2017 APRIA Presentation, Poznan, Poland

Do High Risk and Drunk Drivers Purchase More Coverage?
- Evidence of Adverse Selection and Moral Hazard from the Korean Auto Insurance Market-

2017. June.

Yeon Hur, Ph.D.

Professor

College of Business and Economics

Chung-Ang University

Seoul, Korea

Working Paper

yeonhur@cau.ac.kr

Do High Risk and Drunk Drivers Purchase More Coverage? Evidence of Adverse Selection and Moral Hazard from the Korean Auto Insurance Market.

[ABSTRACT]

This study tests whether adverse selection and moral hazard exist in the Korean auto insurance market where a tight regulation is exercised, most policy forms are standardized, and all policyholder's experience is shared by all market participants. The results from the previous study, however, are mixed and depend on the unique condition of market they analyzed. The sample data set includes standard or ordinary drivers group, drunk drivers group, and drivers in the high risk pool with detail insurance coverage data. In addition, we merged the auto insurance data two additional supplementary insurance coverage information such as the long-term driver protection coverage and the supplementary health insurance coverage to trace how they changed their behavior after they are insured or experienced auto accidents.

In the analysis we could not verify that adverse selection problem exist in the current auto insurance scheme. However, an insured who purchased additional long-term insurance and supplementary health insurance coverage in previous year has more likelihood to experience auto accident(s) next year, which verifies that adverse selection problem exists where there is no underwriting is required. Also, we figure out that if policyholders are covered more in terms of coverage limits and the number of coverage they purchased, then they have a higher probability of auto accident in coming year because they become indifferent or less cautious to possible losses after they purchase larger coverage. Therefore, we have *ex-ante* as well as *ex-post* moral hazard in the Korean auto insurance market.

I. Introduction

Since the introduction of adverse selection theory by Rothchild and Stiglitz(1976)[1] and the theory of moral hazard by Arnott and Stiglitz(1988)[2], the subjects of adverse selection and moral hazard in a competitive insurance market have been well tested with various data and models until recently. Previous empirical studies have tested the relationship between risk and insurance coverage to see whether these two market problems exist in various insurance lines. Most of the studies focusing on auto insurance analyzed the relationship between the amount

[1] Rothchild, M. and J. Stiglitz, 1976, Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information, *Quarterly Journal of Economics*, 4: 629-650.

[2] Arnott, R. J. and J. E. Stigilitz, 1988, The Basic Analytics of Moral Hazard, *Scandinavian Journal of Economics*, 90: 383-413.

of deductible and actual claims data with several demographic variables of policyholders such as age, driving experiences, gender, and residence as control variables. Cohen and Siegelman(2010)[3] summarized the previous studies on the subject in a succinct and well organized way. But the previous studies are not coincide in results: some results show strong evidence of the problems (Puelz and Snow(1994)[4], Kim et al.(2009)[5], Dionne et al.(2011)[6], Shi et al.(2012)[7], Dionne et.al(2013)[8]), some do not (Chiappori and Salanié(2000)[9], Abbring et

[3] Cohen A., and P. Siegelman, 2010, Testing for Adverse Selection in Insurance Markets, *The Journal of Risk and Insurance*, 77(1): 39-84.

[4] Puelz, R. and A. Snow, 1994, Evidence on Adverse Selection: Equilibrium Signaling and Cross-Subsidization in the Insurance Market, *Journal of Political Economy*, 102: 236-257.

[5] Kim H., D. Kim, S. Im, and J.W. Hardin, 2009, Evidence of Asymmetric Information in the Auto Insurance Market: Dichotomous Versus Multinomial Measurement of Insurance coverage, *The Journal of Risk and Insurance*, 76(2): 343-366.

They analyze whether adverse selection exists in Korean auto insurance market using multinomial measurement instead of dichotomous indicator, which categorizes coverage into ordered multinomial levels. They collect 28,689 data sample for two calendar years from an insurer. They insist adverse selection problem prevails in choosing coverage areas and amount in Korean auto insurance market.

This paper corrects, however, two minor flaws in the description part of Korean auto insurance market from their paper: (1) Korea Insurance Development Institute(KIDI) is not funded by the government. The institution is run mostly by insurance industry fund; (2) In the description of deductible amount, they mentioned that there are 6 different levels of deductible. But we have never had 6 levels but 5 levels only until today. The maximum deductible is still maintained at 500,000 Korean Won. Thus they need to correct those facts which are minor ones though.

[6] Dionne, G., J. Pinquet, M. Maurice, and C. Vanasse, 2011, Incentive Mechanism for Safe Driving: A Comparative Analysis with Dynamic Data, The Review of Economics and Statistics, 93(1): 218-227.

They found an evidence of moral hazard in Quebec public insurance plan.

[7] Shi P., W. Zhang, and E. Valdez, 2012, Testing Adverse Selection with Two-Dimensional Information: Evidence from the Singapore Auto Insurance Market, *The Journal of Risk and Insurance*, 79(4): 1077-1114.

They examine adverse selection in Singapore automobile insurance market with two dimensional information: riskiness and risk aversion of policyholders. Using 15,418 cross-sectional data, they classify drivers into two groups (driving experience and drivers' age) and test the coverage-risk relationship. They find positive relationship in sub-groups with 3 or more years of driving experience and mid-aged drivers.

[8] Dionne, G, P. Michaud, and M. Dahchour, 2013, Separating Moral Hazard from Adverse Selection and Learning in Automobile Insurance: Longitudinal Evidence from France, *Journal of the European Economic Association*, 11(4): 807-917.

They research whether moral hazard problem exists in a market where a regulated experience rating scheme is applied such as in France. They employ 3-year longitudinal data of French auto insurance data between 1995-1997 to separate adverse selection and moral hazard. They find a strong evidence of moral hazard among subgroup with less than 15 years of driving experience but weak evidence of adverse selection in the group of less than 5 years of driving experience.

[9] Chiappori, P., and B. Salanié, 2000, Testing for Asymmetric Information in Insurance Markets, *Journal of Political Economy*, 108: 56-78.

Al.(2003)[10] Cohen(2005)[11], Saito(2006)[12], Zavadil(2015)[13]), and some are inconclusive (Richaudeau(1999)[14]) due to different data quality, policyholders' lack of informational advantage or offsetting factors, and institutional and regulatory factors. But the most of recent works show a strong evidence of adverse selection in auto insurance market except Zavadil(2015).

In the previous study the deductible is used as a typical proxy of a coverage variable. Smith and Head(1978)[15] argues, however, if deductible credit given to insurance premium reduction does not provide policyholders enough incentives to choose higher deductible, they would choose lower deductible amounts to increase expected claims payment received from the insurer. So that it may exacerbate adverse selection as well as moral hazard problems. Setting aside the argument of Smith and Head(1978), the deductible system is different by country in terms of type, structure, and relative worthiness of the amount to policyholders' income or wealth level. Therefore, we have to admit that if a deductible type or structure in a policy cannot function to mitigate adverse selection or moral hazards problem, then the deductible is simply serving as a way to reduce small claims administration expenses only for insurers.

The Korean auto insurance industry has adopted a hybrid deductible system since 2011[16], different from the countries where a straight or absolute amount deductible system is used. To find the final deductible amount under the system in Korea we have to go through three steps. Firstly, a tentative proportional deductible amount is calculated to the damage, e.g., 20% of the damage amount to the vehicle. Then secondly, compare the 20% amount of damage to the

---

[10] Abbring J. H., J. Pinquet, P. A. Chiappori, 2003, Moral Hazard and Dynamic Insurance Data, Journal of the European Economic Association, 1: 767-820. They find no evidence of moral hazard in French auto insurance.

[11] Cohen, A., 2005, Asymmetric Information and Learning: Evidence from the Automobile Insurance Market, *The Review of Economics and Statistics*, 87(2): 197-207. However, the study found a correlation between coverage and risk for more than 3 years of experience.

[12] Saito, K., 2006, Testing for Asymmetric Information in the Automobile Insurance Market under Rate Regulation, *The Journal of Risk and Insurance*, 73(2): 335-356.

[13] Zavadil, T., 2015, Do the Better Insured Cause More Damage? Testing for Asymmetric Information in Car Insurance, *The Journal of Risk and Insurance*, 82(4): 865-889. This paper tests whether better insureds incur more damage in terms of frequency and severity in Dutch auto insurance market using several nonparametric tests. He collects 80,186 data with personal demographic information, vehicle information, coverage, and claims amount from Netherland between 1995 to year 2000. He does not find any evidence of asymmetric information from the market.

[14] Richaudeau, D.,1999, Automobile Insurance Contracts and Risk of Accident: An Empirical Test Using French Indvidual Data, *Geneva Papers on Risk and Insurance Theory*, 24: 97-114.

[15] Smith, M. and G. Head, 1978, Guidelines for Insurers in Pricing Deductibles, *The Journal of Risk and Insurance*, 45(2): 217-238.

[16] But we introduced different deductible systems in 2010 and changed it again due to severe moral hazards in 2011. In 2010, the Korean financial supervisory service simply increased the surcharge threshold to ₩2 million, thus we experienced severe soft and hard fraud on the damage to your car coverage. Thus the authority changed the system again.

minimum and maximum straight deductible band. The minimum deductible amount, which is always equivalent to 10% of the threshold amount selected, varies as a different threshold amount is chosen.[17] On the other hand, the maximum deductible amount is always locked at ₩500,000. Finally, if the 20% amount of damage to the vehicle falls between the minimum and maximum range, the 20% amount is fixed as the deductible. Otherwise the minimum or maximum amount becomes final deductible one. This paper uses a threshold level as a proxy variable in place of deductible or coverage because deductible varies upon the threshold level.

This study argues that the higher the threshold a policyholder choose, the bigger his(her) moral hazard and adverse selection will be because the maximum deductible limit is always fixed at ₩500,000 while the minimum deductible amount varies proportionally to the threshold amount. Therefore, under the system the larger amount of threshold is equivalent to the smaller deductible because you do pay less money from your pocket. Thus in spite of ample previous studies on this subject, this paper tries to revisit previous studies with a different set of data and variables to see how different groups of policyholders react to this system.

Another important feature of Korean auto insurance policy is that you can select extended medical payment coverage(EMED) alternative to standard medical payment(MED) as a form of an endorsement. It pays loss of income during the medical treatment period (similar to a supplementary coverage to medical coverage but the coverage is much bigger than the typical supplementary coverage found in other countries), small amounts of general damage or pain and suffering damage as well as medical payment up to the coverage limit. However, due to the fact that the loss of income is covered during the medical treatment period, there is room for moral hazard in this case[18]. If someone purchases the extended medical coverage, we argue that the policyholder has a higher probability of loss or more risk averse. In addition to the threshold variable as a proxy of coverage variable this study analyzes the adverse selection issue with this variable (MED/EMED).

On the other hand, in addition to the medical payment coverage(MED/EMED), a policyholder can purchase additional injury insurance coverage related to auto accidents separately from a property-liability insurer[19]. This additional injury coverage for drivers is sold as a form of package policy that has long-term contract periods e.g., at least 3 to 20 years mostly. Another feature of the policy is that its premium is fixed through the entire policy period and no

---

[17] The threshold amount triggers premium surcharge if the sum of physical damage to your auto and others property damage exceeds the limit. We extended threshold amount up to ₩2,000,000 to reflect increased price level in 2010.

[18] They may exaggerate their bodily injury or want to extend hospitalization period to have more money from their insurers.

[19] In auto insurance all the private information of drivers including loss history is shared through the Korea Insurance Development Institution. However, this long-term drivers' coverage is sold at the fixed amount base regardless of your previous traffic accident record so that we argue there would be adverse selection always. This insurance does not cover bodily injury to yourself from drink and drive.

underwriting is needed[20]. This 'long-term driver protection insurance(LONG)' contains a pure protection part and savings component that accumulates a cash value during the policy periods. It typically pays 60% - 80% of the face amount back at the maturity or generates a surrender value if they discontinue during the contract period. This coverage also provides broad protection for you even in case you are at fault, which is not covered by a typical auto insurance: e.g., but not limited to supplementary medical coverage, loss of income, rental expenses, and even premium surcharge and traffic violation fines. This paper also includes this variable in the analysis.

Using the dynamic insurance contract data set, this study contrasts behaviors of policyholders in respect to adverse selection and moral hazard. The purposes of this paper are many as described below.

(1) As previous studies have examined, we test the existence of adverse selection with variables of age, gender, years of named insured, level of threshold, insurance coverage such as the extended medical payment and the long-term driver protection insurance, and claims payment. Also, standard group, drunk-driver group, and high risk pool group are compared in the model. This research randomly collected 80,000 samples from different groups each year: 40,000 samples of standard group and 20,000 samples each from both drunk-driver and high risk pool. These observations are structured 2-year contract data with performance records of the policyholders to test the relationship between risk and coverage.

(2) Cohen(2005) argues if insurers share the past claims of those drivers, the correlation between coverage and risk would not exist. Chiappori and Salanié (2000) also argue if an experience rating or bonus-malus system is applied and all insurers share the loss history of drivers, moral hazard will be reduced. However, previous studies with data from a market where all market participants share policyholders' information and experience rating is used as in France(Chiappori and Salanié(2000)), Japan(Saito(2006)[21]), and Korea(Kim et al.(2009)) resulted in different conclusions from Cohen's(2005) argument.

In Korea, like many other countries, all the private observable drivers' information including loss history is shared through the Korea Insurance Development Institution so this information

[20] The rejection ratio by insurer is less than 2% in most case. Those rejected include so called 'black list' applicants.

[21] Saito(2006) examines whether adverse selection and moral hazard exist under a rate regulated market using 30,000 individual stratified sampling data in Japan. He concludes that there is no adverse selection or moral hazard evidence where insurers can observe some key private information that influence rate calculation. He suggests that as long as there is adverse selection or moral hazard only to a limited extent, then those problem can be mitigated with deductibles and experience ratings. Saito(2006), however, as well as Kim et al.(2009) collect too many control variables related to car itself rather than policyholder's behavior such as car value, year, size, make, and residence that results noises to figure out the relationship and possibly may show spurious one.

becomes public in Korea. On the contrary, the long-term driver protection insurance is sold at a fixed premium regardless of previous claim record so we argue that there would be always a higher probability of adverse selection.

This study tests Cohen's(2005) argument again using the data set. At the same time, this article compares two different situations: one where all policyholders' information is shared and another one where those loss experiences are not considered such as in the case of long-term driver protection insurance. Also, this study investigates how demand on these insurance is affected by each categorized criterion.

(3) Age and/or driving experience can be an indicator of risk awareness[22]. Generally young drivers regard themselves as more skillful than others so they tend to underestimate their riskiness. This fact may influence the risk and coverage relationship. Chiappori and Salanié(2000) and Cohen(2005) found no correlation between risk and coverage in the beginner or young driver group for those who have 3 years or less driving experience. This study will revisit their conclusions using a different set of data and variables.

(4) From the perspective of "propitious selection", the term used by Hemenway(1990)[23], this study tests whether high-risk drivers are less likely to purchase coverage because they are less risk averse. This study investigates whether high-risk pool and drunk drivers purchase less coverage than the standard group. In addition to it, we consider the number of extended coverage an insured purchased (e.g., extended medical payment, higher threshold, and long-term coverage) in the analysis.

(5) This study compares Saito(2006) not only because the Korean auto insurance market and regulation resembles the Japanese market to a large extent but also because this study observed different data and variables associated with risk and coverage. However, like the auto insurance line in Japan and Korea where rate regulation is tight and products are almost standardized, most policyholders purchase nearly the same coverage regardless of their riskiness. If this is the case, he continues we may not observe any correlation or observe a negative correlation if policyholders who have higher probability of loss are not able to purchase more coverage. On the other hand, if we also admit that general policyholders do not understand well the price mechanism or structure applied in the deductible schedule, then it is customary for them to follow a typical advice or suggestion from an intermediary in choosing a deductible level. This also may result in selection of high threshold level.

(6) Finally, Cohen and Dehejia(2004)[24] find that someone who purchases large coverage does

[22] Risk awareness or attitudes are different by gender as well as age. Please refer Cohen and Einav(2007) and Doerpinghaus et al(2008) works.

[23] Hemenway, D., 1990, Propitious Selection, *Quarterly Journal of Economics*, 105:1073-1069.

[24] Cohen, A. and R. Dehejia, 2004, The Effects of Automobile Insurance and Accident Liability Laws on Traffic Fatalities,

not need to be precautious, thus *ex-ante* moral hazard involved. This study will test the existence of *ex-ante* moral hazard by analyzing whether policyholders who purchase large coverage show a high probability of loss during the next policy period (t+1). Also this paper tests whether *ex-post* moral hazard[25] exists by comparing the standard group and high risk driver pool including the drunk drivers group for a tendency of purchasing additional insurance coverage after an insured experienced accident(s). If the high risk agents purchase more coverage the year after they caused accidents, then they clearly show moral hazard. This study investigates whether policyholders from the high risk driver pool and the drunk drivers group purchase more coverage and incur larger losses because they become indifferent or less cautious to possible losses after they purchase larger coverage.

This article is organized as follows. In the next section we introduce the Korean auto insurance market as well as its unique features and structure, and a description of data and variables follows in the next section. The results are then discussed and explained. Finally, concluding remarks are presented.

II. Korean auto insurance market

The total number of registered automobiles is 20,935,447 in Korea as of the end of 2015 besides motorbikes[26]. Among them 15,807,517 are private passenger cars. The total auto insurance premium income is ₩15 trillion Korean Won or almost equivalent of US$ 13.5 billion, which was 20.7% of the property-liability premium income in 2015. Total earned premium income was ₩12.8 trillion Korean Won or almost US$ 11 billion in 2015. The loss ratio (loss payout/earned income) of auto insurance was 87.8%. The expense ratio of auto insurance was 19.3% so the combined ratio was 107% in 2015.[27]

Basic structure of Korean auto insurance and its main features

Journal of Law and Economics, 47(2):357-393.

[25] This is not adverse selection because insurance companies already recognize that the risks of those groups are higher than a standard group.

[26] http://stat.molit.go.kr/portal/cate/statView.do Total number of motorbikes is 2,1651,774 in 2015.

[27] More specifically the loss ratio of the voluntary coverage of passenger car is 97.1% whereas 73.8 % on compulsory part in 2015. One of the main reason is that the regulatory body controls the voluntary insurance rate tight. Please refer '2016 General insurance in Korea (fact book)' (http://www.knia.or.kr) for more detail figures.

The auto insurance coverage was standardized in Korea until 2015[28]. As in <Figure 1>, the coverage consisted of 6 parts: one compulsory coverage(bodily damage and minimum property damage to a third party) and 5 voluntary coverages(excess of the compulsory coverage limits - bodily damage liability up to some amount or unlimited amount; property damage liability up to the amount selected by the individual; medical payments coverage to the individual and those insured; un(under)insured motorists coverage to the driver and their family[29]; and collision and comprehensive coverage for vehicle damage).

The maximum of the compulsory coverage in bodily damage liability is ₩150 Million (US$ 125,000)[30] in case of death and ₩30 Million (US$ 25,000) in case of injury. Of course if a victim died during the treatment for severe injury, the maximum would be the sum of the two (death and injury protection) or ₩180 Million (US$150,000). The maximum property damage to a third party in the compulsory coverage is ₩20,000,000(US$ 16,700) from April of 2016. If bodily damage incurred from an unidentified hit and run automobile accident (including motorbike accidents), the bodily damage is covered by the 'Government Guaranty Fund (for unidentified hit and run cases) up to the same limit of the bodily damage part of the compulsory insurance.[31] For damage to a third party that exceeds the compulsory limits a voluntary coverage kicks in as an excess coverage above the limit of the compulsory coverage. Bodily damage to a third party in the voluntary coverage is unlimited with a minimum of ₩50,000,000. For property damage above the compulsory part to a third party, ₩30,000,000 to ₩100,000,000 or above can be chosen.

<Figure 1> Basic structure of Korean auto insurance coverage

<table>
<tr><td rowspan="2">Liability to third party</td><td rowspan="2">Compulsory</td><td colspan="2">Bodily damage(death / injury)</td><td rowspan="2">Voluntary (Excess)</td><td>Bodily damage</td></tr>
<tr><td colspan="2">Physical damage(₩20Million)</td><td>Physical damage</td></tr>
<tr><td rowspan="3">Coverage for your Damage</td><td rowspan="3">Voluntary</td><td colspan="4">Medical Payment or Extended Medical payment coverage</td></tr>
<tr><td colspan="4">Un(under)insured Motorist Coverage (you and your family, insured)</td></tr>
<tr><td>Deducible(hybrid)</td><td colspan="3">Collision and Comprehensive damage</td></tr>
</table>

(Government Guaranty Fund for unidentified hit and run is run by the ministry of land, infrastructure, and transport independently.)

The voluntary coverage to protect the individual includes coverage for their medical payments, uninsured motorist coverage, and damage to their vehicle. The medical payment provides a

[28] The Financial supervisory committee scheduled to deregulate forms and rate entirely from 2016.

[29] Especially you and your spouse including your children are covered regardless of on board or not.

[30] 1US$=₩1,200 (Korean Won), Currently around ₩1,160 as of Feb. 2017

[31] The fund is created by assign 1% of compulsory auto premium to bodily injury from all insured. The amount is approximately US$ 30 million per year. http://www.molit.go.kr/USR/policyTarget/dtl.jsp?idx=490

financial protection against injury treatment expenses from a vehicular accident incurred up to the coverage limit which could be ₩15million, ₩30million, ₩50million, or ₩100million. Alternatively the extended medical payment coverage can be chosen instead of the basic medical payment, which provides up to ₩15million, ₩30million, ₩50million, ₩100million, ₩200million, ₩300million, or ₩500million depending on the coverage limit regardless of the driver's fault.

Un(under)insured motorist coverage covers bodily damage sustained from an uninsured or underinsured motorist up to ₩200,000,000 or ₩500,000,000 over and above the offenders' liability coverage limit. Especially bodily damage to the individual and their spouse and children are always covered regardless of whether the individual and their family are included or not. For example, if your child or spouse is hit by an un(under)insured motorist while he(she) is walking, your child or spouse is still covered by your un(under)insured motorist coverage above the liability coverage limit the tort-feasor carry.

Finally, the damage to your auto covers the collision and comprehensive damage incurred. But the deductible limit must be paid before the coverage kicks in. The deductible system is a little different from straight or proportional deductible structure.

Deductible clause and threshold system

The deductible clause applied in collision and comprehensive coverage mandates the policyholder to pay the first 20% of the total damage to the individuals vehicle but limited to a minimum of 10% of their threshold limit and to a maximum of ₩500,000 from Feb. 2011. The minimum deductible amount becomes 10% of the threshold limit chosen so that it varies with the threshold amount chosen. If the total claim is less than the threshold amount then the premium does not change for the next 3 year period[32]. A threshold limit can be chosen out of ₩500,000, ₩1,000,000, ₩1,500,000, and ₩2,000,000. If the sum of the claim on the damage to the vehicle and to the other vehicle (or property) exceeds the threshold limit, then the premium will go up according to a surcharge schedule(bonus-malus) during the next 3 year period. For example, as in <Figure 2> if the ₩1,500,000 threshold limit is chosen and if the damage to the vehicle is ₩300,000, then the final deductible becomes ₩150,000, because the minimum schedule is ₩150,000 or 10% of the threshold amount even though 20% of the damage is ₩60,000. If a higher threshold limit is chosen, the minimum deductible amount increases proportionally and the premium is also increased accordingly. If an accident claim is less than the threshold, however, the premium will remain the same for the next three years. This fact, therefore, provides incentives for adverse selection as well as moral hazard.

[32] If you have small claim that does not exceed the threshold limit your insurance premium will be staying same for the next 3 years. But if you have another small claim within the policy year, you will be surcharged.

Conversely, if the minimum threshold is chosen a saving can be made on the premium, but more damages have to be paid out of pocket and the insurance premium will be increased in the coming policy year because the damage and property damage to others exceeds the lowest threshold chosen. Thus, if the premium difference does not provide policyholders incentives to choose a lower threshold then policyholders will be smart enough to choose a higher threshold as Smith and Head(1978) argued.

<Figure 2> Deductible schedule with threshold amount

Threshold amount	Damage to your auto	20% of your damage	Deductible Band		Final Deductible
			Minimum	Maximum	
₩500,000	300K	60K	50K (10% of the threshold)	500K	60K
	1,000K	200K			200K
	3,000K	600K			500K
₩1,000,000	300K	60K	100K	500K	100K
	1,000K	200K			200K
	3,000K	600K			500K
₩1,500,000	300K	60K	150K	500K	150K
	1,000K	200K			200K
	3,000K	600K			500K
₩2,000,000	300K	60K	200K	500K	200K
	1,000K	200K			200K
	3,000K	600K			500K

Long-term drivers insurance with savings components

Other than Japan, Korean Property-liability insurers sell long-term (with more than 3-years and up to a 20-year contract period) insurance with a savings component. The main features of the long-term driver protection insurance include coverage for surcharged auto insurance premium due to claims for supplementary payments such as a payment for criminal settlement, additional medical payment, and payments for various general damages. Most of the long-term property-liability contracts promise to pay a large portion back of the principal amount (usually 60% - 80% or more) at the end of contract. The premium charged on these types of products are flat or at a fixed level during the entire policy period to every policyholders. Thus there is no need to underwrite on these types of policies.

High risk driver pool

The Korean High Risk Drivers Pool, established in 1987, provides auto insurance coverage to those who have excluded from the voluntary market, which is currently 14 insurers. The main features of those excluded from the voluntary market include applicants involved in auto

accidents caused by drunk driving within a 3 year period [33] or hit and run accidents. Also included are those who made fraudulent claims or had more than 2-3 auto accidents during a policy period. These high risk drivers can be surcharged up to maximum limit of 200% of their current premium payment if they have to go the pool. Typically, if an insurer accepts a high risk driver, the insurer should retain 30% of the risk and transfer the rest of risk to the pool. In return, the insurer receives expense charges or loadings equivalent to 12% of the transferred premium or 12% x 70% =8.4% of the total premium from the pool. According to the Korean Financial Supervisory Service the total number of passenger cars insured in the pool is 130,427 in 2015. This figure has increased sharply from 37,149 in 2014 due to the progressive deregulation regime in Korea[34]. According to the fact book on Korean General Insurance 2016, the loss ratio of the high risk pool is 94.8%[35].

III. Data and Variables

This research extracted 160,000 individual auto insurance policy data of 2014 and 2015 (80,000 each year) using stratified random sampling from the Korea Insurance Development Institution (KIDI)[36]. The data set sample was compiled from the individual records of 40,000 standard drivers, 20,000 high risk drivers from high risk pool, and 20,000 drunk-drivers over 2 years to trace how they changed their insurance contracts after they are insured.

The first category of the data includes 4 demographic variables that contain personal information as in the <Figure 3>. Age and gender are important factors that determine risk perception. It is well known that young drivers consider themselves more skillful and less likely to have accidents than their peers.[37] Therefore the younger group (e.g., 20's and 30's) tends to underestimate their risk level so this study investigates whether they spend less on coverage. Particularly this paper classified drivers as beginners if they have been insured for less than 4years; intermediate if they have been insured for more than 3 years but less than 8 years, and experienced for drivers with 8 years or more of insurance[38].This variable 'period of named

[33] In 2015, total death toll from auto accidents is 4,621: 583(12.6%) victims from drink and drive accidents and 254(5.5%) from without proper license or privilege accidents.

[34] http://www.kukinews.com/news/article.html?no=399161

[35] 2016 General Insurance in Korea (Fact book), Korea non-life insurance association. (http://www.knia.or.kr)

[36] KIDI is the only rate making agency in Korea. It collects every insurance data and maintains statistics related to all kinds of insurance business transacted in Korea.

[37] Horswill, M., A. Waylen, and M. Tofield, 2004, Drivers' ratings of different components of their own driving skill: a greater illusion of superiority for skills that relate to accident involvement, *Journal of Applied Social Psychology*, 34(1): 177–195.

[38] The same credit is given to 8 or more years of named insured period.

insured(PONI)' indicates how many years they have driven with their own car. Therefore, they are the policyholders.

The second and third category of the variables are the coverage and claims in 2014 $_{(t)}$ and 2015 $_{(t+1)}$ respectively. MED/EMED refers to medical payment or extended medical payment. The medical payment(MED) as a standard coverage covers the medical expenses of the driver and insureds. The extended medical payment(EMED) is an endorsement that extends medical coverage with generous supplementary payment. If a policyholder chooses the EMED, then he(or she) may be more risk averse or has a higher probability of loss. As an alternative to the deductible variable this paper employs the threshold(THRES) limit. Claims records contain claims paid to third party(bodily damage amount(BIDAMT) and property damage amount(PROPDAMT)). Finally, it contains the amount of the medical payment made to your bodily injury claims (MEDAMT). The amount of paid claims is used as a proxy variable of the risk that each insured carries as in the previous study.

<Figure 3> Description of the variables

Category	**Variable name**	**Description** (t=2014, t+1=2015)
Demo-graphic	O, D, H	Ordinary driver(0), Drink and Drive(1), High Risk Pool(2)
	AGE	20s, 30s, 40s, 50s, 60s+ as of 2014: categorized as below: 20s and 30s:(0); 40s and 50s(1); 60s+:(2)
	GEND	Female(0) or Male(1)
	PONI	Period of named insured: 3years≥Insured:(0), 4years≤Insured≥7years:(1), 8years≤Insured:(2)
Coverage	$MED_{(t)}$/$EMED_{(t)}$	Medical Payment coverage:(0), Extended Medical payment coverage:(1) * EMED coverage is an optional endorsement.
	$THRES_{(t)}$	Surcharge threshold limit of physical damage(s): ₩500K, ₩1,000K, ₩1,500K, ₩2,000K (₩500K and ₩1,000K):(0), (₩1,500K and ₩2,000K)(1)
Claims in 2014:$_{(t)}$ and 2015$_{(t+1)}$	BIDAMT	Bodily injury damage amount from the accident
	PROPDAMT	Property damage amount from the accident
	TOTliab	Total liability to others= BIDAM + PROPDAMT
	MEDAMT	Medical payment amount to your bodily injury
	LOSSEXP	No loss experience:(0), Loss Experience:(1)
Extended Insurance	LONG(2014)	Long-term driver protection insurance purchased in 2014
	LONG(2015)	Long-term driver protection insurance purchased in 2015
Other Insurance	HEALTHINS(2014)	Supplementary health insurance purchased in 2014
	HEALTHINS(2015)	Supplementary health insurance purchased in 2015
Size of Insurance Coverage	SOIC(0, 1, 2)	MED + Low Threshold + No Long-term Ins : (0)
		EMED + Higher Threshold + Long-term Ins : (2)
		Otherwise : (1)

The fourth category of variables represents the additional separate coverage other than auto insurance, the so called the 'long-term driver protection insurance' with the savings component as explained above, policyholder purchased in 2014 (LONG2014) and in 2015 (LONG(2015)) as a form of categorical value. This variable is added to see if policyholders' characteristics are consistent with in purchasing additional insurance coverage to protect more.

The fifth category denotes a supplementary medical insurance (HEALTHINS2014 and HEALTHINS2015) to the national health insurance coverage. It covers all the medical expenses that are not covered by the national health insurance plan up to 80% of actual medical expenses paid (including co-payment) by the insured. Of course this coverage is not related to automobile insurance. However, if an individual is injured in an automobile accident caused by them and if they don't have enough medical payment coverage then they can apply their national health insurance coverage as well as supplementary health insurance in excess of the medical coverage limit of their auto insurance. Therefore, even though this is not a main purpose of this paper, it is interesting to check whether the person who purchases the coverage is risk averse.

The last variable is the size of insurance coverage(SOIC) which indicates how many extended or additional coverage you selected to protect yourself from an auto accident. If a policyholder simply purchases a standard medical payment(MED), chooses low threshold level, and buys no long-term insurance then we categorized as "(0)". If an insured selects the extended medial payment(EMED), higher threshold level, and purchases an additional long-term insurance(LONG) at the same time, then the person is categorized as "(2)". Otherwise, we categorized as "(1)".

Summary Statistics[39]

<Table 1> to <Table5> show detail observations by three different groups: ordinary driver group; drunk driver group; and drivers in the high risk driver pool. In <Table 1> Age variable, as we can expect the age 40's and 50's takes more than 60% in all three groups. In Gender variable male takes 2/3 of all observations.

< Table 1 > Age and Gender by group(2014)

Category	AGE			Gender		Total
	20+30's	40+50's	60's+	Female	Male	
Ordinary Group	6,676	26,203	7,121	10,550	29,450	40,000
Drunk Group	6,150	11,456	2,394	4,362	15,638	20,000
High Risk Group	4,435	11,257	4,308	5,410	14,590	20,000
Total	17,261	48,916	13,823	20,322	59,678	80,000

[39] We found that all variables in each category of O/D/H are statistically different except only very few cases.

<Table 2> shows years of named insured, that is, the period of insured under the individual's name. The period of named insured does not exactly match to the driving experience. However, the driving experience tends to be tandem with the period of named insured to a certain degree. We can assume that if someone has less than 3 years of named insured then the individual would be a novice in driving. If someone would be a experienced driver if the person is insured more than 8 years. In our data around 75% the observation is insured more than 8 years.

< Table 2 > Period of named insured and MED/EMED coverage by group(2014)

Category	Period of Named Insured			MED/EMED		Total
	≤3 yrs	4 to 7 yrs	8years≤	MED	EMED	
Ordinary Group	3,259	4,295	32,446	24,195	15,805	40,000
Drunk Group	3,628	3,649	12,723	13,694	6,306	20,000
High Risk Group	1,864	3,624	14,512	17,292	2,708	20,000
Total	8,751	11,568	59,681	55,181	24,819	80,000

The next variable MED/EMED stands for the standard medical payment coverage(MED) and extended medical payment coverage(EMED). If you choose the EMED then your loss of income and expanded medical coverage during the hospitalization period are given even in case you are at fault. In our sample 39.5% the ordinary group chooses EMED whereas the drunk driver and high risk driver group select 31.5% and 13.5% respectively. <Table 3> shows the threshold level chosen by each group in both years. In our analysis we classify the threshold level into 2 categories: 500K and 1,000K as 'low'; 1,500K and 2,000K as 'high' because we don't have significant number of observation in both 1,000K and 1,500K levels: more than 85% insured opted the highest threshold level, 2,000K and 12.5% selected 500K in all group.

<Table 3> Threshold level chosen by Group

Category	Year	Threshold Level (Korean ₩)				Total
		500K	1,000K	1,500K	2,000K	
Ordinary Group	2014	1,603	1,225	193	36,979	40,000
	2015	1,534	1,136	190	37,140	40,000
Drunk Group	2014	1,701	805	150	17,344	20,000
	2015	1,636	618	151	17,595	20,000
High Risk Group	2014	4,198	702	134	14,966	20,000
	2015	3,155	650	108	16,087	20,000
Total	2014	7,502	2,732	477	69,289	80,000
	2015	6,325	2,404	449	70,822	80,000

<Table 4> represents average liability amount to a third party and average medical payment to the insured. In the table the drunk driver group shows the highest amount per claim in both claims, then high risk driver group follows.

<Table 4> Average Liability Amount to third party and Medical Payment to the insured

Category	year	Average Liability Claims (Korean ₩)	Average medical payment amount (Korean ₩)
Ordinary Group	2014	1,687,895	1,175,509
	2015	2,190,553	1,782,478
Drunk Driver Group	2014	5,073,652	2,904,833
	2015	2,266,964	6,743,900
High Risk Group	2014	2,058,852	969,184
	2015	3,299,652	2,898,223

<Table 5> represents the number of drivers who purchased long-term driver's insurance coverage and extended health insurance coverage in each group. In the table, we can figure out that these two supplementary coverage are quite popular to all group.

<Table 5> The Number of Insured who purchased additional coverage

Category	year	Long-term Driver's Insurance Coverage		Extended Health Insurance Coverage		Total
		Covered	No	Covered	No	
Ordinary Group	2014	38,618	1,382	36,873	3,127	40,000
	2015	39,489	511	39,328	672	40,000
Drunk Group	2014	17,413	2,587	12,962	7,038	20,000
	2015	17,740	2,260	16,612	3,388	20,000
High Risk Group	2014	19,031	969	17,805	2,195	20,000
	2015	19,129	871	18,938	1,062	20,000
Total	2014	75,062	4,938	67,640	12,360	80,000
	2015	76,358	3642	74,878	5,122	80,000

This study employs both the general regression model and the bivariate model which are widely used and accepted in empirical studies such as in Chiappori and Salanié(2000), Cohen(2005), and Saito(2006).

$$Risk_i = \propto + \beta \cdot Coverage_i + \gamma \cdot X_i + \varepsilon_i$$

Alternatively Chiappori and Salanié(1997[40], 2000) introduced and followed by others, we apply the bivariate model as well:

$$Risk_i = g(X_i) + \eta_i$$

$$Coverage_i = f(X_i) + \varepsilon_i$$

Where $Risk_i$ represents a policyholder i's *ex-post* risk such as total claims paid in the event

[40] Chiappori, P., and B. Salanié, 1997, Empirical Contract Theory: The case of Insurance Data, European Economic Review, 41: 943-950.

of an accident, $Coverage_i$ is a variable that represents the policyholder's choice of insurance coverage, and X_i denotes a vector of all the policyholder's characteristics that are already known to the insurer or of publicly known information related to underwriting[41].

IV. Results

<Table 6> shows the correlation among variables. As we expected the period of named insured(PONI) and AGE variables show somewhat meaningful correlation but others do not.

<Table 6> Pearson's correlation among variables

	AGE	GEND	PONI	MED/ EMED$_{(t)}$	THRES$_{(t)}$	LOSS EXP$_{(t)}$	LONG$_{(t)}$	HEALT HINS$_{(t)}$
AGE	1.000							
GEND	0.033 (0.000)	1.000						
PONI	0.442 (0.000)	0.179 (0.000)	1.000					
MED/ EMED$_{(t)}$	-0.026 (0.000)	-0.001 (0.820)	0.014 (0.000)	1.000				
THRES$_{(t)}$	-0.029 (0.000)	-0.014 (0.000)	-0.051 (0.000)	0.152 (0.000)	1.000			
LOSS EXP$_{(t)}$	-0.088 (0.000)	0.009 (0.011)	-0.143 (0.000)	0.021 (0.000)	0.002 (0.654)	1.000		
LONG$_{(t)}$	0.002 (0.633)	0.016 (0.000)	-0.011 (0.002)	0.054 (0.000)	0.029 (0.000)	0.254 (0.000)	1.000	
HEALTH INS$_{(t)}$	-0.151 (0.000)	-0.023 (0.000)	-0.126 (0.000)	0.032 (0.000)	0.022 (0.000)	0.435 (0.000)	0.176 (0.000)	1.000

To test whether adverse selection problem exists in Korean auto insurance market, we employ a logistic regression with the following model.

$$\text{Logit P} = \ln o = \ln \frac{P}{1-P} = \beta^{\tau} \text{x}$$

Where

$$\hat{P}(x) = \frac{e^{\beta^{\tau} x}}{1 + e^{\beta^{\tau} x}}$$

[41] Cohen A., P. Siegelman, 2010, Testing for Adverse Selection in Insurance Markets, *The Journal of Risk and Insurance*, 77(1): 39-84.

THRESHOLD

$THRES_{(t+1)} = f(O/D/H, AGE, GEND, PONI_{(t+1)}, MED/EMED_{(t+1)}, LOSSEXP_{(t)})$

The THRES variable represents a policyholder's coverage. If a policyholder chooses a higher level of threshold amount, in fact the person purchases larger coverage. We need to check which factors of the policyholder's characteristic influence the choice of a THRES level. If the $LOSSEXP_{(t)}$ shows a meaningful statistics then there would be a learning effect after the individual experienced an accident. We can call this *ex-post* moral hazard. We also need to investigate which group out of O/D/H has the strongest relationship. As in the <Figure 3> and <Table 3> we contracted 4 levels of threshold into two: low(500K and 1Million : 0) and high (1.5Million and 2Million : 1)

<Table 7> Factors that influence the choice of a THRES level

Variable	Coefficient	P-value	odds ratio
(Intercept)	2.75442	0.0000	15.71193
ODH=1	-0.81482	0.0000	0.442719
ODH=2	-1.05226	0.0000	0.349148
AGE=1	0.08096	0.0135	1.084328
AGE=2	-0.05877	0.1566	0.942924
GEND=1	0.02415	0.3817	1.024444
PONI=1	-0.23457	0.0000	0.790911
PONI=2	-0.5754	0.0000	0.56248
$MED/EMED_{t+1}$=1	0.96333	0.0000	2.620408
$LOSSEXP_t$=1	0.25582	0.0000	1.29152
Testing Global Null Hypothesis BETA=0			
Criterion	Value	DF	Pr>Chisq(P-value)
Likelihood Ratio	3282.2	9	0.0000

(Odd ratio represents P/(1-P))

As in <Table 7> every variable except AGE=2 and GEND variables significantly affects the choice of a THRES level. However, the results do not support that the high risk driver group including drunk driver group purchases more coverage. Rather different from our general expectation, the ordinary group driver(O) has tendency to select a higher threshold level than two riskier groups(D+H) do. The negative relationship may imply that these high risk groups try to select a lower threshold level to reduce their premium charges in coming year. At the same time the result may support the argument of 'propitious selection' (Hemenway(1990)) that high-risk drivers are less likely to purchase coverage because they are less risk averse. The result may indicate that the threshold amount system is not working as intended.

With the AGE variable only mid-aged(40's and 50's) group shows a tendency to buy higher threshold amount than younger group. Age 60+ is not statistically significant. The period of named insured(PONI) result shows that the subgroup with longer named insured(PONI=2) tends not to buy higher threshold level than PONI=1 group. Therefore, this result is different

from Chiappori and Salanié(2000) and Cohen(2005) that the beginners or younger group does not show significant correlation. MED/EMED result indicates that a driver who purchases an extended medical payment coverage(EMED) prefers to choose higher threshold level. Finally, a driver with a loss experience in 2014 purchases a higher threshold coverage so that there would be a 'learning effect' after the policyholder experienced an accident in 2014 (*ex-post* moral hazard).

Medical Payment/Extended Medical Payment

The Medical payment(MED) covers only actual medical expenses of the first party injury within a payment band or death payment up to the coverage limit you select. Alternatively you can choose an extended medical payment coverage(EMED) that provides loss of income and small amount of pain and suffering damage as well as actual medical expenses.

We tested that if a policyholder chooses the EMED(extended coverage option to medical payment coverage) instead of the MED(standard medical payment coverage for the first party) then the policyholder would be risk averse or show higher probability of loss. We use a logistic regression analysis as follow.

$$MED/EMED_{(t+1)} = f(O/D/H, AGE, GEND, PONI_{(t+1)}, THRES_{(t+1)}, LOSSEXP_{(t)})$$

<Table 8> Influential factors on the selection of MED/EMED by various cohorts

Variable	Coefficient	P-value	odds ratio
(Intercept)	-1.346181	0.0000	0.260232
ODH=1	-0.146614	0.0000	0.863627
ODH=2	-1.309167	0.0000	0.270045
AGE=1	-0.035114	0.1092	0.965495
AGE=2	-0.298936	0.0000	0.741607
GEND=1	-0.040805	0.0293	0.960016
PONI=1	-0.006405	0.8436	0.993615
PONI=2	0.166597	0.0000	1.181278
$THRES_{t+1}$=1	0.962135	0.0000	2.617278
$LOSSEXP_t$=1	-0.183846	0.0000	0.832064
Testing Global Null Hypothesis BETA=0			
Test	Value	DF	Pr>Chisq(P-value)
Likelihood Ratio	5827.8	9	0.0000

As you see <Table 8> shows that the ordinary driver group(ODH=0) purchases EMED coverage more than any other group, which contradicts to our general expectation that a high risk individual tends to purchase more coverage. In our sample with MED/EMED variable, no adverse selection is observable in this sense. Insureds over age 60's + and male policyholders show less tendency to purchase the extended medical coverage, while PONI=2 group and THRES=1 group tend to choose extended medical payment coverage(EMED). But if you have experienced an auto accident in 2014 then you simply tend to choose the standard medical coverage(MED). So that we cannot observe 'learning effect' in this anaysis.

Size of Insurance Coverage related to auto insurance and Loss Experience

$SOIC_{2015} = f(O/D/H_{(t)}, AGE, GEND, PONI_{(t)}, LOSSEXP_{(t)})$

<Table 9> Factors that influence choice of coverage limit and number of policy

Variable	Coefficient	P-value	odds ratio
(Intercept) 0|1	-3.0565	0.0000	0.047052
(Intercept) 1|2	3.8566	0.0000	47.30424
ODH=1	-0.56204	0.0000	0.570045
ODH=2	-1.244428	0.0000	0.288106
AGE=1	0.1213	0.000247	1.128964
AGE=2	-0.086786	0.039153	0.916873
GEND=1	0.022489	0.420605	1.022744
PONI=1	-0.247064	0.0000	0.781091
PONI=2	-0.51364	0.0000	0.598314
$LOSSEXP_t$=1	0.463087	0.0000	1.588972
Testing Global Null Hypothesis BETA=0			
Test	Value	DF	Pr>Chisq(P-value)
Likelihood Ratio	2501.9	8	0.0000

(* Two intercepts are calculated from the ordinal logit regression with 3 layers of observation.)

In <Table 9> as we also have seen in <Table 7> and <Table 8>, the ordinary insured group buys more coverage than other groups. We can observe that mid-aged group(40's and 50's) purchase more coverage whereas age 60's+ tends to buy less coverage. If you have a longer period of insured, then you tend to purchase less coverage. On the other hand, if someone experienced an auto accident(s) in the previous year the person tends to purchase more coverage. So there is a clear 'learning effect' in Korean insurance market.

LOSS EXPERIENCE

This paper investigates what factors of policyholder influence loss experience in coming year. If a policyholder experiences any claim(liabilities or medical payment) during 2015, we categorize LOSSEXP=1 otherwise 0. We apply a logit regression model as below.

$LOSSEXP_{(t+1)} = f(AGE, GEND, PONI_{(t+1)}, MED/EMED_{(t+1)}, THRES_{(t+1)}, LONG2014, HEALTHINS_{2014})$

In <Table 10> the older driver group and female group show higher probability of loss than younger group and male drivers, respectively, which are contradictory to our general belief. On the contrary to AGE variable, the policyholder group who has been insured more than 8 years is less likely to incur auto accident(s) than less period of insured group, while PONI=1 and PONI=0 groups do not show any difference in loss experience in 2015. A policyholder who purchased the extended medical payment coverage(EMED) has less probability of loss. The threshold variable is not significant so that it does not impact to loss probability but vice

versa as in <Table 7>.

<Table 10> Factors that influence to loss experience

Variable	Coefficient	P-value	odds ratio
(Intercept)	-1.45818	0.0000	0.232659
AGE=1	0.172284	0.0000	1.188015
AGE=2	0.478532	0.0000	1.613704
GEND=1	-0.186153	0.0000	0.830147
PONI=1	0.020616	0.577	1.02083
PONI=2	-0.240442	0.0000	0.78628
$MED/EMED_t$=1	-0.325852	0.0000	0.721912
$THRES_t$=1	-0.007236	0.801	0.99279
$LONG_{2014}$=1	0.310803	0.0000	1.36452
$HEALTHINS_{2014}$=1	0.191181	0.0000	1.210679
Testing Global Null Hypothesis BETA=0			
Test	Value	DF	Pr>Chisq(P-value)
Likelihood Ratio	688.41	9	0.0000

On the other hand, an insured who purchased a long-term insurance and supplementary health insurance coverage in 2014 has more likelihood to experience auto accident(s), which supports that adverse selection problem may exist in case where there is no underwriting is required. Therefore, this result may support Cohen(2005) and Chiappori and Salanié (2000) arguments that if insurers share the past claims of those drivers, the correlation between coverage and risk would not exist.

To make clearer this argument, we tested whether a policyholder who purchased more coverage such as who chose EMED, High THRES, and LONG coverage has higher probability of loss than those who didn't. We classified entire group into three ones based on size of insurance coverage(SOIC): SOIC=0 if an insured chose MED, lower threshold level, and no long-term coverage; SOIC=2 if an insured chose EMED, higher threshold level, and long-term coverage at the same time; otherwise, "1".

$LOSSEXP_{(t+1)} = f(ODH, SOIC_{(t+1)})$

<Table 11> Loss experience and size of insurance coverage

Variable	Coefficient	P-value	odds ratio
(Intercept)	-1.820112	0.0000	0.162008
ODH=1	-0.027898	0.273033	0.972488
ODH=2	0.734058	0.0000	2.083518
$SOIC_{2015}$=1	0.246396	0.0000	1.279406
$SOIC_{2015}$=2	0.004767	0.0000	1.004778
Testing Global Null Hypothesis BETA=0			
Test	Value	DF	Pr>Chisq(P-value)
Likelihood Ratio	1252.6	4	0.0000

<Table 11> shows that the high risk pool drivers tend to experience more accidents than other two groups. A possible reason that drunk driver group shows a negative coefficient is they were already arrested as DUI in 2014, so that they try to become careful in driving. Also SOIC=1 and SOIC=2 groups show positive relationship with loss probability, so that we can argue that if you are covered more in terms of coverage limit and number of coverage, then you have a higher probability of an auto accident in coming year. Thus, we argue that there is an *ex-ante* moral hazard in this market. This result supports the argument of Cohen and Dehejia(2004).

Total Liability Incurred

Alternative to the loss experience we can measure '*ex-post*' realization of a policyholder's risk using the amount of total liability to third party. Total liability amount is the sum of the property damages and bodily injury to others. Of course, this is different from an adverse selection issue because all insurance company already recognize that the risky groups are higher than the standard group. We analyze what factors affect the total damage to others with a multiple linear regression model using 13,093 observations that incurred liability claims in 2015.

$$Log(TOTliab_{(t+1)\,i}) = \beta_{0i} + \beta_1 ODH_{1i} + \beta_2 ODH_{2i} + \beta_3 AGE_{1i} + \beta_4 AGE_{2i} + \beta_7 GEND_{1i} + \beta_8 PONI_{1i} + \beta_9 PONI_{2i} + \beta_{11} MED_{1i} + \beta_{12} THRES_{1i} + \beta_{13} LONG_{1i} + \beta_{14} HEALTH_{1i} + \varepsilon_i$$

<Table 12> Influential factors on the total liability amount

Variable	Coefficient	P-value
(Intercept)	13.819606	0.0000
ODH=1	0.019638	0.472112
ODH=2	0.21447	0.0000
AGE=1	-0.015859	0.560288
AGE=2	0.030965	0.371647
GEND=1	-0.003876	0.860235
PONI=1	-0.019034	0.603847
PONI=2	-0.042734	0.207345
$MED/EMED_{t+1}$=1	-0.012875	0.564732
$THRES_{t+1}$=1	0.114081	0.000235
$LONG_{2014}$=1	0.153586	0.0000
$HEALTHINS_{2014}$=1	-0.010986	0.680091

Goodness of Fit Statistics			
	Value	DF	Pr>F(P-value)
F-value	13.36	11, 13081	0.0000

In <Table 12> the high-risk driver group(ODH=2) caused more amount of liability to others than other two groups in 2015. Of course the drunk driver group has the same possible reason as in <Table 11>. The groups that chose higher threshold amount and that purchased a separate long-term coverage tend to incur larger liability amount than others, which may reflect their carelessness after purchase large coverage. This result also supports Cohen and Dehejia(2004)

argument that if someone purchases large coverage the person does not need to be precautious, thus *ex-ante* moral hazard involved.

Moral Hazards

As mentioned earlier the 'Long-term driver's protection coverage' does not consider underwriting factors at all[42]. Thus if a person purchases an additional long-term coverage after experienced an accident, we argue that there would be a moral hazard.

$LONG_{2015}=f(O/D/H, AGE, GEND, PONI_{(t+1)}, MED/EMED_{(t+1)}, THRES_{(t+1)}, LOSSEXP_{(t)})$

<Table 13> Influential factors on the selection of the long-term coverage by various cohorts

Variable	Coefficient	P-value	odds ratio
(Intercept)	-5.32558	0.0000	0.004866
ODH=1	0.71827	0.0000	2.050882
ODH=2	0.93721	0.0000	2.552849
AGE=1	0.3753	0.0000	1.455428
AGE=2	0.24379	0.000395	1.276076
GEND=1	0.06583	0.117776	1.068045
PONI=1	-0.34083	0.0000	0.71118
PONI=2	-0.4646	0.0000	0.628386
$MED/EMED_{t+1}$=1	0.11233	0.004692	1.118882
$THRES_{t+1}$=1	0.05929	0.293175	1.061083
$LOSSEXP_t$=1	2.51444	0.0000	12.35969
Testing Global Null Hypothesis BETA=0			
Test	Value	DF	Pr>Chisq(P-value)
Likelihood Ratio	4852.1	10	0.0000

<Table 13> shows that the two risk groups, the younger driver groups have tendency to purchase long-term driver's coverage more. The group with more periods of named insured shows less likelihood of purchasing the long-term coverage. But a policyholder with extended medical coverage in 2015 and who experienced an accident in 2014 tend to purchase long-term coverage in 2015. Therefore, moral hazard exists in the market.

Finally, this paper investigates who tends to purchase supplementary health insurance coverage as an extension of the study. The results indicate that two risk groups want more coverage. Also the older driver group and the longer named insured group less likely to purchase the supplementary health insurance coverage. But coherently with the case of the long-term coverage as in <Table 13> who choose EMED in 2015 and has a loss experience in 2014 show a tendency to purchase the supplementary health insurance coverage so that this study argues that moral hazard exists in the market overall but not in auto insurance policy specifically.

[42] The rejection ratio is less than 2% in leading insurers or less among mid to small insurers, generally.

$HEALTHINS_{2015}=f(O/D/H, AGE, GEND, PONI_{(t+1)}, MED/EMED_{(t+1)}, THRES_{(t+1)}, LOSSEXP_{(t)})$

<Table 14> Influential factors on the selection of the extended health coverage

Variable	Coefficient	P-value	odds ratio
(Intercept)	-4.821707	0.0000	0.008053
ODH=1	0.880333	0.0000	2.411703
ODH=2	0.867516	0.0000	2.380989
AGE=1	-0.121031	0.002488	0.886006
AGE=2	-0.304101	0.0000	0.737786
GEND=1	0.072981	0.045967	1.07571
PONI=1	-0.05847	0.253279	0.943207
PONI=2	-0.148322	0.002201	0.862153
$MEDEMED_{t+1}$=1	0.129626	0.000142	1.138403
$THRES_{t+1}$=1	0.004394	0.927135	1.004404
$LOSSEXP_t$=1	2.444622	0.0000	11.52619
Testing Global Null Hypothesis BETA=0			
Test	Value	DF	Pr>Chisq(P-value)
Likelihood Ratio	7022	10	0.0000

V. Conclusion

Adverse selection and moral hazard problems stemming from asymmetric information have been tested in various insurance markets. Most of the studies analyzed the relationship between coverage and risk using the amount of deductible and actual claims data with several demographic variables of policyholders such as age, driving experiences, gender, and residence as control variables in auto insurance market. The results from the previous study, however, are mixed and depend on the unique condition of market they analyzed. This study contrasts behaviors of policyholders in respect to adverse selection and moral hazard using the dynamic insurance contract data set in Korea. This study collected 80,000 individual auto insurance data of 2014 and 2015 using stratified random sampling from the Korea Insurance Development Institution (KIDI). The sample data set includes standard or ordinary drivers group, drunk drivers group, and drivers in the high risk pool with detail insurance coverage data. In addition, we merged the auto insurance data two additional supplementary insurance coverage information such as the long-term driver protection coverage and the supplementary health insurance coverage to trace how they changed their behavior after they are insured or experienced auto accidents.

The major findings in Korean auto insurance market are follows.

First, in the analysis of the threshold level as a proxy of deductible we found a negative relationship. The results may support Saito's(2006) argument that where rate regulation is tight and a policy is standardized, most policyholders purchase almost the same coverage regardless

of their riskiness. He insists that in this case we may observe a negative correlation if those risky agents are not able to purchase more coverage. In sum, we argue that the high risk drivers including drunk drivers tend to purchase other supplementary insurance coverage because they cannot purchase more coverage in auto insurance policy. In addition, our result is in line with Smith and Head's(1978) argument that if deductible credit given to insurance premium reduction does not provide policyholders enough incentives to choose higher deductible, they would choose lower deductible amounts so that it may aggravate adverse selection as well as moral hazard problems. Therefore, this study argues that this negative relationship may be signaling that the threshold system does not function as intended such as to provide a guideline for careful driving as well as to reduce moral hazard and small claims payment. On the other hand, the result may also support the 'propitious selection' argument of Hemenway(1990) that high-risk drivers are less likely to purchase coverage because they are less risk averse. Also, a driver with a loss experience in 2014 purchases a higher threshold coverage in 2015 so that there would be a 'learning effect' after the policyholder experienced an accident in <Table 7, 9, 11, 13, 14>. Thus we find *ex-post* moral hazard exist in Korean auto insurance market. This finding is different from Kim et al.(2009).

Second, with the selection of MED/EMED, the results show a negative relationship as same as in the case of the threshold. Thus, this result also support Smith and Head(1978) and Saito(2006). But we could not find the 'learning effect' with this variable.

Third, an insured who purchased a long-term insurance and supplementary health insurance coverage in 2014 has more likelihood to experience auto accident(s) next year, which verifies that adverse selection problem exists where there is no underwriting is required[43]. Also, because there is no underwriting, no information of policyholder's claim history is shared in the market, our findings may indirectly support Cohen(2005) and Chiappori and Salanié (2000) arguments that if insurers share the past claims of those drivers, the correlation between coverage and risk would not exist or moral hazard will be reduced.

Fourth, we figure out that if policyholders are covered more in terms of coverage limits and the number of coverage they purchased, then they have a higher probability of auto accident in coming year because they become indifferent or less cautious to possible losses after they purchase larger coverage. So, there exists an *ex-ante* moral hazard in this market. This result supports the argument of Cohen and Dehejia(2004) that someone who purchases large coverage does not need to be precautious. At the same time <Table 11> shows that high risk driver pool group tends to purchase more number of coverage, which supports that we have moral hazard in the market in general. This study argues that there are *ex-ante* and *ex-post* moral hazard at the same time in Korean auto-related insurance market in a broad sense.

In sum, this study tests whether adverse selection exists in Korean insurance market where a

[43] In fact the supplementary health insurance has underwriting process but it is not related to auto insurance coverage.

tight regulation is exercised, most policy forms are standardized, and all policyholder's experience is shared by all market participants. The findings support Hemenway(1990), Chiappori and Salanié (2000), Cohen(2005), and Saito(2006) arguments. Also this study finds that we have *ex-ante* as well as *ex-post* moral hazard in the Korean auto insurance market.

[REFERENCE]

Chiappori, P., and B. Salanié, 1997, Empirical Contract Theory: The case of Insurance Data, European Economic Review, 41: 943-950.

Chiappori, P., and B. Salanié, 2000, Testing for Asymmetric Information in Insurance Markets, *Journal of Political Economy*, 108, pp.56-78.

Cohen, A., 2005, Asymmetric Information and Learning: Evidence from the Automobile Insurance Market, *The Review of Economics and Statistics*, 87(2): 197-207.

Cohen, A. and R. Dehejia, 2004, The Effects of Automobile Insurance and Accident Liability Laws on Traffic Fatalities, *Journal of Law and Economics*, 47(2):357-393.

Cohen, A. and L. Einav, 2007, Estimating Risk Preferences from Deductible Choice, *The American Economic Review*, 97(3): 745-788.

Cohen, A., and P. Siegelman, 2010, Testing for Adverse Selection in Insurance Markets, *The Journal of Risk and Insurance*, 77(1): 39-84.

Dionne, G., P. Michaud, and M. Dahchour, 2013, Separating Moral Hazard from Adverse Selection and Learning in Automobile Insurance: Longitudinal Evidence from France, *Journal of the European Economic Association*, 11(4): 807-917.

Dionne, G., N. Fombaron, N. Doherty, 2012, Adverse Selection In Contracting, (https://www.researchgate.net/publication/238597457)

Doerpinghaus, H., J. Schmit, and J. J. Yeh, 2008, Age and Gender Effects on Auto Liability Insurance Payouts, *The Journal of Risk and Insurance*, 75(3): 527-550.

Hemenway, D., 1990, Propitious Selection, *Quarterly Journal of Economics*, 105:1073-1069.

Horswill, M., A. Waylen, and M. Tofield, 2004, Drivers' ratings of different components of their own driving skill: a greater illusion of superiority for skills that relate to accident involvement, *Journal of Applied Social Psychology*, 34(1): 177–195.

Kim H., Kim D., Im S., and Hardin J.W., 2009, Evidence of Asymmetric Information in the Auto Insurance Market: Dichotomous Versus Multinomial Measurement of Insurance coverage, *The Journal of Risk and Insurance*, 76(2): 343-366.

Saito, Kuniyoshi, 2006, Testing for Asymmetric Information in the Automobile Insurance Market under Rate Regulation, *The Journal of Risk and Insurance*, 73(2): 335-356.

Shi P., Zhang W., and Valdez E., 2012, Testing Adverse Selection with Two-Dimensional Information: Evidence from the Singapore Auto Insurance Market, *The Journal of Risk and Insurance*, 79(4): 1077-1114.

Smith, M. and G. Head, 1978, Guidelines for Insurers in Pricing Deductibles, *The Journal of Risk and Insurance*, 45(2): 217-238.

2016 General Insurance in Korea (Fact book), Korea non-life insurance association. (http://www.knia.or.kr)