Household Bundling of Health Insurance^{*}

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Abstract

This paper studies how to bundle household health insurance policies, where each household member's policy is a product in the bundle. Two bundling regimes are considered: pure bundling and bundle discounts. I show that pure bundling is socially optimal when there is significant within-household heterogeneity in willingness to pay for different members' insurance, when a household values the insurance bundle more than its individual components, or when the household prefers to buy insurance for costlier-to-insure members, implying within-household adverse selection. In the context of Vietnam's Social Health Insurance program, the structural estimates suggest that within-household heterogeneity in willingness to pay is largely generated by withinhousehold differences in health types. Therefore, a pure bundling policy generates a 43% increase in consumer surplus relative to bundle discounts.

Keywords: Adverse selection; Household bundling; Health insurance

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1 Introduction

Adverse selection is among the main causes of market failures in the health insurance market and has been at the center of policy initiatives. Much of the economics literature on the remedy for adverse selection and the policies that follow have focused on incentivizing individuals to make optimal insurance choices. However, these choices are often made at the household level. This paper explores the extent to which adverse selection can be mitigated by bundling household members' health insurance policies when household decision making is taken into account.

Two aspects of household demand for health insurance differ from the individual framework. First, when decisions are made at the household level, there may be variation in willingness to pay (WTP) for different members' insurance. This variation could be linked to the cost of providing insurance. For example, if a household chooses to insure a sicker member, the variation in WTP reflects within-household adverse selection. Conversely, if they prefer to insure a member who is less expensive from the insurer's perspective, it indicates within-household advantageous selection. Additionally, even if household members are identical, the household may value the insurance bundle differently from the sum of its parts. If the bundle is valued less than the sum, insurance products are substitutes; if valued more, they are complements.

This paper studies how to bundle household health insurance policies in the context of the Vietnam's Social Health Insurance (SHI) program. SHI is a health financing system commonly used in many developing countries, where health insurance is government-sponsored, and enrollment is voluntary for most of the population. Premiums are determined by the number of household members enrolled in SHI. The data used in this study come from a biannual, repeated cross-sectional household survey conducted between 2004 and 2012, which includes detailed information on household structure, income, demographics, and annual medical expenses. Most importantly, the data provide information on the insurance status of each household member.

Two bundling regimes are considered: bundle discounts and pure bundling. A bundle discount policy specifies a potential discount on each additional policy purchased by the household. By contrast, a pure bundling policy only allows either the entire household to purchase health insurance or no member to be insured.¹ Both regimes are frequently used in health insurance settings. For example, many government-sponsored insurance schemes in developing countries rely on pure bundling.² On the other hand, in the U.S. health insurance market, insurers often offer discounts when spouses purchase insurance jointly or when children are included in the policy. Nevertheless, how household insurance should be bundled is still largely unexplored in the literature.

I begin with an illustrative example to highlight the key determinants of the optimal bundling regime in the context of a social planner selling insurance under a neutral budget constraint, similar to Vietnam's SHI system. Intuitively, a pure bundling policy can be optimal through two channels: (1) by homogenizing the demand for insurance across households, which increases insurance demand, or (2) by incentivizing lower-cost individuals to purchase insurance, thus generating a positive externality on the insurance pool and lowering premiums. I show that the first channel is achievable when the degree of within-household heterogeneity in WTP for insurance exceeds a certain threshold. Furthermore, this threshold is positively correlated with the difference between the household's WTP for the bundle and the sum of its individual components. Specifically, a pure bundling policy is more likely to be optimal when insurance policies for different household members are complements. The

¹Since a pure bundling policy can always be replicated by an appropriately defined bundle discount policy, I refer to a pure bundling policy in this paper whenever the equilibrium insurance demand results in no partially-enrolled households.

²The NCMS program in China for families in rural areas only allows household enrollment. In Thailand, workers in the informal sector can purchase health insurance through the Social Security Scheme, and their family members receive free enrollment in the Universal Coverage Scheme. Burkina Faso also sets the unit of enrollment for their community-based health insurance scheme at the household level

second channel arises when households tend to select higher-cost members to insure, leading to within-household adverse selection.

My first contribution is constructing an empirical model that quantifies the degree of heterogeneity in WTP within the household, the sources of this heterogeneity, and the household's preferences for an insurance bundle relative to individual insurance policies. In this model, a unitary household decides on the optimal insurance bundle and, conditional on its health insurance choice, the medical care demand of each member. The household is riskaverse, and each member is characterized by (1) their risk type, (2) the price elasticity of their medical care demand (i.e., moral hazard), and (3) their utility weight. In addition, all household members share a similar degree of income elasticity in their demand for medical care. The preferences of household members and the household's attitude toward risk are private information not observed by the insurer.

In this framework, a household has a higher WTP to insure a member with worse health risks, a higher utility weight, or a lower price elasticity. The model does not assume the existence of within-household adverse selection a priori. Instead, whether within-household adverse or advantageous selection arises depends on the relative magnitude of the heterogeneity in price elasticity compared to other factors that characterize household members' preferences and risks. The model also allows for the complementarity or substitutability of different members' insurance depending on the correlation between income and the demand for medical care. If higher income increases (or decreases) the demand for medical care, the household values insurance products as substitutes (or complements).

The primitive objects of this model are the distribution of health risks within and across households, the preference parameters of individuals and households in the population (include income elasticity, price elasticity, and utility weights), and household risk preferences. Another of my contributions is to show that these objects are identified using available data on insurance choices and medical expenditures. In the model, observed medical consumption does not necessarily reflect health risks alone, as it also includes additional medical consumption driven by preferences for medical care. This additional component, which I term 'optional care', only arises when a household has sufficiently high income. Therefore, the distribution of health risks in the population can be identified from the distribution of medical spending among households with sufficiently low incomes. The identification of preference parameters relies on the existence of individuals who are involuntarily insured, either because their insurance is mandated by the government via employers or because they receive SHI for free. Since their insurance choices are exogenous to their preferences and health risks, the variation in their medical spending across different coinsurance rates and household income levels is sufficient to identify the distribution of the preference parameters. Finally, the distribution of risk preferences and a household's beliefs about its health risks are identified through observed health insurance choices and the differences in medical spending between voluntarily insured and uninsured members.

The results from the empirical model indicate that households in the data exhibit a significant degree of within-household heterogeneity in WTP for insurance. On average, a household's lowest WTP for a single member's insurance is only 34% of its highest WTP. Most of this heterogeneity is generated from differences in the risk profiles of household members, as 76% of those selected for insurance are also members with the worst health types, suggesting the presence of within-household adverse selection. The income elasticity of medical care consumption is estimated to be positive, resulting in an average decrease of 1205 KVND in WTP for a second member's insurance when household members are homogeneous in both risks and preferences.³

I then use the structural estimates to conduct counterfactual exercises on the impact of different bundling strategies on welfare and the composition of the insurance pool. Using the

 $^{^{3}\}mathrm{In}$ 2012, one thousand VND was approximately 0.0475 USD. For comparison, Vietnam's GDP per capita in 2012 was \$2190.23.

observed insurance contract in the data and the SHI program's 2012 budget, I first compare the outcomes under the optimal premiums for bundle discounts and pure bundling. The analysis shows that implementing a pure bundling policy significantly improves the average risk type of the insurance pool. While the average cost to insure a member under bundle discounts is 3335.7 KVND, the average cost under pure bundling is only 2228.31 KVND. As a result, the per-member premium under pure bundling is, on average, lower than that under bundle discounts. In terms of welfare, bundle discounts leads to a 43% increase in consumer surplus. This exercise also compares these results to the benchmark of a mandate. Because a significant degree of within-household selection is based on health risk, a universal mandate yields the highest level of social surplus. Relative to a mandate, pure bundling still achieves 88% of the consumer surplus. In addition, I show that pure bundling is no longer the optimal bundling policy when within-household heterogeneity in health types is eliminated.

Next, I explore the possibility of combining risk-based pricing with pure bundling. In this counterfactual, the social planner has access to coarse information about each household member's risk type, specifically whether their health risk is above or below the population median. Pure bundling enables the social planner to implement third-degree price discrimination based on household types, whereas traditional price discrimination based on individual risk type is complicated by the interdependency in WTP for insurance among household members. The counterfactual results show that combining pure bundling with risk-based pricing increases consumer surplus compared to implementing each policy separately. This suggests that bundling policies can serve as effective complementary tools to commonly used third-degree price discrimination schemes, such as age-based and risk-based pricing.

The final counterfactual exercise examines the role of the government's budget in setting insurance bundle policies. When the pool of eligible members receives a generous premium subsidy, adverse selection is alleviated. As a result, the welfare difference between a bundle discount policy and a pure bundling policy stems from their effects on the demand for insurance. The estimates suggest that, due to varying within-household WTP for insurance, the optimal pure bundling policy still generates higher consumer surplus than the optimal bundle discount policy, even with a more generous budget. Furthermore, the welfare difference increases as the government's budget (and, consequently, the premium subsidy) decreases.

1.1 Related Literature

This paper is related to the literature on designing household health insurance. Existing empirical evidence in the literature has highlighted the positive impacts of bundling policies on the cost of providing insurance. For example, Sinaiko et al. (2017) shows that individual spending under household insurance plans is, on average, lower than under individual plans, based on data from enrollees in commercial health plans in the US. Fischer et al. (2023) demonstrates that there is a lower correlation between the cost of providing insurance and the demand for insurance under a pure bundling policy than when insurance is sold only at the individual level, using data from a randomized controlled trial in Pakistan's public health insurance scheme. While the results of the counterfactual analysis in my paper are qualitatively similar to these findings, the analysis from the structural model allows us to compare the welfare and distributional impacts under the optimal bundling regime to those of other traditional tools (such as mandates) and to disentangle the effect of risk pooling from other factors that influence a household's demand for an insurance bundle.

More broadly, this paper contributes to the growing literature on market design in markets with asymmetric information (Akerlof, 1970; Rothschild and Stiglitz, 1976). In the classical framework of Akerlof (1970), mandated full insurance is socially optimal when there is no moral hazard or other dimensions of heterogeneity that affect the optimal contract for each individual. When a mandate is not feasible, much of the literature has focused on third-degree price discrimination schemes that encourage low-risk individuals to enroll, based on the correlation between observed characteristics and health risks (Ericson and Starc, 2015; Tebaldi, 2016; Jaffe and Shepard, 2017). In contrast, bundling strategies exploit the private information that a household has about its members and focus on addressing within-household heterogeneity in WTP for insurance and in the cost of providing insurance.⁴ Thus, bundling provides a complementary policy that could be implemented alongside third-degree price discrimination schemes, such as risk ratings and premium subsidies. Theoretically, when within-household selection into insurance is based solely on health risks, Nguyen and Tan (2023) characterizes the optimal bundling strategy in a setup resembling the insurance market for households. In my paper, the assumption that members differ only in health risks is relaxed, allowing household members to also sort into insurance based on their preferences for medical care unrelated to risks.

This paper is also related to the literature that studies the demand for health insurance using a two-stage approach (Cardon and Hendel, 2001; Carlin and Town, 2009; Einav et al., 2013; Handel, 2013; Bajari et al., 2014). My model incorporates multiple features that have been studied in the literature, such as selection on moral hazard (Einav et al., 2013) and selection on risk aversion (Finkelstein and McGarry, 2006; Cohen and Einav, 2007). Unlike prior household health insurance models in the literature that assume a household chooses a single plan for all of its members based on aggregate measures of household characteristics (Bundorf et al., 2012; Ho and Lee, 2017), in my model, the household can make different insurance choices for different household members.

Lastly, this paper adds to the empirical literature on the estimation of consumer demand

⁴There are three key differences between the bundling problem studied here and that in the product bundling literature (Long, 1984; Schmalensee, 1984; Fang and Norman, 2006; Chen and Riordan, 2013; Armstrong, 2013). First, the product bundling literature often assumes a constant marginal cost, whereas in the insurance market, adverse selection on risk types affects both the demand for insurance and the average cost of providing insurance. Second, in the absence of any differences in observed characteristics, the insurer views household members as ex-ante identical; therefore, the insurer cannot set a member-specific premium. In contrast, in the product bundling literature, each product in the bundle can be priced separately by the firm. Lastly, the product bundling literature considers profit maximizing firms, whereas in this context, insurance bundles are designed by a social planner to maximize social welfare.

for bundles (Manski and Sherman, 1980; Train et al., 1987; Hendel, 1999; Augereau et al., 2006; Gentzkow, 2007). As noted in Gentzkow (2007), a key empirical challenge in estimating the demand for a bundle is to separate the substitutability or complementarity of goods from the correlation in consumer preferences. In my model, the substitutability of different members' insurance arises from risk sharing and income pooling within the household, and the correlation in consumer preferences is the correlation in household members' health risks. However, the approach commonly used in the literature, which assumes that bundle (dis)synergy is exogenously given and common across consumers, is not applicable to the health insurance context. Here, the substitutability of different members' insurance arises endogenously from the unobserved heterogeneity in household risk aversion and income effect. Therefore, my model relies on the parametric assumption of the curvature of the indirect utility function to estimate the degree of substitutability.

The remainder of this paper proceeds as follows. Section 2 describes the data and the institutional setting of the SHI program in Vietnam. Section 3 provides an example to illustrate the different channels that influence the optimal bundling scheme. Section 4 presents the empirical framework. Section 5 discusses the identification and parameterization of the model, along with the estimation results. Section 6 analyzes the welfare impacts of various bundling policies, and Section 7 concludes.

2 Institutional Setting and Data

2.1 Setting

Vietnam's SHI program is the main health insurance scheme for the majority of the population. The program is government-sponsored and partially funded by tax revenues. SHI does not exclude preexisting conditions and covers only enrollees, not their dependents. Similar to other developing countries, the market for private health insurance is virtually nonexistent in Vietnam.⁵ As of 2012, 31.9 million Vietnamese, or 30% of the population, were uninsured. Throughout this paper, I maintain the assumption that SHI is the sole insurance option for the population.

There are two types of enrollees in SHI: involuntary insurees and voluntary insurees. Involuntary enrollees consist of (1) workers whose enrollment in SHI is mandated by their employers, (2) individuals who receive free insurance from the government, and (3) student insurance.⁶ Due to the lack of government enforcement, only approximately 50% of formal sector workers are in the involuntary group (Tran et al., 2011; Yamada and Vu, 2018; Somanathan et al., 2014). The rest of the population, including all informal and formal sector workers who do not have SHI through their employers, can purchase voluntary SHI.

The two determinants of voluntary SHI premiums are: (1) the minimum wage (MW), which is city-specific, and (2) the number of household members who are also buying voluntary SHI. Notably, premiums do not depend on age or gender. Each year, the voluntary SHI premium is indexed to a certain percentage of the annual salary computed at MW, and this percentage ranges between 3% and 4.5% (Table B.3 in Appendix B). On the other hand, involuntary SHI premiums for workers whose enrollment are mandated by their employers are always 6% of their wages.

The relationship between voluntary SHI premiums and the number of household members buying voluntary SHI varies across years and can be categorized into two regimes: bundle discount and pure bundling. Under the bundle discount regime, the government allows households to select specific members for insurance and rewards households with more members buying voluntary SHI by offering a lower per-member premium. For example, in

⁵As of 2010, the per capita health expenditures paid by private health insurance are less than \$1 USD in Vietnam (≈ 0.07 % GDP per capita) (Roland Berger, 2010). The private market serves mostly foreigners working in Vietnam and the very wealthy (Cheng, 2014).

⁶The group of enrollees that receive free SHI includes the poor, pensioners, veterans, and children under the age of 6. Poor households are given policy beneficiary enrollment for the entire household. Other eligible categories of policy beneficiaries are given at the individual level. Student insurance is often mandated at the school level and its premium is part of tuition fees.

2008, the premiums for the first and second household members were 4.5% of MW, while the premium for the third member was reduced to 4.05% of MW. In contrast, under the pure bundling regime, voluntary SHI purchase is only permitted if all household members (except those already covered as involuntary insured individuals) buy voluntary SHI. In this regime, the premium paid by each household is determined based on the minimum wage and the total number of household members eligible to buy voluntary SHI. For instance, in 2006, the premium for a household with 2 eligible members was 6.0% of MW (covering both members), and the household did not have the option to insure only one member. The premium for a household with only one eligible member was 3.0% of MW. The last column of Table B.3 documents the bundling regimes across years.

The coinsurance rates of SHI contracts are piecewise linear, varying across years and enrollee types, and are set at the individual level. Table B.2 in Appendix B provides a summary of the coinsurance rates between 2004 and 2012 for different types of enrollees.⁷ For example, in 2012, a voluntary member had a 0% coinsurance rate for expenses below 100 KVND and a 20% coinsurance rate for higher expenses. Other dimensions of SHI contracts such as the set of medical procedures not covered and inflation-adjusted medical procedure and drug prices, which are also set by the government, have remained relatively stable over time.⁸

Both the purchase and the renewal of voluntary SHI must be done in person at local

⁷Whether the cost-sharing features of the insurance contract should be set at the household level or at the individual level is an interesting topic for future research. Keeler et al. (1977) theoretically shows that out-of-pocket expenses have a lower variance when the deductibles are set at the individual level compared to the household level. The underlying economic mechanisms of how cost-sharing features should be set when there are multiple members also share some similarities with how individuals dynamically consider their medical consumption when the coinsurance rate is nonlinear (Campo, 2021) and the optimal length of the insurance contract (Hong and Mommaerts, Forthcoming).

⁸The services not covered by SHI include family planning, assisted reproductive technologies, organ transplants, vaccinations, cosmetic surgery, innate disability, occupational disease, traffic accidents, suicide, and drug addiction. Some of the excluded diagnoses are covered by another government agency for the entire population regardless of whether a patient has SHI; these include tuberculosis, malaria, HIV/AIDS, and STDs.

offices, which alleviates concerns about inertia (Handel, 2013). In my data, the number of people who switched from being uninsured to being voluntarily insured and vice versa is approximately the same as the number of people who remained voluntarily insured during both periods (Table B.4 in Appendix B).

2.2 Data

My main source of data is the biannual Vietnamese Household Living Standard Survey (VHLSS) from 2004 to 2012. VHLSS essentially has a repeated cross-sectional structure.⁹ Each round of the VHLSS is conducted on more than 9000 households (approximately 36000 individuals) by the General Statistic Office of Vietnam to monitor household living standards. The sample of households in the VHLSS is representative of the entire population. The data consist of the demographic characteristics of household members, income, expenditures, education level, and health insurance status. The VHLSS also records annual out-of-pocket (OOP) costs for each individual regardless of insurance status. However, it does not include medical expenditures paid by SHI for most years.¹⁰ Crucially, the survey includes information on household status similar to that used by SHI.¹¹. I supplement these survey data with the aggregate administrative annual revenue data collected from health insurance premiums and claim payments by VSS, grouped by enrollee type and city, from 2008 to 2012. The aggregate statistics from the administrative VSS data are comparable to the aggregate statistics produced by the VHLSS surveys. In the subsequent analysis, I exclude households with more than 10 members and households in the top and bottom 2.5

⁹Some households were surveyed in two consecutive waves, but no households were observed for more than 2 years. Table B.1 in the Appendix shows the number of households observed in multiple survey rounds. Much of the analysis in this paper does not rely on this panel dimension of the data mainly because of the small sample size of the repeatedly observed households.

¹⁰Medical expenditures cannot be backed out from OOP costs because not all such expenditures are covered under SHI. In Appendix E, I explain how this issue is overcome in the structural estimation.

¹¹Vietnam's household registration system is similar to that of other Asian nations, such as China, Japan, Korea, Thailand, and Indonesia, in which the household registry determines voting districts and right to attend public schools and is required for official recognition of certain events, such as marriages and births.

percentiles of the income distribution.

	Involuntarily	Voluntarily	Uninsured		
	insured	insured			
Percentage	50%	5%	45%		
Age	25.75	46.71	34.89		
	(20.68)	(16.82)	(17.81)		
In-patient visits (IPVs)	0.11	0.21	0.07		
	(0.52)	(0.69)	(0.38)		
Out-patient visits (OPVs)	1.11	2.66	1.05		
	(2.98)	(5.56)	(3.06)		
Out-of-pocket (OOP) costs	284.04	1097.25	373.34		
	(2034.89)	(4114.85)	(1979.58)		
College degree	0.21	0.22	0.15		
	(0.41)	(0.42)	(0.36)		
Female	0.49	0.6	0.51		
	(0.5)	(0.49)	(0.5)		
Married	0.71	0.88	0.76		
	(0.45)	(0.32)	(0.43)		
Sample size: 171507 individuals					

Table 2.1: Summary statistics at the individual level

Note: Sample standard deviations are in parentheses. OOP costs are measured in thousands of VND.

Table 2.1 reports the summary statistics of the sample at the individual level. Involuntary enrollees account for 50% of the sample, and only 10% of eligible individuals are voluntarily insured. Those without insurance tend to be younger and have lower levels of education compared to those who are voluntarily insured. The differences in the average frequency of medical visits among these groups suggest the presence of adverse selection and/or moral hazard. On average, a member with voluntary insurance experiences 0.21 in-patient visits (IPVs) annually, which is higher than the average for those involuntarily insured (0.11 visit) and those without insurance (0.07 visit). Similarly, those with voluntary insurance also have a higher average number of out-patient visits (OPVs) compared to both the involuntarily insured groups, with 2.66 visits as opposed to 1.11 and 1.05 visits, respectively.

Table 2.2 reports the summary statistics of households in the sample, which show substantial variation in health insurance profiles across households. 61% of households in the sample choose not to insure any members not already covered involuntarily. Only 6% of

	All insured (with	All insured (no	No voluntarily	Other
	some voluntary	voluntary	insured	
	members)	members)	members	
Percentage of households	6%	26%	61%	6%
Household size	3.57	3.77	4.16	4.53
	(1.39)	(1.8)	(1.5)	(1.42)
IPVs (per member)	0.14	0.14	0.08	0.14
	(0.35)	(0.45)	(0.25)	(0.31)
OPVs (per member)	1.94	1.25	1.18	1.75
	(3.36)	(2.52)	(2.26)	(2.75)
OOP costs (per member)	712	365	380	676
	(2172.84)	(1595.04)	(1175.58)	(1868.55)
HH income (per member)	24529	19237	14276	16097
	(22619)	(26905)	(15313)	(12130)
	Sample size	: 42396 households	}	

Table 2.2: Summary statistics at the household level

Note: Sample standard deviations are in parentheses. OOP costs and household income are measured in thousands of VND. Households are categorized as follows: The first column includes only households where all members are insured, with at least one member being voluntarily insured. The second column includes only households where all members are involuntarily insured. The third column includes only households without any voluntarily insured members but with at least one uninsured member. The fourth column includes the remaining households in the sample.

households are fully insured voluntarily, and these households tend to have the highest average OOP costs, IPVs, and OPVs per member, as well as higher average household income and fewer household members.¹² In Table B.5 in Appendix B, I show that the variation in voluntary insurance choices, IPVs, and OPVs across households cannot be attributed solely to variations in the observable characteristics of household members.

Table 2.3 provides evidence consistent with the hypothesis that households possess private information about the demand for medical care of their members when making voluntary SHI purchase decisions. In this regression, I regress various measures of medical utilization on SHI status, accounting for household-fixed effects, year-fixed effects, and observed characteristics of each individual member. It appears that, within each household and after accounting for differences in observed characteristics, members with voluntary insurance utilize more healthcare services compared to both those with involuntary insurance or no insurance.

¹² For each household, household income is the sum of all individual members' income, regardless of whether a member is voluntarily insured, involuntarily insured, or uninsured.

	IPVs	OPVs	OOP costs	Total expenditure
	(1)	(2)	(3)	(4)
Involuntarily Insured	0.09	0.77	168.72	319.27
	(0.01)	(0.10)	(62.68)	(171.91)
Voluntarily Insured	0.20	1.67	925.26	793.85
	(0.02)	(0.11)	(94.99)	(213.05)
Observations	12,049	12,049	12,049	2,636
\mathbb{R}^2	0.06	0.14	0.05	0.03

Table 2.3: Within-household differences in medical consumption across insurance types

Note: The controlled variables not reported include household-time fixed effects, age dummies, gender, marital status, college status, relationship to household head categories, household size, household income (in log), and whether a member is female of childbearing age. The regression is conducted on the sample of households partially enrolled in voluntary SHI (column (4) of Table 2.2). The omitted insurance type category is the uninsured group. OOP costs and total expenditure are measured in thousands of VND. Standard errors, adjusted for heteroskedasticity, are reported in parentheses. In column (4), the sample includes only data from 2008, when total expenditure was reported in the survey.

Because the number of IPVs primarily reflects members' health risks rather than moral hazard, the findings in Table 2.3 also indicate the presence of within-household selection based on health risks.

Various patterns in the data suggest that both the insurance status of individual members and their healthcare utilization are influenced by the overall insurance composition of the household. Table 2.4 shows that a household is less likely to purchase additional voluntary SHI when more members are already covered involuntarily (column (1)). However, this negative correlation is unlikely to be due to differences in the health risks of the members, as there is no statistically significant correlation between average IPVs and the number of involuntarily insured members (column (3)).¹³ In addition, Table 2.5 shows that uninsured members in households with a higher proportion of voluntarily insured members tend to exhibit lower health risks. For instance, compared to a household with similar demographics

¹³The negative correlation between average OPVs and the number of involuntarily insured members in column (2) is consistent with the presence of moral hazard, as households with fewer members in involuntary insurance are more likely to purchase voluntary SHI and subsequently increase medical spending.

Table 2.4: Relationship between the number of involuntary enrollees and household's voluntary SHI purchase as well as medical utilization among members not covered by involuntary SHI

	Number of voluntary members	Average OPVs per member	Average IPVs per member	Average OOP costs per member
	(1)	(2)	(3)	(4)
Number of involun- tary members	-0.03	-0.06	-0.00	-4.42
J	(0.01)	(0.01)	(0.00)	(10.76)
Observations	25,232	25,232	25,232	25,232
\mathbb{R}^2	0.09	0.08	0.01	0.03

Note: The dependent variables in columns (2)–(4) represent the average medical usage per member for individuals without involuntary SHI coverage. These variables are measured in terms of OPVs, IPVs, and OOP costs, respectively. The regressions are conducted on households where some members are eligible to purchase voluntary SHI, excluding data from 2006, when pure bundling was implemented. Controlled variables, not reported, include household size, household income (in log), year-fixed effects, area-fixed effects, and the following summary statistics for household members without involuntary SHI coverage: average age, age of the oldest member, proportion of female members, and proportion of members with a college education. OOP costs are measured in thousands of VND. Standard errors, adjusted for heteroskedasticity, are reported in parentheses.

but with an additional voluntarily insured member, the uninsured members of a household with fewer voluntary SHI enrollees have 0.04 more IPVs, 0.34 more OPVs, and incur 321 thousand VND more in medical expenses.

Lastly, Table 2.6 provides summary statistics for households that chose full insurance enrollment under the bundle discount regime and the pure bundling regime of 2006. There is a slight increase in the proportion of households opting for full enrollment under the pure bundling regime compared to the bundle discount regime (6.31% vs. 6.22% of households, respectively). However, there are notable shifts in the characteristics of households that choose full enrollment under these two bundling policies. For example, under pure bundling, fully enrolled households tend to be larger, younger, and have a higher proportion of female members. In terms of medical utilization, households fully enrolled under pure bundling exhibit a similar average number of IPVs but significantly fewer OPVs.

	IPV	OPV	OOP costs
	(1)	(2)	(3)
Number of voluntarily insured members	-0.043	-0.344	-321.019
	(0.016)	(0.119)	(103.950)
Number of involuntarily insured members	-0.014	-0.052	-19.483
	(0.008)	(0.052)	(42.031)
Observations	61,794	61,794	61,794
\mathbb{R}^2	0.007	0.060	0.020

Table 2.5: Relationship between uninsured members' medical consumption and the number of insured household members

Note: This table reports the coefficients from regressions of uninsured members' medical consumption measures on the number of voluntarily and involuntarily insured members in their households, controlling for member characteristics. Controlled variables, not reported here, include age dummies, gender, marital status, college status, whether a member is female of childbearing age, relationship to household head categories, household size, household income (in log), area fixed effects, and year fixed effects. OOP costs are measured in thousands of VND. Standard errors, adjusted for heteroskedasticity, are reported in parentheses.

The descriptive statistics presented in this section suggest an interdependency in household decisions regarding health insurance purchases and medical care utilization. This is consistent with a model where the household, as the sole decision-maker, determines both the consumption of medical care and the purchase of health insurance for all members, taking into account each individual's preferences for medical care. In the following section, I present a simple example to illustrate the potential effects of household decision-making on the optimal bundling regime. I then introduce a rich model of medical care and health insurance demand, which will be applied in the empirical analysis.

3 An illustrative example

The goal of this example is to examine how various components of household decision-making influence the optimal insurance bundling strategy. Specifically, I focus on the following components: (1) the degree of heterogeneity in WTP for insurance within the household,

Table 2.6: Summary statistics of fully enrolled households under bundle discount and pure bundling

	Bundle discount	Pure bundling	p-value
Proportion of fully enrolled households	6.22%	6.31%	
Average age	39.16	35.84	< 0.01
	(15.34)	(12.89)	
Age of eldest member	55.17	53.83	0.07
	(15.3)	(14.4)	
Proportion of female members	0.53	0.51	< 0.01
	(0.22)	(0.18)	
Proportion of college educated members	0.31	0.28	0.06
	(0.31)	(0.28)	
Household size	3.5	3.98	< 0.01
	(1.4)	(1.3)	
Average per-member IPVs	0.14	0.13	0.4
	(0.36)	(0.31)	
Average per-member OPVs	1.99	1.68	0.04
	(3.47)	(2.74)	

Note: The last column reports the p-value of the test comparing the population mean between bundle discount and pure bundling for each variable. In 2006, the government also imposed a commune requirement, where voluntary SHI was only available if at least 10% of the commune's population was fully enrolled. As a result, this regulation rendered certain households unable to purchase voluntary SHI (1.05% of households in the 2006 sample). The summary statistics on household age, size, gender, and education profile account for households in 2006 who indicated on the survey that they were unable to purchase voluntary SHI due to the commune requirement. The summary statistics on medical utilization only include households that were able to purchase voluntary SHI.

(2) whether this heterogeneity leads to within-household adverse selection—i.e., if there is a positive correlation between the household's WTP and the insurer's cost, and (3) how a household values an insurance bundle compared to its individual components.

The insurance company offers insurance to a population of households, each consisting of two members. There are two types of households. The first type is denoted as (L, L), where the household's WTP to insure one member is v_L , regardless of which member is insured. The second type is denoted as (L, H), where the household's WTP to insure member L is v_L , and for member H, it is v_H . I assume that $v_H > v_L$, meaning that an (L, H) household will always prefer to buy insurance for the H member. Therefore, an (L, L) household does not exhibit within-household heterogeneity in WTP, while an (L, H) household does. The type of each household is private information. In the population, the probability of a household being type (L, H) is π , and the probability of being type (L, L) is $1 - \pi$. Thus, π represents the degree of heterogeneity in WTP for insurance within households.

The difference between a household's WTP for insuring both members and the sum of its WTP for each member's insurance is denoted by δ . For example, an (L, L) household is willing to pay $2v_L + \delta$ to insure both members. A negative δ represents substitutability between the members' insurance, while a positive δ indicates complementarity. In the case of substitutability ($\delta < 0$), I further assume that the household's WTP for insuring both members is always at least as high as for insuring only one member. This is equivalent to assuming $\delta > -v_L$.

The insurer's cost of covering a member L(H) is denoted as $c_L(c_H)$, and the total cost of insuring multiple household members is additive. For example, if both members of an (L, H)household are insured, the total cost to the insurer is $c_L + c_H$. The relative magnitudes of c_L and c_H determine the key factor influencing within-household selection into insurance. When $c_L < c_H$, this reflects within-household adverse selection, as an (L, H) household will prioritize insuring the higher-cost member (i.e., member H). Conversely, when $c_L > c_H$, member H is the lower-risk individual, leading to within-household advantageous selection, where the (L, H) household prefers to insure the healthier member. When $c_L = c_H$, the choice of which member to insure has no impact on the insurer's overall costs. I assume that insurance is always socially optimal, meaning $v_H > c_H$, $v_L > c_L$, and $\delta \ge \max\{2v_L - 2c_L, v_L + v_H - c_L - c_H\}$.

The insurance company offers individual insurance at a price p_1 and insurance for the entire household at a price p_2 . Let $v^*(\cdot)$, $c^*(\cdot)$, and $p^*(\cdot)$ represent the household's WTP, the insurer's cost, and the premium paid by the household at its optimal insurance choice. For example, $v^*(L, L)$ denotes household (L, L)'s WTP for its optimal insurance choice with premium $p^*(L, L)$, and the insurer's cost at this choice is $c^*(L, L)$. The insurance company chooses (p_1, p_2) to maximize social surplus, subject to a neutral budget constraint, as follows

$$\max_{p_1,p_2} (1-\pi) \left[v^*(L,L) - c^*(L,L) \right] + \pi \left[v^*(L,H) - c^*(L,H) \right] \tag{P}$$

subject to

$$(1-\pi)c^*(L,L) + \pi c^*(L,H) \le (1-\pi)p^*(L,L) + \pi p^*(L,H)$$
(1)

I assume that when a household is indifferent between different insurance choices, it chooses the option that insures more members.

I show that it is without loss of generality to consider only the following prices:¹⁴

$$p_1 = v_H; \quad p_2 = 2v_L + \delta \tag{Menu 1}$$

$$p_1 = v_H; \quad p_2 = v_L + v_H + \delta \tag{Menu 2}$$

$$p_1 = v_L; \quad p_2 = v_L + v_H + \delta \tag{Menu 3}$$

(Menu 1) represents the first-best menu, where both types of households purchase insurance for both members. From here, I focus on the case where the first-best outcome cannot be attained—that is, when (Menu 1) violates the budget constraint (1).

(Menu 2) represents a *pure bundling* regime. Under these premiums, only (L, H) households purchase insurance for both members and pay p_2 , while (L, L) households opt out of insurance. In contrast, under (Menu 3), an (L, H) household buys insurance only for member H and pays the corresponding premium p_1 . An (L, L) household also pays p_1 to purchase insurance for one member L. Furthermore, when $v_L + v_H + \delta < 2v_L$, the premium for the bundle includes a discounted price for the second member's insurance, representing an *bundle*

¹⁴The proof is provided in Appendix A.1. Intuitively, this result is achieved because the relative preference ranking of an (L, L) household when considering whether to insure on or both members is the same as that of an (L, H) household. For example, if an (L, L) household prefers to insure both members rather than just one, an (L, H) household will have the same preference. Therefore, it is sufficient to consider whether a household type prefers to buy insurance or not.

discount regime.

The following proposition lists the conditions under which the optimal pricing strategy features a pure bundling policy (i.e., (Menu 2)).

Proposition 1. Pure bundling is the optimal pricing strategy under severe adverse selection if one of the following conditions holds:

- 1. $\pi \geq \frac{v_L c_L}{2v_L + \delta 2c_L}$
- 2. $\frac{v_L c_L}{\pi} \le c_H c_L$

Proposition 1 highlights two factors that determine whether pure bundling is the optimal pricing strategy: (1) when within-household heterogeneity in WTP for insurance is sufficiently high, or (2) when within-household adverse selection is sufficiently severe. The proof of this proposition relies on the observation that the prices set in (Menu 2) always satisfy the budget constraint in (1). Therefore, it is sufficient to compare the surplus generated under (Menu 2) and (Menu 3), and to determine whether (Menu 3) satisfies the budget constraint.

The first condition of Proposition 1 indicates that pure bundling is more favorable when π is higher—that is, when there is a greater degree of within-household heterogeneity in WTP for insurance. To understand why, consider the right-hand side (RHS) of this condition, which represents the economic tradeoff in social surplus between (Menu 2) and (Menu 3). Under (Menu 2), L members of (L, H) households are insured, but members of (L, L) households are excluded from insurance. A higher π reduces the loss in surplus caused by excluding (L, L) households from the insurance pool. Additionally, the threshold for π decreases as δ increases—that is, when insurances for different members are close complements, generating greater surplus from insuring an additional household member, regardless of their type.

The second condition of Proposition 1 emphasizes the importance of within-household adverse selection, as this condition is only met when c_H exceeds c_L . Under this scenario, (Menu 3) violates the budget constraint in (1), making (Menu 2) the optimal choice for the insurer. This condition can be rewritten as $(v_L - c_H)\pi + (v_L - c_L)(1 - \pi) \leq 0$, where the RHS represents the budget constraint under (Menu 3). The first term illustrates the net impact on the insurer's profit from including H members from (L, H) households in the insurance pool, while the second term represents the net effect of including an L member from (L, L) households.

4 Model

In this section, I introduce a model of how households make choices regarding health insurance and their medical care needs, which will later be applied in the empirical analysis. This model also provides a microfoundation for the relationship between the household's WTP for insurance and the cost of providing insurance. In this model, each household has a representative agent—henceforth, the decision maker (DM)—who makes all decisions on behalf of the entire household. For notational simplicity, this section only considers insurance contracts with linear coinsurance rates.

Let h denote a unitary household with n_h members and household income Y_h . Let subscript j denote a member of the household, and let bold symbols denote vectors of household variables. The household consumes a basket of $n_h + 1$ goods. This basket includes a consumption good $c_h \ge 0$, whose price is normalized to 1, and all members' medical care utilization $\mathbf{m}_h := (m_{hj})_{j=1,2,...,n_h}$, where m_{hj} is member j's medical utilization in monetary value. Within the household, \mathbf{m}_h are private goods, whereas c_h is a public good.

The household can choose to purchase health insurance for each member at a premium, and the health insurance choice affects the price of that member's medical care. This price is denoted by κ_{hj} , which is equal to the coinsurance rate of the insurance contract if a member is insured and is equal to 1 otherwise. An insurance choice for household h is then represented by $\kappa_h := (\kappa_{hj})_{j=1,2,...,n_h}$, where $\kappa_{hj} = 1$ ($\kappa_{hj} < 1$) indicates an uninsured (insured) member. The premium of an insurance choice $\boldsymbol{\kappa}_h$ is given by $\pi(\boldsymbol{\kappa}_h)$, where $\pi(\cdot) \geq 0$.

Next, the health shocks of household h are denoted by $\boldsymbol{\theta}_h := (\theta_{hj})_{j=1,2,\dots,n_h}$, where $\theta_{hj} \geq 0$ is the health shock of member j. The household's belief about the distribution of $\boldsymbol{\theta}_h$ is denoted by $F_{\boldsymbol{\theta}_h}$. When $\theta_{hj} = 0$, member j is healthy and does not require any medical care. When $\theta_{hj} > 0$, θ_{hj} is the amount of *necessary* medical care for member j that the household must incur. The necessary care component represents the financial impact of an adverse health shock that cannot be controlled by the household. In addition, the household can also choose to consume additional *optional care*, which is equal to $m_{hj} - \theta_{hj}$, and the marginal utility of this additional care depends on the member's preference for medical care must be treated (necessary care), but a household with a higher income level can choose to spend more to obtain cancer treatment that is less invasive (optional care).

Let \underline{c} represent the subsistence expenditure, which is the amount of money the household must allocate to cover essential non-medical expenses such as food. I assume that \underline{c} is the same for all households. Conditional on the household's insurance choice κ_h and realization of health shocks $\boldsymbol{\theta}_h$, define:

$$R(\boldsymbol{\theta}_{h},\boldsymbol{\kappa}_{h}) := Y_{h} - \pi(\boldsymbol{\kappa}_{h}) - \boldsymbol{\theta}_{h} \cdot \boldsymbol{\kappa}_{h} - \underline{c}$$

 $R(\cdot)$ is thus the residual income of the household after paying the health insurance premium $\pi(\kappa_h)$, the total OOP costs of necessary care for all household members $\theta_h \cdot \kappa_h$, and the subsistence expenditure \underline{c} .

Let $\underline{U} > 0$. Given the household's insurance choice κ_h and realization of health shocks

 $\boldsymbol{\theta}_h$, I assume that the household's indirect utility function is as follows:

$$U_{h}^{*}(\boldsymbol{\theta}_{h},\boldsymbol{\kappa}_{h}) = \begin{cases} -\exp\left[-r_{h}\left(\frac{(R(\boldsymbol{\theta}_{h},\boldsymbol{\kappa}_{h}))^{1-\omega_{h}}}{1-\omega_{h}} - \sum_{j=1}^{n_{h}} \delta_{hj} \theta_{hj} \frac{(1+\kappa_{hj})^{1-\gamma_{hj}}-1}{1-\gamma_{hj}}\right)\right] & \text{if } R(\boldsymbol{\theta}_{h},\boldsymbol{\kappa}_{h}) \ge 0\\ -\exp\left[-r_{h}\left(\max\left[\{0, R(\boldsymbol{\theta}_{h},\boldsymbol{\kappa}_{h}) + \underline{c}\} - \underline{U}\right]\right)\right] & \text{if otherwise} \end{cases}$$

$$\tag{2}$$

where r_h , $(\delta_{hj}, \gamma_{hj})_{j=1,...,n_h}$, and ω_h are positive constants. The subsequent proposition provides the economic interpretations of these parameters.

Proposition 2. Conditional on $R_h(\boldsymbol{\theta}_h, \boldsymbol{\kappa}_h) \geq 0$, let $m_{hj}^*(\boldsymbol{\theta}_h, \boldsymbol{\kappa}_h)$ denote a demand function for medical care of member j, and $c_h^*(\boldsymbol{\theta}_h, \boldsymbol{\kappa}_h)$ denote the demand function for the consumption good. $\{(m_{hj}^*(\cdot))_{j=1,\dots,n_h}, c_h(\cdot)\}$ is consistent with the indirect utility function $U_h^*(\cdot)$. Then, $\{(m_{hj}^*(\cdot))_{j=1,\dots,n_h}, c_h(\cdot)\}$ is uniquely:

$$m_{hj}^{*}(\boldsymbol{\theta}_{h},\boldsymbol{\kappa}_{h}) = \theta_{hj} + \delta_{hj}\theta_{hj} \left(\max\left\{ R\left(\boldsymbol{\theta}_{h},\boldsymbol{\kappa}_{h}\right),0\right\} \right)^{\omega_{h}} \left(1+\kappa_{hj}\right)^{-\gamma_{hj}}$$
(3)
$$c_{h}^{*}\left(\boldsymbol{\theta}_{h},\boldsymbol{\kappa}_{h}\right) = Y_{h} - \boldsymbol{m}_{h}^{*}\left(\boldsymbol{\theta}_{h},\boldsymbol{\kappa}_{h}\right) \cdot \boldsymbol{\kappa}_{h}$$

The proof of Proposition 2 is provided in Appendix A.2. Proposition 2 states that the optional care demand is positive and dependent on household income only if the household maintains a positive residual income $R_h(\cdot)$. The income elasticity of medical care is represented by $\omega_h > 0$, which is common across all household members in household h. γ_{hj} represents member j's preference for optional medical care that is independent of the health risk; thus, γ_{hj} captures the effect of moral hazard. In addition, conditional on the realized health shocks, the demand for medical care for each member has an upper bound, achieved when medical care is free ($\kappa_{hj} = 0$). This implies that the marginal utility of medical care is zero for sufficiently high spending. The parameters ($\delta_{hj})_{j=1,...,n_h}$ capture the potentially different utility weights that the household places on each member. This difference could be

due to the variation in the members' income contributions to the household, among other factors.¹⁵

The parameter r_h does not have a direct impact on the household's demand for medical care. However, r_h influences the curvature of the indirect utility function, which in turn affects the household's decision regarding health insurance. Consequently, r_h represents the household's attitude toward risks unrelated to the demand for medical care. Henceforth, I refer to r_h as the household's risk aversion.

Since the total OOP cost of necessary care affects the household's residual income, the cross-member substitution effect arises indirectly from the income effect. If a household member has a higher coinsurance rate of medical care, the household must pay more OOP costs for his necessary care, thus lowering the residual income and reducing the amount of optional care for all other household members.

Lastly, when the residual income $R_h(\cdot)$ is negative, the health shock $\boldsymbol{\theta}_h$ is equivalent to an income shock. Therefore, the household will consume $\boldsymbol{m}_h = \boldsymbol{\theta}_h$ if it can afford to. If the household is unable to cover the cost of $\boldsymbol{\theta}_h$, Equation (2) assumes that the household receives a utility level of $-\exp(r\underline{U})$. I assume that \underline{U} is sufficiently large such that the indirect utility function in Equation (10) is weakly increasing in $R_h(\cdot)$.¹⁶

Household's health insurance choice Given the set of possible health insurance choices K_h , the household's DM chooses the health insurance choice that maximizes the indirect utility $U_h^*(\cdot)$.

$$\max_{\boldsymbol{\kappa}_h \in K_h} U_h^*(\boldsymbol{\kappa}_h, \boldsymbol{\theta}_h) \tag{4}$$

 $^{{}^{15}\}sum_{j=1}^{n_h} \delta_{hj}$ does not need to be normalized to 1 because δ_{hj} determines the magnitude of the optional care relative to the magnitude of the necessary care. In addition, as Equation (2) shows, δ_{hj} is also equivalent to the relative weight of the disutility from j's sickness relative to the household's utility from income.

¹⁶When a household in Vietnam cannot afford to pay for necessary care, there are several potential coping mechanisms. For example, Mitra et al. (2016) show that, on average, 0.2% of households with a hospitalization shock receive public transfers, 0.48% of households receive loans, and 0.33% of households sell their assets.

The available options in K_h encompass the scenario where household members might be enrolled in involuntary SHI. To illustrate, consider a household with 4 members $(n_h = 4)$, of which 2 members $(j \in \{1, 2\})$ are obligated to participate in involuntary SHI. Suppose that both voluntary SHI and involuntary SHI offer a linear coinsurance rate of k < 1, K_h consists of the following options $\{(k, k, 1, 1), (k, k, 1, k), (k, k, k, 1), (k, k, k, k)\}$.

The functional form of $U_h^*(\cdot)$ yields familiar characterizations of the household's WTP for insurance. For member j, the household's WTP for j's insurance increases if the household's risk aversion r_h is higher, if the household's belief about j's health shock is worse, or if j's utility weight δ_{hj} is higher. On the other hand, the household is more likely to buy health insurance for a member with a lower moral hazard coefficient γ_{hj} .¹⁷

Furthermore, since the household considers medical care for different members as substitutes, different members' health insurance policies are also substitutes. The intuition is the following. When the household chooses to insure the first member, the household expects to have more residual income to spend on medical care. Since medical utilization has decreasing marginal utility, the benefit of having insurance and, thus, being able to consume more medical care for the second member becomes less significant. Therefore, the household is less likely to buy health insurance for the second member. The larger the income effect (ω_h) is, the larger the substitution effect. Figure C.1 in Appendix C illustrates the difference between a 2-member household's WTP for insuring both members as opposed to only a single member.

¹⁷The comparative statics with respect to the moral hazard coefficient γ_{hj} are less straightforward because of two countervailing effects. Consider a household with two members, where $\gamma_{hi} < \gamma_{hj}$. When insured, member *j* increases their medical utilization more than member *i*, resulting in the household receiving greater reimbursement from *j*'s insurance compared to *i*'s insurance. In other words, *j*'s insurance is utilized more. However, because *j* has a higher moral hazard coefficient, the marginal utility function of $m_{hj}|(m_{hi}, c_h)$ is lower than that of $m_{hi}|(m_{hj}, c_h)$. As a result, the household prefers to consume less of m_{hj} and more of m_{hi} , which reduces the household's WTP for *j*'s insurance relative to *i*'s. In our model, the latter effect dominates the former, making the household's WTP for insurance a decreasing function of γ_{hj} .

Social planner's problem Throughout this paper, I assume that health insurance is administered by a social planner to maximize social welfare over a population of households subject to an exogenously given budget constraint. Additionally, I assume that the coinsurance rate for the insurance contract is fixed. The social planner does not observe $(\boldsymbol{\theta}_h, \omega_h, r_h, \boldsymbol{\delta}_h, \boldsymbol{\gamma}_h)$; however, it observes some household characteristics, denoted by X_h^* . The social planner determines the voluntary insurance premium, $\pi(\cdot|X_h^*)$, as a function of the number of household members who opt for voluntary coverage. In the benchmark scenario, which is the pricing regime observed in the data, X_h^* includes only the count of members not enrolled in involuntary SHI and a household's geographical location. In the counterfactual exercises outlined in Section 6.2, I also explore cases where X_h^* includes additional household attributes.

4.1 Discussion

As illustrated in the example of Section 3, two main channels determine whether a pure bundling policy is socially optimal. First, a pure bundling policy is optimal if the degree of within-household heterogeneity in WTP for insurance exceeds a threshold. However, this threshold is higher when the substitutability between different members' insurance is more substantial. The model described in this section highlights several factors that can contribute to heterogeneity in a household's WTP for insuring different members. Within the household, the selection of insurance can be influenced by the heterogeneity across members in the distribution of health risks (θ_{hj}) , in the utility weights (δ_{hj}) , and in the moral hazard coefficient (γ_{hj}) . The magnitude of the income effect ω_h then determines the level of substitutability of different members' insurance.

The second channel that influences the optimality of a pure bundling regime is the extent to which within-household adverse selection exists. Note that the model described here does not impose a priori within-household adverse selection. In the scope of the model, within-household adverse selection arises when the selection of members into insurance is primarily due to the variation in either the distribution of health risks (θ_{hj}) or the difference in the bargaining weights δ_{hj} . On the other hand, significant variation in the moral hazard coefficient γ_{hj} can lead to within-household advantageous selection, where the member for whom the household has the highest WTP for insurance is not the most expensive to insure. Appendix D offers an illustration of when advantageous selection emerges.

5 Identification and Estimation

In the data, for each household h, I observe household income Y_h , the set of possible insurance choices K_h , its corresponding premium function $\pi_h(\cdot)$, the household's actual insurance selection κ_h , and each member's OOP costs $m_h \kappa_h$. The set of insurance choices K_h and premium function $\pi_h(\cdot)$ take into account whether household members are already covered by involuntary SHI. Observable household characteristics include year dummies, whether the household is in the agricultural sector, formal sector, or self-employment, the number of household members, the average age of the household, the age of the eldest member, the average year of education among members, and the ratio of female members in the household. Observable individual characteristics (X_{hj}) include the share of individual income in household income, the relationship between the member and the head of the household (HoH), age dummies, employment status, a gender dummy, marital status, whether a member is a female in child-bearing age, and whether the member has a college education. I fix the value of subsistence expenditure \underline{c} to be the average expenditure on food among households between the 35th and 55th percentiles of income, following Xu et al. (2003). The lower bound on utility \overline{U} is set such that the indirect utility function $U^*(\cdot)$ is continuous in household residual income.

In the identification argument, to simplify notation, I maintain the assumption that

the coinsurance rates are linear and the annual medical expenditure \boldsymbol{m}_h is also observed.¹⁸ Recall that a household's preferences are characterized by $\{\omega_h, \boldsymbol{\gamma}_h, \boldsymbol{\delta}_h, r_h, F_{\boldsymbol{\theta}_h}\}$. I allow each of these objects to have unobserved heterogeneity. Therefore, the objects of interest are the distribution of $\{\omega_h, \boldsymbol{\gamma}_h, \boldsymbol{\delta}_h, r_h, F_{\boldsymbol{\theta}_h} | (X_h, (X_{hj})_{j=1,...,n_h})\}$. Additionally, I assume that all distributions can be identified from their integer moments.¹⁹

5.1 Identification

Assumption 1. Households have rational expectations. Conditional on observed characteristics, a household's belief about its health shocks, $\boldsymbol{\theta}_h$, follows a known distribution with two parameters $\bar{\boldsymbol{\theta}}_h$ and ν , where ν is a constant and $\bar{\boldsymbol{\theta}}_h \in \mathbb{R}^{n_h}$ represents household h's private information. Both ν and the distribution of $\bar{\boldsymbol{\theta}}_h$ are objects to be identified.

The rational expectations assumption in Assumption 1 allows us to use observed medical expenditures to explain health insurance choices. Since households in the data are observed at most twice, identifying a household's belief about its health shocks relies on the parametric restriction outlined in Assumption 1. This assumption also simplifies the heterogeneity in F_{θ_h} to depend only on its mean. For individuals jh and j'h' with similar observed characteristics (both at the individual and household levels), their private beliefs about health shocks differ only if $\bar{\theta}_{hj} \neq \bar{\theta}_{h'j'}$. Henceforth, I will refer to $\bar{\theta}_h$ as the household's health type and $\bar{\theta}_{hj}$ as the member's health type.

Assumption 2. Conditional on observed individual and household characteristics, $\bar{\theta}_h \perp (\delta_h, \gamma_h, \omega_h)$.

Assumption 2 assumes that health types are uncorrelated with the parameters that govern

 $^{^{18}}$ As discussed in Section 2, annual medical expenditure is observed only for the year 2008. Appendix E explains how the estimation procedure deals with missing medical expenditure as well as how the nonlinear coinsurance structure is incorporated.

¹⁹Fox et al. (2012) provides sufficient conditions for this assumption to hold, which are weaker than what is needed for the existence of moment-generating functions.

the household's preferences for its members' medical care. Intuitively, this means that, conditional on observed characteristics, the distribution of the preference parameters $(\omega_h, \delta_h, \gamma_h)$ are similar between insured and uninsured household members. In addition, the distribution of these preference parameters can now be inferred from the distribution of annual medical expenditure of households fully covered under involuntary SHI, which is not affected by endogenous health insurance selection.²⁰

Proposition 3. Under Assumptions 1 and 2, with sufficient variation in Y_h , the joint distribution of $(\omega_h, \boldsymbol{\gamma}_h, \boldsymbol{\delta}_h, \bar{\boldsymbol{\theta}}_h, r_h)$ is identified for a given ν .

The proof of Proposition 3 is in Appendix A.3, and the technical condition for the variation in Y_h for the case of n = 1 is Assumptions 3-4 in the proof. Intuitively, the identification proof proceeds as follows. First, I normalize the unconditional distribution of health shocks to be the distribution of realized medical expenditures of the subsample of households who cannot afford to spend on optional care. I then identify the joint distribution of $(\omega_h, \delta_h, \gamma_h)$ from the distribution of medical expenditures by households fully enrolled in involuntary SHI. Note that if the residual income $R(\cdot)$ is observed, the identification problem here is similar to that of a demand system with random coefficients (Lewbel and Pendakur, 2017). The similarity between Lewbel and Pendakur (2017) and the problem being considered here is that there are variations in income across households and in coinsurance rates across years; however, the main difference lies in $R(\cdot)$ being unobserved, which renders the identification result in Lewbel and Pendakur (2017) not applicable. To address the unobservability of $R(\cdot)$, I utilize Assumption 2 and the unconditional distribution of θ_h to obtain the distribution

²⁰The identification argument here relies on the assumption that, on average, involuntary SHI members are similar to those not covered by involuntary SHI, conditional on observed characteristics. In Tables B.9 and B.10 in Appendix B, I show that this assumption is plausible because (1) involuntary SHI status is assigned based on age and income, and households cannot choose which members obtain involuntary status; (2) when not free, involuntary SHI premiums are higher than voluntary SHI premiums; and (3) involuntary SHI members are, on average, similar in terms of OOP costs, regardless of the composition of other household members not covered by involuntary SHI.

of $R(\boldsymbol{\theta}_h, \boldsymbol{\kappa}_h)$. Therefore, the joint distribution of $\omega_h, \boldsymbol{\gamma}_h$ and $\boldsymbol{\delta}_h$ must rationalize (1) the difference in the distribution of medical spending across different levels of Y_h (hence, different distributions of $R(\boldsymbol{\theta}_h, \boldsymbol{\kappa}_h)$), (2) the variation in \boldsymbol{m}_h across different coinsurance rates $\boldsymbol{\kappa}_h$, and (3) the difference between the distribution of \boldsymbol{m}_h and the distribution of health shocks $\boldsymbol{\theta}_h$. Next, I show that, given a common parameter ν , the variation in the proportion of households who purchase voluntary SHI for all eligible members across different household income level is sufficient to identify the joint distribution of $r_h | (\bar{\boldsymbol{\theta}}_h, \omega_h, \boldsymbol{\gamma}_h, \boldsymbol{\delta}_h)$.

Finally, ν is identified as the solution of the following equation across different voluntary coinsurance rates:

$$\mathbb{E}\left[\boldsymbol{m}|\boldsymbol{\kappa}, X_{h}, (X_{hj})_{j=1,\dots,n_{h}}, K_{h}, Y_{h}\right] =$$
$$\mathbb{E}\left[\boldsymbol{\theta}_{h} + \boldsymbol{\delta}_{h}\boldsymbol{\theta}_{h} \max\{0, R(Y_{h}, \boldsymbol{\kappa})\}^{\omega_{h}}(1-\boldsymbol{\kappa})^{-\boldsymbol{\gamma}_{h}}|\boldsymbol{\kappa}, X_{h}, (X_{hj})_{j=1,\dots,n_{h}}, K_{h}, Y_{h}\right]$$
(5)

5.2 Estimation

In the estimation procedure, I impose parametric assumptions on the distribution of health shocks, health types, and the joint distribution of the preference parameters. Also, the estimation procedure incorporates two additional empirical features of the data. First, the SHI insurance contract features piecewise linear coinsurance rates.²¹ Second, not all medical expenses in the data are covered by SHI. To address this, I assume that household members have uncertainty regarding the proportion of their annual medical expenses eligible for insurance coverage. I then estimate the distribution of coverage based on the 2008 data, which provides coverage information. More details on these two empirical features can be found in Appendix E.

²¹Under a piecewise linear coinsurance rate, the household faces a piecewise linear budget constraint when choosing (c_h, \boldsymbol{m}_h) , with each linear segment of the budget constraint representing a different level of compensated income and prices. To ease the computational burden, I assume that the coinsurance rate associated with the optimal medical consumption decision is the same as that when a household member consumes only the necessary care.

Parametric assumption on the distribution of health shocks. The household's belief about θ_{hj} is parameterized as follows:

$$\theta_{hj} \sim \max\{0, \mathcal{N}(\bar{\theta}_{hj}, \nu)\}$$

The zero-censored distribution was chosen because a large fraction of individuals in the data have zero annual medical utilization.

Parametric assumption on health types. The health types of members within a household follow a multivariate normal distribution:

$$\bar{\boldsymbol{\theta}}_{h} = \boldsymbol{X}_{h}\beta_{\theta} + \boldsymbol{W}_{h}\lambda_{h} + \begin{vmatrix} \epsilon_{h1} \\ \vdots \\ \epsilon_{hn_{h}} \end{vmatrix}$$
(6)

 $\lambda_h \sim \mathcal{N}(0, \sigma_\lambda)$ is the household-specific type and uncorrelated with the idiosyncratic shocks ϵ_{hj} , where $\epsilon_{hj} \sim \mathcal{N}(0, \sigma_\epsilon)$. $\mathbf{W}_h := (W_{hj})_{j=1,...,n_h}$ represents the effect of the household's common shock to each household member, and W_{hj} is linearly dependent on the member's observed characteristics ($W_{hj} = X_{hj}\beta_W$). Because the scale of \mathbf{W}_h cannot be separately identified from the scale of λ_h , σ_λ is normalized to 1. Equation (6) implies the following covariance matrix of the household's health types:

$$\Omega_h = \boldsymbol{W}_h \boldsymbol{W}_h' + \sigma_\epsilon^2$$

Parametric assumption on the distribution of $(\omega_h, \delta_h, \gamma_h, r_h)$. I assume that the distribution of $(\omega_h, \delta_h, \gamma_h, r_h)$ are independent across household members and follow normal distributions truncated at 0. r_h is correlated with the household-specific health type λ_h , and

Parameters	Source of Identification			
Income elasti	city			
$\beta_{\omega},\sigma_{\omega}$	Variation in medical spending across involuntarily insured			
	households with different income levels.			
Moral Hazaro	1			
$\beta_{\gamma}, \sigma_{\gamma}$	Variation in medical spending across involuntarily insured			
	households with different coinsurance rates.			
Utility Weigh	uts			
$\beta_{\delta}, \sigma_{\delta}$	Difference in the distribution of medical spending and the			
	distribution of health shocks.			
Distribution	of Health Types			
$\beta_{ heta}, \sigma_{\epsilon}, \beta_W$	Distribution of medical spending of households with residual			
	income below 0 and households ineligible for voluntary SHI.			
Distribution of Risk Aversion				
eta_r, σ_r	Variations in voluntary health insurance choices under dif-			
	ferent voluntary coinsurance rates and income			
Distribution of Health Shocks				
u	The level of medical spending of voluntarily insured individ-			
	uals and voluntarily uninsured individuals.			

Table 5.1: Summary of parameters for estimation

the (normalized) correlation is represented by ρ .

 $\omega_h \sim \text{zero-truncated } \mathcal{N}(X_h \beta_\omega, \sigma_\omega)$ $\delta_{hj} \sim \text{zero-truncated } \mathcal{N}(X_{hj} \beta_\delta, \sigma_\delta)$ $\gamma_{hj} \sim \text{zero-truncated } \mathcal{N}(X_{hj} \beta_\gamma, \sigma_\gamma)$ $r_h \sim \text{zero-truncated } \mathcal{N}(X_h \beta_r + \rho \lambda_h, \sigma_r)$

The objects of interest are summarized in Table 5.1. The estimation procedure follows the identification argument, but ν , β_{θ} , β_W , and σ_{ϵ} are estimated together to increase efficiency using a nested optimization procedure. In the inner nest, β_{θ} , ν , β_W , and σ_{ϵ} are fixed. Parameters related to medical care preferences ($\beta_{\omega}, \sigma_{\omega}, \beta_{\gamma}, \sigma_{\gamma}, \beta_{\delta}, \sigma_{\delta}$) are estimated via GMM to match the observed medical utilization of households not eligible for voluntary SHI across different values of (Y, κ). Risk aversion parameters (β_r, σ_r) are also estimated via GMM to

align predicted and observed insurance choices for households eligible to purchase voluntary SHI. In the outer nest, the remaining parameters are estimated to match predicted medical expenses for households eligible for voluntary SHI and the within-household correlation in medical expenditures across all households. Standard errors are bootstrapped based on 100 iterations.

5.3 Estimation Results

The estimated coefficients are reported in Table B.6-B.8 in Appendix B. The in-sample fits are summarized in Table 5.2. In the first column, I report the average predicted OOP costs (in KVND) for households fully covered by involuntary SHI. The second column presents the average predicted OOP costs and the voluntarily insured rate (among those not covered by involuntary SHI) for households under a bundle discount policy. The third column shows the corresponding values for households under a pure bundling policy. Figure B.12 in the Appendix shows the model fit for different household income levels.

	Households w	ith only	Households	with	Households	with
	involuntarily insured		members eligible for		members el	igible for
	members		voluntary i	nsurance	voluntary	insurance
			under BD		under PB	
	Predicted	Actual	Predicted	Actual	Predicted	Actual
Average OOP costs	295	254	331	352	238	229
	(55)		(39)		(98)	
Voluntary insurance			11.05%	9.67%	13.61%	13.5%
			(1.98%)		(3.96%)	

Table 5.2: In-sample fit

Note: OOP costs are in thousands of VND. The bootstrapped standard errors are reported in parentheses

The distribution of $(\bar{\theta}, \omega, r, \gamma)$ and medical spendings across households and household members in the data, based on a random draw of the estimated parameters, is summarized in Table 5.3. The estimates suggest significant variations in health types and preference types across households and individuals in the sample, and the differences in the observed characteristics cannot fully explain these variations. Table 5.3 also shows that, on average, 4% of the total medical care consumption is optional care. The income elasticity is estimated to be 0.08 on average, suggesting that optional medical care consumption increases by 0.08% for every 1% increase in residual income. The moral hazard coefficient averages 0.55, indicating a 59% reduction in optional care consumption when a household member transitions from full insurance (with a 0% coinsurance rate) to being uninsured. The average risk aversion coefficient is 0.1, which implies that a household with average income would pay 2.503% of its income to insure against a 5% income risk occurring with a 50% probability. Additionally, Table B.11 in the Appendix shows that household members have positively correlated health types, consistent with previous findings in the literature (Sinaiko et al., 2017).

	Mean	Standard deviation	% Variance from observed
			characteristics
Health types $(\bar{\theta})$	-0.82	0.58	56.97
Risk aversion (r)	0.1	0.24	10.01
Income elasticity (ω)	0.08	0.14	28.71
Moral hazard coefficient (γ)	0.55	0.36	6.53
Utility weights (δ)	0.1	0.13	11.21
Necessary care (θ) in KVND	561	2817	
Optional care $(m - \theta)$ in KVND	25	224	

Table 5.3: Implied distributions of preference for medical care and health type

Note: The household-level individual-level based and parameters computed are random draws of the estimated distribution using the estimated of on values $(\beta_{\omega}, \sigma_{\omega}, \beta_{\gamma}, \sigma_{\gamma}, \beta_{\delta}, \sigma_{\delta}, \beta_{\theta}, \sigma_{\epsilon}, \beta_{W}, \beta_{r}, \sigma_{r}, \nu, \rho)$. In the last row, the correlation between each pair of members within each household is computed from the covariance matrix using a random draw of the estimated values of β_W and σ_{ϵ}^2 . The standard deviation is computed across households for risk aversion (r) and income elasticity (ω) and is across individuals for health types ($\hat{\theta}$), the moral hazard coefficient (γ), and correlation between members' health types.

To gauge the magnitude of within-household heterogeneity in WTP for different members' insurance, I compute the highest and lowest WTP for a single member's insurance within each household. The empirical distribution of the ratio between these two WTPs is shown in Figure 5.4. On average, a household's lowest WTP for a single member's insurance is only 34% of its highest WTP. The estimates also suggest that within-household variation in

health types plays a significant role in household decision-making: among the members for whom each household has the highest WTP for insurance, 76% are also the members with the worst health type draws. Therefore, household insurance choices exhibit within-household adverse selection.

Figure 5.4: Distribution of heterogeneity in WTP for insurance for a single member



Note: For each household, I compute its WTP to insure only one member using random draws of household-level and individual-level parameters. The reported histogram represents the empirical distribution of the ratio between the highest WTP and the lowest WTP within each household, expressed as a percentage. For example, in a household with four members, where member 1 is already insured by involuntary SHI, I compute the WTP of three insurance bundles, each insuring only one member $j \neq 1$. Suppose the household prefers to buy insurance for member 2 over member 3, and member 3 over member 4. In that case, the statistic included in the histogram is the ratio between the WTP for member 3's insurance and the WTP for member 2's insurance.

To quantify the magnitude of the substitution effect in the demand for insurance, I calculate each household's WTP for an insurance bundle that includes exactly two voluntarily enrolled members and compare it to the combined WTP for individual insurance for those same two members in a homogenous household. In this exercise, I assume no within-household heterogeneity in health risks or preferences for medical care among members eligible for voluntary SHI, and no uncertainty in coverage (i.e., all medical expenses are eligible for SHI reimbursement). The average WTP for insurance for a single member in this scenario is 3951 KVND, while the WTP for two members is only 6697 KVND.
6 Counterfactuals

In this section, I examine the social planner's optimal bundling regime. As outlined in Section 4, the social planner observes a set of household characteristics, X_h^* , and maximizes social surplus subject to a budget constraint. The social planner selects $\pi(\cdot|X_h^*)$ as a function of the number of voluntarily insured household members. For this analysis, I set the budget constraint to match the net budget of the voluntary SHI program in 2012. The coinsurance structure is also fixed to mirror the 2012 contract, which features a 0% coinsurance rate for expenses under 100 KVND and a 20% rate for higher expenses. Social surplus is calculated as WTP for health insurance, net of the cost of providing the insurance. The counterfactual analysis is conducted on the 2012 sample of households with only two members eligible to purchase voluntary SHI (but with any number of involuntarily insured members), representing 55.4% of the sample of households with at least two members eligible for voluntary SHI.

I then compare insurance demand and the risk composition of the insurance pool under individual pricing and various bundling regimes, such as bundle discount (BD) or pure bundling (PB). I also consider a benchmark of individual pricing (IP), where the bundle discount is zero. In this setup, I apply the same premium-setting constraints as are used in practice, where X_h^* includes only a household's geographical location, and the premium is indexed to MW and cannot exceed 6% of MW. From this point, premiums are expressed as a percentage of annual MW. Given that each household has only two eligible members, the bundle discount premiums are characterized by (p_1^{BD}, p_2^{BD}) , where p_1^{BD} is the premium when only one member purchases insurance, and p_2^{BD} is the premium when both members purchase insurance. IP is a special case of the bundle discount, where $p_2^{BD} = 2p_1^{BD}$. The PB premium is denoted as $p_2^{PB.22}$ To compute the optimal premiums, each household's preference pa-

²² Due to the restriction that the bundle discount premium, p_1^{BD} , must remain below 6% of MW, the set of BD prices does not include the PB case. For example, the PB price ($p_2^{PB} = 12\%$) is equivalent to

rameters, risk aversion, and health types are drawn based on the estimated parameters that characterize their distribution. I then simulate each household's response—WTP, cost of insured members, and insurance choice—under different premiums and bundling regimes. The optimal premiums in each exercise are computed numerically as the solution to a constrained optimization problem.

6.1 Comparison between BD, PB, and IP

Table 6.1: Optimal prices under bundle discounts, pure bundling, and individual pricing

	Optimal prices
Bundle discounts	$p_1^{BD} = 4.57\%, p_2^{BD} = 8.78\%$
	(0.18%), (0.41%)
Pure bundling	$p_2^{PB} = 7.89\%$
	(2.05%)
Individual pricing	$p_1^{IP} = 4.6\%$
	(0.18%)

Note: The unit of premiums is in percentage of MW. Bootstrapped standard errors are shown in parentheses.

Table 6.1 compares the optimal premiums under BD, PB, and IP. On average, PB results in the lowest insurance premiums, with the premium under PB being 90% of the total bundle premium under BD. While BD imposes a similar single-member price to that under IP (4.57% compared to 4.6% under IP), households pay a lower overall price when both members purchase health insurance under BD. The average discount for the second member under BD is 7.9% of the first member's premium. Additionally, the estimates show that the optimal BD premiums are not statistically different from the 2012 observed premiums, where $p_1 = 4.5\%$ and $p_2 = 8.55\%$.

Table 6.2 presents the differences in consumer welfare and the composition of the insurance pool under the three bundling regimes. On average, each insured member earns $\overline{(p_1^{BD} = 12\%, p_2^{BD} = 12\%)}$.

	BD	PB	IP	Mandate
Pct of members buying voluntary SHI	8.54	12.6	8.47	100
	(3.73)	(6.44)	(3.74)	
Average WTP	4196.15	4418.72	4203.74	616.43
	(2274.35)	(1994.67)	(2289.98)	(370.31)
Average consumer surplus	3435.51	3288.32	3429.01	454.11
	(2212.38)	(1862.04)	(2213.76)	(333.34)
Average cost to insure	3335.7	2228.31	3359.39	309.4
	(1419.08)	(1101.33)	(1438.54)	(188.46)
Average risk type	0.32	-0.09	0.32	
	(0.12)	(0.17)	(0.12)	
Average δ	0.09	0.1	0.09	
	(0.11)	(0.11)	(0.11)	
Average ω	0.1	0.1	0.1	
	(0.1)	(0.1)	(0.1)	
Average γ	0.6	0.58	0.6	
Average r	0.11	0.11	0.11	
	(0.13)	(0.13)	(0.13)	
Average age	37.01	38.75	36.99	
	(3.82)	(2.51)	(3.82)	
Average household size	3.42	3.42	3.42	
	(0.1)	(0.11)	(0.1)	
Fraction of female	0.2	0.48	0.2	
	(0.18)	(0.02)	(0.18)	
Average household income	33251.39	33163.62	33238.65	
	(1901.14)	(1924.05)	(1886.55)	

Table 6.2: Characteristics of insured members under BD, PB, and IP

Note: These statistics are calculated using the optimal premiums for each bundling regime (BD, PB, or IP) across random draws from the bootstrapped estimates. Bootstrapped standard errors are reported in parentheses. WTP, consumer surplus, insurance costs, and income are all expressed in thousands of VND.

a similar surplus across the regimes. Because uninsured members earn zero surplus, the relative comparison between the three regimes in overall welfare hinges on the fraction of insured members. The PB regime results in the highest insurance coverage, with 12.6% of eligible members purchasing voluntary SHI. BD and IP yield similar levels of insurance demand in equilibrium, at 8.54% and 8.47%, respectively. As a result, PB generates 43% higher consumer surplus in aggregate.

Table 6.2 also highlights the role of within-household selection based on health risks in driving the welfare gain under PB. While insured members under PB are similar to those under BD in terms of preference parameters (δ , ω , and γ), members insured under PB are significantly healthier.²³ On average, they exhibit lower health risks (-0.09) compared to those under BD (0.32) and IP (0.32), which reduces insurance costs under PB and, consequently, leads to lower premiums. Additionally, PB significantly increases the percentage of female members insured, rising from 20% under BD to 48% under PB. This shift is largely due to the negative correlation between the health status of female members of childbearing age and the household head, resulting in these members often being excluded from insurance under BD.

The last column in Table 6.2 compares the three bundling policies to a mandate. Under a mandate, households are required to purchase insurance and must pay a premium sufficient to meet the social planner's budget constraint. Since selection into insurance is primarily driven by health status, a mandate is likely to achieve the highest level of social welfare, as it completely eliminates selection both within and across households. On the other hand, a PB policy eliminates only within-household selection. The estimates show that, compared to a mandate, PB still achieves 88% of consumer surplus, while a BD policy achieves only 64%. Therefore, a PB policy is a useful second-best alternative when a mandate is not feasible due to regulatory costs.²⁴

Figure 6.3 shows that PB leads to higher insurance enrollment among lower-risk members. Among higher-risk members, there is a small decrease in enrollment, primarily from households with both high-risk and low-risk members. In these cases, the household opts not to purchase insurance under PB, though they would buy insurance for the high-risk

²³Figure B.17 in the Appendix also shows that the distribution of moral hazard types (γ) among insured members is similar under both PB and BD.

²⁴For example, the individual mandate in the Affordable Care Act, which required individuals to purchase health insurance or face a tax penalty, was considered unconstitutional and later repealed. In developing countries like Vietnam, low tax compliance rates also hinder the implementation of a mandate.

Figure 6.3: Insurance enrollment and consumer surplus (CS) across health types under PB and BD



Note: The figure on the right, showing consumer surplus, includes only households with at least one insured member. Uninsured households always receive zero consumer surplus.

member under BD. However, because of the positive correlation in health types, the number of such households is relatively small. Moreover, when considering the average risk type across households, PB results in higher insurance enrollment and greater consumer surplus on average for all households.

6.2 Eliminating within-household heterogeneity in health types

Table 6.4: Optimal prices under bundle discounts, pure bundling, and individual pricing without within-household variation in health types

	Optimal prices
Bundle discounts	$p_1^{BD} = 4.55\%, p_2^{BD} = 8.64\%$
	(0.1%), (0.18%)
Pure bundling	$p_2^{PB} = 9.91\%$
	(1.21%)
Individual pricing	$p_1^{IP} = 4.62\%$
	(0.39%)

Note: The unit of premiums is in percentage of MW. The bootstrapped standard errors are in parentheses.

In this exercise, I eliminate within-household variation in health types by assuming that

	BD	PB	IP	Mandate
Pct of members buying voluntary SHI	4.16	3.92	4.05	100
	(2.59)	(2.55)	(2.54)	
Average WTP	5504.25	5808.14	5608.72	616.43
	(2327.08)	(2301.4)	(2320.63)	(370.31)
Average consumer surplus	4278.63	4368.44	4313.75	454.11
	(2326.11)	(2284.18)	(2311)	(333.34)
Average cost to insure	2770.52	2901.75	2830.91	309.4
	(1268.9)	(1258.71)	(1261.54)	(188.46)
Average risk type	0.26	0.28	0.27	
	(0.11)	(0.11)	(0.11)	
Fraction of female	0.47	0.46	0.47	
	(0.05)	(0.05)	(0.05)	
Average household income	35669.42	35617.86	35672.77	
	(3515.98)	(3640.61)	(3558.93)	

Table 6.5: Characteristics of insured members under BD, PB, and IP without withinhousehold variation in health types

Note: These statistics are calculated using the optimal premiums for each bundling regime (BD, PB, or IP) across random draws from the bootstrapped estimates. Bootstrapped standard errors are reported in parentheses. WTP, consumer surplus, insurance costs, and income are all expressed in thousands of VND.

all eligible members share the same health type, equal to the mean of the draws in Section 6.1. For example, a household with original health types of eligible members being $\bar{\theta} = (-0.1, 0.1)$ now has $\bar{\theta} = (0, 0)$. The selection of members into insurance is now based only on the differences in members' preferences for medical care. The optimal PB, BD, and IP premiums are reported in Table 6.4, and the composition of insured members is shown in Table 6.5.

The most pronounced difference between the premiums in this exercise and the previous one is the relative magnitude of the optimal premium under PB compared to BD. Specifically, the premium for the bundle under PB is now 14.64% higher than under BD. This is because PB no longer offers the risk-pooling benefit of attracting lower-risk members into the insurance pool. At the optimal premiums, the average insurance cost for a PB-insured member is now 2901.75 KVND, higher than the BD cost of 2770.52 KVND. Figure B.18 in the Appendix also shows that the distribution of health risks in the insurance pool is similar under BD and PB.

In the absence of a difference in the bundle premium, households always earn weakly higher consumer surplus under BD than PB, as BD does not restrict the household's choice set. The lower premium for the bundle under BD further intensifies this benefit. As a result, consumer surplus under PB is now 5% lower than under BD, with insurance demand falling by 0.24 percentage points. Figure B.18 in the Appendix shows that households are always better off under BD, regardless of their risk types.

6.3 Combining bundle pricing with risk-based pricing

	Premium for low-risk members	Premium for high-risk members
Without pure bundling	4.68%	6.71%
	(0.29%)	(16.33%)
With pure bundling	4.81%	5.44%
	(0.36%)	(10.63%)

Table 6.6: Optimal risk-based premiums with and without PB

Note: In this exercise, I remove the constraint that premiums must be below 6% of the minimum wage (MW), as this constraint is often binding. The large bootstrapped standard errors for high-risk premiums suggest that, due to adverse selection, it is sometimes optimal to set very high premiums for this group.

This exercise explores the possibility of combining PB with a third-degree price discrimination scheme. Specifically, I assume that the government can now observe an indicator of whether the predicted health type of a household member is above the sample median. In other words, the government's information set X_h^* now includes $I\{\bar{\theta} > \mathbb{E}(\bar{\theta})\}$, where I is the indicator function. The median value of $\bar{\theta}$ in the sample is -0.16. In this exercise, I consider only individual pricing and pure bundling.

Let L denote a low-risk member (better health status than the median member) and H denote a high-risk member (worse health status than the median member). When we ignore the interdependency in household decision making—i.e., the WTP for the bundle is equal to

	Risk-based pricing	Risk-based pricing with PB
Pct of members buying voluntary SHI	13.17	14.69
	(6.27)	(7.22)
Average WTP	5429.65	5387.53
	(8183.33)	(8186.17)
Average consumer surplus	4760.15	4697.26
	(8184.44)	(8191.29)
Average cost to insure	3021.38	2797.78
	(4488)	(4520.3)
Average risk type	0.05	-0.05
	(0.48)	(0.48)

Table 6.7: Characteristics of insured members under risk-based premiums with and without PB

Note: These statistics are calculated using the optimal premiums for each bundling regime (BD, PB, or IP) across random draws from the bootstrapped estimates. Bootstrapped standard errors are reported in parentheses. WTP, consumer surplus, and insurance costs are expressed in thousands of VND.

the sum of the WTP of its component—risk-based IP sets equilibrium premiums based on the average cost of insuring L members and insuring H members, resulting in a lower premium for L type than for H type. In this paper, due to the substitution effect in the household's WTP for different members' insurance, the social planner cannot segment the market into separate markets for L and H members. However, the same intuition still applies. On the other hand, PB combined with risk-based pricing allows the social planner to segment the market along *household types*. For instance, when adverse selection is sufficiently severe that an (L, L) household is unlikely to purchase insurance, the social planner can set the bundle premium for an (L, H) or (H, H) household based on the average cost of insuring such households. Therefore, we expect to see a lower premium for (L, H) households compared to (H, H) households, which implies that L-type members also receive lower premiums.

Table 6.6 displays the optimal premiums under risk-based pricing with IP and BD, confirming the intuition outlined above. Table 6.7 indicate that risk-based pricing under IP performs better than PB without price discrimination but worse than when both policies are combined. Risk-based pricing combined with PB results in a slightly higher level of insurance enrollment compared to risk-based pricing alone (14.69% compared to 12.6%), leading to a 10.07% increase in consumer surplus. Relative to PB alone, risk-based pricing combined with PB increases welfare by 66.54%. Figure B.19 in the Appendix shows that the welfare gain comes from PB's higher enrollment and the inclusion of more lower-risk members.

6.4 Optimal bundling regime at different budget levels



Figure 6.8: Relative performance of BD and PB at different budget levels

Note: The horizontal axis represents the budget level at various per-member premiums under pure bundling, ranging from 1% to 6% of MW. From left to right, the vertical axis shows the difference in average consumer surplus between BD and PB in thousands of VND, the percentage of the eligible members purchasing insurance, and the average premium paid by insured members (also in thousands of VND). A negative value on the vertical axis indicates that BD yields a lower value compared to PB. The black line represents the mean value, while the gray band represents the 95% bootstrapped confidence interval.

In the last exercise, I examine the effect of market-wide subsidies on the choice of bundling regime. In the 2012 benchmark, the SHI program operated with a budget deficit, as the SHI premium was lower than the average cost of providing insurance. On average, the government provided a subsidy of 95 KVND per eligible member, equivalent to 2131 KVND per insured member. As the government relaxes its budget constraint—i.e., increases its premium subsidy for all eligible members—adverse selection is alleviated. Therefore, the effect of within-household heterogeneity in WTP on the optimal bundling choice becomes relatively more important than the effect of within-household adverse selection.

Figure 6.8 illustrates the relative performance of BD and PB in terms of consumer surplus and insurance enrollment as the government adjusts its budget levels. An increase in the budget level means that the government reduces its premium subsidy, bringing insurance premiums closer to actuarially fair levels. In the extreme case, when insurance is free, both BD and PB yield the highest level of consumer surplus. Away from this benchmark, the results indicate that PB consistently outperforms BD in terms of consumer surplus and insurance enrollment, regardless of the budget level. This finding suggests that the estimated within-household heterogeneity in WTP is sufficiently high to sustain PB as the optimal bundling regime, even when the welfare loss from within-household adverse selection is less severe.

7 Conclusion

This paper empirically explores the optimal bundling strategy in the context of a government selling household health insurance. The outcomes of a bundling strategy can be broadly classified as: (1) a pure bundling strategy, where households must either buy insurance for all members or completely opt out, and (2) a bundle discount strategy, where households can selectively insure a subset of their members. I demonstrate that the choice of the optimal bundling strategy depends on several factors, including the heterogeneity in households' WTP for insurance, the presence of within-household adverse selection, and whether the household's preferences for different members' insurance are substitutes or complements. In the empirical setting of Vietnam's SHI program, I show that much of the heterogeneity in WTP stems from differences in health risks, implying the existence of within-household adverse selection. Consequently, a pure bundling strategy significantly increases consumer surplus and the demand for health insurance. In this paper, a bundled pricing policy helps mitigate welfare losses caused by asymmetric information between households and the insurance provider. In addition to this incentive, other factors can also contribute to the practical use of bundled pricing. For instance, in long-term care insurance, when both spouses apply, the insurance premium discount ranges from 10% to 30%; however, when only one spouse applies, a marital discount of 10–15% still applies (LTC Associates, n.d.). The presence of both marital and spousal discounts suggests that married individuals are perceived as lower risk. On the other hand, in the context of car insurance, policies are often pure bundles that cover all household members, and having multiple drivers with similar characteristics does not necessarily increase the premium. In this case, the use of pure bundling likely reflects lower administrative costs for insurers in processing claims, rather than a response to asymmetric information problems.

Finally, this paper considers a setting in which the supply side features no competition. In many social insurance programs with a single insurer, pure bundling is frequently employed. However, in competitive markets, the use of pure bundling to reduce within-household WTP heterogeneity might intensify competition between insurers. Accordingly, bundle discounts are more common in competitive insurance markets, such as the US Affordable Care Act marketplace and the Medicare Supplement Plan program. I leave the exploration of these issues for future research.

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A Proof

A.1 Proof of Proposition 1

In this proof, I first show that it is WLOG to consider only the three menus outlined in the main text. To see this, consider the following example in Figure A.1.

Figure A.1: Illustration of household choices under (p_1, p_2)



Note: The vertical axis of the figure represents the household's surplus from buying insurance for only 1 member, and the horizontal axis represents the household's surplus from buying insurance for both members. In equilibrium, only the H members from (L, H) households purchase insurance.

Figure A.1 illustrates the insurance choices of (L, L) and (L, H) households under hypothetical prices (p_1, p_2) . The vertical axis represents the household's net surplus from insuring only one member, while the horizontal axis represents the net surplus from insuring both members. The prices being considered in this figure satisfy $v_L - p_1 < 0 < v_H - p_1$ and $2v_L + \delta - p_2 < 0 < v_L + v_H + \delta - p_2$. The blue line is the 45-degree line originating from (0,0). Since both (L, L) and (L, H) households similarly value the marginal utility gain from insuring the second member, the red dashed line connecting $(v_L - p_1, 2v_L + \delta - p_2)$ and $(v_H - p_1, v_L + v_H + \delta - p_2)$ also has a slope of 1. Therefore, in this example, the net surplus from buying insurance for both members for an (L, H) household is lower than the surplus from insuring only one member. As a result, the equilibrium insurance choices are as follows: (L, L) households will choose not to buy insurance, while (L, H) households will choose to insure only one member (member H).

Figure A.2: Illustration of household choices under (p_1, p_2)



Note: The vertical axis of the figure represents the household's surplus from buying insurance for only 1 member, and the horizontal axis represents the household's surplus from buying insurance for both members.

Therefore, the location of (0,0) in Figure A.2 corresponds to a unique pair of prices (p_1, p_2) .

- If (0,0) is in the gray area, an (L, L) household will choose to insure only one L member and pay p_1 , and an (L, H) household will also pay only p_1 to purchase insurance for member H. Therefore, any pair of premiums in this region is weakly dominated by the premiums in (Menu 3), which generate the same insurance outcomes but weakly higher revenue.
- If (0,0) is in the blue area, an (L, L) household will opt out of insurance, while an (L, H) household will purchase only insurance for member L and pay p_1 . This outcome is

dominated by the outcome under Menu 2. Therefore, it is not optimal to set premiums such that (0,0) is in this region.

- If (0,0) is in the red area, an (L, L) household will opt out of insurance, while an (L, H) household will purchase insurance for both members and pay p_2 . Therefore, any pair of premiums in this region is weakly dominated by the premiums in Menu 2, which generate the same insurance outcomes but weakly higher revenue.
- If (0,0) is in the green region, both households pay p_2 to buy insurance for both members. Therefore, any pair of premiums in this region is weakly dominated by the premiums in Menu 1, which generate the same insurance outcomes but weakly higher revenue.

I now provide the proof for Proposition 1.

Under (Menu 2), an (L, H) household will be indifferent between purchasing insurance for 1 member, for both members, or remain uninsured. Therefore, an (L, H) household will buy insurance for both members. An (L, L) household will get negative net surplus when buying insurance for 1 member or for both members, where its net surplus is equal to $v_L - v_H < 0$. Therefore, an (L, L) household will not be insured.

The social surplus from $(Menu \ 2)$ is given by

$$\pi(v_L + v_H + \delta - c_L - c_H)$$

and the resulting budget is

$$\pi(v_L + v_H + \delta - c_L - c_H)$$

Under (Menu 3), an (L, H) household will obtain a net surplus of $v_H - v_L > 0$ if it insures only member H, and it will obtain a net surplus of 0 if it insures for both members or remain uninsured. Therefore, an (L, H) household will buy insurance for only member H. An (L, L) household will obtain a net surplus of 0 if it insures only 1 member, and it will obtain a negative net surplus $(v_L - v_H)$ if it insures both members. Therefore, an (L, L) household will buy insurance for only one member L.

The social surplus from (Menu 3) is given by

$$\pi(v_H - c_H) + (1 - \pi)(v_L - c_L)$$

and the resulting budget is

$$\pi(v_L - c_H) + (1 - \pi)(v_L - c_L)$$

Therefore, (Menu 2) is optimal if (1) (Menu 2) yields higher social surplus than that of (Menu 3) while satisfying the budget constraint, or if (2) (Menu 2) satisfies the budget constraint whereas (Menu 3) does not. Because of the assumption that insurance is always socially optimal, $v_L + v_H + \delta - c_L - c_H > 0$. That implies (Menu 2) is optimal if (1) $\pi(v_L + v_H + \delta - c_L - c_H) > \pi(v_H - c_H) + (1 - \pi)(v_L - c_L)$ or if (2) $\pi(v_L - c_H) + (1 - \pi)(v_L - c_L) < 0$.

A.2 Proof of Proposition 2

The proof of Proposition 2 involves two steps. First, I show that the demand system in Proposition 2 satisfies the integrability theorem (Hurwicz, 1971), which establishes that there exists a (direct) utility function that rationalizes the demand system. Second, I then show that the demand system is consistent with the indirect utility function in (10).

Theorem 1 (Hurwicz - Uzawa Integrability Theorem). Let $\zeta :: \mathbb{R}^n_{++} \times \mathbb{R}_+ \to \mathbb{R}^n_+$. Assume 1. The budget exhaustion condition

$$p \cdot \zeta(p, y) = y$$

is satisfied for every $(p, y) \in \mathbb{R}^n_{++} \times \mathbb{R}_+$

- 2. Each component function ζ_i is differentiable everywhere on $\mathbb{R}^n_{++} \times \mathbb{R}_+$
- 3. The Slutsky matrix is symmetric, that is, for every $(p, y) \in \mathbb{R}^n_{++} \times \mathbb{R}_+$

$$\sigma_{i,j}(p,y) = \sigma_{j,i}(p,y)$$

for $i, j = 1, \ldots, n$ where

$$\sigma_{i,j}(p,y) = \frac{\partial \zeta_i(p,y)}{\partial p_j} + \zeta_j(p,y) \frac{\partial \zeta_i(p,y)}{\partial y}$$

 The Slutsky matrix is negative semidefinite, that is, for every (p, y) ∈ ℝⁿ₊₊ × ℝ₊ and every v ∈ ℝⁿ,

$$\sum_{i=1}^{n} \sum_{j=1}^{n} \sigma_{i,j}(p,y) v_i v_j \le 0$$

 The function ζ satisfies the following boundedness condition on the partial derivative with respect to income. For every 0 ≤ <u>a</u> ≤ <u>a</u> ∈ ℝⁿ₊₊, there exists a (finite) real number M_{<u>a</u>,<u>ā</u>} such that for all m ≥ 0

$$\underline{a} \le p \le \bar{a} \Rightarrow \left| \frac{\partial \zeta_i(p, y)}{\partial y} \right| \le M_{\underline{a}, \overline{a}}, \quad i = 1, \dots, n$$

Let X denote the range of ζ ,

$$X = \{\zeta(p, y) \in \mathbb{R}^n_+ : (p, y) \in \mathbb{R}^n_{++} \times \mathbb{R}_+\}$$

Then there exists a utility function $u : X \to R$ on the range X such that for each $(p, y) \in \mathbb{R}^n_{++} \times \mathbb{R}_+$. $\zeta(p, y)$ is the unique maximizer of u over the budget set $\{x \in X : p \cdot x \leq y\}$

Show that Assumption 3 Satisfies the Integrability Theorem. In Assumption 3, the price of the consumption good has been normalized to 1. The full system with a flexible price for the consumption good p_c is given by:

$$m_{hj} = \theta_{hj} + \theta_{hj} \delta_{hj} \left(\frac{Y_h}{p_c} - \sum_{j=1}^{n_h} \theta_{hj} \frac{\kappa_{hj}}{p_c} \right)^{\omega_h} \left(1 + \frac{\kappa_{hj}}{p_c} \right)^{-\gamma_{hj}}$$

and the demand for the consumption good is pinned down by the budget constraint:

$$c_h = \frac{Y_h}{p_c} - \sum_{i=1}^{n_h} m_{hj} \frac{\kappa_{hj}}{p_c}$$

Thus, the full demand system satisfies Condition 1 of the integrability theorem by construction. It also satisfies Conditions 2, 3 (with some tedious algebra), and 5. Regarding Condition 4, a sufficient condition for an $n \times n$ symmetric matrix to be negative semidefinite is that the determinant of all of its leading principal minors of order k, where $1 \le k \le n-1$, has the same sign as $(-1)^k$, and the determinant of the matrix is 0. The following condition is sufficient for Condition 4 to be satisfied.

$$R(\boldsymbol{\theta}_h, Y_h, \boldsymbol{\kappa}_h) > \sum_{j=1}^{n_h} \frac{\omega_h (1 + \kappa_{hj})}{\gamma_{hj}} (m_{hj} - \theta_{hj})$$
(7)

Intuitively, Condition (7) places an upper bound on the income elasticity ω_h to ensure that the cross-price effect of the (Hicksian) demand, which enters through the effect on the residual income, is smaller than the own-price effect in absolute terms.

In the following, the subscript h is omitted. Let $B_j = 1 + \frac{\kappa_{hj}}{p_c}$ and $A = \frac{R}{p_c} = \frac{Y - \sum_{j=1}^n \theta_j \kappa_j}{p_c}$. For any two members i and j, $\frac{\partial m_i}{\partial \kappa_i} = -(m_i - \theta_i) \left(\frac{\omega \theta_i}{Ap_c} + \frac{\gamma_i}{B_i p_c}\right)$, $\frac{\partial m_i}{\partial Y} = (m_i - \theta_i) \frac{\omega}{Ap_c}$, $\frac{\partial m_i}{\partial p_c} = \frac{\omega}{Ap_c}$ $(m_i - \theta_i) \left(-\frac{\omega}{p_c} + \frac{\gamma_i \kappa_i}{B_i p_c^2} \right), \frac{\partial m_i}{\partial \kappa_j} = -(m_i - \theta_i) \frac{\omega \theta_j}{A p_c}.$ Therefore, the elements of the Slutsky matrix σ are given by

$$\sigma_{ii} = -(m_i - \theta_i) \left(\frac{\gamma_i}{B_i p_c} - (m_i - \theta_i) \frac{\omega}{A p_c} \right)$$

$$\sigma_{nn} = -\left(\sum_{j=1}^n (m_j - \theta_j) \frac{\kappa_j}{p_c} \right)^2 \frac{\omega}{p_c A} - \sum_{j=1}^n (m_j - \theta_j) \frac{\gamma_j \kappa_j^2}{B_j p_c^3}$$

$$\sigma_{ij} = (m_i - \theta_i) (m_j - \theta_j) \frac{\omega}{A p_c} \text{ for } i < n, j < n$$

$$\sigma_{in} = (m_i - \theta_i) \left(-\frac{\omega}{A p_c} \sum_{j=1}^n (m_j - \theta_j) \frac{\kappa_j}{p_c} + \frac{\gamma_i \kappa_i}{B_i p_c^2} \right) \text{ for } i < n$$

Let σ_j be the j-column of σ , it is readily verified that

$$\sum_{j=1}^{n-1} \sigma_j \frac{\kappa_j}{p_c} + \sigma_n = 0$$

Therefore, $det(\sigma) = 0$ since σ is singular.

Let $x = (x_1, x_2, ..., x_n)$ be a $1 \times n$ vector. For notational convenience, denote $m_i - \theta_i = \Delta_i$, $\frac{\omega}{Ap_c} = a$, and $\frac{\gamma_i}{B_i p_c} = b_i$. Let $\tilde{\sigma}$ be the leading principle minor of order n - 1. Since σ is symmetric, it suffices to show that $\tilde{\sigma}$ is negative definite. Consider:

$$\begin{aligned} x\tilde{\sigma}x' &= \sum_{i=1}^{n} \sum_{j=1}^{n} x_i x_j \sigma_{ij} \\ &= \sum_{i=1}^{n} x_i^2 (\Delta_i^2 a - \Delta_i b_i) + \sum_{i=1}^{n} \sum_{j=1, j \neq i}^{n} (x_i x_j \Delta_i \Delta_j a) \\ &< a \left(\left(\sum_{i=1}^{n} (x_i \Delta_i) \right)^2 - \sum_{j=1}^{n} \frac{\Delta_j}{b_j} \sum_{i=1}^{n} (x_i^2 \Delta_i b_i) \right) \\ &= a \left(\sum_{i=1}^{n} \sum_{j=1}^{n} \underbrace{ \left(x_i x_j \Delta_i \Delta_j - x_i^2 \Delta_i \Delta_j \frac{b_i}{b_j} \right) }_{z_{ij}} \right) \end{aligned}$$

where the third inequality follows from the sufficient condition 7. Since

$$z_{ij} + z_{ji} = 2x_i x_j \Delta_i \Delta_j - x_i^2 \Delta_i \Delta_j \frac{b_i}{b_j} - x_j^2 \Delta_i \Delta_j \frac{b_j}{b_i}$$
$$= -\Delta_i \Delta_j \left(x_i \sqrt{\frac{b_i}{b_j}} - x_j \sqrt{\frac{b_j}{b_i}} \right)^2 \le 0$$

 $\forall i, j, x \tilde{\sigma} x' \leq 0 \ \forall x \in \mathbb{R}^n$. Hence, $\tilde{\sigma}$ is negative definite and σ is also negative semidefinite.

Indifference Curve and Indirect Utility. The expenditure function is derived from the ordinary differential equation $\frac{\partial e_h(\boldsymbol{\kappa}_h, u_0)}{\partial \kappa_{hj}} = m_{hj}(\kappa_{hj}, e_h(\kappa_{hj}, u_0)) \forall j$. The solution is given by

$$e_h(\boldsymbol{\kappa}_h, u_0) = \left((1 - \omega_h) \left(v_0 + \sum_{j=1}^{n_h} \delta_{hj} \frac{\theta_{hj} (\kappa_{hj} + 1)^{1 - \gamma_{hj}}}{1 - \gamma_{hj}} \right) \right)^{\frac{1}{1 - \omega}} + \sum_{j=1}^{n_h} \theta_{hj} \kappa_{hj}$$

where v_0 is a constant that satisfies the initial condition:

$$e_h(\mathbf{0}, u_0) = Y_h$$

The expenditure function can be rewritten as

$$e_{h}(\boldsymbol{\kappa}_{h}, u_{0}) = \left((1 - \omega_{h}) \left(\frac{\left[e_{h}(\boldsymbol{0}, u_{0}) - \sum_{j=1}^{n_{h}} \theta_{hj} \kappa_{hj} \right]^{1 - \omega_{h}}}{1 - \omega_{h}} + \sum_{j=1}^{n_{h}} \frac{\delta_{hj} \theta_{hj} (\kappa_{hj} + 1)^{1 - \gamma_{hj}} - 1}{1 - \gamma_{hj}} \right) \right)^{\frac{1}{1 - \omega_{h}}}$$
(8)

The upper contour (at-least-as-good) set that defines the set of all consumption basket (\boldsymbol{m}_h, c_h) that yields utility weakly greater than u_0 is given by

$$V_{u_0} = \{ (\boldsymbol{m}_h, c_h) : \sum_{j=1}^{n_h} m_{hj} \kappa_{hj} + c_h \ge e_h(\boldsymbol{\kappa}_h, u_0) \ \forall \boldsymbol{\kappa}_h \}$$

Figure A.3 shows an example of the indifference curves for $n_h = 1$ and $\gamma_{h1} = 0.6$, $\omega_h = 0.1$

and $\delta_{h1} = 1$. To label the indifference curve, we define utility as a CRRA transformation of the amount of consumption when $\kappa_h = 0$ on each indifference curve.

$$u := \frac{c_h^{1-\omega_h} - 1}{1 - \omega_h} \Big| \boldsymbol{\kappa}_h = 0 \tag{9}$$

The form of Equation (9) is convenient since it allows me to obtain the indirect utility function. To see why, note that when $\kappa_h = 0$ and p_c are normalized to 1, the amount of consumption is also equal to the expenditure function. Given an income level Y_h and price κ_h

$$Y_{h} = e_{h}(\boldsymbol{\kappa}_{h}, u) = \left((1 - \omega_{h}) \left(u + \sum_{j=1}^{n_{h}} \frac{\delta_{hj} \theta_{hj} (\kappa_{hj} + 1)^{1 - \gamma_{hj}} - 1}{1 - \gamma_{hj}} \right) \right)^{\frac{1}{1 - \omega_{h}}} + \sum_{j=1}^{n_{h}} \theta_{hj} \kappa_{hj}$$

$$\Rightarrow \quad u = \frac{\left(Y_{h} - \sum_{j=1}^{n_{h}} \theta_{hj} \kappa_{hj} \right)^{1 - \omega_{h}}}{1 - \omega_{h}} - \sum_{j=1}^{n_{h}} \frac{\delta_{hj} \theta_{hj} (\kappa_{hj} + 1)^{1 - \gamma_{hj}} - 1}{1 - \gamma_{hj}}$$
(10)

Equation (10) is an indirect utility function that is consistent with the demand specifications in Assumption 3. Furthermore, any monotonically increasing transformation of (10) is also consistent with the demand specifications.

Figure A.3 and A.4 illustrate the indifference curves and the isoquants of the health production function at specific parameter values when the household has only one member with sufficient income. The indifference curves show that both medical utilization and the consumption good exhibit decreasing marginal utility. The health production function in figure A.4 shows that medical care has a greater marginal impact on health when sickness is more severe, that is, when there is a worse health shock.

Figure A.3: Example of indifference Figure A.4: Example of isoquants for curves for single-member household single-member household



The preference parameters are set at $\gamma = 0.6$ $\omega = 0.1, \delta = 1$. The health shock is $\theta = 0.1$

The preference parameters are set at $\gamma = 0.6$, $\omega = 0.1$, and $\delta = 1$.

A.3 Proof of Proposition 3

To simplify notation, the observed variables (X_h, X_{hj}) and the household subscript h are omitted. Recall that a household's belief about its health risks is the conditional distribution of $\theta | \bar{\theta}$. Identification is achieved in three steps. In the first step, I identify the (unconditional) distribution of θ , which is different from the conditional distribution $\theta | \bar{\theta}$ when households have private information about their health risks. In the second step, I identify the joint distribution of the preference parameters (ω, γ, δ) from the variation in medical care demand (\boldsymbol{m}) across income and coinsurance rates ($Y, \boldsymbol{\kappa}$). In the last step, the joint distribution of household health types $\bar{\theta}$ and their risk aversions r is identified from the joint distribution of realized medical spending and insurance choices.

In this proof, I consider only the case of n = 1 (single-member households). The proof can be readily extended to the case of n > 1 and is therefore omitted.

I start by formalizing the condition on the variation of Y in the data. Let $Q, s \in \mathbb{N}$, and let $\{y_k\}_{k=0,1,2,\dots,Q} \subseteq supp(Y)$. Consider a matrix M with dimension $(Q+1) \times (Q+1)$ with the element located in the q-th row and q'-th column being defined as

$$M_{qq'} = \mathbb{E}\left(\frac{1}{q'-1}\theta^s \log\left(R(\theta, Y_{q-1}, \kappa)\right)^{q'-1}\right)$$
(11)

Assumption 3. For given $Q, s \in \mathbb{N}$, there exist $\{y_q\}_{q=0,1,2,\dots,Q} \subseteq supp(Y)$ such that M is full rank.

Lemma 2. Let $q \in \mathbb{N}$. Suppose that Assumptions 1-3 hold and the unconditional distribution of θ is identified, then $\mathbb{E}(\omega^q \delta(1+\kappa)^{-\gamma})$ is also identified.

Proof of Lemma 2:

Consider only the sample of households fully covered under involuntary SHI. For this sample, the realization of health shock θ is independent of the coinsurance rate κ . From data, $\mathbb{E}(m|Y,\kappa)$ is identified. Using Proposition 2:

$$\mathbb{E}(m|Y,\kappa) = \mathbb{E}\left(\theta + \theta R(\theta, Y, \kappa)^{\omega} \delta(1+\kappa)^{-\gamma} | Y, \kappa\right)$$
(12)

Note that $R(\theta, Y, \kappa)^{\omega} = \exp(\omega \log R(\theta, Y, \kappa))$. Using a Taylor expansion on $\exp(\cdot)$ around 0, (12) becomes

$$\mathbb{E}(m|Y,\kappa) = \mathbb{E}\left(\theta + \theta \sum_{q=0}^{\infty} \left[\frac{\left(\log R(\theta, Y, \kappa)\right)^q \omega^q}{q!}\right] \delta(1+\kappa)^{-\gamma}|Y,\kappa\right)$$
(13)

Under Assumption 1-2, $(\omega, \gamma, \delta) \perp \overline{\theta}$, which implies that $(\omega, \gamma, \delta) \perp \theta$. Therefore, (13) can be rewritten as

$$\mathbb{E}(m|Y,\kappa) = \mathbb{E}(\theta) + \sum_{q=0}^{\infty} \left[\mathbb{E}\left(\frac{1}{q!}\theta\left(\log R(\theta,Y,\kappa)\right)^{q}|Y,\kappa\right) \mathbb{E}\left(\omega^{q}\delta(1+\kappa)^{-\gamma}|\kappa\right) \right]$$
(14)

When the unconditional distribution of θ is identified, $\mathbb{E}(\theta)$ and $\mathbb{E}\left(\frac{1}{q!}\theta \log\left(R(\theta, Y, \kappa)\right)^q | Y, \kappa\right)$

are both identified for a given q. Therefore, Eq. (14) is a linear function of $(\mathbb{E}(\omega^q \delta(1+\kappa)^{-\gamma}))_{q=1,2,\dots}$ with known coefficients.

To prove that $\{\mathbb{E}(\omega^q \delta(1+\kappa)^{-\gamma}|\kappa)\}_{q=0,1,2,\dots}$ is uniquely pinned down by (14), suppose, for a contradiction, that there exists $\{\mathbb{E}(\omega^q \delta(1+\kappa)^{-\gamma}|\kappa)\}_{q=0,1,2,\dots}$ and $\{\mathbb{\tilde{E}}(\omega^q \delta(1+\kappa)^{-\gamma}|\kappa)\}_{q=0,1,2,\dots}$ that both satisfy (14), and $\max_q \left|\mathbb{E}(\omega^q \delta(1+\kappa)^{-\gamma}|\kappa) - \mathbb{\tilde{E}}(\omega^q \delta(1+\kappa)^{-\gamma}|\kappa)\right| = \Delta > 0$. Let $q^* = \arg \max \left|\mathbb{E}(\omega^q \delta(1+\kappa)^{-\gamma}|\kappa) - \mathbb{\tilde{E}}(\omega^q \delta(1+\kappa)^{-\gamma}|\kappa)\right|$. Consider $Q \ge q^*$, the difference between the value of Eq. (14) evaluated at $\{\mathbb{E}(\omega^q \delta(1+\kappa)^{-\gamma}|\kappa)\}_{q=0,1,2,\dots}$ and at $\{\mathbb{\tilde{E}}(\omega^q \delta(1+\kappa)^{-\gamma}|\kappa)\}_{q=0,1,2,\dots}$ can be rewritten as:

$$0 = \sum_{q=0}^{Q} \left[\mathbb{E} \left(\frac{1}{q!} \theta \left(\log R(\theta, Y, \kappa) \right)^{q} | Y, \kappa \right) \left[\mathbb{E} \left(\omega^{q} \delta(1+\kappa)^{-\gamma} | \kappa \right) - \tilde{\mathbb{E}} \left(\omega^{q} \delta(1+\kappa)^{-\gamma} | \kappa \right) \right] \right] + \Delta_{Q+1}(Y, \kappa)$$
(15)

where $\lim_{Q\to\infty} \Delta_{Q+1}(Y,\kappa) = 0$. Let M be a $(Q+1) \times (Q+1)$ matrix as defined in (11), and $(y_q)_{q=0,1,2,\dots,Q}$ satisfies Assumption 3; thus, the inverse matrix M^{-1} exists. From (11):

$$M^{-1} \begin{bmatrix} -\Delta_{Q+1}(Y_1,\kappa) \\ \vdots \\ -\Delta_{Q+1}(Y_Q,\kappa) \end{bmatrix} = \begin{bmatrix} \mathbb{E}\left(\delta(1+\kappa)^{-\gamma}|\kappa\right) - \tilde{\mathbb{E}}\left(\delta(1+\kappa)^{-\gamma}|\kappa\right) \\ \vdots \\ \mathbb{E}\left(\omega^Q\delta(1+\kappa)^{-\gamma}|\kappa\right) - \tilde{\mathbb{E}}\left(\omega^Q\delta(1+\kappa)^{-\gamma}|\kappa\right) \end{bmatrix}$$
(16)

Note that $||LHS(16)||_{\infty}$ is equal to $\Delta > 0$. On the other hand, $||RHS(16)||_{\infty} \leq ||M||_{\infty}$ $\max_{q} ||\Delta_{Q+1}(Y_{q},\kappa)||_{\infty}$. Because $\lim_{Q\to\infty} \Delta_{Q+1}(Y_{q},\kappa) = 0$, there exists a sufficiently large Qsuch that $||RHS(16)||_{\infty} < \Delta$. Thus, this is a contradiction, and $\{\mathbb{E}(\omega^{q}\delta(1+\kappa)^{-\gamma}|\kappa)\}_{q=0,1,2,\dots}$ is uniquely pinned down by (14).

Lemma 3. Let $q \in \mathbb{N}$. Suppose that Assumptions 1-3 hold and the unconditional distribution of θ is identified, then $\mathbb{E}(\omega^q \gamma^t \delta)$ is identified for any positive integers q and t.

Proof of Lemma 3:

Consider only the sample of households fully covered under involuntary SHI. From Lemma 2, the following integral

$$\int_{Supp(\kappa)} \left[\mathbb{E} \left(\omega^q \delta(1+\kappa)^{-\gamma} | \kappa \right) \left(\log(1+\kappa) \right)^{-t} \frac{1}{1+\kappa} \right] d\kappa$$
(17)

is identified because $\mathbb{E}\left(\omega^q \delta(1+\kappa)^{-\gamma}|\kappa\right)$ is identified and κ is observed.

$$\int \left[\mathbb{E} \left(\omega^q \delta(1+\kappa)^{-\gamma} | \kappa \right) \left(\log(1+\kappa) \right)^{-t} \frac{1}{1+\kappa} \right] d\kappa$$
(18)

$$= \int_{Supp(\kappa)} \int_{Supp(\omega,\delta,\gamma)} \left(\omega^q \delta(1+\kappa)^{-\gamma} \right) \left(\log(1+\kappa) \right)^{-t} dF_{\omega,\gamma,\delta}(\omega,\gamma,\delta) \frac{1}{1+\kappa} d(\kappa)$$
(19)

$$= \int_{Supp(\omega,\delta,\gamma)} \int_{Supp(\kappa)} \left(\omega^q \delta(1+\kappa)^{-\gamma} \right) \left(\log(1+\kappa) \right)^{-t} \frac{1}{1+\kappa} d\kappa \ dF_{\omega,\gamma,\delta}(\omega,\gamma,\delta)$$
(20)

$$= \int_{Supp(\omega,\delta,\gamma)} \int_{Supp(\gamma \log(1+\kappa))} \left(\omega^q \delta \exp(-a) \right) \gamma^t \, da \, dF_{\omega,\gamma,\delta}(\omega,\gamma,\delta)$$
(21)

$$= \left(\int_{supp\gamma \log(1+\kappa)\kappa} \exp(-a) \ da \right) \left(\int_{supp(\omega,\delta,\gamma)} \omega^q \gamma^t \delta dF_{\omega,\gamma,\delta}(\omega,\gamma,\delta) \right)$$
(22)

where the third equality follows from a change in variable, $a = \gamma \log(1 + \kappa)$. Because γ is weakly positive and has a known support, the first integral in (22) is well defined and identified. Therefore, $\mathbb{E}(\omega^q \gamma^t \delta)$ is identified for every q, t = 0, 1, 2, ...

Lemma 4. Let $q, s, t \in \mathbb{N}$. Suppose Assumptions 1-3 hold, and the unconditional distribution of θ is identified. If $\mathbb{E}(\omega^q \gamma^t \delta^{s'})$ is identified for any integer s' < s, then $\mathbb{E}(\omega^q \gamma^t \delta^s)$ is identified.

Proof of Lemma 4:

Conditional on households being fully enrolled in involuntary SHI, consider $\mathbb{E}(m^s|Y,\kappa)$.

$$\mathbb{E}(m^{s}|Y,\kappa) = \mathbb{E}\left[\left(\theta + \theta R(\theta, Y,\kappa)^{\omega}\delta(1+\kappa)^{-\gamma}|Y,\kappa\right)^{s}\right]$$
(23)

which implies

$$\mathbb{E}\left(\theta^{s}\left(R(\theta, Y, \kappa)\right)^{s}\delta^{s}(1+\kappa)^{-\gamma s}\right)$$
$$=\mathbb{E}(m^{s}|Y, \kappa) - \mathbb{E}\left[\left(\theta + \theta R(\theta, Y, \kappa)^{\omega}\delta(1+\kappa)^{-\gamma}|Y, \kappa\right)^{s}\right] + \mathbb{E}\left(\theta^{s}\left(R(\theta, Y, \kappa)\right)^{s\omega}\delta^{s}(1+\kappa)^{-\gamma s}\right)$$
(24)

Using a polynomial expansion on the middle term on the RHS of (24), the highest-order term w.r.t δ in the RHS of (24) is s - 1. In addition, using the same Taylor expansion as in (14), the RHS of (24) is identified. The LHS of (24) can be expressed as

$$\mathbb{E}(\theta^s) + \mathbb{E}\left[\frac{1}{q!}\theta^s \left(s\log\left(Y - \theta\kappa\right)\right)^q\right] \mathbb{E}\left[\omega^q \delta^s (1 + \kappa)^{-\gamma s}\right]$$
(25)

Similar to before, Assumption 3 guarantees that (26) uniquely identify $\mathbb{E} \left[\omega^q \delta^s (1+\kappa)^{-\gamma s} \right]$. Subsequently, following the same logic as in the proof of Lemma 3, $\mathbb{E} \left(\omega^q \gamma^t \delta^s \right)$ is identified for all positive integers q, t, and s.

Lemma 5. Suppose Assumptions 1-3 hold, and the unconditional distribution of θ is identified. The joint distribution of (ω, γ, δ) is identified.

Proof of Lemma 5:

The proof follows a straightforward induction approach, using the results of Lemma 3 and Lemma 4. ■

Consider the sample of households fully enrolled in voluntary SHI. To shorten notation, let $S := (\omega, \gamma, \delta)$. Because all household members are insured, there exists a lower threshold of risk aversion, denoted as $\underline{r}(Y, \kappa, \overline{\theta}, \nu, S)$ such that conditional on $Y, S, \overline{\theta}$, and $r > \underline{r}(\cdot)$, a household will buy insurance for all of its members. $\underline{r}(\cdot)$ is identified from the functional form of the indirect utility function and the parametric assumption on households' belief about their health shocks (Assumption 1). Now, note that if ν is identified, the distribution of $\overline{\theta}$ is also identified from the distribution of θ . The identification argument of the household risk aversion coefficient requires an additional assumption, and this assumption is also related to the variation of Y in the data.

Assumption 4. Conditional on ν , the joint distribution of $(S, \overline{\theta}, \underline{r}|Y)$ is invertible over the support of $(S, \overline{\theta}, \underline{r})$ and a subset in the support of Y.

To see why Assumption 4 implies that there must be sufficient variation in Y in the data, consider the case in which the support of $(S, \bar{\theta}, \underline{r})$ is discrete. Let $(S_q, \bar{\theta}_q, \underline{r}_q)_{q=1,2,...,Q}$ denote the support of $(S, \bar{\theta}, \underline{r})$. Assumption 4 states that there exists $(Y_q)_{q=1,2,...,Q}$ such that the following $Q \times Q$ matrix is full rank.

$$\begin{bmatrix} \Pr\left(S_1, \bar{\theta}_1, \underline{r}_1 | Y = Y_1\right) & \dots & \Pr\left(S_Q, \bar{\theta}_Q, \underline{r}_Q | Y = Y_1\right) \\ \dots & \dots & \dots \\ \Pr\left(S_1, \bar{\theta}_1, \underline{r}_1 | Y = Y_Q\right) & \dots & \Pr\left(S_Q, \bar{\theta}_Q, \underline{r}_Q | Y = Y_Q\right) \end{bmatrix}$$

Lemma 6. Suppose Assumptions 1-4 hold, and the unconditional distribution of θ is identified. For a given ν , the distribution of $r|(\omega, \delta, \gamma, \overline{\theta})$ is identified.

Proof of Lemma 6:

First, note that if ν is identified, the distribution of $\bar{\theta}$ is also identified from the distribution of θ .

Consider the sample of households fully enrolled in voluntary SHI. To shorten notation, let $S := (\omega, \gamma, \delta)$. Because all household members are insured, there exists a lower threshold of risk aversion, denoted as $\underline{r}(Y, \kappa, \overline{\theta}, \nu, S)$ such that conditional on $Y, S, \overline{\theta}$, and $r > \underline{r}(\cdot)$, a household will buy insurance for all of its members. $\underline{r}(\cdot)$ is identified from the functional form of the indirect utility function and the parametric assumption on households' belief about their health shocks (Assumption 1). Therefore, conditional on Y, the probability that a household will choose to be fully enrolled in voluntary SHI is given by

$$\mathbb{E}\left[\Pr\left(r \ge \underline{r}(Y,\kappa,\bar{\theta},\nu,S)|\bar{\theta},S\right)|Y,\kappa\right]$$
(26)

Note that (26) is observed from data. Let $F_r(\cdot|(S,\bar{\theta}))$ denote the conditional distribution of r. (26) can be rewritten as

$$\mathbb{E}\left[\mathbb{E}\left[1 - F_r\left(\underline{r}|(S,\bar{\theta})\right)\right]|(Y,\kappa)\right]$$
(27)

where we now consider \underline{r} a random variable whose distribution conditional on $(S, \overline{\theta}, Y, \kappa)$ is known. The first expectation of (27) is taken over \underline{r} , and the second expectation is taken over $(S, \overline{\theta})$. Thus, (27) is a Fredholm integral equation of the first kind, and a unique solution, which is $F_r(\cdot|(S, \overline{\theta}))$, exists under Assumption 4.

Proof of Proposition 3:

Because households with income below \underline{c} do not consume any optional care, the observed medical expenditure is the same as the realized health shocks. Therefore, the (unconditional) distribution of θ is identified from the distribution of medical expenditure for households fully enrolled in involuntary SHI with income below \underline{c} . Proposition 3 thus follows from Lemma 2-6.

B Additional Tables and Figures

Year	Number of households	Number of individuals
2004 and 2006	307	1353
2006 and 2008	1736	7749
2008 and 2010	0	0
2010 and 2012	3535	14376
3 consecutive years	0	0

Table B.1: Number of repeated households and individuals in VHLSS 2004-2012

	Table B.2:	Coinsurance	structures	of SHI	contracts
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			1
Year	Free involuntary insurance	Involuntary insurance via employers and student insurance	Voluntary Enrollees
2004	0%	$\begin{cases} 20\% & \text{If expense is below 1500} \\ 0\% & \text{For additional expense} \end{cases}$	$\begin{cases} 20\% & \text{If expense is below 1500} \\ 0\% & \text{Otherwise} \end{cases}$
2006	0%	$\begin{cases} 0\% & \text{If expense is below 7000} \\ 100\% & \text{For additional expense, but} \\ & \text{OOP costs not} \\ & \text{exceeding 4666} \\ 40\% & \text{For additional expense} \end{cases}$	$\begin{cases} 0\% & \text{If expense is below 7000} \\ 100\% & \text{For additional expense, but} \\ & \text{OOP costs not} \\ & \text{exceeding 4666} \\ 40\% & \text{For additional expense} \end{cases}$
2008	0%	$\begin{cases} 0\% & \text{If expense is below 7000} \\ 100\% & \text{For additional expense, but} \\ & \text{OOP costs not} \\ & \text{exceeding 4666} \\ 40\% & \text{Erg additional expense} \end{cases}$	$\begin{cases} 0\% & \text{If expense is below 100} \\ 20\% & \text{For expense above 100} \end{cases}$
2010	$\begin{cases} 0\% & \text{If expense is below 100} \\ 5\% & \text{For expense above 100} \end{cases}$	$\begin{cases} 40\% & \text{For additional expense} \\ \begin{cases} 0\% & \text{If expense is below 100} \\ 20\% & \text{For expense above 100} \end{cases}$	$\begin{cases} 0\% & \text{If expense is below 100} \\ 20\% & \text{For expense above 100} \end{cases}$
2012	$\begin{cases} 0\% & \text{If expense is below 100} \\ 5\% & \text{For expense above 100} \end{cases}$	$\begin{cases} 0\% & \text{If expense is below 100} \\ 20\% & \text{For expense above 100} \end{cases}$	$\begin{cases} 0\% & \text{If expense is below 100} \\ 20\% & \text{For expense above 100} \end{cases}$

Note: All units are in thousands of VND.

Year	Eligible Member ⁽³⁾	Indivi	dual Voluntary Pren	nium ⁽¹⁾	Policy
2004	$1 \\ 2+$	$4.5\% \\ 4.275\%$			Bundle discount
2006	$ \begin{array}{c} 1 \\ 2 \\ 3 \\ 4+ \end{array} $		$3.0\% \\ 3.0\% \\ 2.7\% \\ 2.4\%$		Pure bundling
2008	$ \begin{array}{c} 1 \\ 2 \\ 3 \\ 4+ \end{array} $		$4.5\% \\ 4.5\% \\ 4.05\% \\ 3.6\%$		Bundle discount
2010, 2012	$\begin{array}{c}1\\2\\3\\4+\end{array}$	$\begin{array}{c} \text{Agricultural HH} \\ & 4.5\% \\ & 4.05\%^{(2)} \\ & 3.6\%^{(2)} \\ & 3.15\%^{(2)} \end{array}$	Formal-sector HH 4.5% 4.05% 3.6% 3.15%	Self-employed HH 4.5 % 4.5 % 4.5% 4.5%	Bundle discount

Table B.3: Premium structure for households with members eligible for voluntary SHI

 $^{(1)}$ The premiums for the involuntary group is as follows. Student premium is 3.15% of the minimum wage. Enrollees whose enrollment is mandated by their employers pay 6% of their annual wages with 2/3 being subsidized by the employers.

⁽²⁾ Additional household members are charged lower premiums only if the household is fully enrolled in insurance.

⁽³⁾ Under a pure bundling regime, the number of eligible members is the total number of members not covered by involuntary SHI. In contrast, under a bundle discount, the number of eligible members is the number of individuals who self-select into voluntary SHI.

Note: All premiums are indexed to the minimum wage. Per the Health Insurance Law of 1998, the maximum individual premium for voluntary enrollees is capped at 6% of the minimum wage.

Table B.4: Choices of individuals who were observed in two periods

Number of people who change their health insurance selection	N = 2338
Number of people who bought voluntary health insurance in both periods	N = 2140
Number of people who stayed uninsured in both periods	N = 23110

Note: This sample only includes people who were eligible for voluntary SHI (i.e., exclude involuntary SHI enrollees) in both periods.

Variance	Across-	Within-	Within-
	household	household	household
	variance	variance	variance with
			controls

0.02

5.65

0.1

0.02

0.1

5.4

0.06

0.07

5.7

Voluntary insurance choice

IPVs

OPVs

0.08

0.17

11.35

Table B.5: Variance decomposition of voluntary insurance choices and medical utilization

Note: In column (1), the variance represents the unconditional variance of the specific variable among members eligible for voluntary SHI within households. To capture the within-household variance (column (3)), I calculate the residuals by regressing the same variable on household fixed effects, and the within-household variance is then computed as the variance of these residuals. The across-household variance (column (2)) is obtained by taking the difference between the variance in column (1) and the variance in column (3).

In column (4), I compute the residuals by regressing the variable in question on household fixed effects and individual members' observable characteristics. The reported variance corresponds to the variance of these residuals. The control variables used include age-category indicators, gender, whether a member is a female in child-bearing age, college enrollment status, marital status, and the relationship of the member to the household's head.

	0	0	0	0
	β_{θ}	β_W	β_{γ}	β_{δ}
Constant	-0.503	0.028	0.167	0.199
	(0.187)	(0.003)	(0.035)	(0.158)
Age 18-35	0.011	0.34	0.077	-0.377
	(0.115)	(0.107)	(0.012)	(0.042)
Age 35-54	-0.191	0.105	0.056	-0.22
	(0.12)	(0.105)	(0.004)	(0.007)
Age 54-64	0.014	-0.025	0.006	-0.045
	(0.157)	(0.134)	(0.048)	(0.069)
Age $64+$	0.089	-0.085	0.002	-0.014
	(0.139)	(0.132)	(0.006)	(0.011)
Spouse	-0.201	-0.113	-0.044	0.186
	(0.172)	(0.104)	(0.015)	(0.019)
Children	-0.189	-0.069	0.067	-0.326
	(0.136)	(0.108)	(0.008)	(0.007)
Parent	-0.369	0.213	0	0.001
	(0.13)	(0.113)	(0)	(0.001)
Other member	0.163	0.126	0.017	-0.083
	(0.128)	(0.111)	(0.035)	(0.15)
Share of income	0.014	-0.026	0.073	-0.333
	(0.107)	(0.132)	(0.008)	(0.051)
Employed	0.361	-0.073	0.139	-0.684
	(0.137)	(0.128)	(0.021)	(0.044)
Female	-0.18	0.082	0.085	-0.393
	(0.121)	(0.137)	(0.002)	(0.05)
Married	-0.229	0.051	0.097	-0.445
	(0.148)	(0.136)	(0.041)	(0.125)
College education	0.085	0.37	0.137	-0.658
5	(0.111)	(0.109)	(0.022)	(0.12)
Female member in child-bearing age	-0.288	-0.243	-0.005	0.018
0.00	(0.124)	(0.069)	(0.001)	(0.012)

Table B.6: Summary of individual-level parameters

Note: The bootstrapped standard errors are reported in parentheses. Year FEs are included in β_{θ} and are not reported.
	β_r	β_{ω}
Constant	-0.536	-0.125
	(0.286)	(0.182)
Formal sector HH	0.067	-0.49
	(0.195)	(0.003)
Self-employed HH	-0.123	-0.008
	(0.275)	(0.069)
HH size	-0.295	-0.366
	(0.28)	(0.051)
Proportion of female members	-0.104	-0.426
	(0.33)	(0.023)
Age of eldest member	0.226	0.387
	(0.34)	(0.113)
Average number of years of education	-0.252	-0.596
	(0.387)	(0.405)

Table B.7: Summary of household-level parameters

Note: The bootstrapped standard errors are reported in parentheses. The age of the eldest member, the average number of years of education, and the household size are normalized to have a mean of 1 in the sample.

Table B.8: Summary of unobserved heterogeneity estimates

ν	σ_{ϵ}	σ_{ω}	σ_{δ}	σ_{γ}	σ_r	ρ
0.178	0.14	0.25	0.305	0.44	0.296	-0.079
(0.018)	(0.009)	(0.009)	(0.083)	(0.015)	(0.141)	(0.299)

Note: the bootstrapped standard errors are reported in parentheses.

	(1)	(2)	(3)
	Premium	Premium	Premium
Premium _{Voluntary} – Premium _{Involuntary}	-133.8	-87.08	-88.18
· · ·	(3.942)	(3.242)	(3.276)

No

No

Yes

Yes

Yes

Yes

Year FE

Geography FE

Table B.9: Comparison between monthly voluntary premium and monthly involuntary premium (for members in the formal sector)

Age FE	No	No	Yes	
Standard errors adjusted for heteroskedasticity are rep	orted in pa	arentheses. In	ndividuals in th	ne formal
sector are required to purchase involuntary SHI at a sub	osidized cos	st through th	eir employers.	Unlike in
other contexts, where affordable health insurance is an in	nportant p	art of employ	ment benefits a	nd might
affect job choices (Currie and Madrian, 1999), both volu	untary and	involuntary	SHI have been	available
in Vietnam since 2004 (the beginning of the sample per	riod), with	largely simil	ar cost-sharing	policies.
Additionally, subsidized involuntary SHI premiums are	e higher th	an voluntary	SHI premiums	because
the involuntary SHI premium is indexed to individual w	ages, where	eas the volunt	tary premium is	s indexed
to the minimum wage. This table shows that compute	sory enroll	ees pay signi	ficantly higher	monthly
premiums on average than voluntary enrollees, with	the averag	e difference l	being approxin	nately 88
KVND, which is 5.6% of the highest monthly minimum	wage in 20	12. In contra	ast, the highest	monthly
voluntary premium is set at 4.5% of the minimum wa	ge. Unlike	in other set	tings where inv	oluntary
insurance premiums tend to be lower than those in the	e voluntary	market, the	higher involun	tary SHI
premiums in Vietnam are due to the government's role	in setting	both involue	tary and volun	tary SHI
premiums and using the involuntary premiums to partia	ally subsidi	ze the volunt	ary market. To	the best
of my knowledge, no evidence exists regarding the rela	ationship b	between Vietz	namese firms' i	nsurance
compliance and workers' medical care preferences.				

	Annual OOP costs			
	(1)	(2)	(3)	
Ineligible HHs	24.236	21.916	8.675	
	(38.756)	(39.827)	(40.777)	
Age, Gender, and Education FEs	No	Yes	Yes	
Relationship to HoH FEs	No	No	Yes	
Area FEs	No	No	Yes	
Year-Insurance type FEs	Yes	Yes	Yes	
Observations	$24,\!659$	$24,\!659$	$24,\!659$	
R^2	0.005	0.015	0.019	

Table B.10: Comparing involuntary SHI members across households with and without members eligible for voluntary SHI

Note: Standard errors adjusted for heteroskedasticity are reported in parentheses. This table provides suggestive evidence that involuntarily insured members are similar across households, regardless of the composition of other household members. On average, in households fully enrolled in involuntary SHI, members spend only 8.67 KVND more in OOP costs than those covered by involuntary SHI in households with some members eligible to purchase voluntary SHI. This difference is not statistically significant. For context, the average OOP cost in the data is 362.27 KVND.

	HoH	Spouse	Children	Parents	Others
HoH	0.14				
	(0.11)				
Spouse	0.08	0.14			
	(0.11)	(0.19)			
Children	0.05	0.04	0.12		
	(0.08)	(0.09)	(0.08)		
Parents	0.1	0.09	0.06	0.18	
	(0.12)	(0.16)	(0.09)	(0.18)	
Others	0.06	0.06	0.09	0.13	0.15
	(0.08)	(0.12)	(0.11)	(0.11)	(0.11)

Table B.11: Within-HH covariance matrix of health types

Note: The covariance matrix of health types is $\Sigma_h = \boldsymbol{W}_h \boldsymbol{W}'_h + \sigma_{\epsilon}^2$. The estimates provided above represent the mean and the bootstrapped standard errors of the average Σ_h across households in the 2012 sample.



Figure B.12: Model fit across income levels

Note: Each point on the horizontal axis represents households grouped by income percentiles: 0th–20th, 20th–40th, 40th–60th, 60th–80th, and above the 80th percentile of the household income distribution.

Table B.13: Optimal prices under bundle discounts, pure bundling, and individual pricing with reduced across-household variation in health types

	Optimal prices
Bundle discounts	$p_1^{BD} = 4.54\%, \ p_2^{BD} = 8.63\%$
	(0.07%), (0.15%)
Pure bundling	$p_2^{PB} = 8.12\%$
	(2.16%)
Individual pricing	$p_1^{IP} = 4.64\%$
	(0.26%)

Note: The unit of premiums is in percentage of MW. The bootstrapped standard errors are in parentheses. In this exercise, I decrease the variance of the household-specific factor λ_h by a factor of 10.

	BD	PB	IP	Mandate
Pct of members buying voluntary SHI	5.02	7.05	4.97	100
	(4.24)	(7.36)	(4.24)	(0)
Average WTP	1783.63	2279.57	1791.98	616.43
	(562.21)	(598.87)	(561.67)	(370.31)
Average consumer surplus	1100.39	1133.04	1099.12	454.11
	(558.84)	(508.87)	(558.69)	(333.34)
Average cost to insure	1680.82	1133.11	1697.29	309.4
	(522.45)	(300.21)	(524.03)	(188.46)
Average risk type	0.14	-0.28	0.14	
	(0.06)	(0.11)	(0.06)	

Table B.14: Characteristics of insured members under BD, PB, and IP with reduced acrosshousehold variation in health types

Note: The bootstrapped standard errors are reported in parentheses. WTP, consumer surplus, insurance costs, and income are all expressed in thousands of VND. In this exercise, I decrease the variance of the household-specific factor λ_h by a factor of 10. This change generates three effects. First, the distribution of health types in the population is now more concentrated around the mean. Second, there is less across-household heterogeneity in health type. Third, as within-household health types are positively correlated, lowering the variance of λ_h also lowers the positive correlation in health types between members. Therefore, the risk-pooling property of PB remains; however, the overall demand for insurance falls under both BD and PB relative to Section 6.1. Overall, PB generates 48% higher consumer surplus in aggregate.

Table B.15: Optimal prices under bundle discounts, pure bundling, and individual pricing without moral hazard (γ)

	Optimal prices
Bundle discounts	$p_1^{BD} = 4.5\%, \ p_2^{BD} = 8.55\%$
	(0%), $(0.01%)$
Pure bundling	$p_2^{PB} = 6.37\%$
	(0.66%)
Individual pricing	$p_1^{IP} = 4.52\%$
	(0.05%)

Note: The unit of premiums is in percentage of MW. The bootstrapped standard errors are in parentheses. In this exercise, I decrease the variance of the household-specific factor λ_h by a factor of 10.

	BD	PB	IP	Mandate
Pct of members buying voluntary SHI	8.82	14.14	8.77	100
	(3.7)	(6.57)	(3.68)	(0)
Average WTP	3742.2	3778.39	3740.8	616.43
	(1038.44)	(840.25)	(1038.74)	(370.31)
Average consumer surplus	3004.23	2864.75	2994.81	454.11
	(1005.7)	(826.45)	(1004.28)	(333.34)
Average cost to insure	3058.28	1873.5	3071.77	309.4
	(697.83)	(418.56)	(700.71)	(188.46)
Average risk type	0.3	-0.14	0.3	
	(0.08)	(0.12)	(0.08)	
Average δ	0.07	0.08	0.07	
	(0.06)	(0.06)	(0.06)	
Average ω	0.09	0.09	0.09	
	(0.03)	(0.03)	(0.03)	
Average γ	0	0	0	
	(0)	(0)	(0)	
Average r	0.09	0.09	0.09	
	(0.07)	(0.08)	(0.07)	
Average age	36.64	38.59	36.63	
	(3.51)	(2.19)	(3.51)	
Average household size	3.41	3.41	3.41	
	(0.09)	(0.1)	(0.09)	
Fraction of female	0.16	0.48	0.16	
	(0.13)	(0.02)	(0.13)	
Average household income	33249.06	33115.85	33239.19	
	(1892.16)	(1846.61)	(1890.44)	

Table B.16: Characteristics of insured members under BD, PB, and IP without moral hazard (γ)

Note: Bootstrapped standard errors are reported in parentheses. WTP, consumer surplus, insurance costs, and income are all expressed in thousands of VND. In this exercise, I assume that the moral hazard coefficient is zero for all household members ($\gamma = 0$). Since the margin of selection on moral hazard is small, setting γ to zero affects the levels of insurance demand by increasing all households' WTP for insurance but does not influence within-household selection into insurance. The estimates show that pure bundling still dominates bundle discounts, generating 54% higher consumer surplus.



Figure B.17: Insurance enrollment across moral hazard types under PB and BD

Figure B.18: Insurance enrollment and consumer surplus (CS) across health types under PB and BD without within-household heterogeneity in health risks



Note: The figure on the right, showing consumer surplus, includes only households with at least one insured member. Uninsured households always receive zero consumer surplus.

Figure B.19: Insurance enrollment and consumer surplus (CS) across health types under IP and PB with risk-based pricing



Note: The figure on the right, showing consumer surplus, includes only households with at least one insured member. Uninsured households always receive zero consumer surplus. PB results in higher insurance enrollment for lower-risk members and increased enrollment across all health types.

C Example: Substitution effect

Figure C.1: Example of the decrease in the WTP for the bundle relative to the WTP for each member's insurance



Note: In this example, the household has 2 members with independent health risks (θ_1, θ_2) , where $\theta_i \sim U\{0, 2\}$. The household's income is Y = 20. $\gamma_1 = \gamma_2 = 0$, $\delta_1 = \delta_2 = 0.7$. WTP_1 is the WTP for full insurance of only one member, and WTP_2 is the WTP for full insurance for both members.

D Example: Advantageous selection

I omit the household index h to simplify notation. Consider a household comprising only two members with independent and identically distributed health risks, where each member's health risk θ_j can take one of two values, 0 or $\bar{\theta}$ with equal probability. To keep things simple, let's assume that the household's demand for medical care does not exhibit any income effect, i.e., $\omega = 0$. The household assigns a higher bargaining weight to member 2, specifically, $\delta_1 = 0.09$, and $\delta_2 = 0.1$. In addition, member 1 has no moral hazard, i.e., $\gamma_1 = 0$. The insurance contract features a coinsurance rate of 0.

Figure D.1: Difference in WTP for each member's insurance, and the difference between WTP for member 2's insurance and the cost of insuring member 1



Note: The left panel illustrates the difference in WTP for insuring only one member, comparing member 1 with member 2. When γ_2 is low, the household opts to insure member 2 due to the member's higher bargaining weight. However, as γ_2 increases, member 1 becomes the preferred choice for insurance enrollment. The blue line represents the cost difference between insuring member 1 and member 2, which is negative and independent of γ_2 because the coinsurance rate is 0. Consequently, for high γ_2 values, within-household advantageous selection occurs as the household selects the less costly member for insurance.

The right panel displays the difference between the WTP for member 2's insurance and the cost of insuring member 1. For the considered γ_2 values, this difference is positive.

The household's WTP to insure member j is denoted by WTP_j and is the solution of the following equation

$$\mathbb{E}\left(\exp\left[-r\left(Y-\theta_{-j}-WTP_{j}-\delta_{-j}\theta_{-j}\frac{2^{1-\gamma_{-j}}}{1-\gamma_{-j}}\right)\right]\right)$$

$$= \mathbb{E}\left(\exp\left[-r\left(Y - \sum_{j}\theta_{j} - \sum_{j}\delta_{j}\theta_{j}\frac{2^{1-\gamma_{j}}}{1-\gamma_{-j}}\right)\right]\right)$$
(28)

Figure D.1 shows the difference in WTP for insuring only one member. For low values of γ_2 , the household prefers to buy insurance for member 2. However, for sufficiently high values of γ_2 , the household prefers to buy insurance for member 1 despite member 1's lower cost of being insured, exhibiting within-household advantageous selection.

E Estimation Procedure

E.1 Uncertainty in Coinsurance Rates κ

In the empirical framework of Section 4, there is no uncertainty over the coinsurance rate in the second period. However, we observe in the data that most insured individuals pay more than the coinsurance rates of the insurance contract because some medical expenses are not covered under SHI. Let $\zeta_{hj} \in [0, 1]$ be the fraction of annual medical expense that is eligible for insurance coverage, and the actual OOP coinsurance rate is given by²⁵

Figure E.1: Distribution of probability of coverage from 2008 reimbursement data.



 $\tilde{\kappa}_{hj} = (1 - \zeta_{hj}) + \zeta_{hj} \kappa_{hj}$

I assume that ζ_{hj} is realized only when θ_{hj} is realized, and households have correct beliefs and no private information about the distribution of ζ_{hj} . When deciding on the optimal insurance choice, the household now takes into account its health types, the insurance premium, the coinsurance rate, and its belief about ζ_{hj} . Although ζ_{hj} is observed for 2008, it is not observed

²⁵For example, if the coinsurance rate specified in the insurance contract is 0.2, and all medical expenses are eligible for insurance coverage, $\zeta_{hj} = 1$, and $\tilde{\kappa}_{hj} = \kappa_{hj} = 0.2$. If only 40% of medical expenses are eligible for insurance coverage, $\zeta_{hj} = 0.4$, and $\tilde{\kappa}_{hj} = 0.6 + 0.4 \times 0.2 = 0.68$.

for other years. Therefore, we assume that the belief about ζ_{hj} is given by

$$\zeta_{hj} = \begin{cases} 0 & \text{With probability } p_0(X_{hj}) \\ 1 & \text{With probability } p_1(X_{hj}) \\ \sim U(0,1) & \text{With probability } 1 - p_0(X_{hj}) - p_1(X_{hj}) \end{cases}$$

where $p_0(X_{hj}) = \frac{\exp(X_{hj}\beta_{\zeta}^0)}{1+\exp(X_{hj}\beta_{\zeta}^0)+\exp(X_{hj}\beta_{\zeta}^1)}$ and $p_1(X_{hj}) = \frac{\exp(X_{hj}\beta_{\zeta}^1)}{1+\exp(X_{hj}\beta_{\zeta}^0)+\exp(X_{hj}\beta_{\zeta}^1)}$. This parameterization essentially assumes that households know for certain that some diseases are covered and some are not. However, for other diseases, households do not know whether these diseases are covered. As shown in Figure E.1, the majority of individuals either receive no coverage or have complete coverage; therefore, the uniform distribution assumption does not have a strong effect on the estimation.

E.2 Estimating parameters

The estimation procedure utilizes a nested optimization routine. In the outer nest, the parameters of interest are $\{\nu, \sigma_{\epsilon}, \beta_{\theta}, \beta_W\}$. In the inner nest, I optimize over $\{\beta_{\omega}, \beta_{\gamma}, \beta_{\delta}, \sigma_{\omega}, \sigma_{\gamma}, \sigma_{\delta}, \beta_r, \sigma_r\}$, taking the parameters of the outer nest as given.

Inner nest In the inner nest, $\beta_{\omega}, \beta_{\gamma}, \beta_{\delta}, \sigma_{\omega}, \sigma_{\gamma}, \sigma_{\delta}$ are obtained via GMM. I first compute

$$\mathbb{E}(\boldsymbol{m}|Y,\boldsymbol{\kappa}) = \mathbb{E}\left[\mathbb{E}(\boldsymbol{m}|\boldsymbol{\theta})|Y,\boldsymbol{\kappa}\right]$$
(29)

The expectation w.r.t $\boldsymbol{\theta}$ on the RHS of (29) is done numerically using Halton draws of $\boldsymbol{\theta}$ using the sample of households fully enrolled in involuntary SHI. The inner expectation, which is taken over $(\omega, \boldsymbol{\gamma}, \boldsymbol{\delta})$, is computed anlytically using the properties of the truncated normal distribution.

Similarly, $\mathbb{E}(\boldsymbol{m}^2|Y,\boldsymbol{\kappa})$ is computed. The GMM moments are then:

$$\sum \left[\boldsymbol{m} Y - \mathbb{E}(\boldsymbol{m} | Y, \boldsymbol{\kappa}) Y \right] = 0$$
(30)

$$\sum \left[\boldsymbol{m}\boldsymbol{\kappa} - \mathbb{E}(\boldsymbol{m}|Y,\boldsymbol{\kappa})Y\right] = 0 \tag{31}$$

$$\sum \left[\boldsymbol{m}^2 Y - \mathbb{E}(\boldsymbol{m}^2 | Y, \boldsymbol{\kappa}) Y \right] = 0$$
(32)

$$\sum \left[\boldsymbol{m}^{2} \boldsymbol{\kappa} - \mathbb{E}(\boldsymbol{m}^{2} | \boldsymbol{Y}, \boldsymbol{\kappa}) \boldsymbol{\kappa} \right] = 0$$
(33)

$$\sum \left[\boldsymbol{m} Y \boldsymbol{\kappa} - \mathbb{E}(\boldsymbol{m} | Y, \boldsymbol{\kappa}) Y \boldsymbol{\kappa} \right] = 0$$
(34)

$$\sum \left[\boldsymbol{m} Y \boldsymbol{\kappa} - \mathbb{E}(\boldsymbol{m} | Y, \boldsymbol{\kappa}) Y \boldsymbol{\kappa} \right] = 0$$
(35)

I then compute β_r and σ_r . In this step, only the sample of households with members eligible to purchase voluntary SHI is considered. For each household, I simulate the draws of $\boldsymbol{\theta}$ based on the parameters of the outer nest, the draws of $\omega, \boldsymbol{\gamma}, \boldsymbol{\delta}$ using the estimated values of $\beta_{\omega}, \beta_{\gamma}, \beta_{\delta}, \sigma_{\omega}, \sigma_{\gamma}, \sigma_{\delta}$. For each draw, I compute the lower bound and upper bound of rsuch that the observed insurance bundle is optimal. β_r and σ_r are then the MLE estimator.

Outer nest Using the estimated values from the inner nest, I compute $\mathbb{E}(\boldsymbol{m})$ and $\mathbb{E}(\boldsymbol{mm'})$ for all households fully enrolled in involuntary SHI. The GMM moments for the outer nest matches the first moment of \boldsymbol{m} and the second moment $\boldsymbol{mm'}$. Finally, the moment that identifies ν is $\mathbb{E}(\boldsymbol{m}|\boldsymbol{\kappa})$ from households with members eligible for voluntary SHI.