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BETWEEN-GROUP ADVERSE SELECTION: EVIDENCE FROM GROUP CRITICAL ILLNESS INSURANCE

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WORKING PAPERS ON RISK MANAGEMENT AND INSURANCE NO. 141

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OCTOBER 2014

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Abstract

This paper demonstrates the presence of adverse selection in the group insurance market for policies that allow no individual choice. As a "conventional wisdom," group insurance mitigates adverse selection, since individual choice is minimized and group losses have less variability than individual losses. We complement this "conventional wisdom" by analyzing a group insurance scenario in which individual choice is excluded, and find that there is still adverse selection at the level of group, i.e. between-group adverse selection. Between-group adverse selection, however, disappears over time if the group renews with the same insurer for certain periods. Our results thus indicate that addressing adverse selection via group insurance is not necessarily effective enough to mitigate adverse selection, but that experience rating and underwriting based on the information that insurers learn over time are important.

Keywords

Adverse Selection, Information Asymmetry, Learning Over Time, Group Insurance, Critical Illness Insurance

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Introduction

Group insurance constitutes a substantial part of global insurance markets and its importance to the life and health insurance is increasing.[1] Administrative efficiency and low volatility of performance are strong motivations for the insurance industry to develop group insurance products (Bickelhaupt, 1983). Many policyholders are also in favor of group insurance since it avoids the difficult and anxious task of shopping for insurance (Pauly and Percy, 2000).

As a "conventional wisdom" and widely accepted industry practice, insurers use group insurance to mitigate adverse selection, because (1) the mixture of high and low risks decreases the variance of group losses as opposed to individual losses, (2) individual choice is minimized, and (3) individuals do not strategically act on information asymmetry regarding risk types when group insurance is tangential to other factors influencing an employment decision (Mayers and Smith, 1981; Smith and Stutzer, 1990; Browne, 1992). Mayers and Smith (1981) predict that the group insurance market should have no adverse selection, if the group insurance does not allow individual choices within each group, and if the group is formed for purposes other than purchasing insurance. Browne (1992) uses the group insurance market as the benchmark market free of adverse selection and concludes that individual insurance suffers more from adverse selection than group insurance. Contrast to Mayers and Smith's (1981) prediction, Hanson (2005) proves that the equilibrium in the group insurance market with no individual choice is not materially different from the equilibrium in the individual insurance market. Hanson's (2005) model implies that groups strategically act on their information advantages, if any, just as individuals do, which yields group adverse selection. The existence of group adverse selection does not necessarily depend on individual choice, but results from group strategic actions on behalf of the collective welfare. The two competing theoretical predictions motivate us to empirically test for the existence of, and if found, the extent of persistence of adverse selection in a group insurance market without individual choice.

The existing empirical evidence on adverse selection in group insurance concentrates on the U.S. health insurance market, where individual choice among competing

[1] For example, in 2012, the direct written premium of group insurance in U.S. was USD 295 billion, accounting for 41.9% total premium in life and health sector; particularly, group insurance dominates the U.S. health insurance market with 53.8% total health premium (Insurance Information Institute, 2013). The portion of group insurance in life and health premium was 36.6% in 2010 and 36.1% in 2008. In Europe, group insurance takes 36% total premium in life insurance in 2012, while the percentage was 29% in 2010 and 31% in 2008 (Insurance Europe aisbl, 2014).

health insurance plans is an important driver of adverse selection (see e.g., Cutler and Zeckhauser, 2000; Handel, 2013). Simon (2005) shows the adverse selection in U.S. small-group health insurance, which combines the effects of individual choice and group selection. To our knowledge, no empirical literature has tested for the existence and/or persistence of adverse selection in a group insurance market where no individual choice is allowed.

Following Mayers and Smith (1981), we split the individual choice effect and the group decision effect in group adverse selection by differentiating within- and between-group adverse selection. We use a new and comprehensive dataset of group critical illness (CI) insurance policies.[2] Our findings show that adverse selection may exist even if individuals within a group are not allowed to choose their participation and/or coverage; this is in line with Hanson's (2005) theoretical prediction. The information advantages that the group has over the insurer come from the claim history's underreporting of new customers and from the individual-level information that the group possesses and the insurer does not.

We also find evidence that the between-group adverse selection, together with the group's information advantages, disappears over time, if the group renews with the same insurer for certain periods. We attribute this disappearance to the insurer learning over time (Kunreuther and Pauly, 1985; D'Arcy and Doherty, 1990; Hendel and Lizzeri, 2003; De Garidel-Thoron, 2005). Once the insurer has experience with the group, it will gain knowledge on the risk type, and then adjusts the premium or rejects poor risks based on each group's claim experience. Therefore, the information advantage of the group as a new client diminishes with the renewal process. There is no longer any asymmetric information that the group can act on strategically and thus no between-group adverse selection. Cohen (2012) draws the evidence of insurer learning over time from an Israel automobile insurance portfolio. Cutler (1994) documents the wide existence of experience rating in U.S. small-group health insurance market and show that the variation in small-group insurance premium does not result from demographic or benefit differences but from experience rating. This paper complements the empirical evidence by showing the disappearance of between-group adverse selection over time.

The remainder of the paper is structured as follows. In Section 2, we introduce our hypotheses and theoretical background. Section 3 presents the data. Section 4

[2] Critical Illness Insurance covers a limited number of named critical diseases. It pays the insured amount, if any of the diseases listed in Appendix 1 is firstly diagnosed during the policy period and after a predefined waiting period.

explains our empirical models. Section 5 discusses the results. In Section 6, we present the results of the robustness tests. Sections 7 and 8 are discussions and concluding remarks, respectively.

Hypotheses and Theoretical Background

Adverse selection is the tendency of high risks to be more likely to buy insurance or to buy larger amounts of insurance than low risks (Cummins, Smith, Vance, and VanDerhei, 1983). Adverse selection results from the asymmetric information that favors the insurance buyer over the insurer (Akerlof, 1970; Rothshild and Stiglitz, 1976). In making insurance decisions,[3] insureds self-classify themselves into different risk pools, where low risks suffer a welfare loss because they buy less than the optimal amount of insurance (Rothshild and Stiglitz, 1976; Miyazaki, 1977; Wilson, 1977; Spence, 1978). The existence of adverse selection has been widely documented in many lines of individual insurance (see Cohen and Siegelman, 2010, for a review). The evidence is extensive and derived from both real markets (see e.g., Cohen, 2005) and lab experiments (see e.g., Riahi, Levy-Garboua and Montmarquette, 2013), and covering both private competitive markets (see e.g., Cohen, 2005) and public provision of insurance (see e.g., Dumm, Eckles and Halek, 2013).

Regarding adverse selection in the group insurance market, Mayers and Smith (1981) distinguish *within-group adverse selection* that results from individual choices within a group, from *between-group adverse selection* that results from group insurance decisions. Cutler and Zeckhauser (2000) review 14 empirical studies that examine the selection of group health insurance with individual choices, all of which find some type of adverse selection; however, none of them distinguish within-group adverse selection from between-group adverse selection. Simon (2005) analyzes the adverse selection in U.S. small-group health insurance, which results in low availability of health coverage and high premium. The government intervention to restrict insurers' ability to distinguish high from low-risk customers, e.g., restrictions on experience rating and redlining,[4] further limits the availability of insurance for healthier individuals. However, Simon's (2005) evidence from the U.S. small-group health

[3] There are two insurance decisions to be made by the insurance buyer, which may cause adverse selection. Firstly, the participation decision involves choices whether to buy, to cancel, to renew and/or to switch the insurer for certain insurance policy. Positive participation decision is the necessary condition for the next, insurance coverage decision. The coverage decision involves choices of scope of cover, insured amount, deductible and/or other optional details in the policy.

[4] Redlining is the practice of systematically refusing to insure groups in certain high-risk industries or occupations (Simon, 2005).

insurance has strong individual choice element in addition to group selection,[5] and focuses on the reform's impact on small-group insurance with no more than 50 people, which might not be representative of general group behavior. The empirical studies based on U.S. group health insurance reveal the relationship between individual choices and within-group adverse selection. However, whether between-group adverse selection exists and, if so, its extent of persistence, is as yet unknown. Our paper shows the existence of between-group adverse selection, which results from a pure group decision and from a group strategic action. Table 1 summarizes the theoretical framework, empirical literature, and contribution of this paper.

Table 1

Three Types of Adverse Selection

Types of adverse selection	**Insurance decision on participation and coverage**	**Literature providing empirical evidence**
Type I: Individual adverse selection	Individual	See Cohen and Siegelman (2010) for a review of empirical studies, focusing on the individual insurance market
Type II: Within-group adverse selection	Individual and group: the participation of group members is voluntary and/or coverage choice is allowed within a group.	See Cutler and Zeckhauser (2000) for a review of empirical studies, focusing on the U.S. group health insurance market
Type III: Between-group adverse selection	Group: the participation of group members is mandatory and the coverage is identical within a group	Aim of this paper, not covered by existing literature

There are two competing theoretical predictions about between-group adverse selection. Mayers and Smith (1981) predict that if the group is formed for other than insurance purposes, the average risk for the group is less likely to deviate from the relevant population average, which solves any between-group adverse selection problem. However, Hanson's (2005) theoretical model yields the opposite result. It compares the equilibria in the individual insurance market with that in the group insurance market with no individual choice. Hanson (2005) concludes that a profit-maximizing employer[6] will choose contracts off the same equilibrium contract curve as would a purchaser of individual insurance, which suggests the existence of adverse selection for group insurance. This conclusion is subject to the conditions

[5] Simon (2005) documents that "*young single men were particularly sensitive to premium changes in their take-up decisions*," which suggests individual contribution and individual choice are important selection factors.

[6] The profit-maximizing employer is defined as the employer who wants to maximize the sum of the benefits its employees get from the group insurance, minus the price paid for the insurance.

that (1) the group insured[7] makes all decisions on behalf of group members, (2) there is a uniform group policy, (3) there is no wealth effect, (4) there are no administrative costs, and (5) the group is formed for a purpose other than purchasing insurance. According to Hanson's model, even though the pooling of high and low risks reduces the variance of group risks, this turns out to be irrelevant to the standard equilibrium. Between-group adverse selection is independent of individual choices within a group. Simon's (2004) model of insurance where employers buy policies on behalf of their workforce suggests a similar group adverse selection to Hanson's (2005). The two competing theoretical predictions yield our first hypothesis.

Hypothesis I: If group insurance does not allow individual choices within each group and if the group is formed for purposes other than purchasing insurance, the group insurance market does not exhibit adverse selection.

Under the two conditions in *Hypothesis I*, two explanations suggest how and why adverse selection may still exist. Mayers and Smith (1981) argue that individual insured may switch employers because of the differences in health insurance coverage among similar jobs; therefore, high risks choose jobs that offer more comprehensive health insurance coverage and low risks choose jobs offering less. This explanation is unlikely to apply to our dataset because the expected benefit of group critical illness (CI) insurance is relatively small; in our dataset, on statistical average, over 90% of individual insureds have an expected benefit less than CNY 69 (USD 11) per year and over 99% of individual insureds have an expected benefit less than CNY 207 (USD 33) per year.[8] It will not be a solid motivation for the employee to switch jobs because of such small expected benefit. Hanson (2005) provides another explanation for the existence of between-group adverse selection. The profit-maximizing employer behaves the same as the individual insurance buyer when choosing insurance coverage. The employer will choose more comprehensive coverage on behalf of its employees if its employees to be covered are high risks, and vice versa. This explanation requires that the employer, specifically HRs or other responsible department of the employer, possesses an information advantage over the insurer (Akerlof, 1970; Rothshild and Stiglitz, 1976), because, otherwise, the insurer would be able to charge a risk-adequate rate to eliminate adverse selection.

Under the condition of group insured making all insurance decisions, the following two explanations point out the potential sources of group insured's information

[7] The group insured is the employer or other types of group purchasing coverage, e.g., the union.

[8] The expected benefit is calculated by the insured amount, times the average claim frequency (see summary statistics in Table 2).

advantage over the insurer. Cohen's (2005, 2012) empirical evidence shows that the insurer is not able to fully observe a new customer's past claim record and draw inferences about the insured's risk type, because in general the self-reporting of past claims is believed to be incomplete or inaccurate (Insurance Research Council, 1991). Therefore, the insurer can only use risk exposure information and underreported risk experience information to make underwriting and pricing decisions for new clients. In other words, an insured is most likely to have the information advantage when he/she is a new customer to the insurer (Cohen, 2005). This argument applies to both individual and group insurance. Thus, we will use the sub-portfolio of new policies to test *Hypothesis I,* the existence of between-group adverse selection.

Hanson (2005) offers another explanation for the group insured's information advantage, that is, the group insured usually knows the health condition of its employees at the individual level, but the insurer only knows this information at the group average level. In reality, the employer's HR (or other) department usually possesses individual-level health information that the insurer does not, such as whether the employee smokes, or whether the employee himself/herself has a history of serious illnesses (e.g. heart attacks). In some circumstances, the employer is aware that some of its employees have symptoms of critical diseases and purchases insurance based on such information (Monheit and Schone, 2003). The group insured obtains its information advantage via daily interactions with employees, and/or via employees' health examination results consolidated by the HR department, if regulations allow. As many U.S. small-group health insurance studies show, the small groups are expected either to have more information advantages or to make better use of those information advantages than large groups do, thus shall have stronger between-group adverse selection; large groups may not have or may have less between-group adverse selection, because when such groups are large, the risk of unanticipated and expensive medical care events can be spread over a sizeable and typically stable risk pool. As a result, the availability of coverage and associated experience rated premiums generally display little year-to-year variation (Cultler, 1994; Monheit and Schone, 2003). We will address this issue in later robustness test.

Kunreuther and Pauly (1985) and Watt and Vazquez (1997) emphasize that observing the realization of a policyholder's risks in a given period enables an insurer to update its prior beliefs concerning the risks posed by that policyholder in a future policy period. Kunreuther and Pauly (1985) and Cohen and Siegelman (2010) call this "learning over time." Jean-Baptiste and Santomero (2000) construct a model in the reinsurance market supported by evidence in Garven, Hilliard and Grace (2014), showing that the asymmetric information between insurer and reinsurer declines over time with the tenure of the insurer-reinsurer relationship.

Insurer learning over time occurs when the insurer is able to use the observed respective insured's claim experience to adjust the premium and/or reject the renewal. However, this necessary condition does not apply to many individual insurance products. For instance, individual health insurance usually includes the insurer's commitment as the guaranteed renewable clause, which prevents the premium increase and/or the renewal rejection based on the individual's past claim experience with the insurer. Individual life insurance usually involves a long-term commitment from the insurer and, often, policy termination by the insurer or premium rate adjustment are not allowed during the entire policy period. In contrast, an insurer offering group insurance, in almost all lines, is free to adjust the premium rate at renewals or to reject renewals to reflect each group's past claim experience. Therefore, after a few policy periods with the same insurer, the group insured's information advantage from initial claim underreporting disappears. The group insured's information advantage in Hanson (2005) also fails to persist, because the employer's information advantage regarding individual risk type will diminish as high-risk individuals reveal their risk type over time by making claims. The insurer can thus adjust the group premium or reject to renew high-risk groups based on its claim experience. Eventually, the only possible information advantage the group insured may have pertains to the individual health conditions of its new employees.

Mayers and Smith (1981) summarize such process as that frequent contract renegotiation controls adverse selection as long as the information is revealed over time and the insurer is able to monitor and apply the information in pricing and underwriting accordingly. Since information asymmetry is a necessary condition for the existence and persistence of adverse selection (Akerlof, 1970; Rothshild and Stiglitz, 1976), adverse selection should cease to be a problem as soon as the insurance buyer's information advantage over the insurer disappears. We phrase our second hypothesis as follows.

Hypothesis II: The between-group adverse selection in the group insurance market, if any, will disappear if the group renews with the same insurer for a few policy periods.

There is a substantial body of empirical literature showing informational asymmetries and adverse selection falling over time as a result of repeated contracting (see e.g., Cohen, 2012; Garven, Hilliard and Grace, 2014). This paper further documents such a process for between-group adverse selection.

Data and Summary Statistics

To test our hypotheses, we explore the dataset from a life and health insurance company in China. The company has more than 15 years of nationwide operations and competes for open market business. Its operational model, growth path as well as insurance portfolio are representative of the competitive Chinese insurance market. The dataset includes all of the information the insurer uses for making its underwriting decisions and policy pricing for group critical illness (CI) insurance. It also includes information of each claim record. It covers all group CI policies issued between January 2008 and June 2013, and all claims settled between January 2008 and August 2012 under these group CI policies.[9] The business nature of the insurance portfolio is largely, but not only, employee benefits, including benefits for an employee's family.

Critical Illness Insurance is a type of health insurance that was offered for the first time in 1984. It is a loss occurrence based product with claim trigger as the first diagnosis of the critical diseases listed in Appendix 1. Usually, there is a 30- to 90-day waiting period for the first-time purchaser, and the insurer pays the insured amount if the claim is triggered during the policy period and after the waiting period. The claim benefit always equals the insured amount and is paid to the insured in a lump sum without additional benefit, such as medical service. The Insurance Association of China and the Chinese Medical Doctor Association issued guidelines that define 25 types of critical diseases in 2007. In our case and in most cases in the Chinese market, insurers strictly follow the coverage in the guideline. CI insurance serves as the additional financing resource to medical expense insurance, considering the co-payments and exclusions in medical expense insurance. Cochrane (1995) proposed a time-consistent health insurance plan, which provides a lump sum of payment that enables the insured with long-term critical disease to afford future health insurance coverage. This solution echoes the provision of CI insurance as the extra funding for insured with critical disease.

In 2012, 68 life and health insurers and 62 property and liability insurers operated in China's insurance market. Most of them are legally eligible to issue group CI insurance policies. In 2012, the total written premium of CI insurance was CNY 40.6

[9] The claim information is electronically recorded real time, but only retrieved and organized by the actuarial team once a year. When we obtained our data, the claim information between September 2012 and June 2013 was not yet available. In later analysis, to avoid the potential truncation problem, we identify the claim status for polices expiring after August 2012 as missing values, thus these observations are automatically excluded from our regressions.

billion (USD 6.5 billion), accounting for 38% of health insurance premiums in China; more than 90 million people were covered by CI insurance in 2012 (China Insurance Regulatory Committee, 2013; Su, 2013). Both group and individual CI insurance are available in the market. The group CI insurance market is dominated by employee benefits, where the employer pays the premium and the employee's contribution is minimal. The Chinese group CI insurance market has no restrictions regarding risk classification based on age, gender, occupation, region or other possible pricing factors. The insurer has the sole discretion to determine the price offered for both new and renewed contracts. The Chinese group CI insurance market is completely commercial and voluntary, thus the concerns for risk re-classification, availability and affordability of such insurance are minimal.

Our dataset is on individual policy level originally. For each individual policy entry, the dataset contains (1) policy information including individual policy number, group policy number, insured amount, premium, policy inception date, policy expiring date, and policy issuance date; (2) individual insured's demographic information including name, age, gender, and occupation category[10]; and (3) group insured's demographic information including group name, group location area, and group size. The dataset also contains the claim amount and the claim settlement date for those individual policies having claims.[11]

We organize the individual policy entries into group policies by referring to the group policy number. Since this paper focuses on between-group adverse selection, where individual choices are not allowed within each group, we select those group policies with identical insurance coverage for each individual insured in the group.[12] This leaves us 7,784 group policy-year observations purchased by 3,453 groups, representing more than 2,230,000 individual policies. Table 2 summarizes the key features of our insurance portfolio. Our portfolio has low claim frequency, relatively small insured amount for most policies, and a mixture of different group sizes,

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[10] The occupation category is based on the tendency of accident of occupations instead of the tendency of illness. We acknowledge that the industry classification reflecting the illness tendency of different occupations is a better indicator to control for the tendency of critical disease than our occupation category; however, it is available neither to the insurer nor to us.

[11] We do not have the information on rejected claims, which is a common issue in empirical literature using real market data (see e.g., Cohen and Siegelman, 2010 for a review). However, since what we care is the actual risk type of the insured, it is reasonable to assume that the rejected claims are claims falling outside the policy coverage, thus irrelevant to the actual risk type of the insured. Therefore, rejected claims have minimal impact on our conclusion.

[12] In group CI insurance, the only possible coverage difference within a group policy is the insured amount. No difference in deductible and/or covered critical diseases is allowed. Group policies with identical insurance coverage, i.e. with no individual choice, take more than 75% of all policies.

occupations, ages, and genders. Since the claim size of CI insurance always equals the insured amount, the claim severity is also small on average.

Table 3 compares the features of new policies to those of renewed policies. It also includes the sub-portfolio of policies with two or more consecutive renewals and the sub-portfolio of policies with three or more consecutive renewals. ANOVA mean difference F-tests are reported. We observe no significant difference in claim frequency among these portfolios, which implies that the risk quality of new policy portfolio, renewed policy portfolio and portfolios with more renewal times does not materially differ from each other. Therefore, our conclusions are not influenced by the inherent risk quality difference among portfolios. We find, however, significant trends in most demographic variables and policy features along with the increase of renewal times. The portfolio with more renewal times contains groups with larger size, in richer region, with younger age and with more women. The portfolio with more renewal times has a smaller average insured amount per person, a lower premium rate and shorter policy duration. The policy duration decreases with the renewal times, because short-term policies renew more times than long-term policies during our observation period. We do not observe a systematic trend on the insured's occupation category along with the renewal times. Considering the observed trends, we will always control the policy features, and control either the insured's demographic features or the premium rate[13] in later regression analysis.

Our CI insurance portfolio is a good approximation to the condition of mandatory participation of group members. According to the insurer's underwriting guideline, for small groups of no more than 50 people, the participation ratio has to be 100% in order to issue the group CI policy. For larger groups, the participation ratio can be reduced to a minimum of 75%. The participation of the employee's family is usually voluntary, however, since the employer usually pays the premiums, the participation of employee family is also very high if the contract is open to them. The portfolio described in Table 2 has identical coverage and identical insured amount for everyone within each group. The dataset excludes the possibility of within-group adverse selection, therefore, the group adverse selection identified, if any, is between-group adverse selection. The product also has good features of minimal moral hazard, which will be covered in the Discussion section.

[13] Premium rate is defined as the policy premium divided by the insured amount.

Table 2

Summary Statistics: Insurance Portfolio Overview

Variables	Descriptions	Valid Obs.	Mean	Min	p5	Median	p95	Max
grpclyn	1 if any claim(s) under the group policy	4,846[c]	0.088	0	0	0	1	1
grpclcont	Number of claims under the group policy	4,846[c]	0.16	0	0	0	1	60[d]
grpclfreq	Average number of claims per insured under the group policy, i.e. fraction of insureds having a claim	4,846[c]	0.00069	0	0	0	0.0026	0.17[e]
amnt	Insured amount per insured in CNY	7,784	61,799.8	1,000	3000	50,000	170,000	1,000,000
grppoldur	Group policy duration in days	7,784	310.8	3	31	365	366	485[f]
actgrpsize	Number of individual insureds under the group policy	7,784	286.5	5	7	58	1062	28,691
area[a]	Indicator of relative wealth and insurance market development of the group insured's location	7,784	1.77	1	1	2	3	4
sex	Fraction of women under the group policy	7,784	0.41	0	0.074	0.39	0.81	1
age	Group average age	7,783	34.1	0 [g]	23.3	33.5	46.5	67.8
work[b]	Group average level of occupation accident tendency	7,670	1.97	1	1	1.98	3.62	6
anlpremrate	Annualized premium rate per insured	7,784	0.0026	0.000033	0.00050	0.0019	0.0064	0.52
N	Total number of group policies	7,784 [h]						

Note:

a. 1 represents the most developed regions in China, 4 represents the least developed areas. The *area* variable is based on the insurer's branch categories, which considers not only the regional wealth level but also the regional insurance development level. It is a more accurate control variable than pure wealth measurement.

b. 1 represents the safest occupations, 6 represents the most dangerous. The *work* variable is measured by the accident tendency of an occupation, e.g., office workers are 1 and coal mine workers are 6.

c. The less valid observations are due to time constraints of the dataset. We do not know whether the group policy has a claim if the policy expired after 31 August 2012 and did not settle any claim before 31 August 2012. We identify the claim status of such policies as missing values.

d. Only one group policy has 60 claims and only seven policies have more than 20. Our results are robust if they exclude these seven policies.

e. Small groups may have very high claim frequency in case any insured in the group raises a claim. There are only four group policies with claim frequency higher than 10%. Our results are robust if these four policies are excluded.

f. Only 19 group policies have policy duration longer than 366 days. They are negotiated conditions for special clients. Our results are robust if these 19 policies are excluded.

g. Only one group policy has the minimum age of zero. Our results are robust if this policy is excluded.

h. Excluding observations with missing values in various variables, we have fewer valid observations with full information than N. Only observations with full information will be used in later regression analyses.

Table 3
Comparison between New Policies, Renewed Policies and Policies with More Renewal Times

Variables	New Policies			Renewed Policies (Policies renewed one or more times)			Policies renewed two or more times			Policies renewed three or more times			ANOVA F-Test for Mean Difference	
	Mean	Median	Valid Obs.	Mean	Median	Valid Obs.	Mean	Median	Valid Obs.	Mean	Median	Valid Obs.	F-Value	P-Value
avgrpclyn[a]	0.0000019	0	1,690	0.0000016	0	1,850	0.0000012	0	1,088	0.0000010	0	745	1.29	0.275
avgrpclcont[a]	0.0000020	0	1,690	0.0000018	0	1,850	0.0000013	0	1,088	0.0000010	0	745	1.71	0.163
amnt	66,926.7	50,000	2,736	65,841.0	50,000	3,329	63,394.3	50,000	2,071	60,223.1	50,000	1,368	5.11	0.002
poldur	338.4	365	2,736	277.4	364.8	3,329	240.1	353.9	2,071	193.0	92	1,368	454.77	0.000
actgrpsize	224.2	38	2,736	366.2	98	3,329	393.6	114	2,071	399.8	119	1,368	8.70	0.000
area	1.92	2	2,736	1.55	1	3,329	1.49	1	2,071	1.39	1	1,368	215.83	0.000
sex	0.40	0.38	2,736	0.41	0.40	3,329	0.42	0.40	2,071	0.43	0.41	1,368	8.89	0.000
age	34.1	33.6	2,736	33.6	32.6	3,328	33.1	31.9	2,070	32.1	30.7	1,367	22.70	0.000
work	2.02	2	2,643	1.92	1.84	3,312	2.03	2	2,060	2.19	2.75	1,360	24.82	0.000
anlpremrate	0.0030	0.0020	2,736	0.0021	0.0013	3,329	0.0020	0.0012	2,071	0.0019	0.0012	1,368	19.32	0.000
N	2,736 [b,c,d]			3,329 [b,c,d]			2,071 [d]			1,368 [d]				

Note:

a. *av* represents the average per insured per day. It scales claim performance indicators to comparable level.

b. The total number of new policies and renewed policies, 6,065, is less than the total number of valid group policies, 7,784, because (1) for some policies issued in 2008, we do not know whether they are new or renewed policies because we do not know whether the group insured bought the policy in 2007; (2) some policies are neither renewed nor new but rejoined policies, that the group insured came back to the insurer after a gap period.

c. The renewed policies are more than new policies because one group insured may have several renewed policies during our observation period but only one new policy with the insurer.

d. Excluding observations with missing values in claims, we have fewer valid observations with full information than N. Only observations with full information will be used in later regression analyses.

Empirical Models

To identify potential adverse selection, we use the classical risk-coverage correlation model (see Cohen and Siegelman, 2010) as shown in Equation (1). A positive correlation between risk and coverage is the necessary condition of adverse selection, implying that high risks buy more insurance coverage. An insignificant correlation between risk and coverage suggests no adverse selection.

$$Risk_i = \alpha + \beta Coverage_i + \gamma X_i + \varepsilon_i \quad (1)$$

We measure the actual *Risk* of a group insured by its ex-post claim performance in group policy i. The claim performance is measured by three claim indicators, which are commonly used in existing literature (see Cohen and Siegelman, 2010 for a review). (1) The claim dummy variable, which equals 1 if there is any claim under group policy i; (2) the total number of claims under group policy i; and (3) the claim frequency, which equals the total number of claims divided by the number of individual insureds under group policy i. We do not use the total claim amount or the claim severity as the claim performance indicator, because the claim severity of CI insurance always equals the insured amount on individual basis. The total claim amount and/or the claim severity thus add no additional information to the claim frequency.

We measure the insurance *Coverage* for group policy i by the natural logarithm of the insured amount per insured. The insured amount per insured under group policy i is identical for every individual insured in the group, since no individual choices are allowed in our portfolio. Our group CI insurance always has a zero deductible and covers the same named critical diseases for all insureds as shown in Appendix 1.

X_i is a vector of control variables including policy features, risk classification, and time effects. Regarding policy features, we control for the policy duration and firm size impact on claim indicators. Risk classification refers to the use of observable characteristics by insurers to compute the corresponding premiums and thereby to reduce asymmetric information (Dionne and Rothschild, 2014). Thus the appearance of adverse selection in the market, if any, must reflect the residual asymmetric information after controlling for risk classification. There are two alternative ways to control for risk classification: (1) the observable characteristics or (2) the premium rates computed based on observables. The premium rate is the preferred control variable for risk classification than demographic features, because the premium rate does not only incorporate all demographics but also reflects the insurer's reaction to the respective group's past claim experience (for a detailed discussion, see Finkelstein and McGarry, 2006). It represents the insurer's up-to-date best estimation for the risk of each group. Therefore, we use the average annualized premium rate per person (standardized premium rate) to control for risk classification. We will use the demographic features to replace the standardized premium rate as robustness tests. Full efficiency in risk classification should separate risks into different risk classes and generate different premiums that reflect the risk. This means there should not be any residual asymmetric information between insured and insurer, thus no correlation between insurance coverage and risk, inside the risk classes (Dionne, Michaud, and Pinquet, 2013; Dionnie and Rothschild, 2014). We use year dummy variables to control for time effects.

To test *Hypothesis I*, we apply Equation (1) to the portfolio of new policies, since new customers are most likely to have the information advantage over the insurer (Cohen, 2005). To test *Hypothesis II*, we apply Equation (1) to respective portfolios of renewed policies, thus examine the persistence of between-group adverse selection.

We use the logistic regression to fit the model with dummy dependent variable of *grpclyn* and use probit model as a robustness test. We use the negative binomial regression to fit the model with counted dependent variable of *grpclcont* subject to likelihood ratio tests and use poisson, zero-inflated negative binomial, and zero-inflated poisson models as robustness tests. We use the tobit model to fit the zero censored dependent variable of *grpclfreq*. We use cross-sectional models to test our hypotheses, because one group usually has only one new policy, and use panel data models as robustness tests where applicable.

We examined the issues of potential multi-collinearity, endogeneity and heterogeneity. Regarding the multi-collinearity of independent variables, we obtain the VIFs of each independent variable. The VIFs range from 1.13 to 1.51 for the new policy portfolio and between 1.14 and 1.63 for the renewed policy portfolio. All values are below 5, suggesting little multi-collinearity. We consider the potential endogeneity of the primary explanatory variable *lnamnt* and perform instrumental variable (IV) endogenous tests. The IVs selected are the demographic features, which determine the demand for insurance and thus correlate with our primary explanatory variable, *lnamnt*. The demographic features are also exogenous thus do not relate to error terms. The Wald tests of endogeneity (see Wooldridge, 2002, pp. 472-477, for a detailed discussion) are conducted for nonlinear models with the claim dummy and the claim frequency as dependent variables. For new policy portfolio, the p-values are 0.84 and 0.79 for probit regression and tobit regression, respectively. For renewed portfolio, the p-values are 0.31 and 0.09. The Durbin-Wu-Hausman (DWH) tests of endogeneity are conducted using two-stage least square model with total number of claims as the dependent variable. The DWH tests yield p-values of 0.25 for new policy portfolio and 0.64 for renewed policy portfolio. All tests suggest acceptance of the null hypothesis of exogenous *lnamnt* at 95% confidence level.[14] The use of simple, linear functional forms, such as logit or probit, should be restricted to homogeneous populations (Chiappori and Salanié, 2000). Our dataset approximates the homogeneity, because (1) the business nature of our portfolio is largely similar, as employee benefits; (2) the insurer sources its business nationwide in China; and (3) we are able to control the potential heterogeneities among different group insureds by either premium rate or demographic features.

Results

The regression results of Equation (1) are presented in Table 4. Column 1 shows that in a new policy portfolio, the insured amount positively and significantly correlates with all three claim indicators. We interpret the coefficients as that if the insured amount per person increases by 1%, the probability of the group having claim(s) will increase by 0.85%, and the group claim frequency will increase by 0.34 percentage points, controlling for policy features, risk classification, and time effects. The positive correlation between risk and coverage suggests the existence of between-group adverse selection.[15] The evidence found is against *Hypothesis I.* Adverse selection exists in the group insurance market even if the group insurance does not allow individual choices within each group and even if the group is formed for purposes other than purchasing insurance. Such adverse selection is, by definition, between-group adverse selection. The

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[14] We use Probit model to perform Wald endogenous test with claim dummy as the dependent variable, because the error term of Logit model is not normally distributed, which significantly increases the difficulty of such test. We use 2SLS model to perform DWH endogenous test with total number of claims as the dependent variable, because the counted number of claims approximates to continuous variable, thus standard DWH test for linear models can apply.

[15] The finding in cross-sectional data that coverage is correlated with risk does not suffice to tell us whether it is caused by adverse selection alone, moral hazard alone, or both (Cohen and Siegelman, 2010). We exclude the possibility of moral hazard as the reason for such positive correlation later in the Discussion section.

results support Hanson's (2005) and Simon's (2004) prediction that, in a group insurance market with no individual choice, the group insured behaves the same as the individual insured, and acts strategically on its information advantage, thus yields between-group adverse selection.

To test *Hypothesis II*, the extent of persistence (or lack thereof) of adverse selection for repeat customers, we monitor adverse selection in the three layered sub-portfolios of renewed policies respectively: (1) all renewed policies, (2) policies renewed two or more times, and (3) policies renewed three or more times. *Hypothesis II* predicts that the positive risk-coverage correlation disappears along with increasing renewal times.

The results in Column 2-4, Table 4 show that for policies renewed two or more times, the positive risk-coverage correlation disappears. We conduct Z-statistic tests to compare the claim-coverage coefficients of the new policy portfolio in Column 1 with the claim-coverage coefficients of the renewed policy portfolio in Column 2, which are not statistically different from each other at 95% confidence level. The results suggest that there exist between-group adverse selection in the new policies and that it continue to exist in first-time renewed policies but does not persist in policies renewed two or more times. Since the risk-coverage correlation is a necessary condition of adverse selection[16] (Chiappori and Salanie, 2000), we conclude that between-group adverse selection disappears over time as the group insured renews with the same insurer for certain periods. The evidence supports *Hypothesis II*. These observations can be explained by insurer learning over time, that is, the insurer's efforts in experience rating and underwriting based on respective group's claim experience mitigate the group insured's information advantage, and thus mitigate between-group adverse selection.

Looking at the control variables, we find that there are more claims, if the policy duration is longer, the group size is larger. It is worth to note that the group size remains positively correlated with the claim frequency, which is defined as number of claims divided by group size. It suggests that large groups have higher claim frequency than small groups. The premium rates positively correlate with the claim indicators. The groups with high risks have to pay higher premiums because of both observables and poor claim experience that are known to the insurer.

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[16] Finkelstein and McGarry (2006) argue that the positive correlation between coverage and risk may be neither a necessary nor a sufficient condition for the presence of asymmetric information about risk type but about risk preference. We will analyze this issue later in the Discussion section.

Table 4
Main Results

Sub-Portfolios	New Policies	Renewed Policies (Policies renewed one or more times)	Policies Renewed Two or More Times	Policies Renewed Three or More Times
Panel A	**Logistic on grpclyn** [a,c]			
lnamnt	0.00853***	0.00463*	0.00116	0.00160
	(0.00286)	(0.00246)	(0.00145)	(0.00117)
lnanlpremrate	0.0127***	0.00603*	0.00145	0.00169
	(0.00393)	(0.00321)	(0.00164)	(0.00126)
lnactgrpsize	0.0293***	0.0165**	0.00712	0.00438**
	(0.00379)	(0.00647)	(0.00453)	(0.00189)
lngrppoldur	0.0671***	0.0369***	0.0166**	0.00774***
	(0.0226)	(0.00711)	(0.00731)	(0.00270)
Pseudo R^2	0.307	0.362	0.440	0.427
Panel B	**Negative Binomial on grpclcont** [a,c]			
lnamnt	0.00863***	0.00539***	0.00105	0.0000658
	(0.00236)	(0.00196)	(0.00147)	(4.37e-05)
lnanlpremrate	0.0127***	0.00924***	0.00372**	0.000135***
	(0.00352)	(0.00254)	(0.00163)	(4.68e-05)
lnactgrpsize	0.0284***	0.0201***	0.00953***	0.000220***
	(0.00432)	(0.00416)	(0.00258)	(4.07e-05)
lngrppoldur	0.0776***	0.0380***	0.0209***	0.000293***
	(0.0223)	(0.00494)	(0.00475)	(9.07e-05)
Pseudo R^2	0.319	0.312	0.364	0.396
Panel C	**Tobit with Lower Limit of 0 on grpclfreq (scaled up by 1,000)** [c]			
lnamnt	3.439**	1.292*	0.901	2.402
	(1.510)	(0.708)	(0.802)	(1.768)
lnanlpremrate	5.108**	2.134***	1.875**	3.213*
	(2.054)	(0.780)	(0.937)	(1.646)
lnactgrpsize	10.45***	4.925***	3.840***	4.828***
	(1.415)	(0.487)	(0.592)	(1.026)
lngrppoldur	26.91***	11.25***	8.625***	7.519**
	(10.11)	(2.670)	(2.182)	(3.035)
Pseudo R^2	0.091	0.124	0.182	0.211
Observations [b]	1,690	1,850	1,088	745

Note:
We present the marginal effects of logistic model and negative binomial model, and the estimated coefficients of tobit model with robust standard errors in parentheses; we also present the *, **, *** indicate significant differences of regression coefficients from 0 at the 10%, 5%, and 1% level.
a. Marginal effects at the means of independent variables are reported.
b. The dataset used here is the same as the portfolios shown in Table 3. The smaller number of observations is due to missing values in claims.
c. Intercepts and year dummies are included in models but not reported.

Robustness Tests

We conduct the following six additional robustness tests. First, we use the demographic features to replace the standardized premium rate as the control variables for risk classification. We introduce area dummies, area1 to area4, to control the regional differences in wealth level and insurance market development level. We use the fraction variables of different age ranges to reflect the age mixture within one group, and the fraction variables of occupation categories, work1 to work6, to reflect the mixture of occupations within one group. The fraction variables are better control variables than the group average age or occupation, because they reflect the detailed mixture of different age and occupations within a group (Yao, 2013). For dummy and fraction control variables, we always omit the largest category from the models to avoid the collinearity. The results in Table 5 show that for new policies, all renewed policies, and policies renewed two or more times, the significance level and sign of coefficients between coverage and claim performance are similar to our core models in Table 4, which supports our conclusions. For policies renewed three or more times, the coefficient becomes significant and positive for the negative binomial model, which was insignificant when using standardized premium rate as the control variable for risk classification. As Finkelstein and McGarry (2006), and Chiappori and Salanié (1997, 2000) suggest, there might be spurious positive risk-coverage correlation due to incomplete controlling for risk classification. The premium rate captures more information than demographic features do, thus leaves less residual private information for adverse selection.[17] When looking at the control variables, age is the major driver of critical illness claims.

[17] As a byproduct, the significant coefficient also responds to and refutes the challenge that the disappearance of adverse selection in more-time renewal policies is due to smaller sample size.

Table 5 Robustness Test: Demographic control variables

	New Policies			Renewed Policies			Policies Renewed Two or More Times			Policies Renewed Three or More Times		
Variables	grpclyn [a,c]	grpclcont [a,c]	grpclfreq[c]	grpclyn [a,c]	grpclcont [a,c]	grpclfreq[c]	grpclyn [a,c]	grpclcont [a,c]	grpclfreq[c]	grpclyn [a,c]	grpclcont [a,c]	grpclfreq[c]
lnamnt	0.00853***	0.00672***	3.783***	0.00435*	0.00330**	0.790	0.00207	0.00147	0.736	0.00160	0.0000198*	1.861
	(0.00265)	(0.00226)	(1.430)	(0.00235)	(0.00163)	(0.754)	(0.00168)	(0.00114)	(0.756)	(0.00113)	(1.18e-05)	(1.186)
lnactgrpsize	0.0246***	0.0239***	10.01***	0.0175***	0.0182***	4.936***	0.00791**	0.00712***	3.843***	0.00576**	0.0000659***	6.162***
	(0.00355)	(0.00335)	(1.387)	(0.00573)	(0.00266)	(0.515)	(0.00384)	(0.00181)	(0.490)	(0.00242)	(1.92e-05)	(2.181)
lngrppoldur	0.0352**	0.0437**	17.07**	0.0319***	0.0262***	9.617***	0.0152***	0.0115***	7.253***	0.00386**	0.0000510***	4.218***
	(0.0158)	(0.0185)	(7.599)	(0.00525)	(0.00414)	(2.406)	(0.00493)	(0.00241)	(1.971)	(0.00177)	(9.22e-06)	(0.823)
area2	0.00429	-0.000854	1.301	0.000327	-0.000942	-0.179	0.00121	0.00208	0.812	-0.00146	-0.0000181	-1.984
	(0.00794)	(0.00568)	(3.638)	(0.00421)	(0.00350)	(1.627)	(0.00318)	(0.00237)	(1.838)	(0.00134)	(2.10e-05)	(2.789)
area3	0.0116	0.00232	2.695	0.00433	0.00104	-0.451	0.00207	0.00339	-1.005	0.00172	0.0000255	1.320
	(0.0108)	(0.00700)	(4.525)	(0.00626)	(0.00463)	(2.153)	(0.00474)	(0.00349)	(2.305)	(0.00388)	(4.58e-05)	(3.605)
area4	0.0548	0.0226	12.51*		-0.0212***	-71.94		-0.00885***	-43.99	0.00122	-2.13e-06	1.481
	(0.0368)	(0.0183)	(6.816)		(0.00363)	(0)		(0.00240)	(0)	(0.00454)	(6.34e-05)	(6.324)
sex	-0.0215*	-0.0198*	-10.28	0.00556	-0.00132	4.273	0.00135	0.00170	0.730	-0.00570	-0.0000773	-5.821
	(0.0126)	(0.0107)	(6.783)	(0.0110)	(0.0105)	(4.499)	(0.00729)	(0.00588)	(4.431)	(0.0118)	(0.000148)	(9.467)
age0to15	-0.0186	0.0204	-25.51	-0.00869	-0.0334	-13.26	-0.00912	-0.0274*	-24.70	0.00495	0.0000833	6.176
	(0.0346)	(0.0193)	(28.12)	(0.0336)	(0.0225)	(13.15)	(0.0116)	(0.0148)	(22.57)	(0.00434)	(5.54e-05)	(5.468)
age31to45	0.0464***	0.0402***	23.16**	0.0183	0.0191**	6.579	0.00942	0.00828	7.838*	0.00763	0.000141***	6.893
	(0.0146)	(0.0128)	(9.995)	(0.0132)	(0.00904)	(4.431)	(0.00875)	(0.00573)	(4.119)	(0.00485)	(4.24e-05)	(4.847)
age46to60	0.0748***	0.0811***	42.11***	0.0417**	0.0526***	13.76***	0.0182	0.0208***	11.06**	0.0534*	0.000567**	131.9***
	(0.0173)	(0.0161)	(13.78)	(0.0174)	(0.0115)	(3.990)	(0.0111)	(0.00705)	(4.333)	(0.0322)	(0.000224)	(34.56)
age61over [e]	0.0504	0.107***	8.785	0.0402	0.0539**	28.76	0.0418	0.0349	56.15**	0.000903	0.0000132	-3.441
	(0.0611)	(0.0408)	(29.36)	(0.0466)	(0.0257)	(20.95)	(0.0411)	(0.0229)	(27.48)	(0.00292)	(2.17e-05)	(3.747)
work2	-0.00315	0.00680	-0.00108	0.000558	0.000750	-0.465	-0.00119	0.00283	-2.417	-0.000130	-0.0000152	-0.0773
	(0.00889)	(0.00564)	(5.479)	(0.00596)	(0.00393)	(2.563)	(0.00399)	(0.00246)	(2.484)	(0.00169)	(2.54e-05)	(2.763)
work3	-0.000855	0.000118	-1.926	-0.00865*	-0.0103**	-2.874	-0.000127	-0.00380	-0.103	-0.00158	-0.0000587	-2.740
	(0.00676)	(0.00503)	(3.551)	(0.00507)	(0.00430)	(2.000)	(0.00276)	(0.00254)	(1.977)	(0.00442)	(4.84e-05)	(5.631)
work4	-0.00188	0.00521	-7.535	-0.00696	-0.0126**	-4.061	-0.00149	-0.00422	-1.976		-0.0247***	-1,135
	(0.0110)	(0.00985)	(5.969)	(0.00826)	(0.00511)	(2.985)	(0.00602)	(0.00344)	(3.176)		(0.00643)	(0)
work5 [b]	-0.0311	-0.00760	-15.16	0.0333	0.0145**	6.321*		-12.19***	-3,181	0.00160	0.0000198*	1.861
	(0.0301)	(0.0220)	(14.83)	(0.0226)	(0.00605)	(3.419)		(4.232)	(0)	(0.00113)	(1.18e-05)	(1.186)
Pseudo R^2	0.354	0.364	0.109	0.382	0.347	0.134	0.463	0.410	0.204	0.481	0.467	0.262
Observation [d]	1,597	1,597	1,597	1,835	1,835	1,835	1,079	1,079	1,079	739	739	739

Note: We present the marginal effects of logistic model and negative binomial model, and the estimated coefficients of tobit model with robust standard errors in parentheses; we also present the *, **, *** indicate significant differences of coefficients from 0 at the 10%, 5%, and 1% level.

a. Marginal effects at the means of independent variables are reported.

b. *Work6* is omitted due to too few valid observations in this sub-dataset.

c. Intercepts and year dummies are included in models but not reported.

d. The dataset used here is the same as the portfolios in Table 3. The smaller number of observations are due to missing values of respective variables.

e. Only 0.7% of individual insureds are older than 60 in this regression portfolio, thus the coefficients become insignificant and unstable.

Second, we consider the potential impact of small and large groups on between-group adverse selection. Literature on U.S. group health insurance suggest that the between-group adverse selection may only exist or be more problematic for small groups, since small firms may seek coverage simply because an employee or dependent is ill; large groups may have less of an information advantage, in respect of knowing the health conditions of individual employees and may fail to act on such private information, if any (Monheit and Schone, 2003). We test whether between-group adverse selection exists for large groups, and, if so, whether small groups have stronger adverse selection than large groups. Our dataset contains both small groups with 50 or fewer people and large groups with more than 50.[18] We thus introduce the interaction term of *lnamnt*small* to test these arguments.[19] The results in Table 6 show that (1) the coefficients between coverage and claim indicators remain positive and significant for new policies, and insignificant for policies renewed two or more times, suggesting the same existence and persistence pattern of between-group adverse selection in the large-group insurance; (2) the coefficients of interaction terms are insignificant for all specifications (except for the negative binomial model with policies renewed two or more times), suggesting that the level of between-group adverse selection for the small-group insurance is not materially different from that of large groups.

Third, we present the reduced-form analyses introduced by Chiappori and Salanié (1997, 2000) as shown in Equations (2.1) and (2.2). It is more robust to model misspecification than the full structural approach in Equation (1) (Chiappori and Salanié, 1997). The variables used for *Risk*, *Coverage* and X are the same as in Equation (1). Table 7 shows that the correlation coefficients between the residuals ε_i and ω_i are significant and positive for new policies, which means, conditional on policy features, risk classification, and time effects, the coverage choice and the occurrence of claims are not independent phenomena. The choice with higher amount of coverage predicts a larger tendency of claims. However, the coefficients become insignificant for policies renewed two or more times. The results confirm that between-group adverse selection exists in new policy portfolios and disappears in policies renewed two or more times.

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[18] The 50-person cutoff point of small and large groups has been adopted by most states in U.S. (Simon, 2005) and used by many small-group health insurance studies (see e.g. Cutler, 1994; Monheit and Schone, 2004).

[19] We also test another specification by including dummy variable of *small* together with the interaction term. The results are robust and available from the authors upon request.

$$Risk_i = g(X_i) + \varepsilon_i \tag{2.1}$$
$$Coverage_i = f(X_i) + \omega_i \tag{2.2}$$

Fourth, we consider the potential nonlinear effects of our primary explanatory variable in Equation (1). Dionne, Gouriéroux, and Vanasse (2001, 2006) show that the significant correlation between claim performance and coverage may disappear after adding the projected primary explanatory variable to the classic model. We mirror their methodology by (1) regressing *lnamnt* on other policy features, risk classification and year dummies, (2) predicting the *projected lnamnt* from the step 1 regression, and (3) adding the *projected lnamnt* as an additional control variable to Equation (1). The results are robust to our conclusions and available from the authors upon request.

Fifth, we separate the renewed portfolio into three exclusive sub-portfolios: first-time renewed policies, second-time renewed policies, and third or more times renewed policies. We fit Equation (1) for the three exclusive sub-portfolios respectively. The results in Appendix 2 confirm that between-group adverse selection persist in the first-time renewed policies but does not persist in policies renewed two or more times. The claim-coverage coefficients of the new policies in Column 1, Table 4 and the claim-coverage coefficients of the first-time renewed policies in Column 1, Appendix 2 are not statistically different from each other at 95% confidence level, subject to Z-statistic tests.

Sixth, we use other econometric models to fit Equation (1). We apply Probit model on the group claim dummy, and apply Poisson, Zero-Inflated Poisson, and Zero-Inflated Negative Binomial models on the total number of claims. We apply panel data random effects[20] models for renewed portfolios which contains continuous multiple policies for one group insured. All alternative models are robust to our conclusions. The results are available from the authors upon request.

[20] We use random effects models instead of fixed effects because we use the premium rate for each firm-year to control for risk classification, which incorporates the complete information the insurer has and uses to identify the risk. The residual information asymmetry that is not incorporated in the premium rate, is exactly what we would like to test. Firm fixed effects further control the firm-specific information that is not observed by the insurer, which thus changes the scope of residual information tested in the model. In addition, the fixed effects models cannot incorporate independent variables with small or no within-group variations over time, thus many observations will be dropped if using fixed effects models. Finally, it is reasonable to assume that the group insureds in our portfolio comprise a random sample of the nationwide population and thus the random effects model fits better than the fixed effects model (Greene, 2011; Gujarati, 2010). Zhang and Wang (2008) discuss why and how to apply random effects models to study adverse selection in a dynamic insurance market.

Table 6 Robustness Test: Large vs. Small Groups

Sub-Portfolios	New Policies	Renewed Policies (Policies renewed one or more	Policies Renewed Two or More Times	Policies Renewed Three or More Times
Panel A	**Logistic on grpclyn [a,c]**			
lnamnt	0.00865***	0.00439*	0.00103	0.00163
	(0.00293)	(0.00235)	(0.00132)	(0.00119)
lnamnt*small	0.000644	-0.000510	-0.000408	0.0000900
	(0.00107)	(0.000646)	(0.000529)	(0.000390)
lnanlpremrate	0.0128***	0.00564*	0.00124	0.00174
	(0.00406)	(0.00304)	(0.00150)	(0.00130)
lnactgrpsize	0.0313***	0.0151**	0.00613	0.00456**
	(0.00520)	(0.00605)	(0.00383)	(0.00200)
lngrppoldur	0.0699***	0.0355***	0.0156**	0.00779***
	(0.0237)	(0.00697)	(0.00672)	(0.00270)
Pseudo R^2	0.307	0.363	0.441	0.427
Panel B	**Negative Binomial on grpclcont [a,c]**			
lnamnt	0.00883***	0.00487***	0.000693	0.0000818
	(0.00243)	(0.00183)	(0.00119)	(5.56e-05)
lnamnt*small	0.000521	-0.000913	-0.00104*	0.0000251
	(0.000873)	(0.000653)	(0.000611)	(2.27e-05)
lnanlpremrate	0.0131***	0.00811***	0.00259*	0.000168**
	(0.00369)	(0.00240)	(0.00151)	(6.56e-05)
lnactgrpsize	0.0301***	0.0175***	0.00688***	0.000274***
	(0.00525)	(0.00397)	(0.00231)	(6.73e-05)
lngrppoldur	0.0815***	0.0348***	0.0175***	0.000362***
	(0.0246)	(0.00510)	(0.00439)	(0.000112)
Pseudo R^2	0.320	0.314	0.370	0.396
Panel C	**Tobit with Lower Limit of 0 on grpclfreq (scaled up by 1,000) [c]**			
lnamnt	3.218**	1.279*	0.847	2.411
	(1.452)	(0.707)	(0.812)	(1.780)
lnamnt*small	0.461	-0.243	-0.382	0.162
	(0.433)	(0.247)	(0.303)	(0.584)
lnanlpremrate	4.888**	2.020**	1.641	3.348*
	(1.983)	(0.822)	(1.050)	(1.906)
lnactgrpsize	11.40***	4.444***	3.111***	5.144**
	(2.022)	(0.816)	(0.989)	(2.013)
lngrppoldur	27.33***	11.29***	8.680***	7.437***
	(10.37)	(2.659)	(2.146)	(2.859)
Pseudo R^2	0.092	0.125	0.184	0.212
Observations [b]	1,690	1,850	1,088	745

Note:

We present the marginal effects of logistic model and negative binomial model, and the estimated coefficients of tobit model with robust standard errors in parentheses; we also present the *, **, *** indicate significant differences of regression coefficients from 0 at the 10%, 5%, and 1% level.

a. Marginal effects at the means of independent variables are reported.

b. The dataset used here is the same as the portfolios shown in Table 3. The smaller number of observations is due to missing values of claims.

c. Intercepts and year dummies are included in models but not reported.

Table 7

Correlation between Residuals of Claim Performance and Residuals of Coverage

Correlation Coefficients	Residual of OLS Model on *lnamnt*			
	New Policies	Renewed Policies	Policies Renewed Two or More Times	Policies Renewed Three or More Times
Pearson Residual of Logistic Model on Group Claim Dummy, *grpclyn*	0.0577 (0.018)	0.0371 (0.111)	0.0236 (0.436)	0.0412 (0.262)
Pearson Residual of Negative Binomial Model on Total Number of Claims, *grpclcont*	0.0631 (0.010)	0.0484 (0.037)	0.0319 (0.293)	0.0463 (0.207)
Generalized Residual of Tobit Model on Group Claim Frequency, *grpclfreq*	0.0636 (0.009)	0.0508 (0.029)	0.0380 (0.210)	-0.0067 (0.855)
Observations	1,690	1,850	1,088	745

Note:

P-values are in parentheses.

Discussion

Adverse Selection vs. Moral Hazard

A critical issue to the positive correlation test between coverage and risk is the disentangling of adverse selection and moral hazard. Both adverse selection and moral hazard predict that agents insured (fully insured) should have a higher probability of accident than those uninsured (partially insured) (Richaudeau, 1999). The finding in cross-sectional data that coverage is correlated with risk does not suffice to tell us whether it is caused by adverse selection alone, moral hazard alone, or both (Cohen and Siegelman, 2010). We thus disentangle our results from the moral hazard both statistically and theoretically.

Statistically, we use longitudinal dynamic data to conduct the disentangling test introduced by Abbring, Chiappori, Heckman, and Pinquet (2003) and Abbring, Chiappori, and Pinquet (2003). They suggest that moral hazard should lead to a negative correlation between historical claims and claims in the subsequent period under the experience rating system, since the insured's behavior changes according to experience rating and insurance coverage. In contrast, adverse selection should result in a positive correlation between past and future claims, since claims are determined by the insured's risk type, which does not change because of experience rating and/or insurance coverage. We show, in Appendix 3, that claims in new policies and claims in first-time renewed policies are positively related to each other, controlling for policy features, risk classification and time effects. The observations are consistent with the adverse selection prediction.

Theoretically, the disappearance pattern of risk-coverage correlation itself provides direct evidence that at least some new customers have private information about their risk type. Such a pattern due to claim underreporting of new customers cannot be explained by moral hazard story, in which customers with different levels of coverage present different risks due to different behaviors (Cohen and Siegelman, 2010). We also consider the potential risk-bearing moral hazard and claim-reporting moral hazard in group insurance (Butler and Worrall, 1991; Ruser and Butler, 2010; Butler, Gardner and Kleinman, 2013). They explain the pattern of risk-coverage correlation in Worker's Compensation (WC) with moral hazard. They argue that incentives of employers and employees under experience-rated group insurance coverage are different. Employees tend to care less and report more claims, comparing to employees with no insurance, in order to get the insurance benefit, where the classical moral hazard story holds. Employers, however, have the incentive to improve the safety and report fewer claims, in order to pay a lower a premium in the following year. The employer's incentive, termed as risk-bearing moral hazard, mitigates the moral hazard and claim-reporting moral hazard of employees, if any, which also show a disappearance pattern of risk-coverage correlation. This explanation was developed in the context of worker's compensation, in which adverse selection is minimal due to compulsory insurance, and both employees and employers are able to influence the frequency and/or severity of WC incidents. However, in group CI insurance, neither the employer nor the employee is able to systemically influence the frequency of CI incidents. The claim severity always equals the insured amount. Moreover, the employer has much less incentive to report fewer claims in CI insurance, because under WC, the employer can usually bring the employee back to work by rejecting claims, however, this will not happen under CI insurance. In China, worker's compensation falls into the scope of compulsory social insurance, which cannot be bundled with commercial group CI insurance.

The product design of group CI insurance also mitigates moral hazard, because the simple claim trigger in CI insurance avoids the "over-utilization" problem commonly observed in medical expense insurance (i.e. *ex post* moral hazard), since the insurer pays the insured amount once the defined critical diseases are diagnosed. In other words, the product design excludes the possibility of *ex post* moral hazard. In addition, the insured has little influence on the possibility of being diagnosed with the defined critical diseases after purchasing insurance. Finally, considering the very small expected benefit, the insured's incentive to change life style, because of the insurance, is minimal. Like us, Wang, Peng, Sun, and Chang (2011) focus on adverse selection in Taiwan's cancer insurance market. They conclude that purchasing extended cancer insurance will not reduce insureds' efforts to prevent cancer. We note the potential issue of claim fraud. However, as in the insurer's claim practice, the insurer always asks the claimant to obtain a second opinion on the diagnosis in a different hospital approved by the insurer. The claim payment is subject to this double-check procedure, which significantly reduces the risk of claim fraud. Therefore, the identified adverse selection in group CI insurance is much less disturbed by moral hazard and claim fraud than is medical expense insurance and/or automobile insurance. Wang et al. (2011) draw the same conclusion with a similar cancer product.

Alternative Reasonings of Adverse Selection Disappearance

We propose one explanation for the disappearance of adverse selection as insurer learning over time. This argument is challenged by other possible explanations, which we discuss in more detail below. Future research into theoretical foundation of the disappearance of between-group adverse selection is necessary.

One of the alternative rationales is that if covered individuals are more likely to drop their coverage in the subsequent period when their groups renew, due to death, being fired by the group, or other reasons, the risk quality of a group changes over time and the disappearance of risk-coverage correlation could be driven by risk changes or selections of the group. We thus perform the following two analyses. First, we compare the reasons for dropped coverage between claimants (claimed individuals) and non-claimants (no-claim individuals). For claimants, 65% of the drop-offs are due to their groups' drop-offs and 35% are standalone drop-offs when their groups renew in the subsequent period. For non-claimants, 62% of individual drop-offs are due to their groups' drop-offs and 38% are standalone. Clearly, most individual drop-offs are attributable to group drop-offs and claimants are not more likely to leave the portfolio on a standalone basis than non-claimants. Second, we directly examine whether claimants are more likely to leave the portfolio, subject to the group renews in the subsequent period. For claimants, 28% leave the portfolio when their groups stay; for non-claimants, 25% leave. We conduct the binomial probability test of whether claimants are significantly more likely to leave the portfolio than non-claimants. At the 95% confidence level, claimants are not more likely to leave the portfolio than non-claimnats when their groups stay.

Another explanation is the multi-dimentional information advantages. Finkelstein and McGarry (2006) argue that there are multiple dimensions of private information, not only in regard to insureds' risk types but also as to risk attitudes (or risk preferences). They suggest that empirical studies based on a risk-coverage correlation test should control for the insured's risk attitude, since risk-averse insureds often associate with low risk, and this will blur the positive risk-coverage correlation test, because of "advantageous selection" (De Meza and Webb, 2001; Fang, Keane, and Silverman, 2008). However, it is hard to argue that such correlation between risk attitude and risk coverage also applies to group insureds. It has been pointed out that risk aversion is much less of a motivation for corporate insureds to purchase insurance, especially for stock companies, because the stakeholders could instead manage idiosyncratic losses through diversified portfolios (Mayers and Smith, 1982, 1990). In the case of corporate insurance in China, Zhu, Kui, and Fang (2011), based on province-level panel data, find that risk aversion is not a significant factor in insurance demand. In our analysis, since the group insureds are largely corporates and decision makers are usually HRs or other responsible departments in the group, we assume that group insureds' risk attitudes are not the major driver of insurance demand and will not distort the risk-coverage correlation.[21]

Generalizability of Insurance Portfolio with Low Loss Frequency and from the Chinese Market

Medical expense health insurance and automobile insurance are common types of insurance products used to test adverse selection. The high loss frequency of such products enables econometricians to detect adverse selection more easily than with low loss frequency products. We theoretically and empirically discuss the potential impact of loss frequency on adverse selection. The adverse selection of low frequency risks, such as fire insurance, product liability insurance, cancer insurance, life insurance in a short

[21] In addition, Chiappori and Salanié (2013) provide an alternative explanation. Risk preference alone should have negligible consequences on the positive risk-coverage correlation in competitive markets, because insureds, of all types of risk aversion, prefer full coverage in a competitive market. Group CI insurance in China can be considered as a competitive market with standardized coverage and without rate regulation.

period and the critical illness insurance in our dataset is more difficult to detect adverse selection than high frequency risks, partially because the small number of claims in the dataset bias the measurement of the actual risk by ex-post losses and partially because of the insured's perception bias of risk types for low probability events (see e.g., Cawley and Philipson, 1999; McCarthy and Mitchell, 2010).

Theoretical research on adverse selection does not distinguish their predictions between high and low probability risk. The research on the difference between high and low loss probability largely focuses on the insurance demand (see e.g., Laury, McInnes, and Swarthout, 2009). Some other research has tackled the insured's perception of low frequency risks. Camerer and Kunreuther (1989) concluded that people exhibit biases in judgments about risks and probabilities when the probabilities of events are small. Kunreuther, Novemsky, and Kahneman (2001) investigated the kind of information that can enable laypersons to evaluate the differences among low probability risks. They concluded from a controlled experiment that even laypersons can discriminate risk types of chemical plants' explosions, as long as enough context information and comparison scenarios are provided. In our context of group CI insurance, the insurance decision maker, as the HR department of the group insured, usually possesses some information about employee health and is in a much better position to make risk type judgment than laypersons can about chemical plants.

From the empirical perspective, in our dataset, there is one loss in every six group-year policies or in every 1400 individual-year policies. The loss frequency is lower than in automobile and health insurance, but not materially different from many commonly seen insurance products, such as fire insurance or life insurance in a short period. There are also empirical works that detect adverse selection in a low loss frequency market, where longitudinal data increase the power to detection (see e.g., He, 2008) We perform the robustness test using the bootstrap resampling method to correct the potential bias, due to low loss frequency, in estimated standard errors. The bootstrap resampling method constructs a number of resamples of the observed dataset, thus provides a way to account for the distortions caused by the small sample that may not be fully representative of the population. It corrects the potential bias in confidence intervals (Efron and Tibshirani, 1993). Two hundred replications are used. The results in Appendix 4 confirm our conclusions on both hypotheses.

In addition to our evidence drawn from Chinese group CI insurance, the U.S. small-group health insurance market provides another example of between-group adverse selection, where the high price and low coverage for healthier risks, resulting from adverse selection, are notorious (Simon, 2005). However, two major obstacles jeopardize the empirical conclusions pertaining to between-group adverse selection from the U.S. small-group health insurance market. First, it is hard to separate the effect of individual choices from group strategic actions; second, the small-group reforms in the early 1990s restrict the insurers' experience rating and redlining, thus it becomes impossible to test the persistence of between-group adverse selection in the small-group health insurance market. Compared to the U.S. small-group health insurance market, the Chinese group CI insurance market provides almost laboratory conditions to test between-group adverse selection, considering 1) similar products but competing prices in the market; 2) voluntary purchase and termination of group policies at the end of policy period by both buyers and insurers; 3) commercial markets without the target of broad availability and affordability.

The existence and persistence of between-group adverse selection have been under-researched. We expect future empirical studies to explore other eligible group insurance products and other markets to verify our results[22]. In principle, any group insurance without individual choice is suitable to test the between-group adverse selection. For example, we expect to find similar results from the employer-provided group health insurance in U.S., if policies allowing individual plan choice are excluded. Other product lines may also offer the potential to replicate our empirical results, e.g., crop insurance at the village or county level, where villages and counties susceptible to more natural disasters are more willing to buy and to buy more comprehensive coverage; motor fleet insurance including both liability and own damage cover, where operators in mountainous areas tend to buy larger insured amount. We might also find between-group adverse selection in the supplementary coverage of social insurance, e.g., the Swiss employer can choose, on behalf of all its employees, supplementary accident coverage in addition to the compulsory accident coverage. We expect riskier occupation to buy more supplementary coverage, controlling for premium rate.

[22] We use a micro health insurance portfolio from Pakistan to test the generalizability of our Hypothesis I. The results confirm our conclusion and show that adverse selection also might exist in high loss frequency portfolios. The results are available from the authors upon request. The dataset cannot be used to test Hypothesis II, due to the limitation of too few policy periods.

However, we do not argue for the universality of the existence of between-group adverse selection. We expect the classical measures in individual insurance to deal with adverse selection are also effective in the group insurance market, for example, compulsory insurance; product lines with little adverse selection in the individual insurance market may also not have between-group adverse selection in the group insurance market, e.g., life insurance (see Cohen and Siegelman, 2010 for a review). Therefore, we expect to find either no or a very weak between-group adverse selection in product lines with such a feature, e.g., compulsory workers compensation (Butler, Gardner and Kleinman, 2013) or group life insurance.

Concluding Remarks and Future Research

We analyze adverse selection in the group insurance market and find evidence for the existence of between-group adverse selection. Our dataset allows us to split the effect of individual choice under the group policy and the effect of group strategic actions. The empirical findings complement the "conventional wisdom" and support Hanson's (2005) theoretical prediction; adverse selection may well exist in a group insurance market even if no individual choices are allowed within each group and even if the group is formed for purposes other than purchasing insurance. The paper complements the empirical work based on the U.S. (small-) group health insurance, where individual choices within a group are an important driver of adverse selection.

In addition, we find that between-group adverse selection disappears over time as the group insured renews with the same insurer, although it may persist through the first renewal. The empirical evidence is consistent with the idea that the disappearance occurs due to the insurer learning over time. This paper is the first to show that the insurer learning over time mitigates adverse selection in a group insurance market with no individual choice, via premium adjustment and underwriting based on the respective group insured's past claim experience.

The combination of the two pieces of evidence shows that addressing adverse selection via group insurance is not necessarily sufficient to mitigate adverse selection, but that experience rating and underwriting based on the information that insurers learn over time are important (Mayers and Smith, 1981; Kunreuther and Pauly, 1985). Although we show this evidence only for Chinese critical illness insurance, we expect our results to hold for other group insurance products in other markets with similar nature, e.g., U.S. small-group health insurance. As Hansen (2005) and Simon (2004, 2005) suggested, between-group adverse selection comes from group strategic actions for the welfare of its members, which has a much broader application in various group insurance markets. Moreover, our conclusions are not based on special assumptions regarding critical illness coverage and/or regarding Chinese insurance market. Our results also shed lights on markets other than insurance, but with information asymmetry, where the existence and persistence of adverse selection are also relevant (see e.g., Chari, Shourideh, Zetlin-Jones, 2014). In the repeated contracting setup, learning from the performance of past contracts and taking corresponding actions based on the information observed help to mitigate adverse selection problems (Dionne, 1983).

One implication of our results is that group insurance with no individual choice cannot be considered as a market free of adverse selection, even if the group is formed for purposes other than purchasing insurance. Our results reveal the evolution of adverse selection across renewal stages and therefore introduce another direction of adverse selection testing— the persistence over time. Our results thus also have important business implications for insurers. Insurers must be aware that group insurance policyholders strategically act on their information advantages. Therefore, insurers should carefully observe group behavior and group claim experience over time, first to learn and then to apply that knowledge to their renewal underwriting and pricing decisions. The more efficiently insurers acquire and use such knowledge, the sooner they will overcome adverse selection.

Although we show the existence of adverse selection in group insurance with no individual choice, our dataset does not allow us to compare the level of group adverse selection to the level of individual adverse selection. Browne (1992) conducts such a comparison and finds evidence to support the "conventional wisdom" that individual insurance has more adverse selection than group insurance. An interesting next step would be to compare the magnitude of adverse selection between group insurance and individual insurance. To discover the relative weights and significance among within-group adverse selection, between-group adverse selection, and individual adverse selection may require testing all three types of adverse selection in the same insurance market. Another direction for future research would be to compare the persistent time of adverse selection in group insurance with that in individual insurance. Moreover, there is to date limited theoretical work on why and how between-group adverse selection is generated via group internal processes. It would be interesting and useful to know how the group insurance decision processes differently from the individual insurance decision. Finally, we also recommend more empirical studies to explore other eligible group insurance products and other markets to verify our empirical results.

Appendix 1
Named Critical Diseases Covered under the Group CI Policy

The complete list of 25 named critical diseases covered under the group CI policy is shown below. The list is recommended by the Insurance Association of China and the Chinese Medical Doctor Association and has been adopted by most CI policies in Chinese insurance market. The standard and binding definitions of diseases can be found in Insurance Association of China and Chinese Medical Doctor Association (2007).

1. Malignant Tumor
2. Acute Myocardial Infarction
3. Sequelae of Stroke
4. Major Organ / Hematopoietic Stem Cells Transplant
5. Coronary Artery Bypass Graft
6. End Stage Renal Disease (Chronic Kidney Failure)
7. Loss of Limbs
8. Acute or Subacute Severe Hepatitis
9. Benign Brain Tumor
10. Chronic Liver Failure (End Stage)
11. Encephalitis Sequelae or Meningitis Sequelae
12. Deep Coma
13. Deafness in Both Ears
14. Blindness in Both Eyes
15. Paralysis
16. Heart Valve Surgery
17. Severe Alzheimer's Disease
18. Major Head Trauma
19. Severe Parkinson's Disease
20. Major Third Degree Burn
21. Severe Primary Pulmonary Hypertension
22. Severe Motor Neuron Disease
23. Loss of Speech
24. Severe Aplastic Anemia
25. Aorta Surgery

Appendix 2
Robustness Test: Exclusive Renewed Portfolios

Sub-Portfolios	First-Time Renewed Policies	Second-Time Renewed Policies	Policies Renewed Three or More Times
Panel A	**Logistic on grpclyn [a,c]**		
lnamnt	0.0194***	0.00115	0.00160
	(0.00665)	(0.00651)	(0.00117)
lnanlpremrate	0.0246***	-0.00165	0.00169
	(0.00869)	(0.00907)	(0.00126)
lnactgrpsize	0.0541***	0.0332***	0.00438**
	(0.00739)	(0.0128)	(0.00189)
lngrppoldur	0.165***	0.174***	0.00774***
	(0.0427)	(0.0403)	(0.00270)
Pseudo R^2	0.279	0.419	0.427
Panel B	**Negative Binomial on grpclcont [a,c]**		
lnamnt	0.0211***	-0.00293	6.58e-05
	(0.00570)	(0.0107)	(4.37e-05)
lnanlpremrate	0.0305***	0.00653	0.000135***
	(0.00692)	(0.00991)	(4.68e-05)
lnactgrpsize	0.0599***	0.0455***	0.000220***
	(0.00955)	(0.00951)	(4.07e-05)
lngrppoldur	0.150***	0.140***	0.000293***
	(0.0441)	(0.0341)	(9.07e-05)
Pseudo R^2	0.259	0.310	0.396
Panel C	**Tobit with Lower Limit of 0 on grpclfreq (scaled up by 1,000) [c]**		
lnamnt	1.822*	0.0203	2.402
	(1.016)	(0.848)	(1.768)
lnanlpremrate	2.240*	0.777	3.213*
	(1.250)	(1.200)	(1.646)
lnactgrpsize	5.629***	3.220***	4.828***
	(0.587)	(0.725)	(1.026)
lngrppoldur	19.19**	16.33***	7.519**
	(8.884)	(4.757)	(3.035)
Pseudo R^2	0.072	0.128	0.211
Observations	762	343	745

Note:
We present the marginal effects of logistic model and negative binomial model, and the estimated coefficients of tobit model with robust standard errors in parentheses; we also present the *, **, *** indicate significant differences of regression coefficients from 0 at the 10%, 5%, and 1% level.
a. Marginal effects at the means of independent variables are reported.
c. Intercepts and year dummies are included in models but not reported.

Appendix 3

Disentangle Adverse Selection from Moral Hazard: First-Time Renewed Policies

MODELS	Logistic [a,c]	Negative Binomial [a,c]	Tobit with Lower Limit at 0 [c]
VARIABLES	grpclyn	grpclcont	grpclfreq (scaled up by 1,000)
Claim Indicators in Corresponding New Polices	0.0993**	0.0126***	0.221*
	(0.0401)	(0.00345)	(0.130)
lnamnt	0.0200***	0.0171***	1.759*
	(0.00726)	(0.00604)	(1.014)
lnanlpremrate	0.0203**	0.0273***	2.016
	(0.00922)	(0.00665)	(1.224)
lnactgrpsize	0.0492***	0.0591***	5.659***
	(0.00662)	(0.00771)	(0.591)
lngrppoldur	0.149***	0.142***	19.00**
	(0.0387)	(0.0411)	(8.822)
Pseudo R^2	0.301	0.281	0.074
Observations	762	762	762

Note:

We present the marginal effects of logistic model and negative binomial model, and the estimated coefficients of tobit model with robust standard errors in parentheses; we also present the *, **, *** indicate significant differences of regression coefficients from 0 at the 10%, 5%, and 1% level.

a. Marginal effects at the means of independent variables are reported.

c. Intercepts and year dummies are included in models but not reported.

Appendix 4
Bootstrapping Standard Errors

Sub-Portfolios	New Policies	Renewed Policies (Policies renewed one or more times)	Policies Renewed Two or	Policies Renewed Three or More Times
Panel A	**Logistic on grpclyn [a,c]**			
lnamnt	0.00853***	0.00463*	0.00116	0.00160
	(0.00284)	(0.00239)	(0.00238)	(0.00347)
lnanlpremrate	0.0127***	0.00603*	0.00145	0.00169
	(0.00385)	(0.00349)	(0.00320)	(0.00368)
lnactgrpsize	0.0293***	0.0165**	0.00712	0.00438
	(0.00404)	(0.00706)	(0.0136)	(0.00880)
lngrppoldur	0.0671***	0.0369***	0.0166	0.00774
	(0.0217)	(0.00832)	(0.0212)	(0.0123)
Pseudo R^2	0.307	0.362	0.440	0.427
Panel B	**Negative Binomial on grpclcont [a,c]**			
lnamnt	0.00863***	0.00539**	0.00105	0.0000658
	(0.00265)	(0.00251)	(0.00128)	(8.64e-05)
lnanlpremrate	0.0127***	0.00924***	0.00372	0.000135
	(0.00378)	(0.00347)	(0.00232)	(0.000155)
lnactgrpsize	0.0284***	0.0201***	0.00953**	0.000220
	(0.00631)	(0.00676)	(0.00423)	(0.000241)
lngrppoldur	0.0776***	0.0380***	0.0209***	0.000293
	(0.0244)	(0.00597)	(0.00736)	(0.000304)
Pseudo R^2	0.319	0.312	0.364	0.396
Panel C	**Tobit with Lower Limit of 0 on grpclfreq (scaled up by 1,000) [c]**			
lnamnt	3.439**	1.292*	0.901	2.402
	(1.450)	(0.730)	(0.790)	(1.836)
lnanlpremrate	5.108**	2.134***	1.875*	3.213*
	(2.121)	(0.807)	(1.022)	(1.926)
lnactgrpsize	10.45***	4.925***	3.840***	4.828***
	(1.359)	(0.430)	(0.580)	(0.941)
lngrppoldur	26.91**	11.25***	8.625***	7.519*
	(12.00)	(3.064)	(2.779)	(4.165)
Pseudo R^2	0.091	0.124	0.182	0.211
Observations [b]	1,690	1,850	1,088	745

Note:

We present the marginal effects of logistic model and negative binomial model, and the estimated coefficients of tobit model with bootstrapping standard errors in parentheses; we also present the *, **, *** indicate significant differences of regression coefficients from 0 at the 10%, 5%, and 1% level.

a. Marginal effects at the means of independent variables are reported.

b. The dataset used here is the same as the portfolios shown in Table 3. The smaller number of observations is due to missing values of claims.

c. Intercepts and year dummies are included in models but not reported.

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