TESTING FOR EVIDENCE OF ADVERSE SELECTION IN DEVELOPING AUTOMOBILE INSURANCE MARKET

by

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Abstract

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In the paper I investigate the evidence of adverse selection in Kyiv automobile insurance market, which can be identified as a developing insurance market. For separation of adverse selection from moral hazard, as a cause of asymmetric information problem, I employ the unused observables test, proposed by Finkelstein and Poterba (2006), which allows for the presence of heterogeneity in risk preferences. I find that individual riskiness influences the choice of coverage and the occurrence of accidents, which gives the opportunity to state about the evidence of adverse selection problem in the market. Using different specification of the policyholder's riskiness, I check obtained results for the robustness. Investigating the relationship between the individual loss ratio and choice of coverage, I do not find presence of cross subsidization in the insurance market. Thus, I conclude that Kyiv automobile insurance market is affected by adverse selection, but, on the other hand, it is not seriously infected by cross subsidization problem between policyholders. It supports previous findings suggesting that problem of asymmetric information is immanent mainly for undeveloped and developing insurance markets.

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GLOSSARY

Adverse selection problem – problem, which is present when, before the signing of a contract, the party that establishes the conditions of the contract has less information than the other party on some important characteristics affecting the value of the contract.

Asymmetric information occurs when one party to a transaction has more or better information than the other party.

Cross subsidization – is market situation, where one group pays a relatively high price and thus enables another group to pay a relatively low price.

Insurance – a form of risk management primarily used to hedge against the risk of a contingent loss.

Moral hazard problem – problem, which appears when the agent receives private information after the relationship has been initiated; it refers to the possibility that the redistribution of risk (such as insurance which transfers risk from the insured to the insurer) changes people's behavior.

Chapter 1

INTRODUCTION

During the past decades, the problem of asymmetric information has received increasing attention among insurance and economic theories. Since Rothschild and Stiglitz (1976) first investigated the issues of adverse selection in insurance markets, theoretical analysis on the markets with asymmetric information and adverse selection in particular was provided by many other researchers; among them were Miyazaki (1977), Spence (1978), Riley (1979), and Arnott and Stiglitz (1988).

According to Rothschild and Stiglitz (1976) adverse selection in insurance markets refers to the theoretical tendency for low risk individuals to avoid or drop out of voluntary insurance with the result that insurance pool can be expected to contain too many high risk individuals. In other words, adverse selection problem appears in the case when the insurer has no information about the risk profiles; the cover and premium level are set somewhere between what is required by the low and high risk users, so that the company can at least break even. In this situation, the low risk policyholders feel that they are paying too much for the insurance relative to their risk-profile and drop out of the risk pool, which leads to the average risk in the pool to rise, causing premiums to rise, and more people to drop insurance pool.

A number of recent papers are devoted to the empirical application of the theory in order to determine whether asymmetric information exists in particular insurance markets. To find the evidence of asymmetric information, a correlation test is used. According to it, the null hypothesis of symmetric information is

rejected if there is positive correlation between the choice of contract purchased and the occurrence or severity of an accident, conditional on the policyholder's characteristics which are used in determination of the insurance premium. Under adverse selection as a cause of asymmetric information, it is considered that high-risk agents most likely choose full coverage of the insurance contract and typically get an accident in the period under insurance.

While investigating the problem of asymmetric information and adverse selection in particular, researches came to different conclusions about its existence. Rothschild and Stiglitz (1976) strongly predict that adverse selection exists because of existence of positive correlation between insurance claims and the level of insurance. Puelz and Snow (1994) prove this empirically showing that there is adverse selection in the contractual relationship between an American insurer and its policyholders. However, Dionne et al. (2001) argue that the Puelz's and Snow's results can not be robust because of incomplete specification in the econometric model tested. Dionne et al. (2001) conclude that there is no evidence of asymmetric information using a model based on similar data from a Canadian insurance company and the test for non-linearities in insurance pricing.

Cohen (2005) argues that adverse selection problem in automobile insurance market is present since policyholders with relatively large driving experience get to know their type of risk. Based on this knowledge, they take a decision about the type of contract coverage, causing coverage-accident correlation. Finkelstein and Poterba (2006) identify the presence of adverse selection in the U.K. annuity market by presenting their own unused observables test for adverse selection. Huang et al. (2005) also find the empirical evidence of asymmetric information in Taiwan's automobile insurance market. However, they use data in the early stage of the developing insurance market, and it is possible that asymmetric information is present especially in the early stage of the insurance market.

However, many more empirical studies have failed to find evidence for asymmetric information and adverse selection in particular. Among them are van de Ven and van Vliet (1995), who studied Netherlands health insurance (1995); Cawley and Philipson (1999), who analyzed the American life insurance market; Chiappori and Salanie (2000), who studied French automobile insurance market; Cardon and Hendel (2001), who researched the American health insurance market; Saito (2003), who investigated Japanese automobile insurance market; Finkelstein and McGarry (2004), who analyzed the American long-term life insurance market, and others.

Although the researchers can describe possible problems associated with adverse selection and suggest policy to alleviate these problems, the empirical evidence of insurance market suffering from adverse selection occurs rarely. This phenomenon might be explained by the fact that insurer in the case of using appropriate risk classification, experience rating, and deductibles can eliminate adverse selection in the insurance market (Dionne et al. (2000)).

Asymmetric information matters in less developed insurance markets because insurance companies experience lack of statistical data on traffic accidents, undeveloped relationships between firms, and legislation regulation of bad quality. All these factors cause difficulties when writing optimal contracts. Moreover, companies operating on developing insurance market have less experience detecting the insurance fraud and managing insurance agents. Since these mechanisms help reduce the problem of adverse selection and/or moral hazard, informational problems matter more in developing insurance markets than in the developed ones.

Taking into account that organization and realization of auto insurance in Ukraine do not fully confirm to the world standards and meet a lot of legal, social, economic, and organizational problems, which can be mainly explained by

the lack of insurance market development, I consider that the Kyiv automobile insurance market is a good approximation of developing insurance market. Thus, the aim of my research is to investigate the evidence of adverse selection in developing automobile insurance market. More specifically, I ask the empirical questions: (i) whether developing automobile insurance market is characterized with adverse selection problem and (ii) whether high risk policyholders are cross-subsidized by low risk policyholders in it. To the best of my knowledge, I am the first to do such a research in Ukraine.

Separation of adverse selection from moral hazard is one of the most important empirical issues in this field. That is why, in my research I will concentrate on the question whether the evidence of adverse selection (not just asymmetric information) really exists in the developing automobile insurance market. For determination of evidence for adverse selection, I will employ the unused observables test, proposed by Finkelstein and Poterba (2006), who have used this test for long-term life insurance market. According to this test, if it is found that unused observable characteristic is correlated with policyholder's risk type and his choice of insurance coverage, then the presence of adverse selection is indicated.

In order to investigate the presence of cross subsidization on the automobile insurance market, I implement the test for cross subsidization to determine whether the equilibrium causes the cross subsidization of high risks by low risks within a given risk category as predicted by Miyazaki's theory of adverse selection (1977). To provide evidence for the cross subsidization hypothesis, I will test if the loss ratio is positively related to the choice of insurance coverage. I will check whether low risk policyholders pay a relatively high price and thus enable high risk individuals to pay a relatively low price for the insurance coverage.

In my research I will use the data set which contains information about the automobile insurance policies and claim history provided by a Ukrainian

insurance company. Risk classification used by insurance company is based on driver's characteristics (gender, company experience, and type of use) and on vehicle's characteristics (age, model and value of the car, country, where the car was manufactured, cylinder capacity of engine, and type of car body). The company also has collected other information about policyholder, such as place of residence, but does not use it in setting prices, which give us opportunity to test for adverse selection using unused observables test, where this variable is considered as unused observable characteristic. The observations for the research are available from more than 2000 policyholders during the 2004 year: since January 2004 till December 2004.

The remainder of this paper is organized as follows. In chapter 2 I briefly show the literature review concerning the problem of adverse selection. Empirical hypothesis and methodology are presented in chapter 3. Data descriptions are shown in chapter 4 and estimation of results are described in chapter 5. Finally, in chapter 6 I present concluding remarks.

Chapter 2

LITERATURE REVIEW

2.1. Different Approaches for Separating Adverse Selection from Moral Hazard

Asymmetric information can prevent the efficient operation of insurance markets. However, the issue about existence of asymmetric information in particular market is controversial. Most of the current researches have tested for the evidence of asymmetric information using positive correlation test proposed by Chiappori et al. (2000). According to the test, if a positive correlation between the amount of insurance purchased and risk occurrence, conditional on the policyholder characteristics which are used in premium determination, exists, the null hypothesis of symmetric information is rejected. According to Chiappori et al. (2006), the conditional correlation approach is very robust and simple.

In the Rothschild's and Stiglitz's (1976) model of competition under adverse selection, the existence of correlation is explained by the proposition that high risk agents prefer to pay more than low risk for additional coverage. Thus, high risk agents choose insurance contract with higher coverage. According to Arnott and Stiglitz (1988), under moral hazard the opposite reason causes the same correlation. An agent switches to a contract with greater coverage becomes more risky because he makes less effort being careful.

Trying to separate adverse selection and moral hazard in the insurance market is not easy. Chiappori and Salanie (2000) consider this problem and state that both cause the positive correlation between the choice of insurance coverage and the

occurrence of the claim. Therefore, under the test they proposed, it is not possible to identify whether the asymmetry in information is caused by adverse selection or moral hazard.

Dionne and Gagne (2002) separate moral hazard from adverse selection using the analysis of the effect of the replacement cost endorsement. The test they proposed can not always be used, since the dependent variable characterizes the existence or absence of replacement cost endorsement. This special endorsement gives the opportunity to the policyholder to get a new car in case of its total damage or theft. However, in practice, such endorsement is rare.

Finkelstein and Poterba (2004), as well as Dionne and Gagne (2002), separate moral hazard from adverse selection using a particularity of a sample set. Finkelstein and Poterba (2004) use data of annuity market in order to provide a direct test for adverse selection, assuming that moral hazard problem is limited in the market. They study the mortality experience of people who buys annuities and find support for adverse selection effects in the annuity market. After a robustness check, the authors conclude that no adverse selection exists on initial amount of annuity payment.

Chiappori and Heckman (2000) propose employing dynamic data to verify the moral hazard problem. According to their research, under moral hazard, the hazard rate of an accident increases before an accidents and falls afterwards. In case of the absence of moral hazard problem, the hazard rate should not change after an accident occurs, which is tested in parametric and non parametric way. Abbring et al. (2003) also show that dynamic insurance data allow to separate moral hazard and adverse selection. Testing for adverse selection (and particularly asymmetric learning) requires analyzing the joint process followed by accidents and contractual choice.

Saito (2003) examines whether adverse selection could be inferred when regulation prohibits insurance companies from using some of the drivers' characteristics. If region classification is not used and adverse selection problem exists, policyholders from riskier regions will purchase more insurance coverage. He tests for this with a bivariate probit model and χ^2 test proposed by Chiappori and Salanie (2000) and checks obtained results for the robustness using different definitions of risk.

Huang et al. (2005) propose to test for adverse selection using data on policy renewal. By adopting claim records as a proxy of the insured's risk type, they allege that only adverse selection, not moral hazard, can explain the relationship between the choice of coverage and the previous-year claim records for the continuing renewal contracts. They argue that the individual losses will be positively correlated to choice of coverage, if both adverse selection and cross subsidization exist on the marker.

Finkelstein and Poterba (2006) propose their own test for adverse selection in insurance markets which take into account heterogeneity in policyholders' preferences. This test uses any observable characteristic of policyholder that is not used in setting insurance rates. If that characteristic is correlated with policyholder's risk type and his choice of insurance coverage, then adverse selection exists.

Chiappori et al. (2006) propose the test for asymmetric information complemented to unused observable test proposed by Finkelstein and Poterba (2006). For their test distinguishing between two types of the contract proposed by insurer is needed. According to their test whether policyholder, who choose not full insurance coverage (contracts which covers not all but selected risk occurrence) instead full insurance coverage (contracts which cover all possible insurance risk), get higher premium for the contract and net losses can be

determined. Test for asymmetric information proposed by Chiappori et al. requires an assumption about the insurer's cost structure. The unused observables test proposed by Finkelstein and Poterba does not need this restriction. Moreover, test for asymmetric information can be used only in the case when insurer propose two types of insurance products, while the unused observables test can be used regardless limitation in insurance products offered by insurer. On the other hand, the disadvantage of the unused observables test is that it requires distinguishing among individual characteristics those attributes which are not used in price determination, but which are correlated with demand for insurance policy and risk of accident.

Unused observables test, unlike the test for asymmetric information proposed by Chiappori et al. (2006), gives opportunity to determine the evidence of adverse selection (not just for asymmetric information). Quoting Finkelstein and Poterba (2006), "observing that a characteristic that insurance companies do not use in pricing is positively correlated with insurance quantity purchased and with ex post risk occurrence … [and] when there is external information that certain characteristics are correlated with risk occurrence for reasons other than insurance coverage then the unused observables test can identify the presence of adverse selection and rule out moral hazard as the exclusive source of the observed correlation between individual attributes, insurance quantity, and risk of loss".

2.2. Empirical Studies concerning the Problem of Adverse Selection and Cross Subsidization in Automobile Insurance Market

After considering the main empirical tests used to detect adverse selection, I turn to the empirical evidence. Since I am interested in the behavior of different agents in automobile insurance market, in this section I am going to consider the main results and weaknesses of the principal studies concerning the evidence of

adverse selection in automobile insurance market. I divide these studies into those which find adverse selection and those which do not.

The strongest evidence for adverse selection is in Cohen (2005). She uses Israeli data on a 5-year panel of drivers. She tests for correlation between low deductibles and more accidents using OLS, Poisson and Negative Binomial specifications. In order to define the evidence for adverse selection she also uses bivariate probit recommended by Chiappori and Salanie (2000).

Cohen (2005) finds that policyholder who chooses low-deductible cost the insurer approximately 20% more than a regular-deductible. Thus, she finds that Israel insurance market is spoiled by the adverse selection problem. She also shows the evidence of learning in this panel. For policyholders with low driving experience, choosing low-deductible contract is not associated with a higher accident rate and more claims. Such association exists only with more experienced drivers. The author also concludes that policyholders who change insurers have higher probability of accident and higher insurance rate, which is defined on the base of all characteristics observed to the insurer.

Despite finding the strongest evidence for adverse selection in automobile insurance market, Cohen (2005) raises several unanswered questions. Since tests for the evidence of adverse selection can be considered as tests of the joint hypothesis that insurers maximize their profit, the presence of asymmetric information is inconsistent with the profit-maximizing insurers' behavior. The insurers, who want to operate with profits, should recognize the higher accident risks by low-deductible policyholder's choice, and establish a higher premium to them, overcoming the problem of dishonest behavior of policyholders.

Huang et al. (2005), following Chiappori and Salanie (2000), study Taiwan's automobile insurance market. They find adverse selection showing the positive

correlation between the choice of insurance coverage and the previous-year claim records, and the positive correlation relationship between loss ratio and the choice of coverage. They use data in the early stage of the developing insurance market. It is likely that asymmetric information exists especially in the early stage of the insurance market.

Chiappori and Salanie (2000) test for asymmetric information in France examining a large dataset from a single insurer. Their data represent the insured policies of a homogeneous group of drivers with three year driving experience. They conclude that in the process of choosing automobile insurance contract policyholders behave like they have not better information then the insurer about their risk type. Therefore, the main finding of Chiappori and Salanie (2000) is that there is no evidence for asymmetric information and adverse selection in particular in the automobile insurance market. The absence of evidence for adverse selection suggests that this problem exists only to a very limited extent or not at all in the automobile French insurance market. The absence of adverse selection in the insurance market of low experience drivers is not extremely surprising result. However, it is even more worth defining, whether insured drivers with much experience allow learning about their riskiness faster than the insurance company.

Dionne et al. (2001) test for adverse selection in the Quebec auto insurance market using a more limited dataset. They criticize the econometric methods and dataset used by Puelz and Snow (1994), concluding that high-risk drivers would not choose small deductibles within risk classes in the market under their research. They also show that risk classification used by insurer fixes the problem of adverse selection.

Saito (2003) investigates if adverse selection could be made worse by rate regulation which prohibits insurance company from using some of the driver's

characteristics. He tests data from the automobile insurance policies of the large insurance company, assumed representative in Japan. He finds no evidence of adverse selection. Instead, he finds negative correlation between risk and coverage, which is reverse to the adverse selection hypothesis. He explains the absence of a sign of adverse selection by the fact that this phenomenon exists only to a very limited extent in the Japanese market.

Empirical support of the asymmetric information theory indicates that insurance customers rarely act through an adverse selection mechanism, and does not provide evidence on the cross subsidization hypothesis that high risk policyholders are subsidized by low risk ones. For these reasons, it is also essential for my research to investigate not only the evidence for adverse selection in the undeveloped insurance market, but also the evidence for cross subsidization of high risk policyholders by low risk ones. Only a few researchers find evidence of cross subsidization in insurance markets. Among the recent research the evidence for cross subsidization has been found only by Makki and Somwaru (2001), who show that high risks are undercharged and low risks are overcharged in the U.S. crop insurance market, and by Huang et al. (2005), who find that the loss ratio is positively correlated to the choice of insurance coverage in Taiwan's automobile insurance market.

Chapter 3

METHODOLOGY

3.1. The Positive Correlation Test for Asymmetric Information

According to asymmetric information theory, in insurance market policyholders who purchase more coverage are more likely to experience accident. Under moral hazard problem, drivers under insurance lower their cost when the accidents occur and thus increase the expected losses of the insurer. Under adverse selection problem, policyholders before signing the contract have better knowledge about their riskiness than insurer and thus high risk policyholders will purchase more insurance coverage.

The most common test for asymmetric information is the positive correlation test, proposed by Chiappori and Salanie (2000). According to this test correlation between the amount of policyholder's insurance and his ex-post risk experience, conditional on the observable characteristics that are used in pricing insurance policies, is determined. In order to implement this test I need the following assumption.

Let $i = 1,\ldots,n$ denote policyholders. X_i is the set of exogenous variables for policyholder i. Let suppose existence of two 0-1 endogenous variables: (1) $C_i = 1$ if i buys insurance with full coverage; $C_i = 0$ if i buys insurance product according to which only selected risk is insured; (2) $A_i = 1$ if i occurs at least one accident in which he was at fault; otherwise $A_i = 0$.

Although insurance company offers different possible terms of contract with, for instance, different level of deductibles, I treat them identically since other non standard contracts are proposed rarely and are defined according to the special agreement with company. I also separate accidents in which policyholders are at fault and those in which they are not. I do this because in the case when the insured has an accident in which another driver is blamed, information about policyholder's risk type can not be determined definitely. Finally, since few drivers have more than one accident, I do not distinguish them either.

Following Chiappori and Salanie (2000), I set up two probits models: one for the choice of coverage (C_i) and one for the occurrence of an accident (A_i). The estimating equations are:

$$C_i = \begin{cases} 1 & \text{if } C_i^* = \beta X_i + \varepsilon_i > 0 \\ 0, & \text{otherwise} \end{cases} \tag{1a}$$

and

$$A_i = \begin{cases} 1 & \text{if } A_i^* = \gamma X_i + \eta_i > 0 \\ 0, & \text{otherwise} \end{cases} \tag{1b}$$

Under the null hypothesis of symmetric information, the residuals in these equations, ε_i and η_i, should be uncorrelated. Otherwise, a statistical significant positive correlation between them implies rejection of the null hypothesis. In order to determine the existence of correlation between residuals, I first estimate these probits independently, and then compute the generalized residuals $\hat{\varepsilon}_i$ and $\hat{\eta}_i$:

$$\hat{\varepsilon}_i = E(\varepsilon_i \mid C_i) = \frac{\phi(X_i\beta)}{\Phi(X_i\beta)} C_i - (1 - C_i) \frac{\phi(X_i\beta)}{\Phi(-X_i\beta)} \tag{2a}$$

$$\hat{\eta}_i = E(\eta_i \mid A_i) = \frac{\phi(X_i\beta)}{\Phi(X_i\beta)} A_i - (1 - A_i) \frac{\phi(X_i\beta)}{\Phi(-X_i\beta)} \tag{2b}$$

Where ϕ and Φ specify the density and the cumulative distribution function of $\mathrm{N}(0,1)$. Test statistics is defined as

$$W = \frac{(\sum_{i=1}^{n} \hat{\varepsilon}_i \hat{\eta}_i)^2}{\sum_{i=1}^{n} \hat{\varepsilon}_i^2 \hat{\eta}_i^2} \tag{3}$$

Under the null of conditional independence between the choice of coverage and the occurrence of an accident, $\mathrm{cov}(\varepsilon_i, \eta_i) = 0$, W is distributed asymptotically as $\chi^2(1)$, which give us possibility to test for the existence of symmetric information.

However, in order to use this methodology, I need to choose what exogenous variables should be included in $\mathrm{X_i}$. From a theoretical point of view, the most relevant exogenous variables are variables which insurer uses in the process of ratemaking. For this reason I include in $\mathrm{X_i}$ vehicle's, policyholder's, and contract characteristics which are known for the insurer and recorded in the policy.

Taking into account that estimating two probits independently is appropriate only under the absence of conditional independence between dependent variables, I also estimate a bivariate probit with ε_i and η_i distributed as N (0,1) and correlation coefficient ρ between them. Estimation of this coefficient will allow to test for the evidence of asymmetric information under the null hypothesis for symmetric information $\rho = 0$.

3.2. Testing for Asymmetric Information and Adverse Selection in the Presence of Heterogeneity in Risk Preferences

The positive correlation test can give appropriate information about asymmetric information only in the case of policyholders' homogeneity in risk preferences. If individuals have different preferences for insurance, the absence of correlation between ε_i and η_i may not imply symmetric information in insurance market. To see this, suppose that individuals have private information about their risk type (Z_1) and different risk aversion (Z_2). Then ε_i and η_i, the residuals from the coverage equation (1a) and the risk of accident occurrence (1b) respectively, can be defined as:

$$\varepsilon_i = Z_{1,i} * \pi_1 + Z_{2,i} * \pi_2 + \omega_i \tag{4a}$$

and

$$\eta_i = Z_{1,i} * \theta_1 + Z_{2,i} * \theta_2 + v_i \tag{4b}$$

Under positive correlation test, risk type (Z_1) will be positively correlated with insurance coverage and the risk of accident occurrence if there is private information about risk type so that $\pi_1 > 0$ and $\theta_1 > 0$. However, in the case when risk aversion (Z_2) is also positively correlated with coverage but negatively correlated with risk of loss ($\pi_2 > 0$ but $\theta_2 < 0$), the correlation between ε_i and η_i may be zero or even negative. Therefore, even in the presence of asymmetric information in the case that policyholders' risk heterogeneity exists the positive correlation test can fail to reject the null hypothesis of symmetric information. So, using the positive correlation test in the presence of heterogeneity in individual preferences can lead to Type II error.

Also, more risk-averse policyholders or policyholders with high volatility in income will be more likely to purchase insurance coverage. At the same time, a positive relationship between insurance coverage and risk occurrence can be generated if such individuals also have a higher risk of loss. Again, it does not necessarily mean the presence of asymmetric information in the market. In this case, using the positive correlation test in the presence of heterogeneity in individual preferences can reject the null hypothesis about symmetric information leading to Type I error.

To deal with these complications, I follow Finkelstein and Poterba (2006). According to them, in order to determine the evidence of asymmetric information even in the presence of heterogeneity in preferences test for asymmetric information using unused observables can be employed. The authors argue that "when there is symmetric information, conditional on the risk class in which the insurance company places a buyer, there should not be any buyer characteristics that can be observed by the econometrician and that are correlated with both insurance coverage and risk of loss". The existence of such a characteristic, known to the potential policyholder, but not to the insurer, and correlated with coverage and ex-post risk of loss, provides evidence of asymmetric information.

In order to implement the unused variables test I introduce the following notations. Let X denotes the attributes that are used by an insurer in order to refer a potential policyholder to a risk class. C_i is insurance coverage of individual i, and A_i is his accident occurrence. An element of either policyholder's risk type (Z_1) or his risk preference (Z_2) is denoted by variable W, which represent the unused observable variable. Estimating the following regression by bivariate probit give us opportunity to apply the unused variables test for the automobile insurance market.

$$C_i = \begin{cases} 1 & \text{if } C_i^* = \beta X_i + \alpha W_i + \varepsilon_i' > 0 \\ 0 & \text{otherwise} \end{cases} \quad (5a)$$

and

$$A_i = \begin{cases} 1 & \text{if } A_i^* = \gamma X_i + \delta W_i + \eta_i' > 0 \\ 0 & \text{otherwise} \end{cases} \quad (5b)$$

Regardless of the sign of α and δ, rejecting the joint null hypothesis that $\alpha = 0$ and $\delta = 0$ is equivalent to rejecting the null hypothesis of symmetric information. In order to implement the unused observables test I require the following information about insured: (i) policyholder's characteristics known by insurance companies, (ii) insurance coverage, (iii) ex-post risk experience, and (iv) individual characteristic, which is not used for pricing the contract.

In my case, insurer has the information about individual place of residence, which is not used in insurance price determination, but should be correlated with demand for insurance and policyholder's risk type. Moreover, policyholder's place of residence as unobservable characteristic gives us opportunity to determine the evidence for adverse selection. According to the Finkelstein and Poterba (2006), such an unobservable characteristic, correlated with possible risk occurrence but not taken into account by insurer, allows to eliminate moral hazard as a source of the correlation.

3.3. Testing for Cross Subsidization

In my research I also want to test for cross subsidization. To provide evidence for this, I test whether the loss ratio (LR_i), claim amount divided by premium, is related to the choice of coverage. According to Huang at al. (2006), in the presence of cross subsidization, the loss ratio should be positively correlated with the policyholder's choice of risk coverage. Thus, assuming that LR_i is the total

claim amount divided by the premium for each individual i, X_i and C_i have the same determination as previously; I can define the existence of cross subsidization by testing the following Tobit regression:

$$LR_i = \beta_1 X_i + \beta_2 C_i + \varpi_i \tag{6}$$

The selection of using Tobit regression in determining the relationship between loss ratio and choice of coverage can be explained by the fact that dependent variable LR_i has a mass on zero. This happens because most policyholders do not experience a claim. I run a Tobit regression of (6), estimate parameters, and test the null hypothesis that $\beta_2 > 0$. Rejecting the null hypothesis is equivalent to rejecting the null hypothesis of cross subsidization.

Chapter 4

DATA DESCRIPTION

4.1. Voluntary Automobile Insurance Market in Ukraine

I apply the positive correlation test and unused observables test for the determination of asymmetric information and adverse selection, and test for the cross subsidization to the voluntary automobile insurance market in Kyiv. To do this, I first describe the institutional setting peculiar to Ukraine and Kyiv in particular.

Automobile insurance in Ukraine consists of obligatory automobile liability insurance and voluntary insurance. Obligatory insurance only covers civil liability for bodily injury and property damage liability. All the other damages are covered by voluntary insurance. Types of coverage of voluntary automobile insurance in Ukraine correspond to the types of insurance coverage using in developed automobile insurance markets. Among the main types of insurance coverage used in Ukraine are Collision, Comprehensive, Uninsured, Loss of Use, and Car Towing coverage.

Main characteristic of these types of insurance coverage are described below, following Wikipedia (www.wikipedia.org.ua):

Collision coverage provides coverage for an insured's vehicle that is involved in an accident, subject to a deductible. This coverage is designed to provide payments to repair the damaged vehicle, or payment of the cash value of the vehicle if it is not repairable. *Comprehensive* (a.k.a. - Other Than Collision) coverage provides coverage, subject to a deductible, for an policyholder's vehicle that is damaged by incidents that are not considered by Collisions. For example, fire, theft (or attempted theft), vandalism, weather, or impacts with animals are some types of

Comprehensive losses. *Uninsured coverage* provides coverage if another at-fault party either does not have insurance or does not have enough insurance. In effect, insurance company acts as at fault party's insurance company. *Loss of Use* coverage, also known as rental coverage, provides reimbursement for rental expenses associated with having an insured vehicle repaired due to a covered loss. *Car Towing* coverage is also known as Roadside Assistance coverage. Traditionally, automobile insurance companies have agreed only to pay for the cost of a tow that is related to an accident that is covered under the automobile policy of insurance. This had left a gap in coverage for tows that are related to mechanical breakdowns, flat tires and running out of gas. To fill that void, insurance companies started to offer the Car Towing coverage, which pays for non-accident related tows. Insurance companies in Ukraine also propose for their potential customers *Liability coverage* can have higher limit of liability than under obligatory civil liability coverage. Liability coverage in the case of obligation and option provides payment for loss of health for third person or his damaged vehicle within a limit defined in contract.

Law of Ukraine concerning automobile insurance confirms to the common features of international market of insurance. In Ukraine the potential insured can freely choose the insurance company in which he wants to insure his vehicle. However, the insurer can not force the policyholder to renew his insurance contract in the next period or even to disrupt the contract in the period of insurance. At the same time, there is requirement according to which policyholder could not insure the same risk several time by using services of different insurers.

Insurance market of Ukraine is not well developed in comparison with other markets, primarily because of the lack of development in rate making. Experience rating, where the policyholder's insurance premium for the next year is defined on the base of the previous driver's claim history, is commonly used in the countries of EU. In Ukraine, this methodology is not common, mainly because non-publicity of insurance information. There is no database in Ukraine, which is accessible for all insurers and which has information about the drivers and their claim history. Hence, the bonus-malus system of ratemaking, where positive (claim-free) history of driving experience leads to decrease in the premium, is not present. Since experience rating is one of the methods to eliminate possible

problems of asymmetric information, it is wise to expect that in the absence of appropriate rate making system it is more probable to observe problems of asymmetric information, because of the higher attractiveness of insurance to the bad drivers and drivers without experience.

4.2. Descriptive Statistics

For my research I use data obtained from a large insurance company that operates in the market for automobile insurance in Ukraine. Since most of data observations come from Kyiv region, I limit the sample to the policies that were sold in Kyiv in order to investigate the evidence of adverse selection in this region. For simplicity, I also exclude the policyholders who purchased contracts with contractual periods not equal to one year, since this exclusion influences my sample by less than one percent. My final sample for the period from the 1st of January 2004 to the 31st of December 2004 consists of more than 2000 voluntary insurance policies undertaken. This data should be representative for the automobile insurance market in Kyiv, since it comes from a top 10 (by sales) insurance company, out of more than 100 in Ukraine. Data corresponds to the main features of automobile insurance market in Ukraine, and Kiev in particular: the main peculiarities, which are typical for the entire market (that I am going to discuss below), are also typical for the company from which I obtain information for research.

Data for the research contains all information that the insurance company has about policyholders. In particular, I have the information about the policy issued in the year policyholder joined the insurer and for those who stayed for more than one year. The information about the claim history is also available. Thus, I have both quantitative and qualitative information about the contracts and claims occurred (see Table 1).

Table 1: List of Variables

Vehicle's characteristics	
Value of car	The value of the car (in UAH)
Weight of vehicle	The weight of the car (in kilograms)
Size of engine	The size of engine (in square centimeters)
Type of body	
Sedan	Equal to 1 if the car is sedan
Estate car	Equal to 1 if the car is estate car
Off-road vehicle	Equal to 1 if the car is off-road vehicle
Minivan	Equal to 1 if the car is minivan
Minibus	Equal to 1 if the car is minibus
Truck	Equal to 1 if the car is truck or wagon
Country of the car	
Asia	Equal to 1 if the car is made in Asia
Eastern Europe	Equal to 1 if the car is made in Eastern Europe
West Europe	Equal to 1 if the car is made in West Europe
USA	Equal to 1 if the car is made in USA
Age of the car	Age of the car (in years)
Policyholder's characteristics	
Company experience	Equal to the number of years that the policyholder has been with the insurer
Gender	Equal to 1 if policyholder is male
Type of vehicle's use	Equal to 1 if car is used in private needs and equal to 0 if it is used in commercial needs
Place of residence	Equal from 1 to 10 depending on the city district were policyholder is registered
Contract's characteristics	
Type of coverage	Equal to 1 if all risks are insured
Premium paid	Yearly premium
Amount of claims	All payments resulting from the from the insurance of the policy
Claim occurrence	Equal to 1 if claim concerning the insurance contract appears

I have the following information about policyholders, their cars, and claim occurrences.

Policyholder's car characteristics: size of engine, type of fuel, model year, car weight, type of car body, value of car, country of car in which it was made;

Policyholder's characteristics: place of residence which is used for billing purposes, gender, company experience, which show how many years policyholder had

insurance with this insurer in the past, and type of vehicle's use (commercial or private).

Contract's characteristics: type of contract (new policy or renewal), type of coverage (full or not full), premium paid.

Period covered: the length of the period covered by the purchased policy.

Realization of risk covered by the policy: description of the claim occurred, including the amount of damages reported and the amount which the insurer paid or was expected to pay.

The insurer offers for its potential customers a menu of contract choices after obtaining the above information. Voluntary motor insurance, under which policyholder insures possible risks and which are not contrary to Ukrainian legislation, are connected with the following risks:

1) risk of loosing the possession, using and disposing of vehicle, including risk of vehicle's damage and theft (Comprehensive Coverage);

2) risk of reimbursement by insured a property damage or personal injury to third parties in the case of insured's fault (Civil liability: Death / Bodily Injury and Damage to Property);

3) risk of loosing life, health and ability to work for persons which was in insured vehicle during the risk occurrence (Personal Injury Protection).

The company proposes three types of insurance coverage that are typical for automobile insurance in Ukraine and some achievable combinations of the three. In order to support the methodology, which I am going to use, I divide all policies issued into two types: contract, which covers all risk (full coverage)

against the one, which covers only selected risks (not full coverage). I assume that more individuals, who are not confident in their driving capability, will demand full coverage in the presence of adverse selection.

As shown in Table 2, from the data obtained, I can state that about 43% of all customers choose to insure all type of risks. However, the claim frequency is quite large and equals to 22% with average claim amounting UAH 3042.30. Likewise, the average premium that policyholder paid equals UAH 4267.47. On average, more than 90% of policyholders are men and only about 26% of the policyholders use vehicles for private needs. These numbers are typical for the entire automobile insurance market in Ukraine. According to Annual Insurance Market Overviews which were done by the League of Insurance Companies in Ukraine (www.uainsur.com) and other independent researchers (www.forinsurer.com), voluntary automobile insurance and other types of insurance, are relatively expensive for a driver with middle income. For this reason, most of the insured are legal entities. Ukrainian insurance statistics also shows that females in Ukraine, like in the rest of the world, have lower probability to get into an accident. So, I can state that those descriptive statistics are representative for the automobile insurance in Ukraine and Kyiv in particular.

The average length of the insurance of the vehicle amounts to 2.5 years, which gives us the sense that mostly new cars are insured with the average size of engine about 2055 square centimeters. The average value of a car insured amounts to UAH 92967. On average, expensive cars are mostly insured with the min value of UAH 5100 and the maximum value of UAH 988006. Insurer also divides vehicles by the type of body (sedan, estate car, off-road vehicle, minivan, minibus, truck) and according to the country where the cars were made (Eastern Europe, Western Europe, Asia, and USA). From the data descriptive statistics I can see that the common car insured is sedan (63%), and as a rule, the car insured comes

from Western Europe (57%) or Eastern Europe (21%). Previous statistics also corresponds to the main features of the entire insurance market in Ukraine, since demand for new cars, especially for not big daily used cars, increases which influences the automobile insurance contracts. At the same time, the most popular cars come to Ukraine from Germany, France, England, and countries of Far East.

Table 2: Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
Vehicle characteristics				
Value of car	92966.71	89437.91	5100	988006
Weight of vehicle	1471.353	1418.117	720	19700
Size of engine	2054.764	1522.52	796	14566
Age of the car	2.45118	2.66763	0	25
Type of body				
Sedan	0.633966	0.481831	0	1
Estate car	0.118001	0.322684	0	1
Off-road vehicle	0.088385	0.28392	0	1
Minivan	0.050902	0.219849	0	1
Minibus	0.026377	0.16029	0	1
Truck	0.082369	0.27499	0	1
Country of the car				
Asia	0.178158	0.382735	0	1
Eastern Europe	0.206386	0.404804	0	1
West Europe	0.568718	0.49537	0	1
USA	0.046738	0.211125	0	1
Policyholder's characteristics				
Company experience	1.030541	1.445617	0	6
Gender	0.910227	0.285923	0	1
Type of vehicle's use	0.256826	0.436984	0	1
Contract characteristics				
Type of coverage	0.434058	0.495747	0	1
Premium paid	4267.468	4602.167	94	82305.5
Amount of claims	3042.304	13290.83	0	250000
Claims occurrence	0.223508	0.416692	0	1

In setting the price (premium) of the contract for each potential policyholder, the insurance company uses the information described above, which is obtained from its customers. Not having an access to the insurer's formula, I try to define how the insurance company determined premium to the policyholders. I regress for all individuals the premium paid by each policyholder on all characteristics that the company has as shown in Appendix 1 by regression (1). At 5% level of significance, most of coefficients of ordinary least square are significant and fit the model well (R^2=0.69).

Moreover, after including squares of the major variables and their interception as shown in Appendix 1 by regressions (2) - (4), I find that they are insignificant, suggesting that the company's formula for premium determination is pretty much linear. The model for premium gives us reasonable explanation of how policyholder's and his car's characteristics influence the premium. Thus, within 90% confidence interval, in the case of full coverage the premium should increased by UAH 1378 against the case of not full insurance coverage. In the case when a car is used for private needs, the premium should increase by UAH 667 and the male should pay approximately by UAH 541 more than female. The last dependence is commonly used not only by Ukrainian insurance companies, but also in the world practices because it is proved that women are more careful drivers.

The value of a car is also a reasonable factor in defining the premium level. Value's increase by UAH 1 causes the increase in premium by UAH 0.045. However, a type of body is not always significant in determination of value of premium. Nevertheless, at 10% level of significance for the insurance of off-road vehicle and estate car the premium increases by UAH 848 and UAH 400 correspondingly, and for the insurance of truck premium of insurance contract's premium decreases by UAH 804 in comparison with the premium for sedan's

insurance. If car is made in the USA, Asia, or Eastern Europe, the premium should increase by UAH 992, UAH 402, and UAH 424 accordingly in comparison to the car made in Western Europe.

However, from the regression I also observe that every additional year of insurance experience in the same company increases the amount of premium by UAH 360. This suggests that it is not common for the Ukrainian company to use driver's experience in order to encourage safe driving. However, it is more usual that the policyholder who renews his policy has not good claim history. The last statement is supported by finding that, with 95% confidence interval, there is a significant positive influence of policyholder's experience relative to his loss ratio (see Table 6.). Thus, I find that every additional year of policyholder's experience in the same company increases loss ratio by 0.664. This suggests that insurance company mostly insures bad drivers, who have high probability of having accidents. This fact is confirmed by the finding that the loss rate is quite large.

Chapter 5

EVIDENCE FOR ADVERSE SELECTION

5.1. Testing for Asymmetric Information

My empirical analysis begins with testing the existence of asymmetric information in Kyiv automobile insurance market. I start by comparing policyholders with full and not full coverage in terms of the claims submitted. I first test for a correlation between contracts with full coverage and claim amount using ordinary OLS and a correlation between contracts with full coverage and occurrence of an accident using biprobit and logit specifications. For the set of all customers choosing either full or not full coverage in a contract, I regress the amount of claim in monetary units (for the probit and logit, occurrence of at least one claim) on all policyholder's and vehicle's characteristics and on a dummy variable representing whether a full or non-full coverage was chosen.

The results, which are shown in Table 3, indicate that even at 10% level of significance the amount of claims is not statistically significantly influenced by the type of policyholder's contracts. In other words, if a policyholder chooses contract which covers all risk or only selected ones, in general, this does not influence the amount of claims which individual requires if an accident occurs. Similar conclusion follows from the binary equations. Since type of contract's coverage does not influence the occurrence of an accident, policyholder's choice of contract does not influence the probability of accident occurrence, which gives the possibility to reject the hypothesis of evidence for asymmetric information in the Kyiv automobile market.

Table 3: Estimation Results for Coverage-Claim Correlation
(asymmetric information determination)

COEFFICIENT	OLS	Probit	Logit
	Amount of claims	Claim occurrence	Claim occurrence
Full coverage	166.7	0.0999	0.167
	(604)	(0.066)	(0.11)
Company experience	478.1**	0.132***	0.225***
	(212)	(0.022)	(0.037)
Private use	1332	0.277***	0.472***
	(828)	(0.089)	(0.15)
Male	-719.2	-0.169	-0.279
	(1156)	(0.12)	(0.20)
Age of car	-130.3	-0.0620***	-0.112***
	(121)	(0.015)	(0.027)
Size of engine	-3.53e-05	-1.07e-04	-2.89e-05
	(2.90e-05)	(2.80e-05)	(2.90e-05)
Value of car	1.03e-06***	3.68e-07**	9.64e-07**
	(4.50e-07)	(4.40e-07)	(4.40e-07)
Off-road vehicle	502.6	-0.243**	-0.417**
	(1140)	(0.12)	(0.21)
Minibus	1081	-0.336	-0.632
	(1814)	(0.23)	(0.42)
Minivan	1054	-0.101	-0.190
	(1325)	(0.15)	(0.26)
Estate car	877.4	-0.112	-0.207
	(911)	(0.10)	(0.18)
Truck	-780.0	-0.109	-0.212
	(1216)	(0.14)	(0.26)
USA	4.464	-0.1000	-0.160
	(1404)	(0.16)	(0.29)
Asia	573.3	0.323***	0.540***
	(888)	(0.092)	(0.16)
Eastern Europe	643.2	0.145*	0.247*
	(786)	(0.086)	(0.15)
Constant	778.8	-0.807***	-1.321***
	(1335)	(0.14)	(0.24)
Observations	2161	2161	2161

Standard errors are shown in parentheses.
***, **, * indicate statistical significance at 1%, 5%, and 10% levels respectively.

I also use positive correlation test for determining the evidence of asymmetric information suggested by Chiappori and Salanie (2000), in which a pair of probits

models are used in order to test the conditional dependence between the choice of coverage and the occurrence of claim. These two equations are the choice of the contract's coverage (full or not full) on the policyholder's and vehicle's characteristics and the occurrence of at least one claim on the policyholder's and vehicle's characteristics. To test the conditional dependence of models' residuals I use a test statistic W using formula (3) described in chapter 3. W is distributed asymptotically as $\chi^2(1)$. Under the null hypothesis of $\text{cov}(\varepsilon_i, \eta_i) = 0$ there is no asymmetric information. If asymmetric information exists in automobile insurance market, the conditional dependence between the choice of coverage and the occurrence of the claim should be significantly positive. However, in insurance market under consideration the statistics W displayed in Table 4 shows that the correlations between the choice of coverage and the occurrence of a claim are not significantly different from zero. Thus, I can reject null hypothesis about existence of asymmetric information in the market.

Table 4: The Conditional Correlation between Coverage and Claim

W~ $\chi^2(1)$	**ϱ**
2.288281	0.0600413
Prob > $\chi^2(1)$ = 0.1304	Prob > |z| = 0.134
Do not reject H^0: $\text{cov}(\varepsilon_i, \eta_i) = 0$	Do not reject H^0: $\varrho = \text{cov}(\varepsilon_i, \eta_i) = 0$
No evidence for asymmetric information	No evidence for asymmetric information

In order to test the same conditional dependence between the choice of coverage and the occurrence of the claim, I also estimate these regressions using bivariate probit. The bivariate probit estimates the correlation ϱ between the errors terms of two binary equations. If the error terms of the two equations are independent, then ϱ will be equal to zero. The results of this regression are displayed in Appendix 2. An estimate for ϱ is positive, but statistically insignificant even at

10% confidence level. Thus, test statistic W and correlation coefficient ρ between the errors terms of two binary equations, which are reported in Table 4, show that the empirical evidence implies that asymmetric information problems do not exist in Kyiv automobile insurance market.

5.2. Testing for Adverse Selection caused by Unobservable Variables

The first look at the data from the Kyiv State Vehicle Inspectorate, displaying in Appendix 3, suggests that probability of accidents, injuries, and death from car accidents vary among the city districts: the probabilities of crash accidents are higher in non-central district, since they mostly occur in the case of high-speed driving.

Thus, if premiums are not discriminated by region and if disposition for adverse selection exists, drivers in more risk region are more likely to purchase insurance with high coverage than in lower risk region. However, according to Finkelstein and Poterba (2006) in order to prove that adverse selection exists in the automobile insurance market, place of residence, as a policyholder's characteristic that is unused by the insurance company, should be correlated with both insurance coverage and ex-post risk of loss.

I assume that place of residence as geographic information is correlated with individual characteristics that affect both demand for insurance and policyholder's risk type and thus cause the problem of adverse selection. Drivers, who live in risk region, where it is high possibility to get an accident, and where they are probably drive in morning and evening rush hours or around the place of residence during the day, are more likely to demand insurance contract compared to the drivers who are registered in safer city regions. On the other hand, I suppose that drivers registered in more risky city regions should be more risky, since they are not able to avoid bad road infrastructure (for instance dangerous

turning), to limit speed for other drivers and to avoid other traffic disadvantages of a district. For this reason drivers who live in more risk region become more sensitive to get crash accidents.

In order to test for adverse selection using test with unused variables proposed by Finkelstein and Poterba (2006), I estimate bivariate probit model as shown in Table 5 by regression (1), regressing claim occurrence and then type of contract's coverage on all policyholder's and vehicle's characteristics and variable which approximates riskiness of policyholder by representing number of car accidents in previous to insurance year in the district where policyholder is registered. Thus, if adverse selection as a source of asymmetric information exists, coefficient which determines riskiness of region (number of car accidents in previous to insurance year) should significantly influence on the type of coverage policyholder chose and the probability of accident. At 5% level of significance I find that in Kyiv automobile insurance market place of policyholder's residence influences on the policyholder's choice of coverage and on the occurrence of accidents; hence, I can reject the null hypothesis of symmetric information stating that I find evidence for adverse selection.

Moreover, in order to prove that obtained results are robust I use the same model but approximate riskiness of drivers by representing number of car accidents per sq km in previous to insurance year in the district where policyholder is registered. I use this approximation since in smaller district fewer accidents can be registered and the wrong decision about district danger and thus policyholder's riskiness can be taken. For this reason, I consider that it is also valuable to consider density of accidents occurrence in all districts as individual riskiness.

Table 5: Estimation Results for Adverse Selection Determination

COEFFICIENT	Biprobit (1)		Biprobit (2)	
	Claim occurrence	Full coverage	Claim occurrence	Full coverage
Company experience	0.133***	0.183***	0.133***	0.179***
	(0.022)	(0.021)	(0.022)	(0.022)
Private use	0.232***	-0.469***	0.277***	-0.361***
	(0.090)	(0.085)	(0.089)	(0.085)
Male	-0.173	0.161	-0.165	0.175
	(0.12)	(0.12)	(0.12)	(0.12)
Age of car	-0.0635***	-0.0440***	-0.0602***	-0.0326**
	(0.015)	(0.013)	(0.015)	(0.013)
Size of engine	-3.53e-05	-1.07e-04***	-2.89e-05	-9.08e-05***
	(2.90e-05)	(2.80e-05)	(2.90e-05)	(2.80e-05)
Value of car	1.03e-06**	3.68e-07	9.64e-07**	1.96e-07
	(4.50e-07)	(4.40e-07)	(4.40e-07)	(4.40e-07)
Off-road vehicle	-0.240**	-0.0972	-0.254**	-0.143
	(0.12)	(0.11)	(0.12)	(0.11)
Minibus	-0.346	-0.242	-0.304	-0.102
	(0.23)	(0.19)	(0.23)	(0.19)
Minivan	-0.103	-0.0778	-0.0898	-0.0220
	(0.15)	(0.13)	(0.15)	(0.13)
Estate car	-0.101	0.326***	-0.100	0.337***
	(0.10)	(0.091)	(0.10)	(0.091)
Truck	-0.0798	0.139	-0.0851	0.167
	(0.14)	(0.12)	(0.14)	(0.12)
USA	-0.119	0.328**	-0.109	0.304**
	(0.16)	(0.14)	(0.16)	(0.14)
Asia	0.317***	0.269***	0.336***	0.312***
	(0.092)	(0.089)	(0.091)	(0.090)
Eastern Europe	0.124	0.261***	0.150*	0.299***
	(0.087)	(0.080)	(0.086)	(0.079)
Accidents	0.000848**	0.00151***		
	(0.00043)	(0.00041)		
Accidents per area			0.00159*	0.00562***
			(0.00095)	(0.00090)
Constant	-0.945***	-0.632***	-0.888***	-0.760***
	(0.17)	(0.16)	(0.16)	(0.16)
athrho	0.0553		0.0557	
	(0.040)		(0.040)	
Observations	2161	2161	2161	2161

Standard errors are shown in parentheses.
***, **, * indicate statistical significance at 1%, 5%, and 10% levels respectively.

I estimate bivariate probit model again as shown in Table 5 by regression (2), regressing claim occurrence and then type of contract's coverage on all policyholder's and vehicle's characteristics and variable which approximates riskiness of policyholder's by representing number of car accidents per sq km in previous to insurance year in the district where policyholder is registered. There I observed similar results (however with a smaller level of significance): at 10% level of significance, place of policyholder's residence influences on the policyholder's choice of coverage and on the occurrence of accidents. Therefore, I can reject the null hypothesis of symmetric information stating that I find evidence for adverse selection.

Thus, I obtain that positive correlation test proposed by Chiappori and Salanie (2000) indicates for the absence of asymmetric information in Kyiv automobile insurance market, while unused observables test indicates for the existence of asymmetric information caused by adverse selection due to different riskiness of the city districts. However, these results are not surprising: Finkelstein and Poterba (2006) and Chiappori at al. (2006) affirmed that primary positive correlation test and just correlation between type of contract coverage and accidence occurrence in the same investigation period can lead to type I and type II errors (which I describe in chapter 3) due to neglecting policyholder's risk heterogeneity. Therefore, under pure theoretical assumption that all policyholders are homogeneous in risk tolerance, the positive correlation test reflects the absence for asymmetric information and adverse selection in particular. However, taking into account unobserved heterogeneity in individual preferences, and thus eliminating type II error, unused observables test shows that at 10% level of significance I can reject the null hypothesis of symmetric information. At the same time, I can state that I found the evidence for adverse selection (not just for asymmetric information). This can be explained by the fact that using policyholder's place of residence as unused variable in the model corresponds to

condition of determination for the evidence of adverse selection. According to Finlelstein and Poterba (2006), "observing that a characteristic that insurance companies do not use in pricing is positively correlated with insurance quantity purchased and with ex post risk occurrence … [and] when there is external information that certain characteristics are correlated with risk occurrence for reasons other than insurance coverage [such case as I have] then the unused observables test can identify the presence of adverse selection and rule out moral hazard as the exclusive source of the observed correlation between individual attributes, insurance quantity, and risk of loss".

Thus, I can conclude that taking into account heterogeneity in individual risk preferences, there is evidence for adverse selection as a source of asymmetric information in the Kyiv automobile insurance market.

I go even further in order to check for the robustness of my conclusions. Since most of the researchers, among which there are Chiappori and Heckman (2000), Abbring et al. (2003), Huang et al. (2005), have used dynamic data in order to define the evidence for adverse selection, I also use claim history of policyholders in order to approximate their riskiness. I use a sub-sample with policyholders who were insured with this insurance company in previous years. The record of accident in previous to investigation period could be a proxy of driver's risk type. To test whether a high risk type will choose high coverage, causing problem of adverse selection, I regress type of contract's coverage chosen by insured on all his characteristics, characteristics of his car and variable which approximates riskiness of policyholder's by representing his claim (or accident occurrence) in previous to insurance year.

The results, which are shown in Appendix 4, indicate that at 1% level of significance the type of contract's coverage chosen by insured is statistically significantly influenced by his risk type, which give us possibility to state that I

cannot reject the hypothesis of evidence for adverse selection. In other words, more risky drivers (in my case drivers who had accident in previous to insurance year) choose contract with full coverage insuring all possible risks, thus causing the problem of adverse selection in the market.

5.3. Testing for Cross subsidization

Finally, to trace the existence of cross subsidization as a problem which accompanies problems of asymmetric information in Kyiv automobile insurance market, I check whether the choice of contract's type influences the policyholder's loss-ratio.

Table 6: Estimation Results for the Loss Ratio Determination

COEFFICIENT	Tobit	COEFFICIENT	Tobit
	Loss ratio		Loss ratio
Full coverage	0.572	Minibus	0.0685
	(0.41)		(1.32)
Company experience	0.664***	Minivan	-0.00197
	(0.14)		(0.92)
Private use	1.783***	Estate car	-0.330
	(0.56)		(0.64)
Male	-0.591	Truck	-0.772
	(0.73)		(0.91)
Age of car	-0.360***	USA	-0.473
	(0.093)		(1.01)
Size of engine	0.000109	Asia	1.816***
	(0.00017)		(0.57)
Value of car	0.00000114	Eastern Europe	0.864
	(0.0000027)		(0.54)
Off-road vehicle	-1.118	Constant	-6.131***
	(0.76)		(0.91)
sigma		6.579***	
		(0.24)	
Observations		2161	

Standard errors are shown in parentheses.
***, **, * indicate statistical significance at 1%, 5%, and 10% levels respectively.

I regress loss ratio on all the policyholder's and vehicle's characteristics and type of coverage they chose as shown in Table 6. Using this methodology, I want to check whether policyholders who buy contract with full coverage are more risky and have higher loss ratio and thus are cross-subsidized by low risk policyholders, whose price for the contracts are overcharged in this case. Finding that coefficient near the variable 'type of insurance coverage' is insignificant, give opportunity to state that loss ratio does not depend on the type of coverage insured chose, and therefore there is no evidence for cross subsidization in the Kyiv automobile insurance market.

From the regression above I also come to conclusion that company experience, type of vehicle's use and the age of car are the variables which at 1% level of significance influence the loss ratio. Thus, additional year of previous insurance within the same insurer increases loss ratio by around 0.664 times, if policyholder is private agent his loss ratio increase by 1.783 times compared to the policyholder, who represent legal entity. If an insured has a newer car his loss ratio decreases.

Thus, the issues from this and previous models imply that the developing voluntary automobile insurance market under consideration is spoilt by the asymmetric information problem caused by adverse selection and free from cross subsidization problems. Although I find that there is no problem of cross subsidization, I am not insisting that this problem does not exist in the market. My study indicates that the Kyiv automobile insurance market is affected by adverse selection but is not seriously infected by cross subsidization problem between policyholders.

Chapter 6

CONCLUSIONS

The empirical application of the theory concerning identifying the evidence of asymmetric information has received increasing attention. Special concern in the literature is devoted to determination of the source of asymmetric information in the insurance market. In my research, for separation of adverse selection from moral hazard I employ the unused observables test, proposed by Finkelstein and Poterba (2006). According to this test, I investigate whether place of residence as unused observable characteristic is correlated with policyholder's risk type and his choice of insurance coverage. For determining the cross subsidization problem, which accompanies to the problem of adverse selection, I test whether individual loss ratio is positively related to the choice of insurance coverage.

I start with investigating whether the problem of asymmetric information is typical for Kyiv voluntary automobile insurance market, which can be identified as a developing insurance market. I use ordinary OLS, biprobit and logit specifications to test for a correlation between contracts with full coverage and claim occurrence. I find that whether a policyholder chooses contract which covers all risks or only selected ones, in general, this does not influence the amount of claims which an individual requires if an accident occurs. Positive correlation test for the asymmetric information proposed by Chiappori and Salanie (2000) gives us the same conclusion supporting the evidence of symmetric information in the market.

Taking into account that primary positive correlation test and just correlation between type of contract coverage and accidence occurrence in the same

investigation period need an assumption about individual homogeneity in risk preferences, I also test for the evidence of asymmetric information using unused observables test, which relaxes this assumption. Using different specifications of the policyholder's riskiness based on his place of residence, I come to the conclusion that there is problem of adverse selection in the market under consideration. In order to check whether obtained results are robust, I also employ dynamic data, approximating policyholder's riskiness by accident occurrence in a previous to insurance year. I find that more risky drivers choose contracts with full coverage insuring all possible risks, thus causing the problem of adverse selection in the market. Investigating the relationship between individual loss ration and choice of coverage, I do not find presence of cross subsidization in insurance market.

Thus, I conclude that Kyiv automobile insurance market is affected by adverse selection, but is not seriously influenced by cross subsidization problem between policyholders. My finding does not contradict the papers in which the evidence for adverse selection is not found, since in most of them developed insurance markets are examined. My investigation supports findings that asymmetric information problem is more common to the developing markets since existing mechanisms in developed insurance market tend to alleviate the problem of adverse selection and/or moral hazard. My study suggests that further research of asymmetric information and adverse selection in particular should concern the investigation of insurance market over larger period of time or across countries with insurance markets in different stages of development, in order to determine how the improvement in market performance influences on the asymmetric problem.

BIBLIOGRAPHY

Abbring, Jaap, Pierre-Andre Chiappori, and Jean Pinquet. 2003. "Moral hazard and dynamic insurance data," Journal of the European Economic Association, 1, pp. 767-820.

Arnott, Richard and Joseph Stiglitz. 1988. "The basic analytics of moral hazard," Scandinavian Journal of Economics, 90, pp. 383-413.

Cardon, James and Igal Hendel. 2001. "Asymmetric information in Health Insurance: Evidence from the National Medical Expenditure Survey," Rand Journal of Economics, 32, pp. 408-427.

Cawley, John and Tomas Philipson. 1999. "An empirical examination of information barriers to trade in insurance," American Economic Review, 89, pp. 827-846.

Chiappori, Pierre-Andre and James Heckman. 2000. "Testing for moral hazard on dynamic insurance data: theory and econometric tests," mimeo, University of Chicago, accessed at http://home.uchicago.edu/~pchiappo/wp/pacjhfin.pdf

Chiappori, Pierre-Andre and Bernard Salanie. 2000. "Testing for Asymmetric Information in Insurance Markets," Journal of Political Economy, 108, pp. 56-78.

Chiappori, Pierre-Andre, Bruno Jullien, Bernard Salanie, and Francois Salanie. 2006. "Asymmetric Information in Insurance: General Testable Implications," Rand Journal of Economics.

Cohen, Alma. 2005. "Asymmetric Information and Learning in the Automobile Insurance Market," Review of Economics and Statistics, 87, pp. 197-207.

Dionne, Georges and Robert Gagné. 2002. "Replacement Cost Endorsement and Opportunistic Fraud in Automobile Insurance," Journal of Risk and Uncertainty, 24 (3), pp. 213-230.

Dionne, Georges, Christian Gourieroux and Charles Vanasse. 2001. "Testing for evidence of adverse selection in the automobile insurance market: a comment," Journal of Political Economy, 109(2), pp. 444-451.

Dionne, Georges, Neil A. Doherty, and Nathalie Fombaron. 2000. "Adverse selection in insurance markets," In Georges Dionne, ed. Handbook of Insurance Economics, pp. 185-244.

Finkelstein, Amy and James Poterba. 2004. "Adverse Selection in Insurance Markets: Policyholder Evidence from the U.K. Annuity Market," Journal of Political Economy, 112, 183-208.

Finkelstein, Amy and James Poterba. 2006. "Testing for Adverse Selection with "Unused Observables"", NBER Working Paper No. W12112 available at

SSRN: http://ssrn.com/abstract=893767.

Finkelstein, Amy and Kathleen McGarry. 2004. "Multiple Dimensions of Private Information: Evidence from the Long-Term Care Insurance Market," American Economic Review.

Huang Rachel J., Larry Y. Tzeng, Jennifer L. Wang and Kili C. Wang. 2005. "Evidence for Adverse Selection in the Automobile Insurance Market," mimeo, Ming Chuan University, accessed at http://www.aria.org/meetings/2006papers/HuangTzengWangWang.pdf

Makki, Shiva S. and Agapi Somwaru. 2001. "Evidence of Adverse Selection in Crop Insurance Market," Journal of Risk and Insurance, 68, pp. 685-708.

Miyazaki, Hajime. 1977. "The Rat Race and Internal Labor Markets," The Bell Journal of Economics, 8, pp. 394-418.

Puelz, Robert and Arthur Snow. 1994. "Evidence on Adverse: Equilibrium Signaling and Cross Subsidization in the Insurance," Journal of Political Economy, 102 (2), pp. 236-257.

Riley, John G. 1979. "Informational equilibrium," Econometrica, 47, pp. 331-359.

Rothschild, Michael and Joseph Stiglitz. 1976. "An Essay on the Economics of Imperfect Information," Quarterly Journal of Economics, 90, pp. 629-649.

Saito, Kuniyoshi. 2003. "Does Less Risk Classification Induce More Adverse Selection? Evidence from Automobile Insurance Market," mimeo, University of Tokyo, accessed at http://www.e.u-tokyo.ac.jp/cirje/research/workshops/micro/micropaper03/ksaito.pdf

Spence, Michael A. 1978. "Product Differentiation and Performance in Insurance Markets," Journal of Public Economics, 10, pp. 427-447.

van de Ven, Wynand and Rene van Viet. 1995. "Consumer Information Surplus and Adverse Selection in Competitive Health Insurance Markets: An Empirical Study," Health Economics, 14, pp. 149-161.

www.forinsurer.com

www.uainsur.com

www.wikipedia.org.ua

APPENDIX A

Estimation Results for the Premium Determination
Dependent variable: Premium for the contract paid

COEFFICIENT	OLS (1)	OLS (2)	OLS (3)	OLS (4)
	Premium paid	Premium paid	Premium paid	Premium paid
Company experience	359.7***	353.7***	359.9***	361.4***
	(41.7)	(41.9)	(42.7)	(42.2)
Full coverage	1378***	1374***	1378***	1289***
	(119)	(118)	(118)	(133)
Private use	667.4***	635.1***	1326	1511*
	(163)	(162)	(904)	(901)
Male	540.8**	533.2**	1193	1336
	(227)	(226)	(879)	(870)
Age of car	5.601	-36.49	-39.87	-100.1*
	(23.7)	(60.3)	(60.4)	(60.5)
Size of engine	-0.356***	-0.329***	-0.329***	0.714***
	(0.048)	(0.048)	(0.048)	(0.16)
Value of car	0.0445***	0.0378***	0.0378***	0.0327***
	(0.00082)	(0.0020)	(0.0020)	(0.0022)
Off-road vehicle	847.7***	952.4***	947.2***	754.9***
	(224)	(225)	(225)	(225)
Minibus	298.9	369.0	372.1	-338.6
	(356)	(355)	(355)	(367)
Minivan	-137.2	-145.2	-149.3	-240.1
	(260)	(259)	(259)	(257)
Estate car	400.1**	336.3*	330.5*	205.3
	(179)	(179)	(179)	(179)
Truck	-804.1***	-888.7***	-889.8***	-990.3***
	(239)	(239)	(239)	(237)
USA	992.4***	984.9***	981.5***	821.3***
	(276)	(275)	(275)	(273)
Asia	401.7**	428.1**	430.2**	277.8
	(174)	(175)	(175)	(175)
Eastern Europe	424.1***	255.6	251.9	78.57
	(154)	(161)	(161)	(161)
Age of car^2		1.662	1.861	3.210
		(3.68)	(3.69)	(3.67)
Value of car^2		1.18e-08	1.19e-08	1.57e-08
		(2.99e-09)	(3.00e-09)	(3.02e-09)
Value of car*Age of car		-0.000107	-0.000104	-0.000357
		(0.00036)	(0.00036)	(0.00035)

COEFFICIENT	OLS (1)	OLS (2)	OLS (3)	OLS (4)
	Premium paid	Premium paid	Premium paid	Premium paid
Private use*Male			-705.2	-976.7
			(908)	(900)
Private use*Full coverage				120.3
				(279)
Size of engine^2				-7.59e-05
				-1.10e-05
Constant	-1044***	-518.4*	-1175	-2216**
	(262)	(309)	(900)	(906)
Observations	2161	2161	2161	2161
R-squared	0.69	0.69	0.69	0.70

Standard errors are shown in parentheses.
***, **, * indicate statistical significance at 1%, 5%, and 10% levels respectively.

Appendix B
Estimation Results for Asymmetric Information

COEFFICIENT	Biprobit	
	Claim occurrence	Full coverage
Company experience	0.139***	0.198***
	(0.022)	(0.021)
Private use	0.261***	-0.415***
	(0.088)	(0.084)
Male	-0.162	0.175
	(0.12)	(0.12)
Age of car	-0.0634***	-0.0442***
	(0.015)	(0.013)
Size of engine	-0.0000301	-0.0000983***
	(0.000029)	(0.000028)
Value of car	0.000000989**	0.000000315
	(0.00000044)	(0.00000044)
Off-road vehicle	-0.246**	-0.111
	(0.12)	(0.11)
Minibus	-0.345	-0.244
	(0.23)	(0.19)
Minivan	-0.104	-0.0779
	(0.15)	(0.13)
Estate car	-0.100	0.324***
	(0.10)	(0.091)
Truck	-0.106	0.0971
	(0.14)	(0.12)
USA	-0.0851	0.390***
	(0.16)	(0.14)
Asia	0.333***	0.304***
	(0.091)	(0.089)
Eastern Europe	0.157*	0.326***
	(0.086)	(0.078)
Constant	-0.769***	-0.325**
	(0.14)	(0.14)
athrho	0.0600	
	(0.040)	
Observations	2161	2161

Standard errors are shown in parentheses.
***, **, * indicate statistical significance at 1%, 5%, and 10% levels respectively.

APPENDIX C

Distribution of Accidents, Deaths, and Injuries
across the Kyiv City Districts

Districts	Accident		Death		Injury	
	2003	**2004**	**2003**	**2004**	**2003**	**2004**
Holosiivskiy	261	279	41	38	266	318
Darnytskiy	193	205	26	26	213	238
Desnyanskiy	304	441	33	48	333	515
Dniprovskiy	371	330	36	39	396	373
Obolonskiy	250	283	37	34	284	319
Pecherskiy	174	170	13	10	208	197
Podilskiy	215	204	28	26	234	257
Svyatoshynskiy	322	385	38	36	344	461
Solomyanskiy	350	318	32	27	384	339
Shevchenkivskiy	351	437	23	25	388	508

APPENDIX D

Estimation Results for Coverage-Past Claim Correlation (adverse selection determination)

COEFFICIENT	Probit	Logit
	Type of coverage	Type of coverage
Claim occurrence in previous year	0.308***	0.514***
	(0.11)	(0.17)
Company experience	0.0787**	0.127**
	(0.038)	(0.062)
Private use	-0.545***	-0.906***
	(0.13)	(0.22)
Male	0.0581	0.0991
	(0.18)	(0.30)
Age of car	-0.0357**	-0.0589**
	(0.017)	(0.028)
Size of engine	-0.0000826*	-0.000134*
	(0.000043)	(0.000069)
Value of car	-0.00000110	-0.00000192
	(0.00000076)	(0.0000013)
Off-road vehicle	-0.0612	-0.126
	(0.15)	(0.25)
Minibus	-0.259	-0.407
	(0.24)	(0.39)
Minivan	0.0416	0.0691
	(0.20)	(0.33)
Estate car	0.367***	0.603***
	(0.13)	(0.22)
Truck	0.487	0.783
	(0.31)	(0.51)
USA	-0.579***	-1.004***
	(0.21)	(0.36)
Asia	-0.230*	-0.370*
	(0.13)	(0.22)
Eastern Europe	-0.314***	-0.525***
	(0.11)	(0.19)
Constant	0.426*	0.709*
	(0.25)	(0.41)
Observations	936	936

Standard errors are shown in parentheses.
***, **, * indicate statistical significance at 1%, 5%, and 10% levels respectively.