PHI significantly increases the use of upgraded hospital accommodation (Table X) but does not affect the probability of CT/MRI imaging. These findings provide suggestive evidence that reductions in the consumer prices lead to increases in expensive services, but patient's healthcare demand responds differently to the value of care. This finding supports Nyman's (1999) assertion that more effective procedures are more responsive to changes in price than less effective procedures.

Figure 7 shows that disparities in private insurance coverage have widened during the study period. The likelihood of enrolling in PHI among older, low-educated, less affluent, or disabled persons has increased at a slower pace than peers. In particular, the difference in the probability of enrolling in PHI between persons aged 60 and 30 increased from 0.05 in 2009 to 0.27 in 2014. Also, the difference in the propensity to enroll between persons from the top 10% household income group and the bottom 10% income group nearly tripled (from 0.08 in 2009 to 0.28 in 2014).

TABLE XII

SUPPLEMENTAL PRIVATE HEALTH INSURANCE AND LOW-VALUE CARE, 2008-2014

	Hospitalization, ACSCs (unconditional)	Hospitalization, ACSCs (conditional)[#]	ER visit, ACSCs (unconditional)	ER visit, ACSCs (conditional)[#]
Supplemental insurance	-0.0005 (0.001)	-0.011 (0.016)	-0.0005 (0.0008)	-0.013 (0.020)
Year (ref: 2008)				
2009	-0.00001 (0.0009)	-0.004 (0.017)	0.0008 (0.0006)	0.010 (0.021)
2010	0.002 (0.001)	0.010 (0.019)	0.0008 (0.0006)	0.006 (0.020)
2011	0.002 (0.001)	-0.002 (0.018)	0.002** (0.0007)	0.030 (0.026)
2012	0.002* (0.001)	0.008 (0.020)	0.002*** (0.0008)	0.022 (0.025)
2013	0.003** (0.001)	-0.008 (0.021)	0.001 (0.0007)	0.005 (0.025)
2014	0.002** (0.001)	-0.002 (0.023)	0.001 (0.0008)	0.027 (0.028)
Educational attainment (ref: primary schooling or less)				
Secondary schooling	-0.001 (0.002)	-0.008 (0.016)	0.0003 (0.0003)	0.077* (0.040)
College attendance	0.010 (0.014)	0.268 (0.258)	-0.002 (0.001)	0.052** (0.025)
Married	-0.002 (0.004)	-0.015 (0.046)	0.0008 (0.002)	0.101 (0.066)
Employed	0.003* (0.001)	0.031* (0.017)	-0.0001 (0.0008)	-0.006 (0.021)
Disabled	-0.010 (0.007)	-0.009 (0.042)	0.005 (0.003)	0.030 (0.064)
Charlson comorbidity index (ref: 0)				
1	-0.001 (0.002)	0.018 (0.024)	0.0003 (0.001)	0.048** (0.023)
2	0.004 (0.003)	0.009 (0.025)	-0.00005 (0.002)	0.049 (0.037)
3+	0.011** (0.005)	0.007 (0.030)	0.003 (0.003)	0.0003 (0.044)
Observations	*64912*	*6000*	*64912*	*4126*
Dep. Var. Mean	0.006	0.061	0.002	0.039

[a] Conditional on any hospitalization/ER visit.

* p-value <0.1, ** <0.05, and *** <0.001.

TABLE XIII

SUPPLEMENTAL PRIVATE HEALTH INSURANCE AND LOW-VALUE CARE: IMAGING IN OUTPATIENT SETTINGS, 2008-2014

	CT imaging (unconditional)	CT imaging (conditional)[a]	MRI imaging (unconditional)	MRI imaging (conditional)[a]
Panel A. Imaging for unspecified low-back pain				
Supplemental insurance	0.0001 (0.001)	-0.013 (0.013)	0.0001 (0.001)	-0.008 (0.014)
Observations	*64912*	*7673*	*64912*	*7673*
Dep. Var. Mean	0.005	0.043	0.007	0.055
Panel B. Imaging for unspecified headache				
Supplemental insurance	0.0008 (0.0009)	-0.020 (0.038)	-0.0003 (0.0008)	0.004 (0.042)
Observations	*64912*	*1775*	*64912*	*1775*
Dep. Var. Mean	0.002	0.057	0.002	0.088
Panel C. Imaging for any reason				
Supplemental insurance	0.002 (0.003)		0.001 (0.003)	
Observations	*64912*		*64912*	
Dep. Var. Mean	0.042		0.022	

[a] Conditional on having low-back pain or headache.

* p-value <0.1, ** <0.05, and *** <0.001.

Figure 8 plots individual OOP health spending as the share of total expenditures or income among persons not enrolled in PHI (all monetary values are converted to the values in 2015 by using consumer price index).[10] Results show that low income groups’ health expenditures have grown faster than their incomes. In 2008, the average OOP health spending as the share of household total expenditures of individuals from lower income groups was higher than 3%, whereas individuals from higher income groups’ share was less than 2%. This gap has widened since 2008 mostly because of the increasing share of OOP spending among low income groups.

[10] Since the panel study does not contain information on the amounts reimbursed by PHI, true OOP amounts of persons holding PHI are unknown.

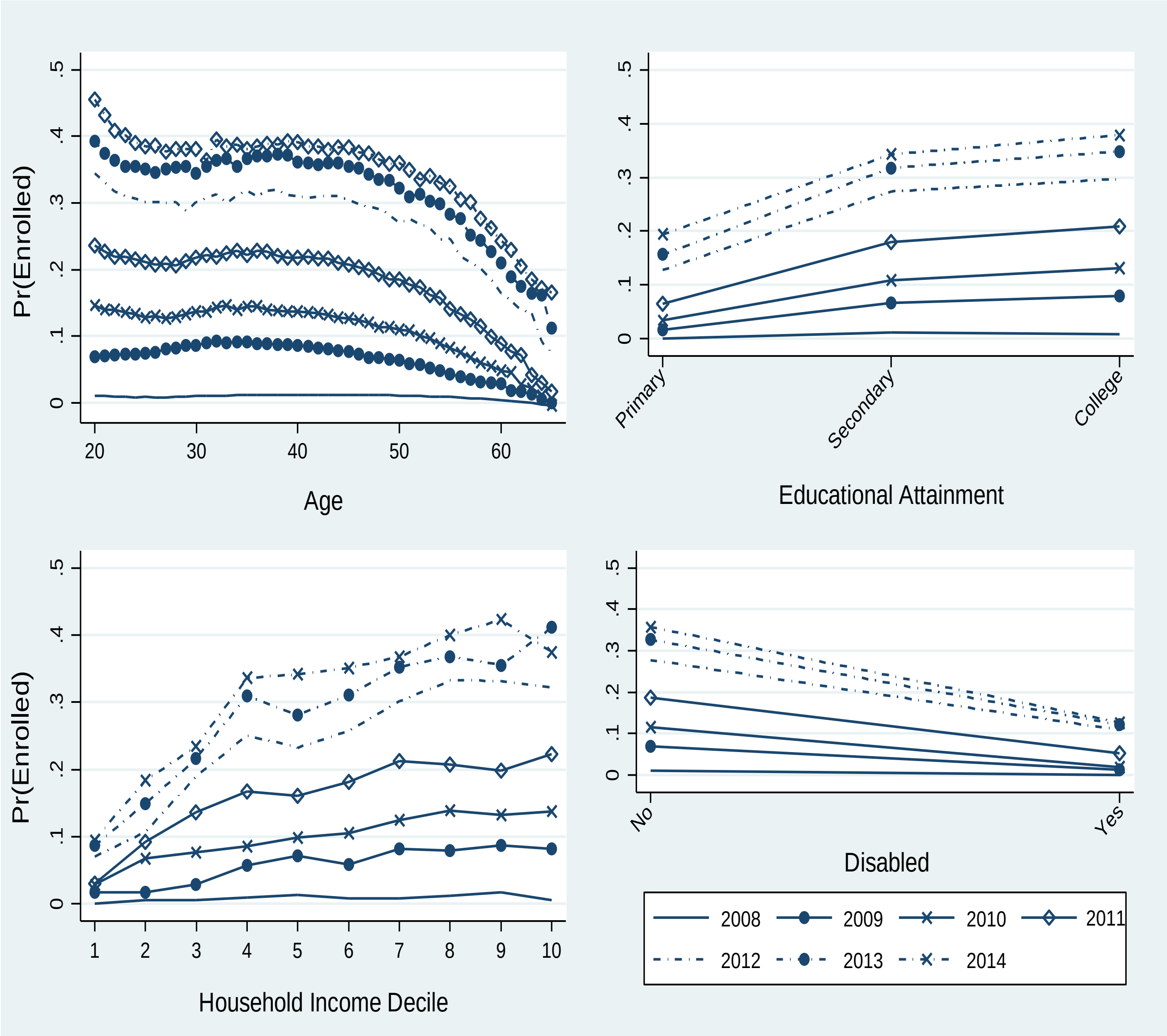

Figure 7. Changes in the distribution of the propensity to enroll in PHI, 2008-2014.

While individuals from lower 20 percentile income groups' average OOP health spending as the share of household expenditures increased from around 3% in 2008 to 6% in 2014, there have been no notable changes among persons from higher income groups. Likewise, OOP health spending as the share of individual earned income significantly increased during the period only among low income groups.

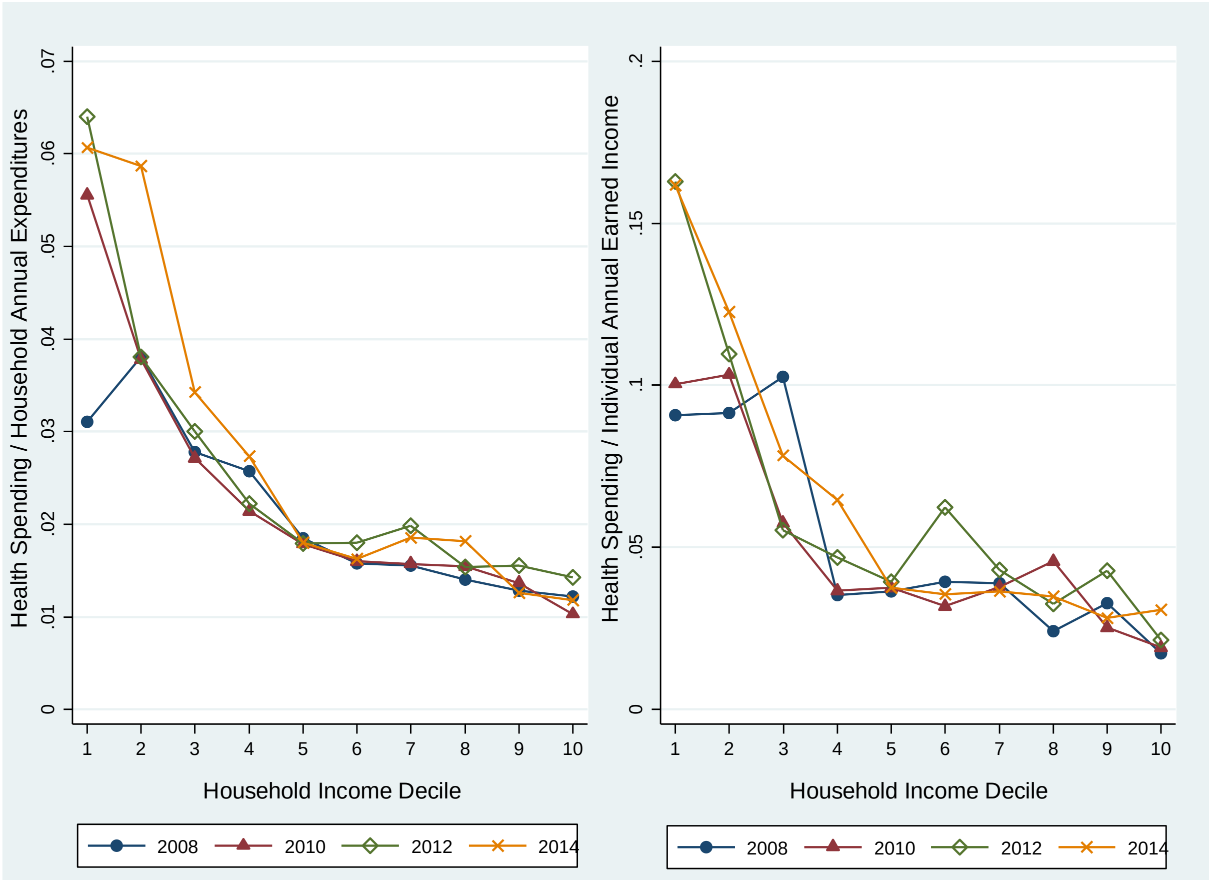

Figure 8. Changes in individual health spending, 2008-2014: Health spending as the share of annual household expenditures (left) and the share of annual individual earned income (right).

Table XXIII, Appendix A lists the top 10 health conditions with the highest annual medical spending in 2012 surveyed by NHI (2013).[11] The average annual OOP costs to leukemia patients was $4,286. This amount is higher than the average annual earned income of persons from the lowest household income distribution ($4,237), meaning that low-income individuals cannot afford the massive spending for severe health conditions without supplemental policy. And results of this study indicate that low-income groups are more likely to face difficulties in being covered by supplemental PHI.

[11] Claims and medical records from 1,103 randomly selected healthcare facilities were reviewed by the National Health Insurance in August through December 2012. Since the survey unit was facility, individual patient's total costs can be underestimated (spending at other institutions was not counted).

To address the equity issues, a pure-type community rating (all consumers are charged the same premium rates regardless of health conditions, age, sex, and other observable factors) or a modified-type (limited premium variation, by age or geographic regions, is allowed) can be considered (Lo Sasso, Lurie, 2009). Though this policy change would address the low coverage among persons with pre-existing conditions, theory and empirical studies show that it can also lead to increased premium rates and a decreased coverage among the healthy and young (Lo Sasso, Lurie, 2009). Implementing guaranteed issues and/or guaranteed renewal would also result in an increase in the coverage of sick persons and an increase in premium rates as well.

To gain some sense of welfare effects between groups, I calculate the annual OOP spending on health predicted from my main specification (Equation (5)). This procedure provides the weighted average of annual OOP spending on health for the healthy population without supplemental insurance (N=27,947) as $362.22 (the average among persons with Charlson comorbidity index higher than zero is $522.77). It implies that, assuming the coinsurance rate of 20%, the actuarially-fair monthly premium for a first-dollar insurance should be at least $24.15 for healthy population under community rating – with an expected influx of persons with chronic conditions, the premium would need to be higher. This estimated community-rated premium would require young and healthy individuals, who typically pay under $20 per month (Figure 9), to pay at least 35% more than now for supplemental coverage.

To empirically estimate the welfare consequences of PHI, Feldman and Dowd’s (1991) solution to the value of insurance which balances expected utility when insured by PHI and expected utility when uninsured is used:

$$(6)\ \frac{V_{PHI}-V_{SHI}}{U'} \approx -\frac{U''}{U'}\frac{\sigma^2}{2} + \frac{[E(U(M)-E(U(m))]}{U'} + [E(pm)-E(pM)]$$

where M and m represent quantity of healthcare demanded with and without PHI. p is the unit price of healthcare (assume that insurance does not induce an increase in the unit price). $[E(pm)-E(pM)]$ is welfare loss due to increases in spending on health with supplemental insurance.

$-\frac{U''}{U'}\frac{\sigma^2}{2}$ represents gains from risk-pooling ($\frac{U''}{U'}$ is the degree of risk aversion and σ^2 is the variance of spending on health) and $\frac{[E(U(M)-E(U(m)]}{U'}$ is the value of increased healthcare utilization (consumer's surplus triangle) (Feldman, Dowd, 1991). This welfare gain is expressed in Figure 9 as the rotated budget constraint and higher indifference curve (preferred bundle of the two goods: a change from U to U').

First, I calculate variances of OOP spending on health among persons without PHI (N=53,942) for different age groups. The absolute risk-aversion parameter ($-\frac{U''}{U'}$) is obtained from Park and MacLachlan (2013): 0.0002. Risk gain from purchasing free PHI policy for each age group is calculated by multiplying the risk-aversion parameter by variances of OOP spending. For instance, for persons 60 years or older, gain from risk bearing is $0.0002 * \left(\frac{\$2,417,405}{2}\right) = \$246.58$. The value of additional healthcare consumed (consumer's surplus triangle) is added to this amount: $\$246.58 + \left(\frac{49.85}{2}\right) = \$296.4$.

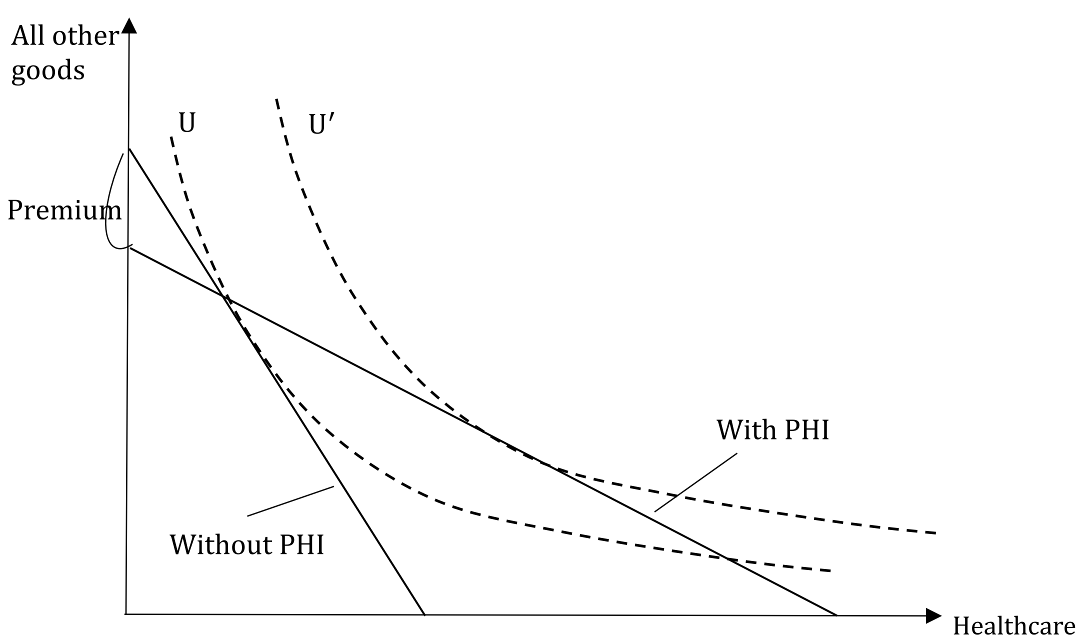

Figure 9. The welfare effects of supplemental private health insurance.
PHI, private health insurance.

Then, to calculate marginal costs of PHI, I use weighted averages of per-visit average OOP amounts, reported by persons without PHI, for each age group. Coefficients on the impact of PHI on the annual number of inpatient and outpatient visits (Table VII) are multiplied by per-visit average OOP amounts for each age group. Thus, variation between age groups in welfare gains comes from differences in the distribution of OOP, while variation in welfare costs comes from differences in per-visit average OOP amounts.[12]

Table XIV summarizes estimated welfare gains, costs, and net gains categorized by age groups. Results show that risk gains outweigh welfare costs for the elderly and young adults (20s). Welfare gains and cost among age group 20~29 are relatively small because both variance of OOP spending and per-visit OOP spending are small for this age group. Age group 50~59 gain most from purchasing PHI ($178), while age group 40~49 lose most (-$145), indicating a surge in (variance of) expected healthcare costs when individuals turn to 50s. Results suggest that covering the elderly by supplemental policies would produce large welfare gains. However, this study finds that the likelihood of enrolling in PHI is the lowest for these persons (Figure 5).

Note that these estimated welfare effects do not directly take into account negative spillover effects on SHI (Column C in Table XV). For instance, persons older than 60 on average spend out of pocket $974.3 on each hospitalization and $34.0 on each outpatient visit. As my data do not contain information on total costs and costs accrue to SHI, I use OOP payments as a percentage of total expenses reported by Kwon (2009): On average, OOP spending is 41% of total costs for hospitalization and 34% for outpatient care.[13] Thus, per-visit OOP spending among persons age 60 or older can be translated to $2,376.3 (inpatient) and $97.9 (outpatient) as total costs incurred per visit. And the remaining costs are accrued to

---

[12] Average per-visit OOP spending is $24.4 (20s) and $34.0 (60s) for outpatient care. And per-event average OOP spending is $669.0 (20s) and $984.0 (60s) for hospitalization.

[13] These figures can be subject to underestimation given that private insurers reported in 2013 and 2014 that of all hospitalization claims, OOP spending is 55.2% of the total costs (Korea Insurance Development Institute, 2016). If so, consequently, the estimated welfare costs due to PHI are in fact higher than reported in Table XV. Also, the estimated SHI's burden due to PHI can be overestimated.

SHI.[14] This procedure provides results indicating that supplemental PHI costs $52.4~178.1 per enrollee per year to SHI.

1.6. Discussion

Results of this study provide policy implications regarding the relationship between public and private insurance and implications regarding regulation of supplemental PHI. First, in line with the fundamental value of insurance, the coverage of private insurance needs to be more generous for less price elastic services with higher financial risks. For instance, McGuire (2012) estimates optimal cost-sharing as 50% for outpatient care and only 5% for inpatient services.[15]

TABLE XIV

WELFARE GAINS ($) FROM SUPPLEMENTAL PRIVATE HEALTH INSURANCE BY AGE GROUPS

Age	Risk gains (*A*)	Deadweight loss (*B*)	Costs to social insurance (*C*)	Net welfare gain (*A*-*B*)
20~29	99.9	80.0	52.4	19.9
30~39	103.4	135.8	94.0	-32.4
40~49	130.6	275.9	178.1	-145.3
50~59	447.9	269.7	175.3	178.2
60~65	296.4	275.2	175.5	21.2

[14] When the cited survey of the average OOP was conducted in 2005, there were essentially no supplemental policies on the market available to individuals.

[15] This differential pricing can be justified by evidence from the RAND experiment that outpatient and inpatient services are complements not substitutes. It implies that higher coinsurance rates for outpatient care would not lead to an increase in hospitalization (Manning et al., 1987). However, Chandra et al. (2010), focusing on the elderly in USA, show that an increase in cost-sharing for physician services and medication leads to an increased hospitalization. In this study, I am not able to check whether outpatient and inpatient care are complements or substitutes because supplemental insurance reduces the consumer prices of physician and hospital services identically.

In addition, as Ellis and Manning's (2007) utility-based framework shows, private supplemental insurance needs to cover preventive care, such as vaccination because it reduces future health spending caused by critical illnesses and thus potentially reduces premium rates.

Second, to minimize negative externalities, PHI's coverage of the statutory copayment set by SHI needs to be limited for restoring the policy tool to prevent excess utilization. My findings indicate that PHI significantly increases hospital outpatient department utilization, especially for discretionary conditions. A comparison of the European countries, where the share of private voluntary insurance of total health expenditure does not exceed 10% in most countries (except for France and the Netherlands) like the Korean private insurance market, finds that private health insurance covering statutory copayments is not common because of the concern that the public financing scheme can be undermined (Mossialos, Thomson, 2002).

Third, the government should regulate the current rating system. Results indicating evidence of advantageous selection suggests that the consumption of private supplemental policies are suboptimal (over-insurance) (Einav et al., 2010). The current private insurance market leads to welfare costs and inequity because of price discrimination and redlining. As Figure 9 shows, persons aged 60 are charged 3 times more on average than those aged 30. The average monthly social insurance contribution was $104.51 for employees regardless of age (the average total contribution was $209 because employers are equally responsible for their employees' contributions) in 2016 and adding dependents does not increase employees' premium rates. Thus, PHI monthly premium for couples in their 60s (around $60) can be a financial burden.

Welfare estimation results indicate that covering the elderly by supplemental policies would produce large welfare gains. Implementing community rating for encouraging older population to enroll in PHI can lead to increases in premium for younger and healthy groups. However, with advantageous selection, low-risk types are more willing to pay than high-risk types for comprehensive policies (de Meza, Webb, 2001; Einav et al., 2010), thus whether community rating will lead to substantial adverse selection is unclear.

In addition, higher demand for supplemental insurance may lead to higher unit prices of services not covered by SHI (Feldstein, 1973). If private insurers reacted to worsened Medical Loss Ratio (MLR) by increasing premium rates, persons who are less healthy or less better-off will more likely to lose their coverage, and thus more likely to be exposed to financial risks.

Table XV shows that the average MLR of the 5 major private insurers was 131.0 in 2016 and 114.9 in 2017, which can be attributed to substantial premium increases (22.8% in 2016 and 25.6% in 2017). In other words, despite universal health insurance coverage in Korea, vulnerable populations have been increasingly exposed to financial risks due to health spending.

When regulators consider tight pricing regulation,[16] they may allow insurance carriers to offer policies with differential deductibles or provider networks to address the anticipated adverse selection.[17] For instance, high deductible plans or narrow network plans will attract persons with low risks because of lower premiums. However, this additional demand-side cost-sharing can result in market segmentation where high-risk persons will end up with higher premiums (Trottmann et al., 2012). Population coverage would remain unchanged if low-risk consumers could purchase an incomplete policy (separating equilibrium) (Buchmueller, DiNardo, 2002).

One would argue that the authorities allow private insurers to directly negotiate payment amounts with providers. However, this alternative does not seem feasible in the near future because the current law (Medical Service Act, National Health Insurance Act, Insurance Business Act) regulating health systems prohibits private insurers’ contractual relationships with providers.

---

[16] Pricing restrictions in general exacerbate adverse selection because of information asymmetricity between the insured and insurance carriers (Geruso, Layton, 2017). And in the market with advantageous selected, premium rating regulation will induce more costly persons to enroll and will drive up average costs.

[17] In terms of contract design, the Korean private health insurance market is deemed “fixed” rather than endogenous in that only prices (premium rates) can respond to selection (Geruso, Layton, 2017).

TABLE XV
THE AVERAGE RATE OF PREMIUM INCREASE AND MLR OF THE 5 MAJOR PRIVATE INSURANCE COMPANIES, 2016-2017

	The annual rate of premium increase (%)		MLR (%)	
	2016	2017	2016	2017
S**	22.6	24.8	109.9	103.4
H**	27.3	26.9	147.7	119.1
D**	24.8	24.8	129.7	116.6
M**	19.5	25.6	133.3	119.6
K**	20.0	26.1	134.2	115.7
Average	22.8	25.6	131.0	114.9

MLR, medical loss ratio

A bill revising the law prohibiting private insurers from directly negotiating payment amounts with providers (Medical Service Act article 27) failed to pass in 2007 due to civil society groups' opposition.[18] Physician groups also have opposed to the government's policy allowing integrating healthcare network because of the possibility of fierce competition.[19] In addition, this lack of insurer's direct contractual relationship prevents the authority from implementing the Medicare Advantage-style risk-adjusted payment regulations (Morrisey et al., 2013; Rahman et al., 2015).

These inefficiencies are the rationale for the government's interventions for promoting public health goods and protecting consumers (Sekhri, Savedoff, 2006). Both the supplemental PHI coverage and its impacts on healthcare utilization depend on how mandatory SHI works. In Belgium, for instance, where mandatory social insurance provides generous and broad benefits coverage, Schokkaert et al. (2010) did

[18] Many feared that customer's choice would be limited if the two leading conglomerates (S** and H**), which own the biggest hospitals and private insurers, would aggressively expand their market share.
[19] Most notably, Korean Medical Association, protesting medical privatization, went on a 22-day strike in 2014.

find pro-rich socioeconomic gradient in the supplemental insurance coverage not did not find inequity in healthcare utilization.

SHI can overcome the selection issue thanks to its mandatory enrollment. Based on its purchasing power, SHI can add more clinically effective (but costly) services to the basic benefits and regulate fees of these services.[20] This directive can address individual's high financial risks by applying the NHI's OOP annual maximum.

Broadening SHI's benefits coverage may change the demand for supplemental policy. However, the private insurance coverage would not substantially change if financial risk left by SHI does not reduce substantially. This ambiguity is consistent with Finkelstein's (2004) study revealing the null impact of enrolling in Medicare on supplemental coverage. Also, even if benefits package of SHI were significantly expanded, there may remain the demand for residual medical services – for instance, upgraded hospital accommodation – when premium rates are optimally set in the market.

This study finds that supplemental PHI has substantial moral hazard effects even though there is evidence of favorable selection in Korea. Previous research in the country has not been trying to explore the source of selection or aiming to estimate the welfare impacts of PHI. Also, this study adds rare evidence on the relationship between social insurance and private insurance to the health policy literature. Most of previous research has been focused on the U.S. healthcare system.

My research finds that PHI increases social insurance's expenses. These findings are closely in line with studies of the U.S. Medigap market (Keane, Stavrunova, 2016). My estimation that PHI increases total expenditures of the National Health Insurance by 1.9~6.6% is comparable to Atherly's (2002)

---

[20] This policy change will require rigorous economic evaluations to decide which services are to be covered. Because both social and private insurance suffer from moral hazard, the presence of it does not provide a valid guidance for deciding whether each service should be covered (Boone, 2015). It is the difference between market prices and marginal costs that determines how social welfare changes. Assume two medical services, currently uncovered by SHI, have the same marginal benefits, price elasticities of demand, and market prices, but have different marginal costs – also assume that the cost-benefit ratio is higher than a threshold. Even though lowering unit prices of the two services to the same level would lead to the same level of increases in quantity demanded due to the additional coverage, covering the service with a lower marginal cost would provide higher net welfare benefits.

finding that Medigap policies, by covering co-pays and uncovered expenses, increase total Medicare expenditures by 6.7%. However, in general, PHI generates welfare benefits when social insurance's benefits coverage is not enough deep.

Private supplemental health insurance significantly increases outpatient and hospitalization utilization. In particular, the reduction in the consumer price by PHI increases both the initiation of the contact with providers (changes at the extensive margin) and subsequent contacts (changes at the intensive margin). This is inconsistent with literature which documents that subsequent contacts are primarily induced by providers (van Doorslaer et al., 2004; van Dijk et al., 2013). Meanwhile, results that changes in the consumer prices affect the use of discretionary services but do not have impacts on less discretionary or low-value care utilization support findings from literature that price elasticities vary by the type of services (Manning et al., 1987; Ellis et al., 2017; Kill, Arendt, 2017).

My results suggest that cost-sharing of both social insurance and private supplemental insurance are not optimally set. On the one hand, low financial coverage (partial nature) of SHI has induced the demand for supplemental PHI. On the other hand, PHI's coinsurance rates are so low that insured persons have financial incentive to use more care, even if an additional unit of care does not provide much health value (Gruber, 2006). This would increase inefficiencies of the health systems.

Findings consistently show that high risk groups are significantly less likely to enroll in PHI. This gap in the private coverage has grown over time. Furthermore, OOP health spending as the share of income or expenditures has increased only among the groups with the lowest level of wealth, suggesting that the increasing demand for supplemental health insurance has contributed to the increasing price of services not covered by mandatory social insurance. This phenomenon would make persons who cannot afford supplemental PHI even worse off.

CITED LITERATURE

Agency for Healthcare Research and Quality (AHRQ). 2016. Prevention Quality Indicators (PQIs). Retrieved May 12, 2019, from http://www.qualityindicators.ahrq.gov/modules/pqi_resources.aspx

Arcury TA, Gesler WM, Preisser JS, Sherman J, Spencer J, Perin J. 2005. The effects of geography and spatial behavior on health care utilization among the residents of a rural region. Health Services Research 40: 135-155. DOI: 10.1111/j.1475-6773.2005.00346.x

Atherly A. 2001. Supplemental insurance: Medicare's accidental stepchild. Medical Care Research and Review 58: 131-161. DOI: 10.1177/107755870105800201

Atherly A. 2002. The effect of Medicare supplemental insurance on Medicare expenditures. International Journal of Health Care Finance and Economics 2: 137-162. DOI: 10.1023/A:1019978531869

Baicker K, Mullainathan S, Schwartzstein J. 2015. Behavioral hazard in health insurance. Quarterly Journal of Economics 130: 1623-1667. DOI: 10.1093/qje/qjv029

Bardey D, Buitago G. 2017. Supplemental health insurance in the Colombian managed care system: Adverse or advantageous selection? Journal of Health Economics 56: 317-329. DOI: 10.1016/j.jhealeco.2017.02.008

Boone J. 2015. Basic versus supplementary health insurance: Moral hazard and adverse selection. Journal of Public Economics 128: 50-58. DOI: 10.1016/j.jpubeco.2015.05.009

Buchmueller TC, DiNardo J. 2002. Did community rating induce an adverse selection death spiral? Evidence from New York, Pennsylvania, and Connecticut. American Economic Review 92: 280-294.

Buchmueller TC, Couffinhal A, Grignon M & Perronnin M. 2004. Access to physician services: does supplemental insurance matter? Evidence from France. Health Economics 13: 669-687. DOI: 10.1002/hec.879

Buchmueller TC,Fiebig DG, Jones G, Savage E. 2013. Preference heterogeneity and selection in private health insurance: The case of Australia. Journal of Health Economics 32: 757-767. DOI: 10.1016/j.jhealeco.2013.05.001

Chae JW, Song CS, Kim H, Lee KB, Seo BS, Kim DI. 2011. Prediction of mortality in patients undergoing maintenance hemodialysis by Charlson comorbidity index Using ICD-10 database. Nephron Clinical Practice 117: c379-c384. DOI: 10.1159/000321525

Chandra A, Gruber J, McKnight R. 2010. Patient cost-sharing and hospitalization offset in the elderly. American Economic Review 100: 193-213. DOI: 10.1257/aer.100.1.193

Charlesworth CJ, Meath THA, Schwartz AL, McConnell KJ. 2016. Comparison of low-value care in Medicaid vs. commercially insured population. JAMA Internal Medicine 176: 998-1004. DOI: 10.1001/jamainternmed.2016.2086

Chun CB, Kim SY, Lee JY, Lee SY. 2009. Republic of Korea: Health system review. Health Systems in Transition (European Observatory on Health Systems and Policies) 11(7): 1-184. Retrieved May 12, 2019, from http://www.euro.who.int/__data/assets/pdf_file/0019/101476/E93762.pdf

Cohen A & Siegelman P. 2010. Testing for adverse selection in insurance markets. The Journal of Risk and Insurance 77: 39-84. DOI: 10.1111/j.1539-6975.2009.01337.x

Colla CH. 2014. Swimming against the current – What might work to reduce low-value care? New England Journal of Medicine 371: 1280-1283. DOI: 10.1056/NEJMp1404503

Colla CH, Morden NE, Sequist TD, Schpero WL, Rosenthal MB. 2014. Choosing Wisely: Prevalence and correlates of low-value health care services in the United States. Journal of General Internal Medicine 30: 221-228. DOI: 10.1007/s11606-014-3070-z

Colla CH, Morden NE, Sequist TD, Mainor AJ, Li Z, Rosenthal MB. 2017. Payer type and low-value care: Comparing Choosing Wisely services across commercial and Medicare populations. Health Services Research 53: 730-746. DOI: 10.1111/1475-6773.12665

Colombo F, Tapay N. 2004. Private health insurance in OECD countries: The benefits and costs for individuals and health systems. OECD Health Working Papers No.15. DOI: 10.1787/18152015

Cutler DM, Reber SJ. 1998. Paying for health insurance: The trade-off between competition and adverse selection. The Quarterly Journal of Economics 113: 433-466. DOI: 10.1162/003355398555649

Cutler DM, Zeckhauser RJ. 2000. The anatomy of health insurance. In: Culyer AJ, Newhouse JP, Handbook of Health Economics volume 1. Waltham: Elsevier Science B.V.

Dardanoni V, Donni PL. 2012. Incentive and selection effects of Medigap insurance on inpatient care. Journal of Health Economics 31: 457-470. DOI: 10.1016/j.jhealeco.2012.02.007

de Meza D, Webb DC. Advantageous selection in insurance markets. RAND Journal of Economics 32: 249-262. DOI: 10.2307/2696408

Einave L, Finkelstein A, Cullen MR. 2010. Estimating welfare insurance markets using variation in prices. Quarterly Journal of Economics 125: 877-921. DOI: 10.1162/qjec.2010.125.3.877

Einav L, Finkelstein A, Ryan SP, Schrimpf P, Cullen MR. 2013. Selection on moral hazard in health insurance. American Economic Review 103: 178-219. DOI: /10.1257/aer.103.1.178

Einav L, Finkelstein A. 2017. Moral hazard in health insurance: What we know and how we know it. NBER Working Paper 24055. DOI: 10.3386/w24055

Ellis PE, Martins B, Zhu W. 2017. Health care demand elasticities by type of service. Journal of Health Economics 55: 232-243. DOI: 10.1016/j.jhealeco.2017.07.007

Ellis RP, Manning WG. 2007. Optimal health insurance for prevention and treatment. Journal of Health Economics 26: 1128-1150. DOI: 10.1016/j.jhealeco.2007.09.002

Ettner SL. 1997. Adverse selection and the purchase of Medigap insurance by the elderly. Journal of Health Economics 16: 543-562. DOI: 10.1016/S0167-6296(97)00011-8

Fang H, Keane MP, Silverman D. 2008. Sources of advantageous selection: Evidence from the Medigap insurance market. Journal of Political Economy 116: 303-350. DOI: 10.1086/587623

Feldman R, Dowd B. 1991. A new estimate of the welfare loss of excess health insurance. American Economic Review 81: 297-301.

Feldstein M. 1973. The welfare loss of excess health insurance. Journal of Political Economy 81: 251-280. DOI: 10.1086/260027

Fernandez-Mayoralas G, Rodriguez V, Rojo F. 2000. Health services accessibility among Spanish elderly. Social Science & Medicine 50: 17-26. DOI: 10.1016/S0277-9536(99)00247-6

Finkelstein A. 2004. The interaction of partial public insurance programs and residual private insurance markets: Evidence from the US Medicare program. Journal of Health Economics 23: 1-24. DOI: 10.1016/j.jhealeco.2003.07.003

Fleitas S, Gowrisankaran G, Lo Sasso A. 2018. Reclassification risk in the small group health insurance market. NBER Working Paper 24463. DOI: 10.3386/w24663

Folland S, Goodman AC, Stano M. 2007. The economics of health and health care. New Jersey: Pearson Prentice Hall.

Geruso M, Layton TJ. 2017. Selection in health insurance markets and its policy remedies Journal of Economics Perspectives 31: 23-50. DOI: 10.1257/jep.31.4.23

Grossman M. 2000. The human capital model. In: Culyer AJ, Newhouse JP, Handbook of health economics. Amsterdam: Elsevier Science B.V.

Gruber J. 2006. The role of consumer copayments for health care: Lessons from the RAND Health Insurance Experiment and beyond. Kaiser Family Foundation Working Paper. Retrieved May 12, 2019, from https://www.kff.org/health-costs/report/the-role-of-consumer-copayments-for-health/

Jeon B, Kwon S. 2013. Effect of private health insurance on health care utilization in a universal public insurance system: A case of South Korea. Health Policy 113: 69-76. DOI: 10.1016/j.healthpol.2013.05.007

Keane M, Stavrunova O. 2016. Adverse selection, moral hazard and the demand for Medigap insurance. Journal of Econometrics 190: 62-78. DOI: 10.1016/j.jeconom.2015.08.002

Kill A, Arendt JN. 2017. The effect of complementary private health insurance on the use of health care services. International Journal of Health Economics and Management 17: 1-27. DOI: 10.1007/s10754-016-9195-3

Kim DH, Kim M, Kim H, Kim YL, Kang SW, Yang CW, Kim NH, Kim YS, Lee JP. 2013. Early referral to a nephrologist improved patient survival: Prospective cohort study for end-stage renal disease in Korea. PLoS One 8: e55323. DOI: 10.1371/journal.pone.0055323

Korea Insurance Development Institute. 2016. Standardization plan of uncovered expenses for supplemental private health insurance. Retrieved May 12, 2019, from http://www.kidi.co.kr

Kwon SM. 2009. Thirty years of national health insurance in South Korea: lessons for achieving universal health care coverage. Health Policy and Planning 24: 63-71. DOI: 10.1093/heapol/czn037

Kwon SM, Lee TJ, Kim CY. 2015. Republic of Korea: Health systems review (Asia Pacific Observatory on Public Health Systems and Policies). Health Systems in Transition 5(4). Retrieved May 12, 2019, from http://iris.wpro.who.int/handle/10665.1/11358

Lo Sasso AT, Lurie IZ. 2009. Community rating and the market for private non-group health insurance. Journal of Public Economics 93: 264-279. DOI: 10.1016/j.jpubeco.2008.07.001

Manning WG, Newhouse JP, Duan N, Keeler EB, Leibowitz A, Marquis S. 1987. Health insurance and the demand for medical care: Evidence from a randomized experiment. American Economic Review 77: 251-277.

Manning WG, Marquis MS. 1996. Health insurance: The tradeoff between risk pooling and moral hazard. Journal of Health Economics 15: 609-639. DOI: 10.1016/S0167-6296(96)00497-3

McGuire TG. 2012. Demand for health insurance. In: Pauly MV, McGuire TG, Barros PP, Handbook of Health Economics volume 2. Waltham: Elsevier Science B.V.

Morrisey MA, Kilgore ML, Becker DJ, Smith W, Delzell E. 2013. Favorable selection, risk adjustment, and the Medicare Advantage program. Health Services Research 48: 1039-1056. DOI: 10.1111/1475-6773.12006

Mossialos E, Thomson SMS. 2002. Voluntary health insurance in the European Union: A critical assessment. International Journal of Health Services 32: 19-88. DOI: 10.2190/K6BP-3H1R-L41M-HVGE

Newhouse J, the Insurance Experiment Group. 1993. Free for all? Lessons from the RAND Health Insurance Experiment. Cambridge: Harvard University Press.

National Health Insurance (NHI). 2013. The national survey of medical expenditures, 2012. [Korean]

National Health Insurance (NHI). 2015. National health insurance statistical yearbook 2015. [Korean]

Nyman JA. 1999. The economics of moral hazard revisited. Journal of Health Economics 18: 811-824. DOI: 10.1016/S0167-6296(99)00015-6

Organisation for Economic Co-operation and Development (OECD). 2017. Health expenditure and financing. Retrieved May 12, 2019, from http://stats.oecd.org/index.aspx?DataSetCode=HEALTH_STAT

Paccagnella O, Rebba V, Weber G. 2013. Voluntary private health insurance among the over 50s in Europe. Health Economics 22: 289-315. DOI: 10.1002/hec.2800

Park JH, MacLachlan DL. 2013. Estimating willingness to pay by risk adjustment mechanism. Applied Economics 45: 37-46. DOI: 10.1080/00036846.2011.568404

Pauly MV, Blavin FE. 2008. Moral hazard in insurance, value-based cost sharing, and the benefits of blissful ignorance. Journal of Health Economics 27: 1407-1417. DOI: 10.1016/j.jhealeco.2008.07.003

Petretto A. 1999. Optimal social health insurance with supplementary private insurance. Journal of Health Economics 18: 727-745. DOI: 10.1016/S0167-6296(99)00017-X

Powell D. 2016. Quantile regression with nonadditive fixed effects. RAND Corporation. Retrieved May 12, 2019, from https://works.bepress.com/david_powell/1/

Rahman M, Keohane L, Trivedi AN, Mor V. 2015. High-cost patients had substantial rates of leaving Medicare Advantage and joining traditional Medicare. Health Affairs 34: 1675-1681. DOI: 10.1377/hlthaff.2015.0272

Rodriguez M, Stoyanova A. 2004. The effect of private insurance access on the choice of GP/specialist and public/private provider in Spain. Health Economics 13: 689-703. DOI: 10.1002/hec.832

Schokkaert E, van Ourti T, de Graeve D, Lecluyse A, van de Voorde C. 2010. Supplemental health insurance and equality of access in Belgium. Health Economics 19: 377-395. DOI: 10.1002/hec.1478

Sekhri N, Savedoff W. 2005. Private health insurance: Implications for developing countries. Bulletin of the World Health Organization 83: 127-134. DOI:

Sekhri N, Savedoff W. 2006. Regulating private health insurance to serve the public interest: Policy issues for developing countries. International Journal of Health Planning and Management 21: 357-392. DOI: 10.1002/hpm.857

Shreibati JB, Baker LC. 2011. The relationship between low back magnetic resonance imaging, surgery, and spending: Impact of physician self-referral status. Health Services Research 46: 1362-1381. 10.1111/j.1475-6773.2011.01265.x

Sohn S, Shin YJ, Kim CY. 2010. Factors influencing household catastrophic health expenditure of the poor. Health and Social Welfare Review 30: 92-110.

Stevens Y, van Rompaey L, Huber V, van Buggenhout B. 1998. Issues in complementary health insurance in Belgium. International Social Security Review 51: 71-91. DOI: 10.1111/1468-246X.00025

Trottmann M, Zweifel P, Beck K. 2012. Supply-side and demand-side cost sharing in deregulated social health insurance: Which is more effective? Journal of Health Economics 31: 231-242. DOI: 10.1016/j.jhealeco.2011.10.004

van Dijk CE, van den Berg B, Verheij RA, Spreeuwenberg P, Groenewegen PP, de Bakker DH. 2013. Moral hazard and supplier-induced demand: Empirical evidence in general practice. Health Economics 22: 340-352. DOI: 10.1002/hec.2801

van Doorslaer E, O’Donnell O, Rannan-Eliya RP, Somanathan A, Adhikari SR, Garg CC et al. 2007. Catastrophic payments for health care in Asia. Health Economics 16: 1159-1184. DOI: 10.1002/hec.1209

van Doorslaer E, Koolman X, Jones AM. 2004. Explaining income-related inequalities in doctor utilisation in Europe. Health Economics 13: 629-647. DOI: 10.1002/hec.919

Saltman RB, Busse R, Figueras J. 2004. Social health insurance systems in Western Europe (European Observatory on Health Systems and Policies Series). New York: World Health Organization.

World Health Organization (WHO). 2009. An analysis of the health financing system of the Republic of Korea and options to strengthen health financing performance. Retrieved May 12, 2019, from http://www.who.int/health_financing/documents/cov-hsfr_e_09-korea/en/

Woo KS, Shin YJ. 2015. The effect of catastrophic health expenditure on household economy: Focusing on financial coping and poverty. Health and Social Welfare Review 35: 166-198. DOI: 10.15709/hswr.2015.35.3.166

2. THE EFFECT OF OUTDOOR SMOKING BAN: EVIDENCE FROM KOREA

2.1. Introduction

Cigarette smoking is responsible for the death of six million people and half a trillion dollars of economic damage annually (WHO, 2013). The 2014 Surgeon General's Report links smoking to numerous cancers and chronic conditions and concludes that smoking affects nearly every organ of the body (U.S. Department of Health and Human Services, 2014). International Agency for Research on Cancer (IARC) designated both active smoking and passive smoking (secondhand smoke or involuntary smoking) as carcinogenic (Group 1) agents to humans (IARC, 2004).

Over 180 parties have joined the World Health Organization Framework Convention on Tobacco Control (WHO FCTC), which is the first international treaty negotiated under WHO, to advance the implementation of evidence-based tobacco control policies including price/tax measures, protection from exposure to secondhand tobacco smoke, regulation of the content of tobacco products, regulation of labelling, public awareness raising program, regulation of tobacco advertising and promotion, regulation of illicit trade, and regulation of sales to minors (WHO, 2018). Since the WHO FCTC entered into force in February 2005, the past decade has witnessed the vast growth of smoking restrictions across the world to protect nonsmokers from the harmful health effects of secondhand smoke and to reduce tobacco consumption among smokers.

To date, most smoking restriction policies have been implemented for reducing exposure of nonsmokers to secondhand smoke in indoor places (Hahn, 2010). In 2004, over 30% of adult non-smokers and 40% of children were regularly exposed to secondhand smoke and 603,000 premature deaths (approximately 1% of worldwide mortality rates) occurred due to passive smoking (Öberg et al., 2011). According to a 2016 WHO report, 92% of parties participating in WHO FCTC have implemented any kind of smoke-free legislation and the most common places designated as smoke-free include public transport, educational and healthcare facilities, government buildings, private workplaces, restaurants, pubs, and bars (WHO, 2016). A 2016 Cochrane systematic review of 77 studies finds consistent evidence that national indoor smoking restrictions reduce secondhand smoke rates and mortality for smoking-related illnesses and improve cardiovascular health outcomes (Frazer et al., 2016). Also, Hahn's (2010) systematic review finds that indoor smoke-free legislations improve indoor air quality.

Studies of the impact of smoking ban on individual smoking behaviors, however, have provided inconsistent evidence of effects on smoking rates. Switzerland's natural experiment – progressive implementation of smoking bans in public venues at state level – is found to reduce the prevalence of smoking by 1% a year after the implementation (Boes et al., 2015). Anger et al (2011) reports that, after the implementation of state-level pubic smoking ban in bars, restaurants, and dance clubs in Germany, the prevalence of smoking among people who often go out to such places falls significantly. In the U.S., the comprehensive indoor smoking ban effectively reduces smoking rates (Carton et al., 2016) and improves the health of infants and children (McGeary et al., 2017).

On the other hand, Jones and colleagues (2015) report that the introduction of smoking bans in enclosed public places does not have short-term effects on the prevalence and intensity of smoking. Adda and Cornaglia (2010) show that U.S. state-level smoking bans in workplaces, restaurants and bars do not affect the proportion of people who smoke or attempt to quit but makes smokers spend more time at home for smoking. They find that, consequently, smoking bans targeting restaurants and bars lead to an increase in cotinine concentration among children, which implies displacement effects. Cooper and Pesko (2017) also find that U.S. county-level electronic cigarette indoor vaping restrictions lead to an increase in consuming traditional tobacco products among pregnant women.

Meanwhile, there has been little research on the impact of smoking restrictions in open public places. Policymakers and scholars have debated over the effectiveness of banning smoking in outdoor public places and ethical questions in relation to individual liberty. Supporters argue that there's sufficient ethical and practical justifications since the policy is believed to reduce secondhand smoke, reduce the likelihood of children to follow unhealthy behaviors, and help smokers to quit (Thomson et al., 2008). A proponent even claims that, by asserting “ban in outdoor public places would build on the incredible success of the indoor ban”, evidence base is not needed for banning outdoor smoking (Barber, 2015). Opponents of bans, however, assert that such policy goes too far (“paternalism”) and that negative health effects of outdoor smoking have not been supported by scientific evidence (Chapman, 2008).

This study fills the knowledge gap by providing evidence on the effects of outdoor smoking ban on individual smoking behavior by exploiting a gradual rollout of outdoor smoking bans in Korea. Results show that outdoor smoking bans increase the probability of making a quit attempt among current smokers by 16%. This effect lasts for three or more years after the implementation of the ban. I also find heterogeneity in effects across the amount of monetary penalty. Whereas the policy change does not reduce the prevalence of smoking, a higher amount of penalty has stronger impacts on reducing the intensity of smoking and increasing the propensity to try to quit among current smokers.

These results suggest that outdoor smoke-free policy affects individual smoking behavior through two mechanisms. Outdoor smoking bans raise awareness about harmful effects of smoking and they lead to an increase in quit attempts – though not enough to reduce the demand for cigarettes. This effect is stronger and significant among persons who spend more time outdoors, indicating that socially active persons are more likely to be exposed to changes in social norms regarding tobacco use in public places. In addition, the amount of the penalty has differential impacts on quit attempts and the intensity of smoking, meaning that outdoor smoking bans change individual smoking behavior through monetary costs of smoking.

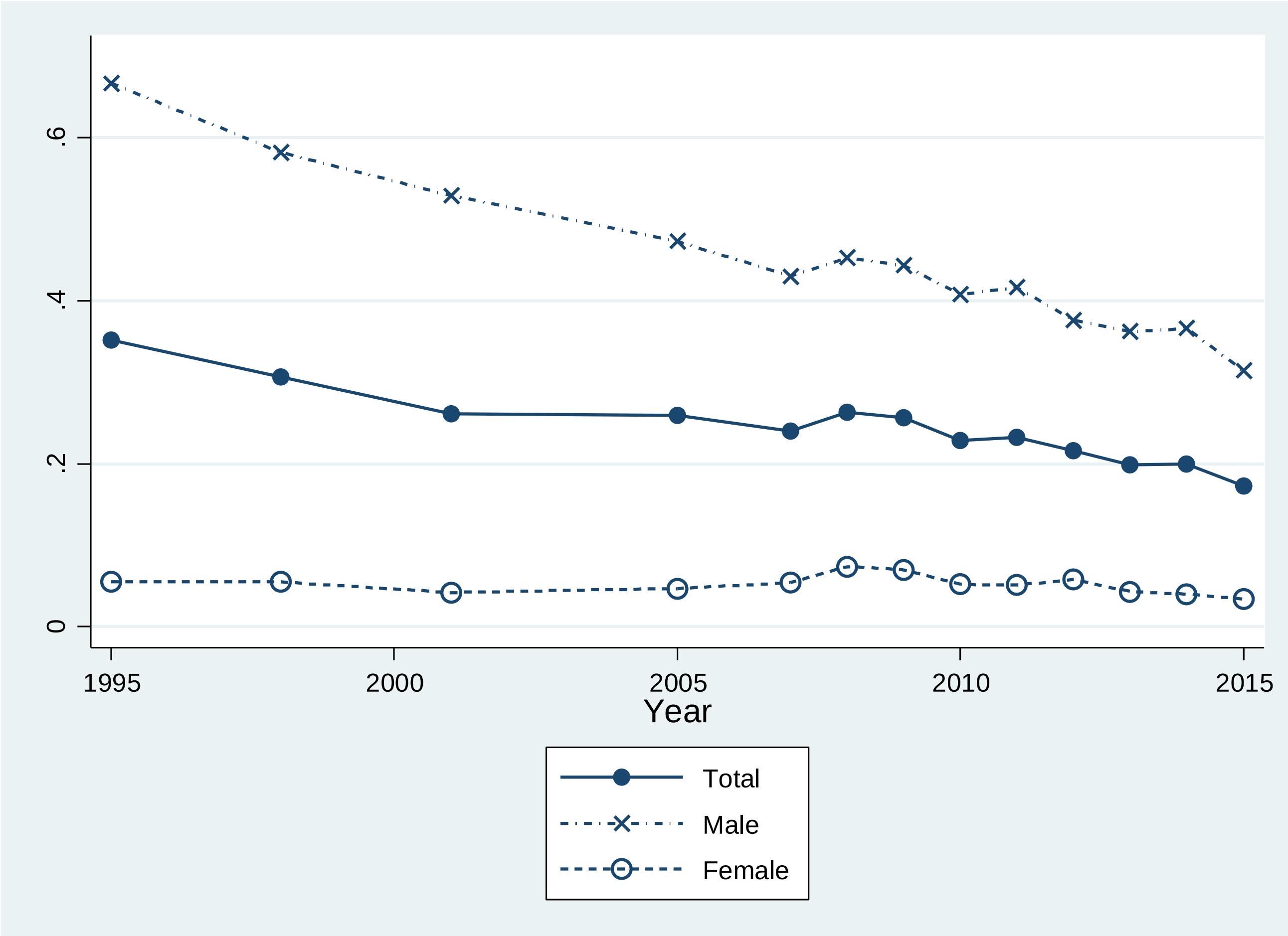

Figure 10. The smoking prevalence in Korea, 1995-2015.

2.2. <u>Background</u>

Cigarette smoking has been highly prevalent in Korea (Figure 10). The proportion of smokers in the general population 15 years or older remains stable at 20% after a sharp decrease in the 1990s. The proportion of men who daily smoke has rapidly decreased from 66.7% in 1995 to 31.4% in 2015, while the share of female daily smokers has fluctuated between 4% and 7% in the past two decades.

Smoking costs more than 1.3 million disability adjusted life years (DALYs) in 2013 (Zahra et al., 2017). Also, using nationally representative claims data taken from the public insurance scheme, Oh and colleagues (2012) estimate the total economic costs of smoking-related cancers as $3 billion in 2008.

According to WHO (2015), the retail price of the most sold brand in Korea was $2.43 in 2014, which was the cheapest among OECD member states. Cigarette taxes comprise 72% of the retail prices and consist of consumption tax, sales tax, health promotion and education charges, and value added tax. The amount of taxes is set by the central government and uniform across the nation – thus, there is no spatial variation in cigarette prices. The central government raised the retail prices of the most sold brand (by increasing cigarette taxes) from 2,000 won (approximately $2) to 4,500 won in 2015. However, cigarettes remain an accessible good because the price of a pack of cigarettes is still cheaper than the average prices in most OECD member states.

Although Korea ratified the WHO FCTC in 2005, tobacco control policies have been weak (Cho, 2014). Tobacco advertising, promotion, and sponsorship are not comprehensively restricted, the sale of tobacco products to minors is poorly enforced, though it is prohibited, and smoking cessation services are not covered by the public insurance scheme.

The rapid expansion of smoking restrictions in the country, which ranks the top on list of OECD member countries with adult male smokers (OECD, 2017), reflects the will of the public to reduce harmful health effects of exposure to secondhand smoke. According to the Statistics Korea (2017), the prevalence of secondhand smoke among adult non-smokers was 46% at workplaces and 14.7% at home in 2007. Total burden of disease due to secondhand smoke was over 44,000 DALYs in 2013 (Zahra et al., 2016).

In 1995, with the enactment of the Health Promotion Act, the central government banned indoor smoking in some public places and selling cigarettes to minors. Smoking in government buildings, hospitals, nurseries, schools, bars and restaurants larger than 150m2 was banned nationwide in December 2012. A nationwide smoking ban in all restaurants was instituted in January 2015.

In 2010, under the National Health Promotion Plan, the central government gave the power to local authorities to enact ordinances banning smoking in outdoor public places to address prevalent secondhand smoke (Cho, 2014). This has led to a rapid spread of outdoor smoking bans across the country. Beginning with Gwanak-gu, Seoul in June 2011, 219 out of 226 cities have implemented ban as of the end of 2016 (Figure 2). Bus stops, public parks, school zones, and outdoor parking lots are the most commonly protected places by local outdoor smoking ban (Cho, 2014). There has been no study estimating the causal effects of the ban on individual smoking behavior in the country so far.

2.3. <u>Previous research</u>

Restrictions on smoking are primarily aimed to reduce secondhand smoke of nonsmokers (Chaloupka, Warner, 2000). Secondhand smoke involves inhaling toxic agents and carcinogens including benzene, 1,3-butadiene, benzo(a)pyrene, and 4-(methyl-nitrosamino)-1-(3-pyridyl)-1-butanone (IARC, 2004) and there is no "safe" level of secondhand smoke exposure (WHO, 2017). Acute exposure to involuntary smoking causes increases in blood pressure, heart rates at rest, and levels of carbon monoxide in blood, and causes endothelial-cell damage and platelet aggregation, thus elevating the risk of atherosclerosis (He et al., 1999; Jefferis et al., 2010). A meta-analysis of epidemiological studies of the effect of secondhand smoke finds evidence that exposure to involuntary smoking increases the risk of coronary heart disease among nonsmokers by 25% (He et al., 1999). Pan et al. (2015) also find the association of passive smoking with an increased incidence of a chronic condition (type 2 diabetes).

Numerous studies have shown that smoking bans are associated with decreases in morbidity and mortality from smoking-related illnesses. Scottish smoking ban in pubs is found to lead to reductions in PM2.5 (particulate matter<2.5 micrometers) compared to the period before the ban (Semple et al., 2007). Azagba (2015) reports that, analyzing the impact of Canadian smoking ban in restaurant and bar patios, smoke-free legislations reduce the probability of secondhand smoke exposure by 20%. Meyers and colleagues' (2009) systematic review and meta-analysis finds that smoking ban in enclosed public places reduces the risk of acute myocardial infarction by 17% with the strongest effect found among nonsmokers and young populations. Smoke-free legislation is also found to reduce hospitalization and deaths for

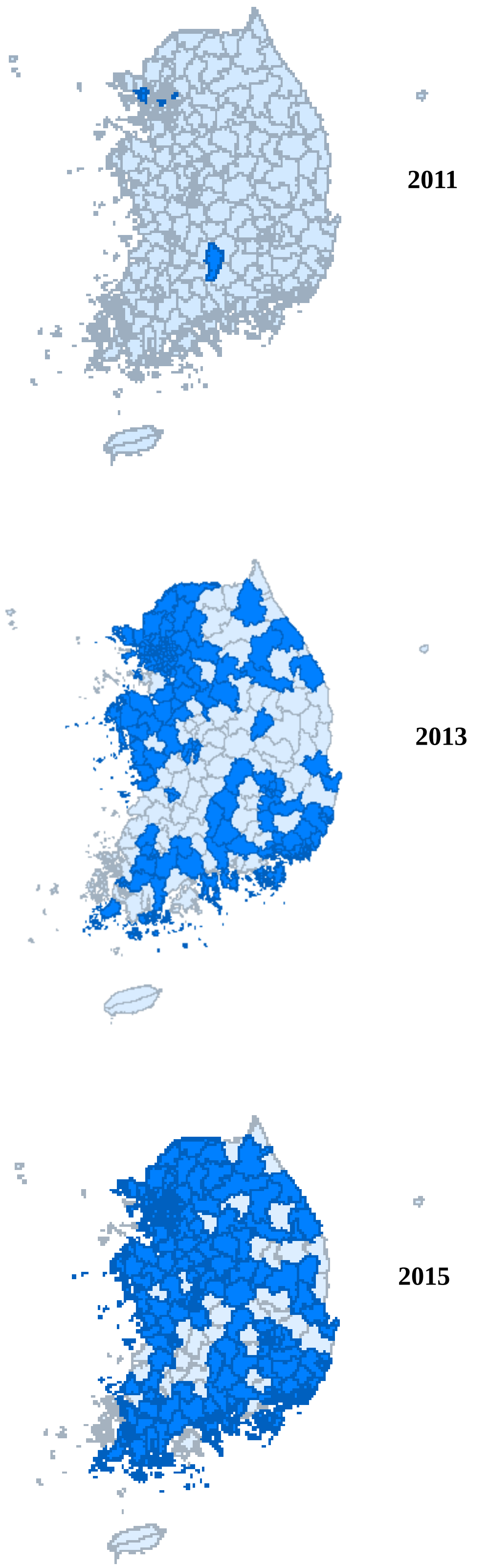

Figure 11. Geographic and temporal variations in outdoor smoking ban at the city level (N=226).

coronary, cerebrovascular, and respiratory diseases (Tan, Glantz, 2012) and reduce preterm births and child asthma admissions (Been et al., 2014). A recent study of smoking bans in bars and restaurants from Germany shows that state-level smoking ban results in short-run reductions in cardiovascular admissions (-2.1%) and asthma admissions (-6.5%) (Kvasnicka et al., 2018).

In addition, theory predicts inhibitory effects on tobacco consumption of smoking ban. Restrictions on smoking can lower the demand for cigarettes by reducing smokers' opportunities to consume tobacco products (Chaloupka, Warner, 2000). Smoking restrictions also can change individual's smoking behavior by increasing disutility from consuming tobacco products because of changes in social norms regarding acceptability of smoking (Jones et al., 2015). In addition, smoking ban requires smokers to make additional investment of time to smoke at non-regulated places (Chaloupka, Warner, 2000; Cooper, Pesko, 2017). Smokers may also change smoking intensity/frequency or attempt to quit when the perceived marginal costs of smoking exceed marginal benefits.

According to theory of marginal smokers, there are certain groups of smokers who regret their addictive habits, want to quit, and fail to do so because of limited willpower (Odermatt, Stutzer, 2015). These smokers tend to demand for self-control devices, which are believed to help them successfully quit. Smoking ban would serve as a trigger to these motivated smokers and would result in an increase in making a quit attempt.

A systematic review of literature finds that nicotine dependence, cigarettes consumed per day, educational attainment and wealth are negatively associated with making a quit attempt, while age, past attempts to quit, personal motivation and intention to quit, and home smoking ban are positively related with quit attempts (Vangeli et al., 2011). The review also reveals that age, personal motivation, intention to quit, and (the lower level of) cigarette dependence are predictors of successful quitting, whereas the level of education and income are not significantly related with quit attempt success.

Smoking cessation guidelines published in the United Kingdom suggest that relapse is a normal process of quitting and smokers on average make three or four quit attempts before finally quitting (Raw et al., 1998). However, numerous studies report that smokers who made quit attempts in the past are less likely than those who never tried to quit to succeed because of experienced withdrawal and fear of failure (Murray et al., 2000; Vangeli et al., 2011; Nakamura et al., 2014).

A Cochrane review finds that the effects of indoor smoking ban on tobacco consumption are not clear (Frazer et al., 2016). Specifically, it would be the case when ban is not comprehensive or not enforced appropriately. These findings indicate that smoking bans alone would not be enough effective at changing the demand for smoking. Ban's impacts would not be substantial unless open public places designated as smoke-free are not the places which smokers used to smoke at.

Even if outdoor smoking bans reduce smokers' opportunities to smoke, it can be offset by individuals' behavioral changes for compensation. For instance, smokers may increase the number of cigarettes consumed at once to compensate the additional inconvenience and to maintain their desired level of nicotine.

In addition, if smoking bans make smokers consume cigarettes at private places which are separated from others, smokers may be less likely to face peer pressure (Odermatt, Stutzer, 2015). In addition, if smokers consume tobacco products at their shared havens, they would spend more time with other smokers. Lee and Kahende's review (2000) suggests that having a daily contact with other smokers is negatively associated with the probability of successful quitting.

2.4. Methods

I combine two data sources to estimate the effects of outdoor smoking bans: Individual smoking behavior data from the 2009~2015 waves of the Korean Labor and Income Panel Study and information on the implementation of bans and monetary penalties from the National Law Information Center (http://www.law.go.kr/eng/engMain.do). The center is a public online repository of acts, executive orders, decrees, and ordinances implemented at the central or the local level.

The Korean Labor and Income Panel Study was first conducted in 1998 by the Korea Labor Institute. The Korea Labor Institute has surveyed a nationally representative sample of 5,000 households and their 13,000 household members aged 15 years or older (excluding military personnel and institutionalized people) through a two-stage stratified sampling method. In the first stage, 951 enumeration districts were randomly selected by using the 10% sampling frame of the 1995 Korea Census (the total census sampling units=21,675). In the second stage, 5~6 households were randomly selected from each sampling unit. Initial contact with the 5,000 households originally sampled led to a success rate of about 75.5%. The rest were replaced by other randomly selected households in the same sampling unit.

Face-to-face interviews have been conducted annually since, and 18 waves (1998~2015) have been completed up to the present. The panel has collected a wide range of individual-level information on health, employment, earnings, education, and demographic and socioeconomic characteristics. All household members aged 15 or over were asked to participate in the survey. As follow-up rules, original household members have been followed even if a panel member forms an independent household. If married, his/her spouse becomes a new respondent to the original panel and the couple is followed and interviewed thereafter. Also, those who turned 15 years old are added to the panel. In this way, the households and members were selected to represent the adult population residing in the country.

My study sample, an unbalanced panel, includes 13,095 unique persons aged 18~80 – minors younger than 18 years are not allowed to buy tobacco products in Korea – at baseline (survey year 2009) and 62,400 person-years. Persons who ever changed their locations of residence during the study periods are excluded from study samples.

Following the implementation of the National Health Promotion Plan in 2010, local authorities began enacting ordinances banning smoking in outdoor public places to address secondhand smoke (Cho, 2014). Because of the gradual rollout of bans, the share of the study population who were exposed to the policy change has increased from zero in the pre-period (2009-2010) to 0.34 in 2011, 0.89 in 2013, and 0.99 in 2015. To exploit such temporal and spatial variation, by using the information on the dates of survey, I construct the policy indicator (Ban_{ct}) which takes 1 if the outdoor smoking ban was in effect at localities[21] where respondents were residing. My main estimation model uses a difference-in-differences approach as below:

(1) $Y_{icpt} = \alpha_{icpt} + \beta Ban_{ct} + \pi X_{it} + \theta Z_{pt} + Y_t + \gamma_i + \varepsilon_{icpt}$

β is a parameter of interest. Unit of analysis is person-year and standard errors are clustered at city level. Y_{icpt} represents self-reported smoking behavior: 1) An indicator whether currently smoking cigarettes, 2) an indicator whether having tried to quit in the last month, 3) and indicators for smoking intensity (fraction of current smokers)[22] of individual i in city c and province p at time t. X_{it} is individual earned income per year. Gross Regional Domestic Product (GRDP) per capita is also controlled for time variant economic condition (Z_{pt})[23].

Year dummies (Y_t) are expected to absorb the common economic/policy shocks affecting smoking behaviors systematically across all subnational regions. Such a shock includes the 2012 indoor smoke-free policy implemented by the central government banning smoking in indoor public places including government offices, medical facilities, and large restaurants/bars (Cho, 2014). Note that cigarette prices are strictly controlled by the central government and identical across the nation. I don't include cigarettes prices/taxes because these are set at the national level and are absorbed by year fixed effects. Also, to the

[21] Both upper-level (provinces) and lower-level (cities) localities are independently able to implement bylaws. My policy indicator equals 1 if there was any outdoor smoking ban in place at the time of survey.
[22] The questionnaire item has four mutually exclusive options: 1) 2 packs or more daily, 2) 20~39 cigarettes, 3) 10~19 cigarettes, and 4) fewer than 10 cigarettes. For the ease of interpretation, I classify the intensity of smoking into three indicators: 40 or more, 20~39, and 19 or fewer cigarettes per daily.
[23] This varies across provinces. City-level information is not publicly available.

best of my knowledge, no other city-level indoor smoking restriction policies have been enacted in the same manner as outdoor smoking ban.

Including individual fixed effects (γ_i) is beneficial since depreciated consumption activities occurred in the past, which might affect the present decision, can be cancelled out (Chaloupka, Warner, 2000). In particular, Cooper and Pesko (2017) document, omitting individual-level time-invariant unobservable factors can result in biased estimates of the impact of smoke-free policy. Because I restrict the study sample to those who never changed their locations of residence, having individual-level fixed effects in the regression model prevent me from including city- or province-level fixed effects (these are omitted because of perfect collinearity).

An identification assumption is that outcomes of both intervention and control groups would have followed same secular trends without the policy change. It would fail, for instance, if local governments select into the smoke-free policy because the social issue (secondhand smoke) has been serious in their jurisdictions. If this is the case, trends in smoking behaviors would have moved differently in treated cities even without ban.

To address this issue, first, I include province-specific linear time trends given the possibility that there might be factors affecting the smoking/quitting trends, which vary within the administrative regions and do not change at the national level (Kurtulus, 2016). Specifically, I check if adding province-specific linear trends changes results from the main specification (table XXXIV, appendix B).

In addition, even with individual fixed effects, year fixed effects, and region-specific trends controlled for, there remains a possibility of reverse causality that changes in anti-smoking laws are affected by changes in smoking trends. Such scenario can arise if pro-ban governments were more sensitive to the anti-smoking sentiment of their citizens. If this is the case, I would expect the pre-existing decreasing (increasing) trends in smoking rates (making quit attempts) before the implementation of ban.

To check this dynamic around the timing of the law enforcement, I estimate a dynamic event study specification which includes leads and lags of the implementation of outdoor smoking ban as below:

$$(2)\ Y_{icpt} = \alpha_{icpt} + \sum_{j=t-3}^{t+3} \beta_j Ban_{cj} + \pi X_{it} + \theta Z_{pt} + Y_t + \gamma_i + \varepsilon_{icpt}$$

where indicator variables Ban_{ct-3}~Ban_{ct+2} are equal to 1 only in the relevant year (for instance, Ban_{ct0} equals 1 only in the year of implementation and Ban_{ct+1} indicates one year after implementation). An indicator variable Ban_{ct+3} equals 1 in every year beginning with the third year after the implementation. In this model, with "1 year before the implementation" as the omitted category, I expect no evidence suggesting anticipatory behavioral changes or reverse causality for providing robust evidence on the causal effect of outdoor smoking ban. Specifically, coefficients on the policy leads ($\hat{\beta}_{j-3}$ and $\hat{\beta}_{j-2}$) should be statistically insignificant and small.

In additional analyses, I replace the policy indicator (Ban_{ct}) with indicators for different amounts of penalty (<50,000, <100,000, and 100,000 won) to see if the strictness of ban is associated with individual smoking behavior. As of the end of 2015, violators are subject to fines of 20,000 (in 44 cities), 30,000 (in 42 cities), 50,000 (in 75 cities), 70,000 (in 2 cities), or 100,000 won (in 43 cities).[24]

2.5. <u>Results</u>

Table XVI shows summary statistics at baseline (survey year 2009). The sample consists of 52% of women and mean age is 46. Smoking rate is 24.6% (49.0% among men and 1.67% among women). Among current smokers, just below than 30% try to quit in the last month. Percentages of current smokers who smoke 40 or more, 20~39, and 19 or fewer cigarettes daily are 2.3%, 31.8%, and 65.9% respectively.

---

[24] I use both categorical variables and continuous variable and find that results are qualitatively similar.

TABLE XVI
BASELINE SUMMARY STATISTICS (SURVEY YEAR 2009)

	Mean (Std. Dev.)	Minimum	Maximum
Individual-level variables			
Current smoker	0.246	0	1
Attempt to quit (among current smokers)	0.294	0	1
Smoking intensity (among current smokers)			
≥40 cigarettes per day	0.023	0	1
20~39 cigarettes per day	0.318	0	1
<20 cigarettes per day	0.659	0	1
Female	0.518	0	1
Age	46.112 (15.978)	18	80
Wage workers	0.383	0	1
Educational attainment			
Primary completion or less	0.184	0	1
Secondary completion or less	0.450	0	1
More than college attendance	0.366	0	1
Annual earned income (10,000 Korean Won)	1369.639 (2101.797)	0	72000
Married	0.670	0	1
Observations	*13095*		

Table XVII reports the results from the main specification (equation (1)). Individual yearly earnings are not associated with quitting attempts and the intensity of smoking but positively associated with current smoking. GRDP per capita is not related with current smoking status and the intensity of smoking but negatively associated with quitting attempt among current smokers. Results also indicate that there were decreasing trends in current smoking during the study period. The prevalence of smoking decreased in 2012, 2013, 2014, and 2015 by around 2~5 percentage points. But there were no statistically significant secular trends in quitting attempts and the intensity of smoking.

TABLE XVII

THE EFFECT OF OUTDOOR SMOKING BAN ON INDIVIDUAL SMOKING BEHAVIOR

	Current smoking	Quit attempt	Smoking intensity		
			40 or more cigarettes per day	20~39 cigarettes per day	19 or fewer cigarettes per day
Outdoor smoking ban	0.007 (0.005)	0.047** (0.021)	-0.005 (0.004)	-0.018 (0.020)	0.023 (0.021)
Yearly earnings (1 million won)	3.780*** (1.280)	-3.790 (2.540)	1.250 (9.510)	-4.560 (2.010)	-7.930 (2.180)
GRDP per capita (1 million won)	0.001 (0.001)	-0.016 *** (0.005)	-0.002 (0.001)	0.0004 (0.006)	0.001 (0.006)
Year (ref=2009)					
2010	-0.002 (0.005)	0.013 (0.024)	-0.003 (0.005)	-0.021 (0.022)	0.025 (0.022)
2011	-0.009 (0.006)	0.018 (0.027)	0.003 (0.006)	-0.034 (0.028)	0.031 (0.029)
2012	-0.022 *** (0.007)	0.005 (0.034)	0.0004 (0.007)	-0.008 (0.035)	0.008 (0.036)
2013	-0.034 *** (0.008)	-0.014 (0.039)	0.003 (0.009)	-0.046 (0.038)	0.043 (0.039)
2014	-0.035 *** (0.009)	-0.042 (0.041)	0.005 (0.010)	-0.037 (0.041)	0.032 (0.043)
2015	-0.054 *** (0.010)	0.016 (0.047)	0.004 (0.011)	-0.073 (0.048)	0.069 (0.051)
Constant	0.209 *** (0.022)	0.676 *** (0.111)	0.065 ** (0.030)	0.321 ** (0.140)	0.615 *** (0.153)
Observations	*62400*	*14217*	*14217*	*14217*	*14217*
Baseline outcome means	0.246	0.294	0.023	0.318	0.659

*, **, ***: Significant at 0.1, 0.05, 0.01 respectively.

The results from the panel event study are presented in Table XVIII and Figure 12. Compared to the reference period (the year before the implementation of ban), the impact of ban on the probability of making a quit attempt immediately appears when ban goes into effect (year 0) and lasts for three or more years with monotonically-increasing effect sizes. In specific, the smoke-free law leads to a substantial long-term impact on making quit attempts: three or more years after the implementation of bans, the propensity to make a quit attempt among current smokers increases by 13.9 percentage points, which is equivalent to a 47.3% increase from the mean at baseline. On the other hand, the prevalence and intensity of smoking are not affected by the ban.

In particular, coefficient estimates of the effect on cessation attempts are not statistically different from zero any time before the policy took effect. Also, there is no distinct upward trends in quitting attempt before the implementation of ban. Together with the findings that including/excluding region-specific time trends does not qualitatively change the main findings (table XXXIV, appendix B), this result reaffirms that a parallel trends assumption does not fail.

TABLE XVIII
PANEL EVENT STUDY: OUTDOOR SMOKING BAN AND INDIVIDUAL SMOKING BEHAVIOR

	Current smoking	Quit attempt (among current smokers)	Smoking intensity (fraction among current smokers)		
			40 or more cigarettes per day	20~39 cigarettes per day	19 or fewer cigarettes per day
Years since implementation (ref=the year before implementation)					
3 or more years before	0.009 (0.008)	0.030 (0.034)	0.001 (0.006)	-0.008 (0.054)	0.003 (0.054)
2 years before	-0.0004 (0.005)	-0.018 (0.019)	0.0004 (0.005)	0.004 (0.027)	-0.007 (0.027)
0 (implementation)	0.005 (0.006)	0.046** (0.019)	-0.0005 (0.004)	-0.027 (0.025)	0.031 (0.025)
1 year after	0.002 (0.009)	0.061** (0.030)	-0.002 (0.004)	-0.015 (0.042)	0.022 (0.041)
2 years after	0.008 (0.012)	0.111*** (0.043)	-0.0006 (0.005)	-0.013 (0.059)	0.020 (0.058)
3 or more years after	0.004 (0.016)	0.139** (0.057)	0.002 (0.007)	-0.017 (0.079)	0.024 (0.078)
Yearly earnings (1 million won)	3.380 *** (1.240)	-4.600 * (2.550)	1.090 (8.860)	-9.810 (1.930)	-1.050 (2.020)
GRDP per capita (1 million won)	0.002 (0.001)	-0.009 * (0.005)	-0.002 (0.001)	0.001 (0.006)	0.001 (0.007)
Year (ref=2009)					
2010	0.00003 (0.005)	0.010 (0.029)	-0.001 (0.007)	-0.047 (0.031)	0.048 (0.031)
2011	-0.006 (0.008)	0.014 (0.041)	0.009 (0.009)	-0.078 * (0.047)	0.069 (0.048)
2012	-0.018 (0.012)	-0.013 (0.057)	0.008 (0.011)	-0.076 (0.063)	0.068 (0.064)
2013	-0.029 * (0.016)	-0.061 (0.072)	0.011 (0.016)	-0.140 * (0.080)	0.130 (0.082)
2014	-0.032 (0.019)	-0.126 (0.089)	0.014 (0.020)	-0.154 (0.098)	0.141 (0.101)
2015	-0.051 ** (0.022)	-0.098 (0.100)	0.012 (0.023)	-0.203 * (0.113)	0.191 (0.116)
Constant	0.185 *** (0.026)	0.505 *** (0.134)	0.063 ** (0.031)	0.359 ** (0.150)	0.578 *** (0.162)
Observations	*54517*	*12160*	*12160*	*12160*	*12160*
Baseline outcome means	0.246	0.294	0.023	0.318	0.659

*, **, ***: Significant at 0.1, 0.05, 0.01 respectively.

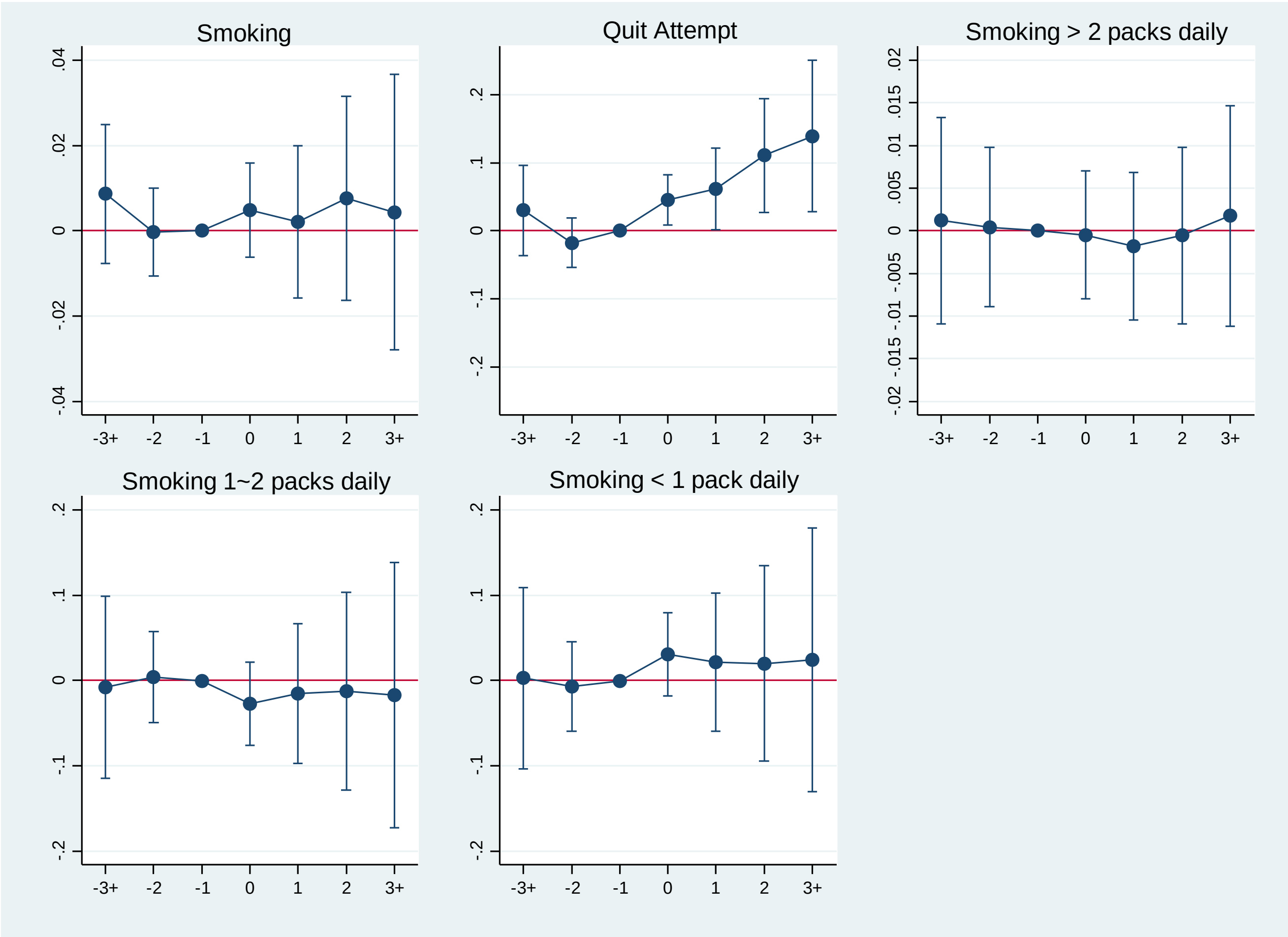

Figure 12. Panel event study: Effects of outdoor smoking ban on individual smoking behaviors.

Table XIX reports the results from subgroup analysis where outcome measures are regressed by the policy indicator separately for subpopulation groups across sociodemographic dimensions (age, employment, health and marriage status). Results indicate that outdoor smoking ban results in statistically significant increases in the probability of quit attempt among persons who are young, employed, or in good health status. In addition, outdoor smoking ban is found to decrease the intensity of smoking among unmarried smokers (Panel E). There is also suggestive evidence that ban is positively associated with cessation attempts among educated or unmarried individuals.

Disparities in the impact of ban on quitting attempt along age groups, employment status, and health status suggest that persons who actively spend more time outdoors (so more likely to be exposed to the restrictions) are more likely to attempt to quit smoking when their local governments implement outdoor smoking ban. It implies one of channels how outdoor smoking affects individual smoking behaviors: More exposure to smoke-free policy (and higher social pressure) pays off.

TABLE XIX

SUBGROUP ANALYSIS

	Current smoking	Quit attempt (among current smokers)	Smoking intensity (fraction among current smokers)		
			40 or more cigarettes per day	20~39 cigarettes per day	19 or fewer cigarettes per day
Panel A. Age					
Aged 18~39	0.012 (0.009)	0.087** (0.036)	-0.012 (0.011)	-0.038 (0.034)	0.050 (0.034)
Aged 40~64	0.008 (0.007)	0.052** (0.024)	-0.001 (0.006)	-0.032 (0.024)	0.033 (0.024)
Aged 65~80	0.004 (0.006)	-0.037 (0.038)	-0.010 (0.010)	0.038 (0.036)	-0.028 (0.035)
Panel B. Education					
Secondary schooling or less	0.004 (0.007)	-0.019 (0.043)	0.002 (0.012)	0.025 (0.042)	-0.027 (0.042)
At least college attendance	0.005 (0.006)	0.051* (0.027)	-0.012 (0.007)	-0.022 (0.024)	0.034 (0.025)
Panel C. Employment					
Not working for wages	0.005 (0.005)	0.024 (0.025)	-0.008 (0.008)	-0.008 (0.028)	0.016 (0.029)
Working for wages	0.010 (0.008)	0.074*** (0.027)	-0.003 (0.006)	-0.021 (0.024)	0.024 (0.025)
Panel D. Self-rated health status					
Moderate/Bad/Very bad	0.004 (0.006)	0.024 (0.027)	-0.006 (0.008)	-0.023 (0.026)	0.029 (0.025)
Good/Very good	0.007 (0.007)	0.061** (0.029)	-0.009 (0.006)	-0.033 (0.027)	0.043 (0.028)
Panel E. Marital status					
Single/Divorced/Widowed	0.001 (0.009)	0.053* (0.032)	-0.008 (0.008)	-0.060* (0.032)	0.068** (0.032)
Married	0.008 (0.005)	0.036 (0.023)	-0.005 (0.005)	-0.003 (0.022)	0.008 (0.022)

*, **, ***: Significant at 0.1, 0.05, 0.01 respectively.

Table XX presents the association of the amount of penalty with self-reported smoking outcome measures. Smoking restrictions imposing different amounts of fines (<50,000, <100,000, and 100,000 won) have all positive associations with the propensity of making a quit attempt, though only the highest amount is statistically associated with the outcome. There is no clear evidence that stricter smoke-free policy leads to changes in the prevalence of smoking and the heavy smokers (consuming more than 2 packs a day). However, I find evidence that imposing the highest amount of monetary penalty makes smokers consuming light to moderate amount of cigarettes decrease their intensity of smoking by around 6 percentage points.

As the nationwide indoor smoking ban was implemented in December 2012, it is plausible that localities that implemented outdoor ban earlier than the national indoor smoking ban might have enforced indoor ban stricter. To test whether these is such differential impact of outdoor smoking ban, I re-estimate the main specification with the periods 2009~2012 (just before the implementation of the national indoor smoking ban) in Table XXI (Panel A). Results are similar to findings in Table XVII in terms of direction and magnitude of coefficient estimates.

In Panel B of Table XXI, as a second robustness check, an analysis is done by including only samples living in Seoul Metropolitan city and other localities where outdoor smoking ban was not implemented until the end of 2012 to address the possibility of heterogeneity in the enforcement of restrictions. In Seoul, after the city council passed a bill, outdoor smoking ban took into effect across the city at the same time in July 2011. This setting helps me test the impacts of ban with less heterogeneity in the enforcement. I find that results are qualitatively similar to the results from the main specification.

TABLE XX

THE AMOUNT OF PENALTY AND INDIVIDUAL SMOKING BEHAVIOR, 2009-2015

	Current smoking	Quit attempt (among current smokers)	Smoking intensity (fraction among current smokers)		
			40 or more cigarettes per day	20~39 cigarettes per day	19 or fewer cigarettes per day
Panel A. Categorized penalty variable (ref=no outdoor smoking ban)					
<50,000 won	0.013* (0.007)	0.025 (0.026)	-0.007 (0.007)	0.010 (0.034)	-0.003 (0.034)
<100,000 won (≥50,000)	0.002 (0.006)	0.024 (0.032)	-0.002 (0.006)	-0.026 (0.028)	0.027 (0.028)
100,000 won	0.009 (0.007)	0.102*** (0.034)	-0.004 (0.005)	-0.062** (0.028)	0.066** (0.029)
p-value (<50K = <100K)	0.160	0.988	0.455	0.365	0.437
p-value (<50K = 100K)	0.657	0.054	0.632	0.043	0.051
p-value (<100K = 100K)	0.388	0.068	0.763	0.234	0.212
Observations	*62400*	*14217*	*14217*	*14217*	*14217*
Panel B. Continuous penalty variable (ref=no outdoor smoking ban)					
Penalty amount (10,000 Korean won)	0.0007 (0.0006)	0.009*** (0.003)	-0.0002 (0.0005)	-0.007** (0.003)	0.007** (0.003)
Observations	*62400*	*14217*	*14217*	*14217*	*14217*
Baseline outcome means	0.246	0.294	0.023	0.318	0.659

*, **, *** denote significant at 0.1, 0.05, 0.01 respectively.

TABLE XXI
ROBUSTNESS CHECK

	Current smoking	Quit attempt (among current smokers)	Smoking intensity (fraction among current smokers)		
			40 or more cigarettes per day	20~39 cigarettes per day	19 or fewer cigarettes per day
Panel A. Year 2009~2013 (before the implementation of the national indoor smoking ban)					
Outdoor smoking ban	0.008 (0.006)	0.084*** (0.027)	-0.00008 (0.005)	-0.029 (0.026)	0.029 (0.026)
Observations	*41249*	*9810*	*9810*	*9810*	*9810*
Baseline outcome means	0.238	0.283	0.018	0.308	0.674
Panel B. Only including the city of Seoul & synthetic control groups (no ban until 2013), 2009~2013					
Outdoor smoking ban	-0.0002 (0.007)	0.100** (0.043)	-0.004 (0.009)	-0.003 (0.037)	0.007 (0.037)
Observations	*21038*	*4728*	*4728*	*4728*	*4728*
Baseline outcome means	0.225	0.307	0.022	0.258	0.720

*, **, ***: Significant at 0.1, 0.05, 0.01 respectively.

2.6. <u>Discussion</u>

In this study, I find that outdoor smoking bans implemented by local governments in Korea increase the probability of making a quit attempt among current smokers by 4.7 percentage points. This effect lasts for three or more years after the implementation of the ban. However, on average, the smoke-free policy does not affect the prevalence and intensity of smoking. I also find heterogeneity in the impacts of the ban. Subgroup analyses provide evidence that socially active persons are more likely to attempt to quit. In addition, a higher amount of penalty has stronger impacts on reducing the intensity of smoking and increasing the propensity to try to quit among current smokers.

These results suggest that the outdoor smoke-free policy affects individual smoking behavior through two mechanisms. Outdoor smoking bans raise awareness about harmful effects of smoking among smokers and it leads to an increase in quit attempts – though not strong enough to reduce the demand for cigarettes. This effect is stronger and significant among persons who spend more time outdoors, indicating that 1) socially active persons are more likely to be exposed to changes in social norms regarding tobacco use in public places (Hahn, 2010), and that 2) more exposure to the smoke-free policy makes smokers try to quit smoking. In addition, the amounts of penalty have differential impacts on quitting attempts and the intensity of smoking, suggesting that outdoor smoking bans change individual smoking behavior through increased monetary costs of smoking. These explanations are consistent with theory predicting that restrictions on smoking can change the demand for cigarettes by increasing disutility from consuming tobacco products and by changing social norms (Chaloupka and Warner, 2000; Jones et al., 2015).

Previous studies of smoking ban provide mixed evidence on the impacts on individual smoking behavior. Unlike natural experiments in Switzerland (Boes et al., 2015) and Germany (Anger et al., 2011), studies from the U.S. report that indoor smoking bans do not affect the prevalence and intensity of smoking (Adda and Cornaglia, 2010; Jones et al., 2015). Main results of this study are in line with those reporting minuscule impacts of smoking bans. In addition, given that there has been little research on smoking restrictions in open public places, this study fills the knowledge gap by providing causal estimates of the impacts of the outdoor smoking ban for the first time.

This study finds that the outdoor smoking ban in Korea is not enough strong to reduce the prevalence of smoking, though the policy change increases the probability of making a quit attempt by 16%. This result is in line with the 2016 Cochrane review which finds that theire is no clear evidence on the effects of smoking ban on tobacco consumption (Frazer et al., 2016). In particular, my results suggest that most smokers triggered by smoking restrictions to try to quit eventually experienced relapse. Because failed quit attempts and experienced withdrawal make smokers less likely to successfully quit smoking (Raw et al., 1998), it is safe to say that the overall impact of ban on active smoking is not substantial.

It has been reported that the majority of smokers who attempt to quit use the least effective method (willpower alone) and that effective individual-level cessation aids (such as counseling, nicotine patch, or drugs) are not for free (West et al., 2000; Malarcher et al., 2011). It implies an implication for public policy that smoking ban should accompany by another policy change aiding cessation. This is important because, given the high prevalence of smoking among the general population in Korea, both active and passive smoking should be targeted to substantially reduce the burden of smoking-related illnesses to society (He et al., 1999).

Another implication for public policy is that violators of smoke-free policies should be subject to considerable amount of penalty. This study finds evidence that impacts of ban on reducing the intensity of smoking and increasing the propensity to try to quit smoking only appear for persons exposed to the highest amount of penalty. In particular, decreased intensity of smoking attributed to outdoor smoking ban implies population health impacts of the policy change.

These results should be interpreted with caution. First, it is plausible that banning smoking cigarettes makes smokers switch to smokeless tobacco to circumvent the restrictions, though I am not able to examine this behavior and its health impacts due to lack of data. Second, additional information on the place of smoking would complement this study by investigating whether outdoor smoking ban just displace smokers from non-smoking places or whether the policy change encourages positive behavioral changes in other settings through norm spreading (Azagba, 2015). Third, due to lack of data, I am not able to study health impacts of the outdoor smoking bans. Given that restrictions on smoking are primarily aimed to reduce secondhand smoke of nonsmokers (Chaloupka, Warner, 2000), future studies need to focus on this issue.

CITED LITERATURE

Adda J, Cornaglia F. 2010. The effect of bans and taxes on passive smoking. American Economic Journal: Applied Economics 2(1): 1-32. DOI: 10.1257/app.2.1.1

Anger S, Kvasnicka M, Siedler T. 2011. One last puff? Public smoking bans and smoking behavior. Journal of Health Economics 30: 591-601. DOI: 10.1016/j.jhealeco.2011.03.003

Barber P. 2015. We don't need an "evidence base" for a smoking ban in outdoor spaces. BMJ 350: h1442. DOI: 10.1136/bmj.h1442

Been JV, Nurmatov UB, Nawrot TS, van Schayck CP, Cheikh A. 2014. Effect of smoke-free legislation on perinatal and child health: A systematic review and meta-analysis. Lancet 383: 1549-1560. DOI: 10.1016/S0140-6736(14)60082-9

Boes S, Marti J, Maclean JC. 2015. The impact of smoking bans on smoking and consumer behavior: Quasi-experimental evidence from Switzerland. Health Economics 24: 1502-1516. DOI: 10.1002/hec.3108

Carton TW, Darden M, Levendis J, Lee SH, Ricket I. 2016. Comprehensive indoor smoking bans and smoking prevalence. American Journal of Health Economics 2(4): 535–556. DOI: 10.1162/ajhe a 00061

Chaloupka FJ, Warner KE. 2000. The economics of smoking. In: Culyer AJ, Newhouse JP, Handbook of health economics. Amsterdam: Elsevier Science B.V.

Chapman S. 2008. Should smoking in outside public spaces be banned? BMJ 337: a2804.

Cho HJ. 2014. The status and future challenges of tobacco control policy in Korea. Journal of Preventive Medicine & Public Health 47: 129-135. DOI: 10.3961/jpmph.2014.47.3.129

Cooper MT, Pesko MF. 2017. The effect of e-cigarette indoor vaping restrictions on adult prenatal smoking and birth outcomes. Journal of Health Economics 56: 178-190. DOI: 10.1016/j.jhealeco.2017.10.002

Frazer K, Callinan JE, McHugh J, van Baarsel S, Clarke A, Doherty K, Kelleher C. 2016. Legislative smoking bans for reducing harms from secondhand smoke exposure, smoking prevalence and tobacco consumption. Cochrane Database of Systematic Reviews 2. DOI: 10.1002/14651858.CD005992.pub3

Hahn EJ. 2010. Smokefree legislation: A review of health and economic outcomes research. American Journal of Preventive Medicine 39(6S1): S66-S76. DOI: 10.1016/j.amepre.2010.08.013

Hankins S, Tarasenko Y. 2016. Do smoking bans improve neonatal health? Health Services Research 51(5): 1858-1878. DOI: 10.1111/1475-6773.12451

He J, Vupputuri S, Allen K, Prerost MR, Hughes J, Whelton PK. 1999. Passive smoking and the risk of coronary heart disease: A meta-analysis of epidemiologic studies. New England Journal of Medicine 340: 920-926. DOI: 10.1056/NEJM199903253401204

International Agency for Research on Cancer (IARC). 2004. IARC monographs on the evaluation of carcinogenic risks to humans, volume 83: Tobacco smoke and involuntary smoking. Retrieved May 12, 2019, from http://monographs.iarc.fr/ENG/Monographs/vol83/index.php

Jefferis BJ, Lowe GDO, Rumley WA, Lawlor DA, Ebrahim S, Carson C, Doig M, Feyerabend C, McMeekin L, Wannamethee SG, Cook DG, Whincup PH. 2010. Secondhand smoke (SHS) exposure is associated with circulating markers of inflammation and endothelial function in adult men and women. Atherosclerosis 208: 550-556. DOI: 10.1016/j.atherosclerosis.2009.07.044

Johns M, Farley SM, Rajulu DT, Kansagra SM, Juster HR. 2014. Smoke-free parks and beaches: an interrupted time-series study of behavioural impact in New York City. Tobacco Control 0: 1-4. DOI: 10.1136/tobaccocontrol-2013-051335

Jones AM, Laporte A, Rice N, Zucchelli E. 2015. Do public smoking bans have an impact on active smoking? Evidence from the UK. Health Economics 24: 175-192. DOI: 10.1002/hec.3009

Kim SJ, Seldon BJ. 2004. The demand for cigarettes in the Republic of Korea and implications for government policy to lower cigarette consumption. Contemporary Economic Policy 22: 299-308. DOI: 10.1093/cep/byh021

Kurtulus FA. 2016. The impact of affirmative action on the employment of minorities and women: A longitudinal analysis using three decades of EEO-a filings. Journal of Policy Analysis and Management 35: 34-66. DOI: 10.1002/pam.21881

Kvasnicka M, Siedler T, Ziebarth N. 2018. The health effects of smoking bans: Evidence from German hospitalization data. Health Economics. DOI: 10.1002/hec.3798

Lee CW, Kahende J. 2007. Factors associated with successful smoking cessation in the United States, 2000. American Journal of Public Health 97: 1503-1509. DOI: 10.2105/AJPH.2005.083527

Malarcher A, Dube S, Shaw L, Babb S, Kaufmann R. 2011. Quitting smoking among adults - United States, 2001–2010. Morbidity and Mortality Weekly Report 60: 1513-1519.

McGeary KA, Dave DM, Lipton BJ, Roeper T. 2017. Impact of comprehensive smoking bans on the health of infants and children. NBER Working Paper No. 23995. DOI: 10.3386/w23995

Murray RP, Gerald LB, Lindren PG, Connett JE, Rand CS, Anthonisen NR. 2000. Characteristics of participants who stop smoking and sustain abstinence for 1 and 5 years in the Lung Health Study. Preventive Medicine 30: 392-400. DOI: 10.1006/pmed.2000.0642

Meyers DG, Neuberger JS, He J. Cardiovascular effect of bans on smoking in public places: A systematic review and meta-analysis. Journal of the American College of Cardiology 54: 1249-1255. DOI: 10.1016/j.jacc.2009.07.022

Nakamura M, Oshima A, Ohkura M, Artega C, Suwa K. 2014. Predictors of lapse and relapse to smoking in successful quitters in a Varenicline post hoc analysis in Japanese smokers. Clinical Therapeutics 36: 918-927. DOI: 10.1016/j.clinthera.2014.03.013

Öberg M, Jaakkola MS, Woodward A, Peruga A, Prüss-Ustün A. 2011. Worldwide burden of disease from exposure to second-hand smoke: A retrospective analysis of data from 192 countries. The Lancet 377: 139-146. DOI: 10.1016/S0140-6736(10)61388-8

Odermatt R, Stutzer A. 2015. Smoking bans, cigarette prices and life satisfaction. Journal of Health Economics 44: 176-194. DOI: 10.1016/j.jhealeco.2015.09.010

Organisation for Economic Co-operation and Development (OECD). 2017. Daily smokers (indicator). DOI: 0.1787/1ff488c2-en (Accessed on December 31, 2017)

Oh IH, Yoon SJ, Yoon TY, Choi JM, Choe BK, Kim EJ, Kim YA, Seo HY, Park YH. 2012. Health and economic burden of major cancers due to smoking in Korea. Asian Pacific Journal of Cancer Prevention 13: 1525-1531. DOI: 10.7314/APJCP.2012.13.4.1525

Okoli C, Johnson A, Pederson A, Adkins S, Rice W. 2013. Changes in smoking behaviours following a smokefree legislation in parks and on beaches: an observational study. BMJ Open 3: e002916. DOI: 10.1136/bmjopen-2013-002916

Pan A, Wang Y, Talaei M, Hu FB, Wu T. 2015. Relation of active, passive, and quitting smoking with incident type 2 diabetes: A systematic review and meta-analysis. The Lancet Diabetes & Endocrinology 3: 958-967. DOI: 10.1016/S2213-8587(15)00316-2

Raw M, McNeill A, West R. 1998. Smoking cessation guidelines for health professionals – A guide to effective smoking cessation interventions for the health care system. Thorax 53: S1-S18. DOI: 10.1136/thx.53.2008.S1

Rocha R, Soares RR. 2010. Evaluating the impact of community-based health interventions: Evidence from Brazil's Family Health Program. Health Economics 19: 126-158. DOI: 10.1002/hec.1607

Semple S, Creely KS, Naji A, Miller BG, Ayres JG. Secondhand smoke levels in Scottish pubs: the effect of smoke-free legislation. Tobacco Control 16: 127-132. DOI: 10.1136/tc.2006.018119

Shetty KD, DeLeire T, White C, Bhattacharya J. 2010. Changes in U.S. hospitalization and mortality rates following smoking bans. Journal of Policy Analysis and Management 30: 6-28. DOI: 10.1002/pam.20548

Statistics Korea. 2017. Korean statistical information services. Retrieved May 12, 2019, from http://kosis.kr/eng/

Tan CE, Glantz SA. 2012. Association between smoke-free legislation and hospitalizations for cardiac, cerebrovascular, and respiratory diseases: A meta-analysis. Circulation 126: 2177-2183. DOI: 10.1161/CIRCULATIONAHA.112.121301

Thomson G, Edwards R, Woodward A. 2008. Should smoking in outside public spaces be banned? BMJ 337: a2804.

U.S. Department of Health and Human Services. 2014. The health consequences of smoking – 50 years of progress: A report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. Retrieved May 12, 2019, from https://www.cdc.gov/tobacco/data_statistics/sgr/50th-anniversary/index.htm

Vangeli E, Stapleton J, Smit ES, Borland R, West R. 2011. Predictors of attempts to stop smoking and their success in adult general population samples: A systematic review. Addiction 106: 2110-2121. DOI: 10.1111/j.1360-0443.2011.03565.x

West R, McNeill A, Raw M. 2000. Smoking cessation guidelines for health professionals: An update. Thorax 55: 987-999. DOI: 10.1136/thorax.55.12.987

World Health Organization (WHO). 2013. WHO report on the global tobacco epidemic, 2013: Enforcing bans on tobacco advertising, promotion and sponsorship. Geneva: WHO. Retrieved May 12, 2019, from http://www.who.int/tobacco/global_report/2013/en/

World Health Organization (WHO). 2015. Global health observatory data repository. Retrieved May 12, 2019, from http://apps.who.int/gho/data/node.main.TOB1300MOSTSOLD?lang=en

World Health Organization (WHO). 2017. WHO report on the global tobacco epidemic, 2017: Monitoring tobacco use and prevention policies. Geneva: WHO. Retrieved May 12, 2019, from http://www.who.int/tobacco/global_report/en/

World Health Organization (WHO). 2018. WHO Framework Convention on Tobacco Control. Retrieved May 12, 2019, from http://www.who.int/fctc/en/

Zahra A, Cheong HK, Lee EW, Park JH. 2016. Burden of disease attributable to secondhand smoking in Korea. Asia Pacific Journal of Public Health 28: 737-750. DOI: 10.1177/1010539516667779

Zahra A, Cheong HK, Park JH. 2017. Burden of disease attributable to smoking in Korea. Asia Pacific Journal of Public Health 29: 47-59. DOI: 10.1177/1010539516675696

3. BEHAVIORAL RESPONSES TO PUBLIC HEALTH EMERGENCY: THE 2015 MERS EPIDEMIC IN KOREA

3.1. Introduction

Negative impacts of external shocks including disease epidemics, natural disasters and violence/conflict on health and human capital have been established by a growing body of research across different disciplines. (Almond, 2006; Di Novi, 2010; Kelly, 2011; Neelsen, Stratmann, 2012; Currie, Vogl, 2013; Karlsson et al., 2014; Acquah et al., 2017; Altindag et al., 2017; Frankenberg, Thomas, 2017; Ogasawara, 2017). Previous research finds consistent evidence that individual health can be affected through changes in wealth, nutritional uptakes, or psychological stress, even without direct contacts with the source of health shock.

Frankenberg and Thomas (2017) find that, facing the 1998 financial crisis, Indonesian families tried to smooth household consumptions by moving to rural areas, reducing expenditures on clothing and furniture, and selling off assets to save money for spending on health and education. However, little research has looked at how individuals react to external health shocks to mitigate the anticipated negative impacts (Currie, Vogl, 2013).

Having little knowledge about immediate personal behavioral responses to external shocks raises at least two practical issues. First, ignoring this factor would lead to biased estimated effects because immediate individual behavioral changes moderate the associations between shocks and health outcomes. Second, it is individual behavior, not external shocks, that are modifiable risk factors. Thus, better knowledge of individual responses and better targeting of vulnerable populations can direct public policy how to distribute limited resources to prevent long-run negative impacts of shocks.

This study aims to investigate the impacts of the 2015 Middle Ease Respiratory Syndrome Coronavirus (MERS-CoV) epidemic in Korea on risky health behaviors and health capital investments. My main estimation relies on the finding that distance from the origin of the epidemic is strongly associated with the city-level incidence rates and is not directly related with individual health behavior. Since most MERS infection transmissions occurred by close contact, persons residing in places near the origin of epidemic are significantly more likely to be exposed to the infection risks. Accordingly, I use this distance measures to predict the disease prevalence at city level and the predicted variation in the risks is used to measure the impacts on health behavior.

The results from instrumental variables (IV) estimations indicate that individuals react to higher risks of epidemic by altering their harmful behavior. Specifically, persons living in worst-hit regions are significantly more likely to stop drinking and attempt to quit smoking. However, I find heterogenous effects in that worse-off persons or individuals with weak social interactions are less likely to change their risky behaviors. In addition, though MERS positively affects health behavior among all workers, workers in precarious employment are in fact more likely to stop, not just attempt to stop, risky behaviors. These findings suggest that private self-protection should be accompanied by public mitigation efforts to fully deal with negative impacts of public health emergencies and to narrow the health investment gap.

This is the first-of-its-kind study on the impacts on general individual behavior of the disease epidemic. The results show that individuals do not respond to the external shock in the same way. This research provides several mechanisms why some individuals are better able to cope with a shock. Disparities in behavioral responses to the MERS epidemic along socioeconomic status, job stability, and social connectedness reveal that better or more resources and more knowledge of the situation play an important role in health investment. Thus, this study helps policymakers better understand individual unhealthy behavior and target the vulnerable populations, who might suffer from the negative health impacts of external shocks.

3.2. Background

MERS is a respiratory disease that spreads MERS-CoV through close contact between persons. The illness has symptoms resembling pneumonia such as cough, myalgia, difficulty in breathing, fever, and diarrhea. It's been reported that about 70% of patients require mechanical ventilation (Lee, Cho, 2016). The MERS epidemic led the Korean government to cut yearly economic growth forecast by 0.7 percentage points (3.8% to 3.1%) and to implement an economic stimulus package of $13.5 billion due to substantial reductions in consumption (Jung et al., 2016).

The spread of MERS showed an unprecedented pattern in Korea. The epidemic originated in the city of Pyeongtaek (Gyeonggi province) on 20th May 2015. The first case in the country ("Patient Zero") became ill after returning from the Middle East. MERS soon spread when the first case visited a nearby hospital for high fever. An outbreak among healthcare workers and patients of the hospital led to secondary outbreaks including the one that occurred in a teaching hospital in Seoul, the capital, where more than 80 people were infected.

Most infection transmissions occurred by close contact. Until the official end of the epidemic in December 2015, 186 people were infected and 38 died. All but four (Incheon, Ulsan, Gyeonnam, and Jeju) of the 16 provinces in the country had some MERS cases. In addition, over 16,000 citizens had been quarantined at some point during the epidemic due to close contact with infected persons – it's equivalent to 1 out of every 3,000 individuals in the population (Lee, Cho, 2016).

Previous studies focusing on individual's health capital investment assume the level of optimization. The level of investment in health and related behaviors would be optimized at the level where the marginal benefits equal the marginal costs (Fichera et al., 2016). For instance, Di Novi (2010) finds that persons invest more in health to offset the negative impact of air pollution as long as the level of pollution is under the optimal level – the authors use the Air Quality Index (AQI) of the Environmental Protection Agency (EPA) as a threshold of severity. Specifically, a higher concentration of carbon monoxide, mostly under the threshold, is positively associated with health investments (on smoking, drinking, diet, and preventive care), whereas a higher level of ozone, mostly concentrated on over the threshold, is related to heavy drinking and a less healthy diet.

The 2015 MERS epidemic, however, had a distinct feature of uncertainty. At the early stage of the epidemic, the government tried to relieve the public by explaining that the MERS-CoV has a low level (0.6) of basic reproduction number (R0). However, the speed of transmission exceeded the government's explanation. In fact, a later study found that a reasonable R0 is higher than 8 (Chang, 2017). Meanwhile, the public were left on their own with a flood of media coverage; the Google trends data show that the share of search terms "MERS" hit almost 100% in early June (Figure 13).

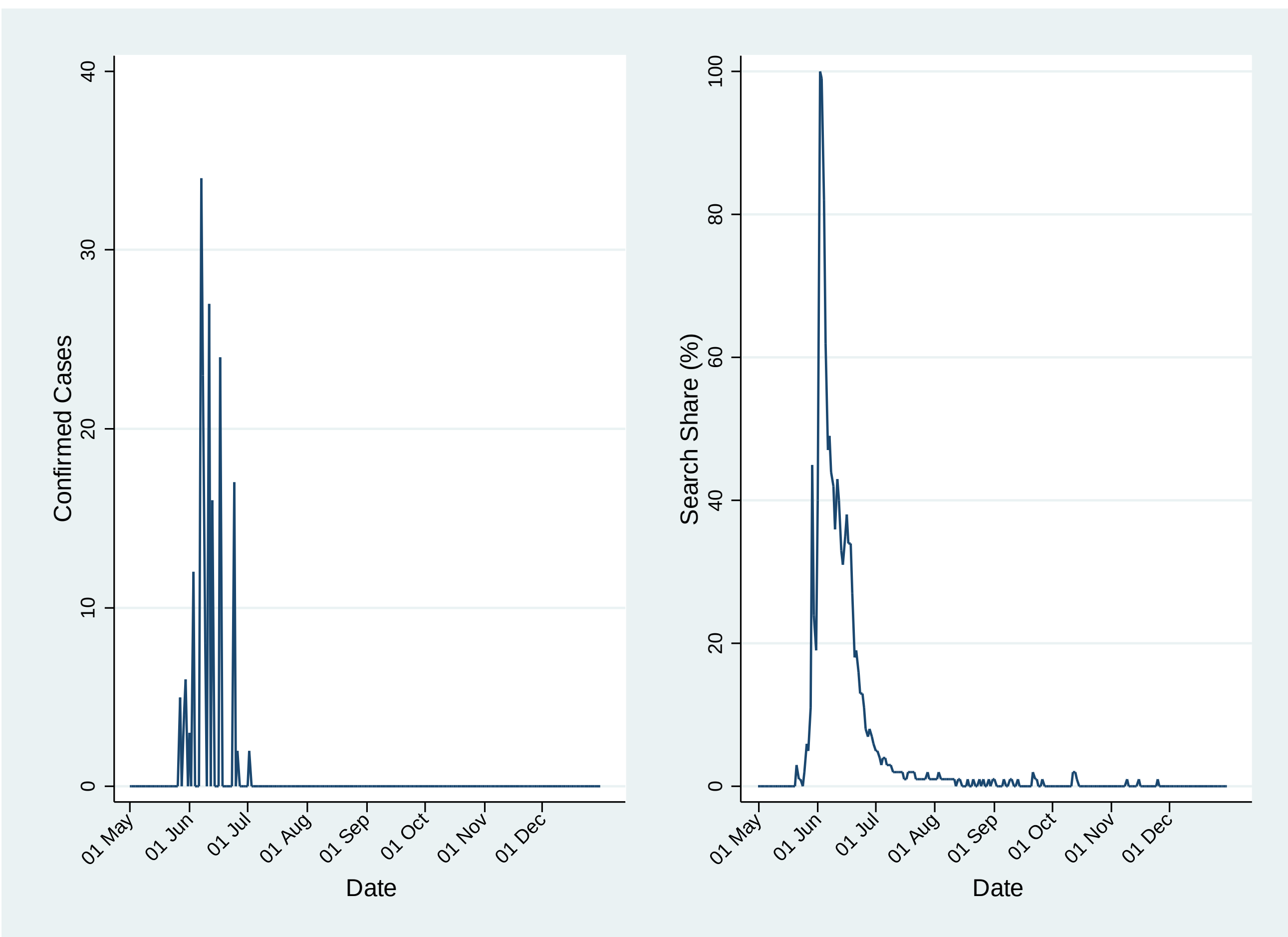

Figure 13. Number of confirmed cases and Google searches for MERS in Korea, from 1st May through 31st December 2015.

External health shocks may have beneficial or detrimental health effects (Marsaudon, Rochaix, 2017). External shocks such as natural disasters or disease epidemics may lead persons to reduce alcohol and tobacco consumption by 1) lowering individual/household wealth, and 2) incentivizing them to maintain their ability to work. Health shocks also can act like a source of information and make persons modify their risk perception. On the other hand, individuals can more likely to engage in risky health behavior to cope with physical/mental stress from shocks. Thus, the direction of overall impacts of health shocks is determined by the interplay between the two effects.

Empirical studies provide mixed predictions on the impacts of disease outbreaks on individual risky behaviors. On the one hand, facing a mysterious disease without vaccines and medicines to cure, individuals may reduce physical activity and social interactions which would raise the risks of infection. This can happen because the perceived probability of contracting the disease exceeds the perceived marginal benefits of health investments. Evidence on this avoidance behavior have been found when avoidance dominated behavioral responses (Case, Paxson, 2011). Examples include studies on the impacts of other threats such as Ozone, the Swine flu, and Yellow dust (Altindag et al., 2017; Neidell, 2009; Rubin et al., 2009). The study on the 2003 SARS epidemic in Taiwan also documents healthcare avoidance due to high infection rates in healthcare facilities (Bennet et al., 2015).

On the other hand, the epidemic can make persons invest more in health by altering the perceived benefits of investments. Oster (2018) finds that the county-level pertussis incidence rates are positively associated with higher vaccination rates in the U.S. Another mechanism proposed to explain this positive behavioral change is that external health shocks may alter persons’ risk perceptions and longevity expectations. Margolis et al. (2014) find that Medicare patients who undergo more invasive procedures (coronary artery bypass grafting) for acute coronary syndrome are more likely to quit smoking than peer patients who received percutaneous coronary interventions.

However, there are also studies showing contradictory evidence on behavioral responses to external shocks. A study on the impacts of the 2011 Great East Japan Earthquake reveals that men living in hard-hit regions spend more time on gambling and drinking (Hanaoka et al., 2015). Smith (2008) investigates changes in longevity expectations of people in their 50s who experienced a large hurricane attack and finds that the natural hazard significantly reduces victims' longevity expectations ("the chance respondents will live to 75 or older"). Smith et al. (2001) document that smoking-related health shocks (chronic lung disorders, smoking-related cancers, or cardiovascular and cerebrovascular diseases) make smokers dramatically reduce their longevity expectations.

3.3. Methods

This study primarily uses the individual-level data from the Korean Labor and Income Panel Study, a nationally-representative survey of individuals and their families. The survey has collected a wide range of individual- and household-level information on demographic and socioeconomic characteristics, job status, and health-related questionnaires including health behaviors (smoking, drinking, and physical activity).

For my main estimations, 8,959 persons who are 20 years or older in 2015 are analyzed. The sample population is restricted to those who are surveyed in the second half of the year (most of them are interviewed in July, August, or September), reflecting the timeline of the epidemic (from May to December).

The official infection data are taken from the government's report on the epidemic (Ministry of Health and Welfare, 2016). This report includes locations (province) of residence of all 183 infected persons. However, the government has not disclosed city-level information to the public yet. To overcome the small number of regions (16 provinces) and infected samples, I use the cross section of the city-level (N=226) data of 2,538 quarantined persons as of 9th June 2015 (3 weeks after the break), which were exposed to the public by news articles on 10th June. As shown in Figure 13, these data reflect risk perceptions of the public at the peak of the epidemic. Also, this information on the early-stage risk provides the ground for an IV estimation strategy given that the link between risks and distance (from the origin) tends to grow weak as epidemics progress (Chin, Wilson, 2017).

Figure 14 shows that cities far from the origin tend to face lower risks of the disease. Also, rural, mountainous, or less-populous areas have lower probabilities to have suspicious cases of MERS. My two-stage least squares (2SLS) regression analysis relies on such spatial variations in MERS risks:

$$\text{(1) Second stage: } Y_{ic} = \alpha + \beta \widehat{Incidence}_c + \delta X_i + \varepsilon_{ic}$$

$$\text{(2) First stage: } Incidence_c = \tilde{\alpha} + \gamma Distance_c + \tilde{\delta} X_i + \epsilon_{ic}$$

Unit of analysis is person-year. The outcome Y represents health investment or risky health behaviors (tobacco smoking, drinking, and physical activity) of person I, who resides on city c. β signifies the ordinary least square (OLS) estimate of the impact of exposure to the epidemic. The disease risks are defined as the incidence rates (the number of quarantined persons per 1,000,000 population). To address a skewedness, the incidence rates are log-transformed and a value of 1 is assigned to zero-case cities. X is a set of individual-level sociodemographic and economic factors such as gender, 10-year-interval age groups, adjusted household monthly expenditure ($\frac{household\ monthly\ expenditures}{\sqrt{(\text{number of household members})}}$), educational attainment dummies (primary schooling, secondary schooling, and at least college attendance), marital status (married or not), an indicator for working for wages, and province fixed effects. Because the city-level risk measure is released on early June, dummies for months of interview (July through November) are also included to reflect probable differences in the perceived risks. Standard errors are clustered at city level.

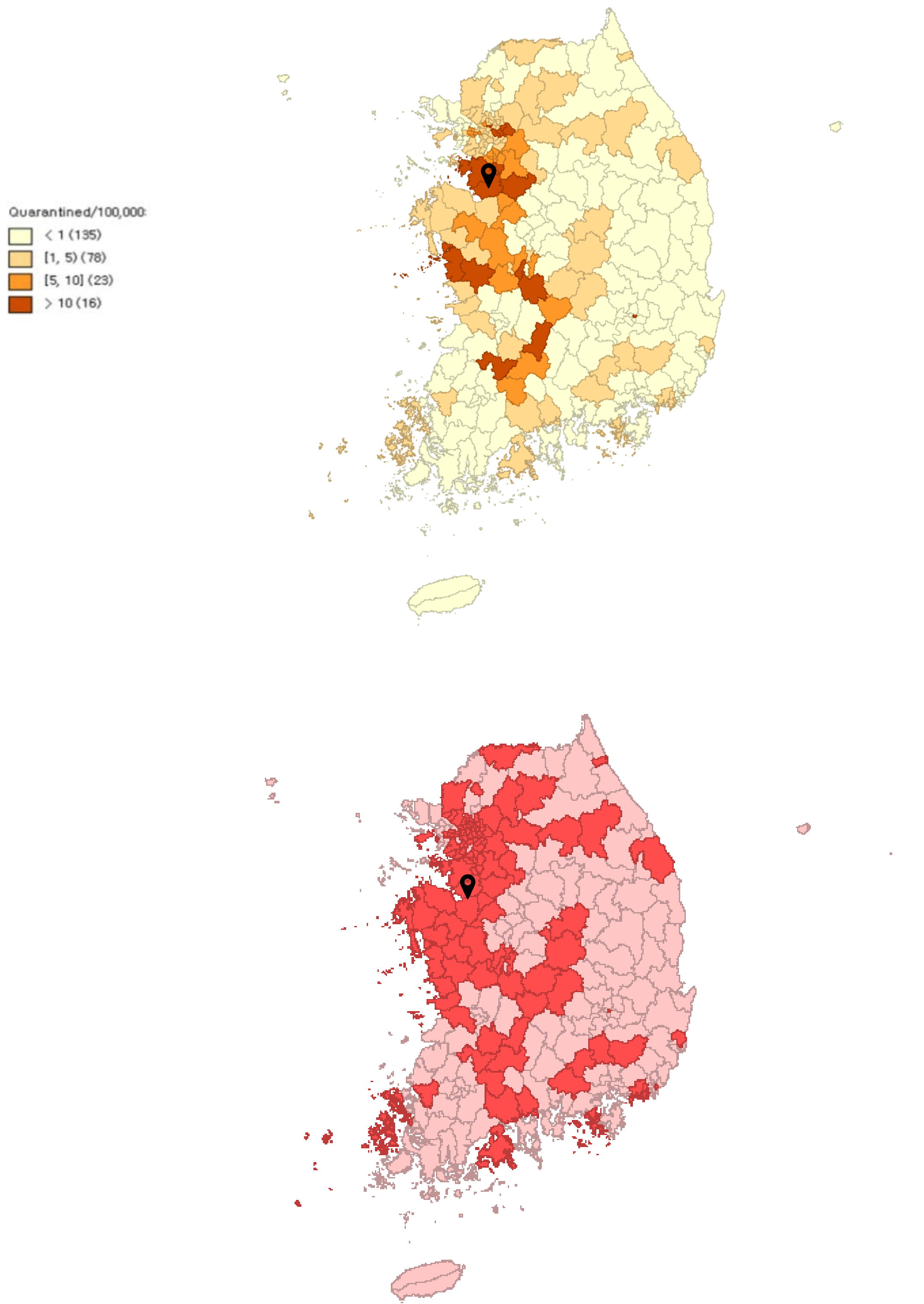

Figure 14. Incidence risks of MERS: The prevalence of the quarantined per 100,000 population (left), and any incidence of quarantine (dark red in the right map), as of 9th June 2015.

denotes the origin (the city of Pyeongtaek).

The instrumental variables procedure in equation (2) predicts the city-level risks ($Incidence_c$) with the distance instrument ($Distance_c$). Given that MERS spreads through close contact between persons, this IV approach assumes that persons residing in cities close to the origin of the epidemic are exposed to higher risks of contagion. Following Chin (2013) and Chin and Willson (2017), my instrument is distances calculated as straight-line distances (miles) between polygon centroids of each city. In addition, to reflect actual time consumed to travel between cities, I use travel time (minutes) by driving as an alternative instrument . I separately estimate my regression model with each instrument and provide the results for comparison.

This procedure would provide the local average treatment effect (LATE) on the coefficient estimate β in the second stage. The underlying assumption is that 1) the distance measure is a statistically strong predictor of disease risks, and 2) conditional on disease risks and included covariates, the distance instrument dose not directly affect individual health behavior.

3.4. <u>Results</u>

The study population, 8,959 persons in 2015, consist of 51% of female, 51% of wage earners, and 68% of married persons (Table XXII). Mean age is 47 and 47% completed secondary schooling. 20% of the study population report they currently smoke and 22% of current smoker ever attempted to quit in the last year. 59% of the sample are current drinkers and 41% of them drink at least once a week. 16% do regular physical activity. Mean number of workouts is 2.7 times per month. 64.1% of all 226 cities have at least one quarantined person and mean city-level quarantined persons is 55.26 per 1 million population.

TABLE XXII

SUMMARY STATISTICS

	Mean (std. dev) / Proportion	Min.	Max.
Outcome variables			
Current smoking	0.205	0	1
Smoking ≥a pack daily	0.048	0	1
Quit attempt	0.046	0	1
Drinking	0.585	0	1
Drinking ≥once a week	0.241	0	1
Attempt to get sober	0.013	0	1
Regular exercise	0.157	0	1
Exercise frequency (# of workouts per month)	2.706 (6.869)	0	30
Exercise ≥an hour at once	0.145	0	1
Independent variables			
Female	0.511	0	1
Age	46.962 (16.305)	18	100
Education attainment			
Primary education or less	0.116	0	1
Secondary education or less	0.415	0	1
At least college attendance	0.469	0	1
Married	0.681	0	1
Adjusted household monthly expenditure (10,000 Won) #	148.874 (71.109)	0	866.025
Wage earner	0.51	0	1
Observations	*8,959*		

monthly expenditure/$\sqrt{number\ of\ household\ members}$

Table XXIII reports the results from first stage regressions. Results show that my instrument has statistically significant associations with the risk measure. A 1-mile increase of distance from the origin predicts a decrease of the prevalence by about 3.6 percentage points. Also, a 1-minute increase of travel time is associated with a reduction in the prevalence by 2.4 percentage points. F-statistics exceed 10 in both regressions.

TABLE XXIII
FIRST STAGE REGRESSION RESULTS

	Dependent variable: $\ln(quarantine\ prevalence)$	
Instrument: Distance (miles) from the origin	-0.035 *** (0.008)	
Instrument: Travel time (minutes) from the origin		-0.024 *** (0.006)
Male	-0.037 *** (0.012)	-0.036 *** (0.012)
Wage earner	0.024 (0.026)	0.013 (0.025)
Married	-0.011 (0.027)	0.0002 (0.028)
Education (ref=less than secondary schooling)		
Secondary education or less	-0.026 (0.049)	-0.001 (0.047)
At least college attendance	-0.016 (0.071)	0.005 (0.068)
F-statistics	18.53	16.63
Observations	*8826*	*8824*

* p<0.1, ** p<0.05, and *** p<0.001.

In Table XXIV, I measure differences in observable characteristics, which are controlled for in my IV regressions, by whether an individual resides on a city that is below or above the median value of the distance measure. Results indicate that there are no statistically significant differences in measure characteristics between the two groups except for educational attainment (difference is marginally significant). This finding provides suggestive evidence that the MERS epidemic and its path spread was quite random and exogenous source of variation.

TABLE XXIV
DIFFERENCES IN OBSERVABLE CHARACTERISTICS BY THE DISTANCE MEASURE

	Distance (miles) from the origin		
	Above the median	Below the median	p-value of difference
Female	0.508	0.515	0.552
Age	46.959	46.967	0.984
Education (ref=less than secondary schooling)			0.056
Secondary education or less	0.414	0.418	
At least college attendance	0.475	0.456	
Married	0.675	0.692	0.109
Adjusted household monthly expenditure (10,000 Won) #	149.650	147.348	0.148
Wage earner	0.447	0.460	0.215
N	*5940*	*3019*	

In Table XXV, I report the reduced form estimates of the associations of the distance measure (miles from origin) with major outcome measures. The associations are significant (except for current smoking) and of plausible magnitude. Persons living in a city close to origin of the epidemic are more likely to engage in healthy behavior. As the IV estimates of the associations of the distance measures with health behavior outcomes equal to the ratio of the association between the risk measure and the outcome to the association of the instrument with the risk measure (Kaestner, Silber, 2010), these findings indicate that the sign of the association between the distance measure (instrument) and outcome measures reported in Table XXVis expected and reasonable.

TABLE XXV
REDUCED FORM ESTIMATES

	Current smoking	Quit attempt	Drinking	Abstaining from alcohol
Distance (100miles) from origin	-0.014 (0.044)	-0.059 * (0.032)	0.178 ** (0.082)	-0.045 ** (0.019)
Travel time (100minutes) from the origin	-0.002 (0.027)	-0.043 * (0.023)	0.109 * (0.058)	-0.034 ** (0.014)

* p<0.1, ** p<0.05, and *** p<0.001.

Individuals who face higher disease risks are significantly more likely to attempt to quit smoking (Table XXVI). IV estimates (column 8 & 9), either instrumented by the distance (miles) or travel time (minutes), show that a doubling of prevalence is associated with an increase in quit attempt by 1.7~1.9 percentage points (37% of the mean). OLS estimate is also positive but not significant (column 7). Also, results reveal that the OLS estimate of the impact of the MERS risk on attempting to quit smoking is biased downward.

Higher level of risks also leads to changes in individual drinking behaviors (Table XXVII). A doubling of the disease risk is associated with a reduction in the probability of drinking by around 5 percentage points (9.3% of the mean). Increases in the disease risks also decrease drinking frequency (the propensity to drink more than once per week), though the association is statistically insignificant.

TABLE XXVI

MERS RISKS AND INDIVIDUAL SMOKING BEHAVIOR

Outcome	Smoking			Smoking intensity (=1 if ≥a pack a day)			Quit attempt		
	OLS	IV_Distance	IV_Travel Time	OLS	IV_Distance	IV_Travel Time	OLS	IV_Distance	IV_Travel Time
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\ln\binom{quarantine}{prevalence}^{\#}$	-0.007	0.004	0.0009	-0.002	-0.002	-0.0009	0.007	0.017 **	0.018 **
	(0.004)	(0.013)	(0.011)	(0.003)	(0.006)	(0.006)	(0.005)	(0.008)	(0.008)
Age groups (ref: <20 years)									
20s	0.152 **	0.153 ***	0.153 ***	0.040 ***	0.040 ***	0.040 ***	0.015 **	0.015 **	0.015 **
	(0.019)	(0.019)	(0.019)	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)
30s	0.298 ***	0.298 ***	0.298 ***	0.095 ***	0.095 ***	0.095 ***	0.051 ***	0.051 ***	0.051 ***
	(0.021)	(0.021)	(0.021)	(0.012)	(0.012)	(0.012)	(0.011)	(0.011)	(0.011)
40s	0.322 ***	0.321 ***	0.321 ***	0.095 ***	0.095 ***	0.095 ***	0.062 ***	0.062 ***	0.062 ***
	(0.019)	(0.019)	(0.019)	(0.011)	(0.011)	(0.011)	(0.013)	(0.013)	(0.013)
50s	0.286 ***	0.286 ***	0.286 ***	0.094 ***	0.094 ***	0.094 ***	0.055 ***	0.055 ***	0.055 ***
	(0.021)	(0.021)	(0.021)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
60s	0.231 ***	0.231 ***	0.231 ***	0.091 ***	0.091 ***	0.091 ***	0.050 ***	0.050 ***	0.050 ***
	(0.024)	(0.024)	(0.024)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
70+	0.151 ***	0.151 ***	0.151 ***	0.037 ***	0.037 ***	0.037 ***	0.027 **	0.027 **	0.027 **
	(0.022)	(0.022)	(0.022)	(0.010)	(0.010)	(0.010)	(0.011)	(0.011)	(0.011)
Male	0.398 ***	0.399 ***	0.399 ***	0.097 ***	0.097 ***	0.097 ***	0.089 ***	0.089 ***	0.089 ***
	(0.010)	(0.010)	(0.010)	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)
Adjusted household monthly expenditure	-0.0001 **	-0.0001 **	-0.0001 **	0.00003	0.00003	0.00003	-0.00004	-0.00004	-0.00004
	(0.00006)	(0.00006)	(0.00006)	(0.00003)	(0.00003)	(0.00003)	(0.00004)	(0.00004)	(0.00004)
Employed	0.029 ***	0.029 ***	0.029 ***	0.0007	0.0007	0.0007	0.008 *	0.008 *	0.008 *
	(0.008)	(0.008)	(0.008)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Self-reported good health	-0.005	-0.005	-0.005	-0.007	-0.007	-0.007	-0.009 *	-0.009 *	-0.009 *
	(0.009)	(0.009)	(0.009)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
Educational attainment (ref: primary schooling or less)									
Secondary schooling	-0.017	-0.017	-0.017	-0.003	-0.003	-0.004	-0.009	-0.009	-0.009
	(0.014)	(0.014)	(0.014)	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)	(0.009)
College attendance	-0.067 ***	-0.067 ***	-0.067 ***	-0.027 ***	-0.027 ***	-0.027 ***	-0.002	-0.002	-0.002
	(0.011)	(0.016)	(0.016)	(0.007)	(0.007)	(0.007)	(0.010)	(0.010)	(0.010)
Married	-0.079 ***	-0.079 ***	-0.079 ***	-0.036 ***	-0.036 ***	-0.036 ***	-0.006	-0.006	-0.006
	(0.011)	(0.011)	(0.011)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
First stage F-stat		18.53	16.63		18.53	16.63		18.53	16.63
Dep. Var. Mean		0.205			0.048			0.046	

* p<0.1, ** p<0.05, and *** p<0.001.

TABLE XXVII
MERS RISKS AND INDIVIDUAL DRINKING BEHAVIOR

Outcome	Drinking			Drinking frequency (=1 if ≥once a wee)			Attempt to stop drinking		
	OLS	IV_Distance	IV_Travel Time	OLS	IV_Distance	IV_Travel Time	OLS	IV_Distance	IV_Travel Time
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\ln\left(\frac{quarantine}{prevalence}\right)^{\#}$	-0.019	-0.051 **	-0.046 **	-0.001	-0.020	-0.015	0.007 **	0.013 ***	0.014 ***
	(0.012)	(0.022)	(0.022)	(0.006)	(0.013)	(0.013)	(0.003)	(0.004)	(0.004)
Age groups (ref: <20 years)									
20s	0.391 ***	0.390 ***	0.390 ***	0.173 ***	0.173 ***	0.173 ***	0.008	0.009	0.009
	(0.033)	(0.033)	(0.033)	(0.022)	(0.022)	(0.022)	(0.006)	(0.006)	(0.006)
30s	0.438 ***	0.438 ***	0.438 ***	0.282 ***	0.282 ***	0.282 ***	0.013 *	0.013 *	0.013 *
	(0.033)	(0.032)	(0.032)	(0.025)	(0.025)	(0.025)	(0.007)	(0.007)	(0.007)
40s	0.395 ***	0.397 ***	0.396 ***	0.288 ***	0.289 ***	0.289 ***	0.011	0.011	0.011
	(0.034)	(0.034)	(0.034)	(0.022)	(0.022)	(0.022)	(0.007)	(0.007)	(0.007)
50s	0.347 ***	0.345 ***	0.345 ***	0.281 ***	0.280 ***	0.280 ***	0.013 *	0.013 *	0.013 *
	(0.034)	(0.033)	(0.033)	(0.023)	(0.023)	(0.023)	(0.008)	(0.008)	(0.008)
60s	0.279 ***	0.279 ***	0.279 ***	0.229 ***	0.230 ***	0.229 ***	0.016 **	0.016 **	0.016 **
	(0.036)	(0.036)	(0.036)	(0.025)	(0.025)	(0.025)	(0.008)	(0.008)	(0.008)
70+	0.148 ***	0.147 ***	0.148 ***	0.176 ***	0.176 ***	0.176 ***	0.007	0.007	0.007
	(0.035)	(0.034)	(0.034)	(0.023)	(0.023)	(0.023)	(0.006)	(0.006)	(0.006)
Male	0.346 ***	0.345 ***	0.345 ***	0.328 ***	0.327 ***	0.328 ***	0.022 ***	0.022 ***	0.022 ***
	(0.016)	(0.016)	(0.016)	(0.010)	(0.010)	(0.010)	(0.004)	(0.004)	(0.004)
Adjusted household monthly expenditure	0.0003 ***	0.0003 ***	0.0003 ***	0.0004 ***	0.0004 ***	0.0004 ***	0.00002	0.00002	0.00002
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.00002)	(0.00002)	(0.00002)
Employed	0.061 ***	0.062 ***	0.062 ***	0.042 ***	0.042 ***	0.042 ***	-0.0004	-0.0005	-0.0005
	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)	(0.003)	(0.003)	(0.003)
Self-reported good health	0.056 ***	0.057 ***	0.057 ***	0.007	0.007	0.007	-0.004	-0.004	-0.004
	(0.013)	(0.013)	(0.013)	(0.010)	(0.010)	(0.010)	(0.003)	(0.003)	(0.003)
Educational attainment (ref: primary schooling or less)									
Secondary schooling	0.026	0.026	0.026	-0.005	-0.004	-0.005	0.002	0.002	0.002
	(0.018)	(0.018)	(0.018)	(0.015)	(0.015)	(0.015)	(0.004)	(0.004)	(0.004)
College attendance	-0.005	-0.003	-0.004	-0.046 **	-0.045 **	-0.045 **	-0.001	-0.002	-0.002
	(0.020)	(0.020)	(0.020)	(0.018)	(0.018)	(0.018)	(0.004)	(0.005)	(0.005)
Married	-0.040 ***	-0.040 ***	-0.039 ***	-0.024 **	-0.024 **	-0.023 **	-0.0006	-0.0007	-0.0007
	(0.014)	(0.014)	(0.014)	(0.011)	(0.011)	(0.011)	(0.004)	(0.004)	(0.004)
First stage F-stat		18.53	16.63		18.51	16.62		18.51	16.62
Observations	*8826*	*8826*	*8824*	*8825*	*8825*	*8823*	*8825*	*8825*	*8823*
Dep. Var. Mean		0.551			0.241			0.013	

* p<0.1, ** p<0.05, and *** p<0.001.

Disease risks do not alter individuals' physical activity patterns (Table XXVIII). Disease risks are not related with the probability of regular exercise, exercise frequency, and the intensity of work-out. Results indicate that individual physical activities are not hindered by the epidemic. Persons might change their location of exercising to avoid contacting with others, though it cannot be tested due to data limitation. Also, together with the impacts of the MERS on smoking and drinking behavior, this finding suggests that the epidemic does not lead to decreases in individual's all social activities.

Subsample analyses presented in Table XXIX show stark disparities in behavioral changes to the epidemic along demographic and socioeconomic characteristics. While the epidemic does not make persons older than 60 years change their smoking and drinking behaviors, younger persons are more likely to do so (Panel A). Especially for those under 40, the epidemic results in more smoking quit attempts (+47.1%) and more attempts to stop drinking (+109.1%). Also, a doubling of the disease risks is associated with a lower probability of drinking (-13.1%). In addition, individuals from households whose monthly expenditures are higher than the median are more likely to attempt to quit smoking (+45.5%) and attempt to stop drinking (+121.4%) than peers from poor households (Panel B). Education gradients are associated with different behavioral responses to the outbreak (Panel C). While less-educated (primary schooling or less) persons are more likely to attempt to quit smoking (+103.2%) without changes in drinking behavior, more educated persons are more likely to change drinking behavior but do not attempt to quit smoking.

TABLE XXVIII

MERS RISKS AND INDIVIDUAL PHYSICAL ACTIVITY

Outcome	Regular exercise			Exercise frequency (# of workouts per month)			Exercise intensity (=1 if ≥an hour at once)		
	OLS	IV_Distance	IV_Travel Time	OLS	IV_Distance	IV_Travel Time	OLS	IV_Distance	IV_Travel Time
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\ln\left(\begin{matrix} quarantine \\ prevalence \end{matrix}\right)^{\#}$	0.003 (0.007)	0.013 (0.014)	0.004 (0.017)	0.058 (0.139)	0.215 (0.302)	0.045 (0.327)	0.002 (0.007)	0.009 (0.013)	0.001 (0.015)
Age groups (ref: <20 years)									
20s	0.045 ** (0.019)	0.046** (0.019)	0.045 ** (0.019)	0.922 *** (0.341)	0.928 *** (0.340)	0.921 *** (0.340)	0.043 ** (0.018)	0.043 ** (0.018)	0.043 ** (0.018)
30s	0.098 *** (0.022)	0.098 *** (0.022)	0.098 *** (0.022)	1.679 *** (0.393)	1.677 *** (0.392)	1.685 *** (0.392)	0.083 *** (0.020)	0.083 *** (0.020)	0.084 *** (0.020)
40s	0.121 *** (0.022)	0.120 *** (0.022)	0.121 *** (0.022)	2.065 *** (0.416)	2.059 *** (0.414)	2.074 *** (0.414)	0.111 *** (0.021)	0.111 *** (0.020)	0.111 *** (0.020)
50s	0.154 *** (0.023)	0.155 *** (0.023)	0.154 *** (0.023)	2.641 *** (0.439)	2.650 *** (0.439)	2.651 *** (0.439)	0.142 *** (0.022)	0.142 *** (0.022)	0.142 *** (0.022)
60s	0.216 *** (0.026)	0.216 *** (0.026)	0.216 *** (0.026)	4.227 *** (0.499)	4.224 *** (0.498)	4.243 *** (0.497)	0.194 *** (0.024)	0.194 *** (0.024)	0.195 *** (0.024)
70+	0.232 *** (0.031)	0.232 *** (0.031)	0.232 *** (0.031)	4.641 *** (0.612)	4.645 *** (0.611)	4.633 *** (0.611)	0.204 *** (0.029)	0.204 *** (0.029)	0.204 *** (0.029)
Male	0.015 ** (0.008)	0.015 ** (0.007)	0.015 ** (0.008)	0.177 (0.143)	0.182 (0.143)	0.167 (0.143)	0.015 ** (0.007)	0.015 ** (0.007)	0.015 ** (0.007)
Adjusted household monthly expenditure	0.0008 *** (0.0001)	0.0008 *** (0.0001)	0.0008 *** (0.0001)	0.014 *** (0.002)	0.014 *** (0.002)	0.014 *** (0.002)	0.0008 *** (0.0001)	0.0008 *** (0.0001)	0.0008 *** (0.0001)
Employed	-0.019 ** (0.009)	-0.019 ** (0.009)	-0.019 ** (0.009)	-0.701 *** (0.172)	-0.703 *** (0.172)	-0.700 *** (0.172)	-0.018 ** (0.009)	-0.018 ** (0.009)	-0.018 ** (0.009)
Self-reported good health	0.039 *** (0.012)	0.039 *** (0.012)	0.039 *** (0.012)	0.697 *** (0.209)	0.696 *** (0.208)	0.701 *** (0.208)	0.035 *** (0.011)	0.035 *** (0.011)	0.035 *** (0.011)
Educational attainment (ref: primary schooling or less)									
Secondary schooling	0.073 *** (0.017)	0.073 *** (0.017)	0.073 *** (0.017)	1.383 *** (0.360)	1.381 *** (0.358)	1.403 *** (0.358)	0.080 *** (0.016)	0.080 *** (0.016)	0.081 *** (0.016)
College attendance	0.127 *** (0.020)	0.126 *** (0.020)	0.127 *** (0.020)	2.182 *** (0.407)	2.175 *** (0.405)	2.204 *** (0.403)	0.129 *** (0.020)	0.129 *** (0.019)	0.130 *** (0.019)
Married	0.008 (0.010)	0.008 (0.010)	0.008 (0.010)	0.144 (0.196)	0.142 (0.195)	0.135 (0.196)	0.014 (0.010)	0.014 (0.010)	0.013 (0.010)
First stage F-stat		18.53	16.63		18.53	16.63		18.53	16.63
Observations	*8826*	*8826*	*8824*	*8826*	*8826*	*8824*	*8826*	*8826*	*8824*
Dep. Var. Mean	0.157			2.706			0.145		

* p<0.1, ** p<0.05, and *** p<0.001.

TABLE XXIX
SUBSAMPLE ANALYSIS

	Attempt to quit smoking	Drinking	Attempt to stop drinking
Panel A. Age			
Under 40	0.016 **	-0.085 ***	0.012 ***
	(0.008)	(0.026)	(0.004)
First-stage F stat	19.52	19.52	19.47
Dep. Var. Mean	0.034	0.647	0.011
Observations	*3143*	*3143*	*3142*
40~59	0.015	-0.031	0.017 ***
	(0.012)	(0.025)	(0.005)
First-stage F stat	15.53	15.53	15.53
Dep. Var. Mean	0.058	0.628	0.014
Observations	*3694*	*3694*	*3694*
Over 60	0.022	-0.024	0.006
	(0.013)	(0.035)	(0.005)
First-stage F stat	21.78	21.78	21.78
Dep. Var. Mean	0.041	0.393	0.013
Observations	*1831*	*1831*	*1831*
Panel B. Household expenditures			
Lower than median	0.013	-0.049 *	0.006
	(0.009)	(0.027)	(0.005)
First-stage F stat	16.81	16.81	16.81
Dep. Var. Mean	0.049	0.517	0.011
Observations	*3403*	*3403*	*3403*
Higher than median	0.020 **	-0.053 **	0.017 ***
	(0.009)	(0.024)	(0.004)
First-stage F stat	18.77	18.77	18.74
Dep. Var. Mean	0.044	0.627	0.014
Observations	*5423*	*5423*	*5422*
Panel C. Education			
Primary schooling or less	0.032 **	-0.024	-0.002
	(0.013)	(0.035)	(0.004)
First-stage F stat	16.63	16.63	16.63
Dep. Var. Mean	0.031	0.333	0.008
Observations	*1014*	*1014*	*1014*
Secondary schooling or less	0.012	-0.056 **	0.013 ***
	(0.009)	(0.025)	(0.004)
First-stage F stat	16.48	16.48	16.48
Dep. Var. Mean	0.044	0.577	0.015
Observations	*3662*	*3662*	*3662*
At least college attendance	0.017	-0.057 **	0.016 **
	(0.011)	(0.026)	(0.006)
First-stage F stat	19.89	19.89	19.84
Dep. Var. Mean	0.051	0.653	0.013
Observations	*4150*	*4150*	*4149*
Panel D. Gender			
Male	0.030 **	-0.020	0.022 ***
	(0.015)	(0.017)	(0.008)
First-stage F stat	20.38	20.38	20.38
Dep. Var. Mean	0.091	0.773	0.023
Observations	*4319*	*4319*	*4319*
Female	0.004 *	-0.079 **	0.004 *
	(0.002)	(0.033)	(0.002)
First-stage F stat	16.71	16.71	16.68
Dep. Var. Mean	0.002	0.404	0.003
Observations	4507	*4507*	*4506*

* p<0.1, ** p<0.05, and *** p<0.001.

Results in Table XXX indicate that the impacts of the epidemic on behavioral changes are not primarily driven by income effects. Both adjusted household expenditures and the probability of being employed (wage-earning job) are not statistically associated with disease risks. These insignificant associations suggest that the behavioral responses to the epidemic are the outcome of changes in the perceived risks of the disease and expected benefits of health investments.

There are potential mechanisms contributing to the disparities in the effects on health investments. They might have less time to learn the latest information on healthcare technologies or might have lower ability to understand it. A review of evidence of socioeconomic disparities in risky behaviors points out that less educated persons are less likely to be motivated to adopt healthy behaviors because they are exposed less often to information on harms of risky behaviors and they have fewer learning opportunities (Pampel et al., 2010). In addition, low-wage workers would face a time barrier, despite their greater needs, because of low autonomy over their work and working time arrangements (for instance, part-time or temporary workers) (Stiehl et al., 2017).

TABLE XXX

MERS RISKS AND EMPLOYMENT STATUS AND WEALTH

	Wage earning	Adjusted household monthly expenditure $^{\$}$
Panel A. IV regression (instrument: distance (miles) from the origin)		
$\ln(quarantine\ prevalence)^{\#}$	-0.010 (0.014)	1.934 (2.736)
First stage F-stat	25.05	25.05
Observations	*8832*	*8832*
Panel B. OLS regression		
$\ln(quarantine\ prevalence)$	0.003 (0.005)	0.788 (1.362)
Observations	*8832*	*8832*
Dep. Var. Mean	0.451	148.874

* p<0.1, ** p<0.05, and *** p<0.001.

Peer affluence is often cited as a source of socioeconomic disparities in health investments (Pampel et al., 2010). More socialized persons have better opportunities to learn from peers about reliable information on local risks of the epidemic. A study of the negative impacts on healthcare utilization of the SARS epidemic in Taiwan finds that social interactions magnify the personal responses to the shock (Bennet et al., 2015).

First, this study investigates the disproportionate health impacts of the MERS epidemic on workers classified by contractual arrangement (temporary vs. regular position), existence of labor union (non-union vs. union company), and self-rated job stability (unstable vs. stable). Table XXXI reveals evidence suggesting that MERS significantly increases attempts to quit smoking and stop drinking among all worker groups – the effects on attempting to quit smoking are higher than peers for permanent employees, workers at union companies, or workers who consider their position stable.

However, workers in precarious employment are in fact more likely to stop, not just try to do, risky behaviors. The effects of exposure to MERS on the prevalence of smoking are statistically significant for temporary or unstable employees. On the contrary, exposure to the epidemic is found to be positively associated with the propensity to smoke among peer workers whose positions are rather stable, though coefficient estimates are insignificant at a traditional level of threshold. In addition, the effects on the prevalence of drinking are significant for temporary employees (-17.4%), workers at non-union companies (-7.2%), or workers how consider their position unstable (-15.4%), whereas the impacts on the likelihood of drinking among peer workers are insignificant.

TABLE XXXI

MERS, PRECARIOUS EMPLOYMENT, AND HEALTH BEHAVIOR

	Attempt to quit smoking	Attempt to stop drinking	Smoking	Drinking
Panel A. Contractual arrangement				
Temporary position	0.016 (0.011)	0.014 * (0.008)	-0.039 ** (0.016)	-0.104 *** (0.027)
First-stage F stat	16.90	16.90	16.90	16.90
Dep. Var. Mean	0.052	0.024	0.248	0.598
Observations	*1345*	*1345*	*1345*	*1345*
Regular position	0.037 ** (0.017)	0.019 *** (0.006)	0.042 * (0.022)	0.0007 (0.022)
First-stage F stat	19.20	19.20	19.20	19.20
Dep. Var. Mean	0.076	0.018	0.290	0.744
Observations	*2579*	*2579*	*2579*	*2579*
Panel B. Existence of labor union				
Non-union company	0.024 ** (0.012)	0.016 *** (0.005)	-0.0002 (0.016)	-0.049 ** (0.020)
First-stage F stat	18.94	18.94	18.94	18.94
Dep. Var. Mean	0.068	0.014	0.279	0.678
Observations	*3202*	*3202*	*3202*	*3202*
Union company	0.057 *** (0.018)	0.031 ** (0.012)	0.049 (0.032)	-0.034 (0.044)
First-stage F stat	14.29	14.29	14.29	14.29
Dep. Var. Mean	0.065	0.016	0.258	0.749
Observations	*722*	*722*	*722*	*722*
Panel C. Self-rated job stability				
Unstable	0.017 (0.016)	0.028 *** (0.009)	-0.060 ** (0.023)	-0.090 *** (0.034)
First-stage F stat	15.64	15.64	15.64	15.64
Dep. Var. Mean	0.051	0.012	0.257	0.586
Observations	*703*	*703*	*703*	*703*
Stable	0.032 ** (0.014)	0.015 *** (0.006)	0.024 (0.018)	-0.033 (0.022)
First-stage F stat	19.08	19.08	19.08	19.08
Dep. Var. Mean	0.071	0.015	0.278	0.715
Observations	*3221*	*3221*	*3221*	*3221*

* p<0.1, ** p<0.05, and *** p<0.001.

Table XXXII shows how social interactions change the impacts of exposure to MERS on investments in health. Compared to recent arrivals, who moved in during the past two years, non-movers are significantly more likely to change their risky health behaviors (Panel A). Exposure to MERS increases longtime residents' propensity to attempt to quit smoking by 1.9 percentage points, propensity to attempt to stop drinking by 1.3 percentage points, and likelihood of drinking by 4.8 percentage points, whereas the effects on movers are never significant. Persons who have satisfactory social relationships are more likely than those not satisfied with their relationships to make a quit attempt, though the impacts of MERS on drinking behaviors are not different between two groups.

3.5. <u>Discussion</u>

This study adds robust evidence to the health economics and policy literature on the relationship between individual behavioral changes and external health shocks. To my best knowledge, this study is the first to reveal that a disease outbreak leads to changes in general health behavior, which is not directly linked to the epidemic. Previous studies have focused on associations of disease outbreaks with vaccination decisions (Schaller et al., 2017; Oster, 2018), the fertility response (Chin and Wilson, 2017), or domestic violence (Chin, 2013). The impacts of the epidemic on health behavior indicate that the MERS epidemic itself acted as a motivator to promote health behavior at individual level. This motivation effect is even stronger for workers with unstable jobs, who are generally not responsive to health promotion campaigns (Stiehl et al., 2017).

Taken together, this study finds sizable protective effects of exposure to the MERS epidemic. I find evidence suggesting that individuals facing higher disease risks invest more in health capital by reducing consumption of harmful products (cigarettes and alcohol). The results that both household expenditures and the probability of being employed are not statistically associated with disease risks suggest that the behavioral responses reported hear are not primarily driven by income effects but by changes in the perceived risks of the disease and expected benefits of health investment.

TABLE XXXII
MERS, SOCIAL INTERACTIONS, AND HEALTH BEHAVIOR

	Attempt to quit smoking	Attempt to stop drinking	Smoking	Drinking
Panel A. Movers vs. non-movers				
Recent arrivals	-0.004 (0.028)	0.005 (0.014)	-0.016 (0.040)	-0.057 (0.052)
First-stage F stat	19.10	19.10	19.10	19.10
Dep. Var. Mean	0.051	0.018	0.204	0.613
Observations	*669*	*669*	*669*	*669*
Longtime residents	0.019 ** (0.008)	0.013 *** (0.004)	0.007 (0.014)	-0.048 ** (0.023)
First-stage F stat	17.63	17.62	17.63	17.63
Dep. Var. Mean	0.045	0.012	0.205	0.582
Observations	*8157*	*8156*	*8157*	*8157*
Panel B. Satisfaction of social relationships				
Normal/dissatisfied/very dissatisfied	0.008 (0.009)	0.014 ** (0.006)	-0.020 (0.013)	-0.046 * (0.024)
First-stage F stat	18.47	18.47	18.47	18.47
Dep. Var. Mean	0.043	0.012	0.223	0.564
Observations	*4405*	*4405*	*4405*	*4405*
Very satisfied/satisfied	0.023 ** (0.010)	0.012 *** (0.003)	0.026 (0.016)	-0.052 * (0.027)
First-stage F stat	17.19	17.19	17.19	17.19
Dep. Var. Mean	0.048	0.013	0.186	0.604
Observations	*4386*	*4386*	*4386*	*4386*

* p<0.1, ** p<0.05, and *** p<0.001.

This finding is closely related to Di Novi's (2010) results that negative external health shocks (traffic pollution) affect individual health-improving lifestyle choices. On the other hand, the positive impacts on risky health behaviors is inconsistent with Hanaoka et al's (2015) finding that individuals living in the worst-hit regions by a natural disaster engage in more risky behaviors. This can be due to the difference between disease epidemics and natural disasters. In contrast to the MERS epidemic (38 deaths), the Japanese earthquake caused substantial psychosocial stress due to massive casualties (around 16,000 deaths) and loss of property and social capital, meaning that it can be less difficult for people to survive an epidemic because society likely continues to function. This finding suggests that individual behavioral responses are not necessarily identical to different external shocks.

The minuscule impact on physical activity of the MERS epidemic, together with the positive impacts on risky health behavior suggests that, when exposed to disease epidemics, individuals are more likely to be willing to give up consuming harmful products but not willing to invest additional time on physical activity to stay healthy. One of possible explanations is that it can be due to the difference in the expected benefits and costs of health investment (Schaller et al., 2017; Oster, 2018); persons might think that the benefits of physical activity tend to appear in more distal future than the benefits of reducing harmful behavior. Also, individuals might expect that the costs of giving up harmful products, mostly disutility from mental distress, are lower than the costs of increasing physical activity (additional time and monetary costs).

The results of this study advocate improved risk communications policy for the public. The Korean government was criticized for not fully releasing updated epidemiologic information on the epidemic to the public and for closing schools without relevant scientific evidence on the massive person-to-person transmission (WHO, 2015). This study's findings suggest that, in contrast to the government's fear of the chaos, keeping persons updated appropriately on real risks leads to rational individual reactions.

My findings support the government's active role in informing its citizens of the severity of the threat for three reasons. First, persons should decide how much and which kind of protective actions (avoidance or more investments in health) will be taken, but the scarcity of information about the external shock would hinder this action (Bennet et al., 2015). Second, given the disparities in health investments along socioeconomic dimensions, the authority should help disadvantaged groups access to clear information on the threat and proper protective actions.

Two mechanisms may explanation sharply distinct results for age groups. Becker's (2007) lifetime utility framework predicts that health shocks are believed to increase individual's perceived survival probability because people who know that their longevity is longer than others have more incentive to invest in health for surviving longer periods. In a similar manner, this study finds that the MERS epidemic motivates more advantaged or young individuals, who have higher expected lifetime utility than older or poor individuals, to stop drinking and attempt to quit smoking. In addition, findings that socially active individuals are more likely to change health behavior suggest that differences in access to risk information cause disparities in health investment. These findings provide an important implication for health policy that the government should focus on promoting health among the vulnerable population to narrow the gap in health investment.

As other factors, such as time preferences, peer effects, or risk aversion, also may affect risky behaviors (Bennet et al., 2015; Hanaoka et al., 2015), the underlying mechanism of the findings of this study should be further investigated. For instance, underinvestment among the old can be explained by their changed beliefs about expected losses and the risks of contracting diseases (Brown et al., 2018), though this study cannot test it due to data limitation. If newer data sets are supplemented later, future research will be able to check whether the effects on individual health behavior last long. Also, investigating the effects on preventive health services such as cancer screening and vaccination would provide valuable insights.

CITED LITERATURE

Acquah JK, Dahal R, Sloan FA. 2017. 1918 Influenza Pandemic: In utero exposure in the United States and long-term impact on hospitalizations. American Journal of Public Health. DOI: 10.2105/AJPH.2017.303887

Agüero JM, Beleche T. 2017. Health shocks and their long-lasting impact on health behaviors: Evidence from the 2009 H1N1 pandemic in Mexico. Journal of Health Economics 54:40-55. DOI: 10.1016/j.jhealeco.2017.03.008

Almond D. 2006. Is the 1918 Influenza Pandemic over? Long-term effects of in utero influenza exposure in the post-1940 U.S. population. Journal of Political Economy 114(4):672-712. DOI: 10.1086/507154

Altindag DT, Baek D, Mocan N. 2017. Chinese Yellow Dust and Korean infant health. Social Science & Medicine 186:78-86. DOI: 10.1016/j.socscimed.2017.05.031

Becker GS. 2007. Health as human capital: Synthesis and extensions. Oxford Economic Papers 59:379-410. DOI: 10.1093/oep/gpm020

Bennet D, Chiang CF, Malani A. 2015. Learning during a crisis: The SARS epidemic in Taiwan. Journal of Development Economics 112: 1-18. DOI: 10.1016/j.jdeveco.2014.09.006

Brown P, Daigneault A, Tjernström E, Zou W. 2018. Natural disasters, social protection, and risk perceptions. World Development 104: 310-325. DOI: 10.1016/j.worlddev.2017.12.002

Case A, Paxson C. 2011. The impact of the AIDS pandemic on health services in Africa: Evidence from Demographic and Health Surveys. Demography 48:675–697. DOI: 10.1007/s13524-011-0026-3

Chin YM. 2013. Does HIV increase the risk of spousal violence in sub-Saharan Africa? Journal of Health Economics 32:997-1006. DOI: 10.1016/j.jhealeco.2013.07.005

Chin YM, Wilson N. 2017. Disease risk and fertility: evidence from the HIV/AIDS pandemic. Journal of Population Economics. DOI: 10.1007/s00148-017-0669-5

Currie J, Vogl T. 2013. Early-life health and adult circumstance in developing countries. Annual Review of Economics 5:1-36. DOI: 10.1146/annurev-economics-081412-103704

Di Novi C. 2010. The influence of traffic-related pollution on individuals' life-style: Results from the BRFSS. Health Economics 19:1318-1344. DOI: 10.1002/hec.1550

Fichera E, Gray, Sutton M. 2016. How do individuals' health behaviours respond to an increase in the supply of health care? Evidence from a natural experiment. Social Science & Medicine 159:170-179. DOI: 10.1016/j.socscimed.2016.05.005

Frankenberg E, Thomas D. 2017. Human capital and shocks: Evidence on education, health and nutrition. NBER working paper No. 23347. DOI: 10.3386/w23347

Gizelis TI, Karim S, Østby G, Urdal H. 2017. Maternal health care in the time of Ebola: A mixed-method exploration of the impact of the epidemic on delivery services in Monrovia. World Development 98:169-178. DOI: 10.1016/j.worlddev.2017.04.027

Hanaoka C, Shigeoka H, Watanabe Y. 2015. Do risk preferences change? Evidence from panel data before and after the Great East Japan Earthquake. NBER Working Paper No.21400. DOI: 10.3386/w21400

Jung H, Park M, Hong K, Hyun E. 2016. The impact of epidemic outbreak on consumer expenditures: An empirical assessment for MERS Korea. Sustainability 8:454. DOI: 10.3390/su8050454

Kaestner R, Silber JH. 2010. Evidence on the efficacy of inpatient spending on Medicare patients. The Milbank Quarterly 88: 560-594. DOI: 10.1111/j.1468-0009.2010.00612.x

Karlsson M, Nilsson T, Pichler S. 2014. The impact of the 1918 Spanish flu epidemic on economic performance in Sweden: An investigation into the consequences of an extraordinary mortality shock. Journal of Health Economics 36: 1-19. DOI: 10.1016/j.jhealeco.2014.03.005

Kelly E. 2011. The scourge of Asian Flu: In utero exposure to pandemic influenza and the development of a cohort of British children. The Journal of Human Resources 46: 669-694. DOI: 10.3368/jhr.46.4.669

Lee A, Cho J. 2016. The impact of epidemics on labor market: Identifying victims of the Middle East Respiratory Syndrome in the Korean labor market. International Journal for Equity in Health 15:196. DOI: 10.1186/s12939-016-0483-9

Margolis J, Hockenberry J, Grossman M, Chou SY. 2014. Moral hazard and less invasive medical treatment for coronary artery disease: The case of cigarette smoking. NBER Working Paper No. 20373. DOI: 10.3386/w20373

Marsaudon A, Rochaix L. 2017. Impact of acute health shocks on cigarette consumption: A combined DiD-matching strategy to address endogeneity issues in the French Gazel panel data. PSE Working Paper 2017-47. Retrieved May 12, 2019, from https://halshs.archives-ouvertes.fr/halshs-01626187

Ministry of Health and Welfare. 2016. The 2015 MERS outbreak in the Republic of Korea: Learning from MERS. Retrieved May 12, 2019, from http://cdc.go.kr/CDC/cms/content/mobile/39/70039_view.html [Korean]

Neelsen S, Stratmann T. 2012. Long-run effects of fetal influenza exposure: Evidence from Switzerland. Social Science & Medicine 74:58-66. DOI: 10.1016/j.socscimed.2011.09.039

Neidell M. 2009. Information, avoidance behavior, and health: The effect of Ozone on asthma hospitalization. Journal of Human Resources 44(2):450-478. DOI: 10.3368/jhr.44.2.450

Ogasawara K. 2017. Persistence of pandemic influenza on the development of children: Evidence from industrializing Japan. Social Science & Medicine 181:43-53. DOI: 10.1016/j.socscimed.2017.03.023

Oster E. 2018. Does disease cause vaccination? Disease outbreaks and vaccination response. Journal of Health Economics 57: 90-101. DOI: 10.1016/j.jhealeco.2017.10.003

Pampel FC, Krueger PM, Denney JT. 2010. Socioeconomic disparities in health behaviors. Annual Review of Sociology 36: 349-370. DOI: 10.1146/annurev.soc.012809.102529

Raw M, McNeill A, West R. 1998. Smoking cessation guidelines for health professionals – A guide to effective smoking cessation interventions for the health care system. Thorax 53: S1-S18. DOI: 10.1136/thx.53.2008.S1

Rubin GJ, Amlot R, Page L, Wessely S. 2009. Public perceptions, anxiety, and behaviour change in relation to the swine flu outbreak: Cross sectional telephone survey. BMJ 339:b2651. DOI: 10.1136/bmj.b2651

Schaller J, Schulkind L, Shapiro TM. 2017. The effects of perceived disease risk and access costs on infant immunization. NBER working paper 23923. DOI: 10.3386/w23923

Smith VK, Taylor DH, Sloan FA, Johnson R, Desvousges WH. 2001. Do smokers respond to health shocks? The Review of Economics and Statistics 83:675-687. DOI: 10.1162/003465301753237759

Smith VK. 2008. Risk perceptions, optimism, and natural hazards. Risk Analysis 28:1763-1767. DOI: 10.1111/j.1539-6924.2008.00880.x

Stiehl E, Shivaprakash N, Thatcher E, Ornelas IJ, Kneipp S, Baron SL, Muramatsu N. 2017. Worksite health promotion for low-wage workers: A scoping literature review. American Journal of Health Promotion 32: 359-373. DOI: 10.1177/0890117117728607

World Health Organization (WHO). 2015. WHO statement on the ninth meeting of the IHR Emergency Committee regarding MERS-CoV. Retrieved May 12, 2019, from http://www.who.int/mediacentre/news/statements/2015/ihr-ec-mers/en/

APPENDICES

APPENDIX A

TABLE XXXIII

THE TOP 10 HEALTH CONDITIONS WITH HIGHEST AVERAGE ANNUAL OOP HEALTH SPENDING, 2012 (US$)

	Total cost	Statutory copayment	Expenditures for uncovered services	Total OOP
Leukemia	19,220.81	2,729.35	1,556.89	4,286.24
Lymphoma	13,186.61	1,687.89	870.32	2,558.20
Brain tumor	7,698.18	1,855.26	669.74	2,525.00
Pancreatic cancer	7,907.17	1,994.60	530.31	2,524.91
Liver cancer	7,438.81	1,859.70	453.77	2,313.47
Lung cancer	8,289.19	1,599.81	5,22.22	2,122.03
Esophageal cancer	7,397.30	1,517.96	348.02	1,865.99
Renal failure	10,814.44	681.31	1,157.15	1,838.46
Non-Hodgkin's lymphoma	8,052.82	1,167.66	491.22	1,658.88
HIV/AIDS	9,918.13	158.69	991.81	1,150.50

APPENDIX B

TABLE XXXIV
REGRESSION MODELS INCLUDING PROVINCE-SPECIFIC LINEAR TRENDS

	Current smoking	Quit attempt (among current smokers)	Smoking intensity (fraction among current smokers)		
			40 or more cigarettes per day	20~39 cigarettes per day	19 or fewer cigarettes per day
Outdoor smoking ban	0.007	0.054 **	-0.004	-0.026	0.030
	(0.005)	(0.021)	(0.004)	(0.020)	(0.020)
Yearly earnings (1 million won)	3.820***	-2.920	1.260	-7.800	-4.810
	(1.280)	(2.820)	(9.530)	(1.930)	(2.080)
GRDP per capita (1 million won)	-0.00005	-0.013 ***	-0.002	0.001	0.0001
	(0.001)	(0.005)	(0.001)	(0.006)	(0.006)
Year (ref=2009)					
2010	0.008 *	0.009	-0.004	-0.011	0.015
	(0.004)	(0.021)	(0.004)	(0.018)	(0.018)
2011	0.010 **	0.010	0.002	-0.010	0.008
	(0.004)	(0.018)	(0.004)	(0.018)	(0.018)
2012	0.005	-0.006	-0.002	0.031	-0.029
	(0.004)	(0.019)	(0.003)	(0.019)	(0.019)
2013	0.002	-0.028 *	0.0002	0.006	-0.006
	(0.003)	(0.015)	(0.003)	(0.014)	(0.015)
2014	0.009	-0.055 ***	0.002	0.025 ***	-0.027 ***
	(0.002)	(0.012)	(0.002)	(0.009)	(0.010)
2015	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)
Province (ref=Seoul) * linear time					
Busan * linear time	-0.003	-0.037 **	-0.002	0.025 **	-0.024 *
	(0.003)	(0.017)	(0.002)	(0.012)	(0.012)
Daegu * linear time	-0.005 **	-0.057 ***	0.002	0.019	-0.021 *
	(0.002)	(0.016)	(0.003)	(0.012)	(0.011)
Daejeon * linear time	0.001	-0.027 *	-0.002	0.004	-0.011
	(0.003)	(0.015)	(0.003)	(0.012)	(0.010)
Incheon * linear time	-0.007 **	-0.071 ***	-0.0005	0.020	-0.019
	(0.003)	(0.019)	(0.005)	(0.016)	(0.017)
Gwangju * linear time	-0.004	-0.051 ***	0.002	-0.015	0.013
	(0.003)	(0.016)	(0.008)	(0.013)	(0.010)
Woolsan * linear time	0.003	-0.058 **	0.0006	0.085 ***	-0.086 ***
	(0.009)	(0.023)	(0.002)	(0.031)	(0.031)
Gyeonggi * linear time	-0.004 *	-0.042 ***	-0.001	0.011	-0.010
	(0.002)	(0.015)	(0.001)	(0.010)	(0.010)
Gangwon * linear time	-0.005	-0.034 **	-0.001	0.014	-0.013
	(0.005)	(0.014)	(0.002)	(0.010)	(0.010)
Choongbook * linear time	0.001	-0.055 ***	-0.003	-0.017	0.020 *
	(0.004)	(0.016)	(0.005)	(0.013)	(0.010)
Choongnam * linear time	-0.003	-0.062 ***	-0.0007	0.010	-0.009
	(0.003)	(0.016)	(0.003)	(0.014)	(0.015)
Jeonbook * linear time	-0.002	-0.012	0.005	0.013	-0.019
	(0.002)	(0.017)	(0.006)	(0.016)	(0.016)
Jeonnam * linear time	-0.005 **	-0.049 ***	-0.013	0.036 **	-0.023 *
	(0.003)	(0.017)	(0.010)	(0.014)	(0.012)
Gyeongbook * linear time	0.002	-0.048 ***	-0.002	0.035	-0.033
	(0.002)	(0.017)	(0.003)	(0.022)	(0.021)
Gyeongnam * linear time	-0.006	-0.029	0.002	0.008	-0.010
	(0.005)	(0.019)	(0.002)	(0.013)	(0.013)
Jeju * linear time	-0.013	-0.004	0.0007	-0.013	0.012
	(0.010)	(0.013)	(0.002)	(0.015)	(0.015)
Constant	15.627 ***	2.583	-0.336	24.744	-23.408
	(4.042)	(15.338)	(4.153)	(17.103)	(18.258)
Observations	*62400*	*14217*	*14217*	*14217*	*14217*
Baseline outcome means	0.246	0.294	0.023	0.318	0.659

*, **, ***: Significant at 0.1, 0.05, 0.01 respectively.

VITA

NAME:	Hansoo Ko
EDUCATION:	MD, Medicine, Chung-Ang University, 2008
	MPH, Health Management & Policy, Seoul National University, 2012
	PhD, Health Policy & Administration, University of Illinois at Chicago, 2019
TEACHING:	Teaching Assistant: Division of Health Policy & Administration, University of Illinois at Chicago, 2014-2016
WORK EXPERIENCE:	Research Assistant, Division of Health Policy & Administration, University of Illinois at Chicago, 2014-2019
	Co-Principal Investigator, Evaluation of the Health for All project in Paraguay, funded by WHO PAHO, 2017-2019
PROFESSIONAL MEMBERSHIP:	Association for Public Policy & Management American Public Health Association
PUBLICATIONS:	Ko H. 2019. Offsetting effects of outpatient cost-sharing for the poor in Korea. Medical Care (In Press)
	Ko H. 2019. Intergenerational effects of old-age pension on children's health and wellbeing. International Journal of Health Planning and Management 34: e1208-e1214.
	Ko H, Kim H, Yoon CG, Kim CY. 2018. Social capital as a key determinant of willingness to join community-based health insurance: Household survey in Nepal. Public Health 160:52-61.
	Ko H. 2016. Unmet Healthcare needs and health status: panel evidence from Korea. Health Policy 120(6):646-53.