Bundling to Mitigate Adverse Selection: Evidence from Land-Expropriated Farmers in China's Social Security System

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February 17, 2025

Abstract

In 2003, Zhejiang Province, China, established a low-premium, low-benefit social security system for land-expropriated farmers. Starting in 2011, the province allowed eligible farmers to make a lump-sum payment to transfer to the high-premium, high-benefit Basic Pension Scheme for Employees (BPSE) and Basic Medical Insurance for Employees (BMIE). This policy transition offers a unique opportunity to study adverse selection in social insurance. Using micro-level social insurance data from C City from 2011 to 2020, we identify evidence of adverse selection in the transition process for both pension and medical insurance. Furthermore, we exploit exogenous price variation set by the government to estimate demand as well as average and marginal cost curves for BPSE and BMIE. Finally, we extend classic information asymmetry insurance theory (Akerlof, 1970) from a single-insurance market to a setting with two types of insurance, quantify the welfare loss caused by adverse selection, and evaluate whether bundling pension and medical insurance mitigates adverse selection.

This paper does not receive any sources of research support or involve any financial relationships.

1. Introduction

China's rapid economic growth has resulted in substantial farmland expropriation, displacing numerous farmers. The China Urban Development Report published by the Chinese Academy of Social Sciences (2011) estimates that by 2011, between 40 and 50 million farmers had been affected by land expropriation. In response to the loss of their primary livelihood, the government established social security systems to support these affected farmers.

In 2003, Zhejiang Province introduced the Basic Pension Scheme for Land-Expropriated Farmers (farmer pension) and the Basic Medical Insurance for Land-Expropriated Farmers (farmer health). Beginning in 2011, land-expropriated farmers in Zhejiang were given the option to make a lump-sum payment to transfer from the farmer pension to the Basic Pension Scheme for Employees (employee pension) or remain in the farmer pension. Those who transferred to the employee pension could then opt to pay an additional lump sum to switch to the Basic Medical Insurance for Employees (employee health) or stay with farmer health.

Because the employee pension and employee health plans offer superior benefits compared to their farmer counterparts, the 2011 transfer policy carries a risk of adverse selection.

Based on social pension microdata from City C in Zhejiang Province from 2011 to 2020, we constructed life tables for land-expropriated farmers who transferred to the employee pension and those who did not. The results indicate that the retirement-age life expectancy of male land-expropriated farmers who transferred is 6.52 years longer than those who did not transfer, while for female land-expropriated farmers, it is 7.84 years longer. This provides evidence of adverse selection in the transfer decision.

To address concerns regarding moral hazard and the treatment effects of higher pension benefits, we conduct an additional test using medical expense data from the year before transfer qualification. The Logit regression analysis shows that for each additional 1,000 yuan in self-paid hospitalization expenses in the year before transfer qualification, the odds of transferring to the employee pension, compared to not transferring, decrease by 3.4%, significant at the 1% level. This suggests that healthier individuals are more likely to transfer to the employee pension, further supporting the presence of adverse selection in pension insurance.

For employee health insurance, the Logit regression analysis reveals that among those who transferred to the employee pension, each additional 1,000 yuan in self-paid hospitalization expenses in the year prior to transfer qualification increases the odds of transferring to employee health insurance by approximately 10.9%, significant at the 1% level. This indicates that individuals in worse health are more inclined to transfer to the employee health, providing evidence of adverse selection in health insurance.

Furthermore, we exploit the exogenous price variation set by the government to estimate

the demand for employee pension and employee health, as well as the corresponding average and marginal cost curves as functions of these prices. The demand and cost for employee pension (or employee health) may depend on the price of employee health (or employee pension) due to complementarity, substitution, or bundling effects.

The employee pension and health prices faced by farmers are set by the government and determined by several factors, including the contribution base, the contribution base rate, the contribution rate, the number of years worked, and age. We propose using the cost per net present value (NPV) benefit as the measure of the employee pension price, since farmers' pension payments vary with their work histories, leading to differences in pension benefits. This measure is calculated as the lump-sum payment divided by the net present value of the farmer's pension benefits, computed under the assumption that the farmer dies at the average remaining life expectancy at retirement. This metric not only accounts for variations in pension benefits but also incorporates factors such as retirement age and gender. In contrast, we use the lump-sum payment directly as the measure for the price of employee health.

The estimates of these curves enable us to test for adverse selection by assessing whether the marginal cost curve slopes downward with increasing quantities, indicating that individuals with the highest willingness to pay also have the highest expected costs.

We then extend classic information asymmetry insurance theory (Akerlof, 1970; Rothschild and Stiglitz, 1976; Stiglitz, 1977) from a single insurance market to a setting with two types of insurance (see Figures 1 and 2), quantify the welfare loss caused by adverse selection, and evaluate whether bundling pension and medical insurance mitigates adverse selection. Bundling may help mitigate adverse selection by pooling risk, as healthier individuals are more likely to transfer to the employee pension, while those in poorer health tend to transfer to the employee health.

This paper makes several contributions to the literature. First, we extend classic information asymmetry insurance theory (Akerlof, 1970; Rothschild and Stiglitz, 1976; Stiglitz, 1977; Wilson, 1977; Miyazaki, 1977; Riley, 1979; Engers and Fernandez, 1987) from a single-insurance market to a setting with two types of insurance. While Einav et al. (2010) provides a graphical framework for testing adverse selection and quantifying its welfare loss by estimating demand and cost curves in a single-insurance context (see Figure 1), we extend the analysis to a two-insurance setting. We offer both graphical (see Figure 2) and mathematical (see Section 5.2) illustrations to test for adverse selection and quantify its associated welfare loss. In contrast to Handel et al. (2015), who consider cases where both low- and high-coverage insurance prices are endogenous, our paper focuses on public policy, where prices are exogenously set. Furthermore, we examine whether bundling pension and health insurance can mitigate adverse selection and generate welfare gains through risk pooling. While Nguyen (2022) study

bundling of social health insurance within households in Vietnam and Banerjee et al. (2014) analyze bundling health insurance with microfinance in India, to the best of our knowledge, this is the first paper to explore bundling pension and health insurance and provide both graphical and mathematical illustrations of its impact.

Second, our paper contributes to the empirical study of adverse selection (Chiappori and Salanie, 2000). While most research on adverse selection in annuity (Finkelstein and Poterba, 2002, 2004; McCarthy and Mitchell, 2010; Finkelstein and Poterba, 2014) and medical insurance (Cutler and Zeckhauser, 1998; Cardon and Hendel, 2001; Jütting, 2004; Dror et al., 2005; Wang et al., 2006; Zhang and Wang, 2008; Lammers and Warmerdam, 2010; Nguyen and Knowles, 2010; Banerjee et al., 2014; Yao et al., 2017; Banerjee et al., 2019; Fischer et al., 2023) has focused on private insurance markets, our paper examines adverse selection in social insurance. Despite the mandatory nature of social insurance—which typically limits adverse selection—we exploit the unique case of land-expropriated farmers who choose between two pension schemes and two medical insurance policies. Whereas previous studies test for adverse selection by examining the relationship between payments and risks after the insurance decision (raising concerns about moral hazard and treatment effects), we leverage a rich dataset on social pension and medical insurance and a unique policy change to isolate adverse selection using medical data from the year prior to the insurance decision for both transferred and non-transferred farmers. This approach aligns closely with the theoretical definition of adverse selection.

The rest of this paper is organized as follows. Section 2 introduces the policy background. Section 3 describes the data sources and summary statistics. Section 4 lays out testing for adverse selection. Section 5 calculates the welfare loss. Section 6 provides robustness checks. Section 7 concludes.

2. Policy Background

In 2003, Zhejiang Province pioneered the establishment of a basic living security system for land-expropriated farmers, which consists of a farmer pension and farmer health scheme. This system is jointly funded by local governments, village collectives, and the farmers themselves. Specifically, local governments cover 30% of the costs (financed through land transfer fees), village collectives cover 40% (financed through land compensation fees, land resettlement benefits, etc.), and land-expropriated farmers cover the remaining 30% (offset by land expropriation and resettlement subsidies).

City C is a county-level city under the jurisdiction of City B in Zhejiang Province. In June

2003, in line with provincial directives, City C established the contribution standards and benefit levels for the basic living social security system for land-expropriated farmers. Under this system, male farmers aged 16–60 and female farmers aged 16–50 at the time of land expropriation were required to make a one-time, lump-sum contribution to the city's social insurance institution. Upon reaching age 60 for males and 50 for females, these farmers began receiving monthly benefits until death. At that time, participants were required to contribute 15,000 yuan personally, with City C's land expropriation adjustment fund providing a one-time subsidy of 6,000 yuan on their behalf. The farmer pension benefit was set at 250 yuan per month, and the reimbursement rate for farmer health expenses was approximately 50%.

In July 2011, Zhejiang Province stipulated that individuals already enrolled in the basic living security system for land-expropriated farmers could opt to make a one-time lump-sum payment to transfer to the employee pension, provided that their original pension relationships are terminated. Additionally, those transferring to the employee pension may settle their employee health coverage through a one-time supplementary payment.

In October 2011, following Zhejiang Province's guidelines, City B stipulated that land-expropriated farmers must make a one-time payment for the employee pension based on the participation standards for flexible workers (18%), with 8% allocated to the individual account and 10% to the social account. Pension benefits consist of the individual account pension, the social account pension, and a social account pension subsidy. Those who choose to transfer to the employee health plan are required to make an additional one-time payment based on the flexible workers' participation standard (7%), which raises their reimbursement rate to approximately 80%.

Before 2020, land-expropriated farmers were required to transfer to the employee pension before they could switch to employee health, creating a semi-bundling requirement. However, from January to April 2020, farmers who had not joined the employee pension were allowed to make a one-time lump-sum payment to transfer directly to employee health, effectively eliminating bundling.

Employee pension and employee health payments are governed by detailed rules. Tables 1 and 2 outline the methodology used to calculate the lump-sum payments.

Payments made under the farmer pension are generally converted into six years of participation in the employee pension. To meet the 15-year minimum participation requirement, individuals must make an additional lump-sum payment equivalent to nine years of contributions. For example, during the period from July 2019 to April 2020, the annual employee pension payment was determined using the 2018 average provincial wage (the contribution base, 66,432 yuan), multiplied by the contribution base rate (100%) and the contribution rate (18%). This resulted in an annual payment of 12,000 yuan, totaling 108,000 yuan for nine

years.

Table 1: The Rule of Employee Pension Payment (Unit: Yuan)

Period	The Average Province Wage from Last Year	The Average City Wage from Last Year	Contribution Base Rate	Contribution Rate	Annual Payment
07/2011-06/2012	30650	28149	80%	18%	4056
07/2012-06/2013	35731	33691	80%	18%	4848
07/2013-06/2014	40087	38377	80%	18%	5520
07/2014-06/2015	44513	44046	80%	18%	6348
07/2015-06/2016	48372	48215	80%	18%	6948
07/2016-06/2017	51719	52275	80%	18%	7512
07/2017-06/2018	56385	55743	100%	18%	10044
07/2018-06/2019	61099	61025	100%	18%	10992
07/2019-04/2020	66432	66229	100%	18%	12000

Table 2: The Rule of Employee Health Payment (Unit: Yuan)

Period	The Average Province Wage from Last Year	The Average City Wage from Last Year	Contribution Base Rate	Contribution Rate	Annual Payment
07/2011-06/2012	30650	28149	80%	7%	1576.68
07/2012-06/2013	35731	33691	80%	7%	1886.64
07/2013-06/2014	40087	38377	80%	7%	2148.72
07/2014-06/2015	44513	44046	80%	7%	2467.08
07/2015-06/2016	48372	48215	80%	7%	2699.76
07/2016-06/2017	51719	52275	80%	7%	2923.2
07/2017-06/2018	56385	55743	80%	7%	3124.8
07/2018-06/2019	61099	61025	80%	7%	3418.8
07/2019-04/2020	66432	66229	100%	5%	3312

Enrolling in the farmer pension automatically enrolls land-expropriated farmers in the

farmer health plan. Their contributions are generally converted into ten years of participation in the employee health plan. To meet the 20-year minimum participation requirement, individuals must make an additional lump-sum payment equivalent to ten years of contributions. For example, during the period from July 2019 to April 2020, the annual employee health payment was calculated using the 2018 average city wage (the contribution base, 66,229 yuan), multiplied by the contribution base rate (100%) and the contribution rate (5%). This resulted in an annual payment of 3,312 yuan, totaling 33,120 yuan for ten years.

Several key policy changes have affected the contribution base and rates: In July 2019, the contribution base for the employee pension switched from the previous year's average city wage to the previous year's average provincial wage. The contribution base rate for the employee pension increased from 80% to 100% in July 2017. The contribution base rate for employee health increased from 80% to 100% in July 2019. The contribution rate for employee health decreased from 7% to 5% in July 2019.

Payments are calculated from July of one year to June of the next, as the policy began in July 2011. However, benefits are determined on a calendar-year basis.

The lump-sum payment for the employee pension decreases by 5% for each year that land-expropriated farmers exceed the age of 60, with a maximum discount of 50%.

From July 2011 to June 2013 in City C, individuals contributing to the employee pension scheme who would not have accumulated a total of 15 years—defined as the sum of their contribution years until retirement plus the six converted years from the farmer pension—were allowed to make lump-sum payments in advance. From July 2013 to December 2019, however, eligibility for lump-sum payments required that individuals reach retirement age. Then, before the policy ended in April 2020, early lump-sum payments were permitted once again. Notably, the lump-sum payment for employee health was never advanced.

As shown in Table 3, the lump-sum payment steadily increases because it is tied to the contribution base—namely, the previous year's average city or provincial wage. This linkage exists because farmers typically lack formal employment, meaning their payments cannot be based on individual wages.

The farmer pension offers an annual return of approximately 50%, meaning farmers begin to profit after just two years. In contrast, the employee pension has an annual return of around 20% meaning it takes about five years to become profitable. However, the employee pension benefits are roughly twice those of the farmer pension. Consequently, the transfer policy has been widely embraced by land-expropriated farmers, with many opting to join the employee pension through the lump-sum payment method.

Table 3: The Payment, Benefit, and Return Table (Unit: Yuan)

Year	Farmer Pension			Employee Pension (Male)			Employee Pension (Female)		
	Lump-Sum Payment	Monthly Benefit	Annual Return	Lump-Sum Payment	Monthly Benefit	Annual Return	Lump-Sum Payment	Monthly Benefit	Annual Return
2011	15000	490	39.20%	36504	906.8	21.13%	36504	842.3	19.63%
2012	15000	540	43.20%	43632	1055.9	21.61%	43632	984.8	20.16%
2013	15000	600	48.00%	49680	1204.2	22.34%	49680	1127.5	20.92%
2014	15000	600	48.00%	57132	1369.8	22.79%	57132	1286.4	21.40%
2015	15000	660	52.80%	62532	1559.5	24.14%	62532	1471.1	22.77%
2016	15000	740	59.20%	67608	1664.2	24.18%	67608	1571.1	22.82%
2017	20000	812	48.72%	90396	1957.2	21.27%	90396	1832.9	19.92%
2018	20000	872	52.32%	98928	2048.9	20.67%	98928	1916.7	19.34%
2019	20000	872	52.32%	108000	2143.8	20.10%	108000	2003.6	18.78%
2020	20000	936	56.16%	108000	2191.1	20.54%	108000	2050.9	19.23%

Between June 2003 and April 2020—when the lump-sum payment transfer policy ended—a total of 161,327 land-expropriated farmers participated in the farmer pension in City C. Of these, 82,057 were enrolled before the transfer policy began at the end of June 2011 (the initial group), and 79,270 enrolled during the policy period from July 2011 to April 2020 (the subsequent group). Those who transferred normally had over nine years of employment, enabling them to meet the minimum 15-year participation requirement without making an additional lump-sum payment. By the policy's conclusion in April 2020, 37,586 farmers—about one-quarter of the total—remained in the farmer pension.

Between December 2003 and June 2011, 82,057 land-expropriated farmers in City C participated in the farmer pension, with 43,993 having reached retirement age (60 for men, 50 for women) by the end of June 2011. From July 2011 to April 2020, an additional 79,270 new farmers joined the farmer pension, and by April 2020, 28,732 of them had reached retirement age.

Table 4: The Number of Land-Expropriated Farmers Participating in Farmer Pension and Employee Pension

Time	No. Join Farmer Pension	No. Transfer to Employee Pension with Lump-Sum Payment	No. Transfer to Employee Pension Normally	No. of Farmer Pension at the End of the Period
2003.12-2011.06	82057	-	13912	68145
2011.07-2011.12	6304	20746	1495	52208
2012.01-2012.12	8800	10461	3202	47345
2013.01-2013.12	7751	6866	2867	45363
2014.01-2014.12	8937	8153	3367	42780
2015.01-2015.12	7333	3760	3486	42867
2016.01-2016.12	7186	4498	3135	42420
2017.01-2017.12	10157	4510	4627	43440
2018.01-2018.12	10032	3257	5143	45072
2019.01-2019.12	10326	3254	6676	45468
2020.01-2020.04	2444	8524	1799	37589
Total	161327	74029	49709	-

As of April 2020, when the transfer policy was terminated, 46,911 farmers from the initial group had transferred to the employee pension via lump-sum payments, including 14,367 males and 32,544 females. In the subsequent group, 27,734 farmers made the transfer, including 9,828 males and 17,906 females.

As of April 2020, aside from those who transferred to the employee pension through lump-sum payment or normal procedures, there were 16,608 farmers in the initial group who did not opt for a lump-sum transfer. Among these, 14,672 met the transfer criteria—comprising 6,352 males and 8,320 females. In the subsequent group, 20,981 farmers did not opt for a lump-sum transfer, of whom 14,050 met the transfer criteria, including 6,908 males and 7,142 females.

3. Data

3.1 Data Sources

This section describes the data sources used in this paper.

This paper uses micro-level social pension data in City C from 2011 to 2020, including ba-

sic personal information such as gender, age, and time of death, as well as pension enrollment information such as the type of pension, enrollment time, transfer time, and retirement time for both the employee pension and farmer pension.

I use this micro-level pension data to compile life tables of different participant groups. After retirement, participants in the pension scheme begin receiving pension benefits. Upon the death of a participant, the payment of pension ceases, while funeral allowances and condolence payments are issued. Any remaining balance in the individual account is inherited by the participant's heirs. The recorded age at the time of death of participants is highly accurate. Therefore, based on the micro-level records of pension data in City C, we are able to compile life tables to calculate the average remaining life expectancy of different groups of pension recipients.

Using individual social security numbers, we matched City C's social pension data with the corresponding social medical insurance data. The dataset comprises employee health, farmer health, and basic medical insurance for urban and rural residents (referred to as resident health).[1] This dataset includes information on gender, age, insurance types, enrollment and transfer dates, as well as various medical expenses and disease diagnoses.

3.2 Summary Statistics

Because the health status of land-expropriated farmers before transfer qualification influences their decision to transfer, we used medical expenditure data from the preceding year for both those who transferred and those who met the transfer criteria but did not transfer.

The summary statistics for the variables, grouped by whether individuals transferred to the employee pension, are presented, including the mean and standard deviation for the transferred group, the non-transferred group, and the entire sample. As shown in Table 5, for both the initial and subsequent groups, prescribed disease expenses, hospitalizations, and social account expenses are significantly higher for non-transfers than for transfers. However, outpatient clinic expenses show a different pattern between the initial and subsequent groups: In the initial group, outpatient clinic expenses are higher for transfers than for non-transfers. In the subsequent group, outpatient self-payments are higher for non-transfers than for transfers. Compared to prescribed disease expenses, hospitalizations, and social account expenses, outpatient clinic expenses more accurately reflect expenditures on minor illnesses among insured individuals.

[1]The institutional framework and benefit levels for farmer health are roughly equivalent to those for resident health. Since our medical expense data were collected from the year prior to transfer qualification, some transferred land-expropriated farmers were enrolled in resident health at that time. Therefore, we used resident health data for those individuals.

Table 5: Summary Statistics for Employee Pension

Variable	Initial Group			Subsequent Group		
	Total	Transferred	Non-Transferred	Total	Transferred	Non-Transferred
Transfer	0.762	-	-	0.664	-	-
	(0.426)	-	-	(0.472)	-	-
Outpatient clinic expense	2.305	2.587	1.403	2.440	1.821	3.663
(hundred yuan)	(5.110)	(5.485)	(3.512)	(6.359)	(5.824)	(7.144)
Prescribed disease expense	0.101	0.0852	0.150	0.0765	0.0373	0.154
(hundred yuan)	(2.260)	(2.172)	(2.523)	(2.184)	(1.500)	(3.120)
Hospitalized expense	2.402	2.185	3.097	2.498	1.189	5.081
(hundred yuan)	(13.07)	(11.76)	(16.55)	(14.06)	(8.552)	(20.82)
Social account expense	7.224	6.370	9.953	8.840	4.232	17.94
(hundred yuan)	(42.63)	(37.89)	(55.03)	(59.11)	(33.22)	(89.93)
Male	0.336	0.306	0.433	0.401	0.354	0.492
	(0.472)	(0.461)	(0.495)	(0.490)	(0.478)	(0.500)
Age	60.857	60.135	63.165	60.878	58.941	64.703
	(8.666)	(8.235)	(10.079)	(9.039)	(8.050)	(9.982)
N	61,583	46911	14672	41784	27734	14050

Standard deviations are in parentheses.

The summary statistics for the variables, grouped by whether individuals transferred to employee health, are presented, including the mean and standard deviation for the transfer group, the non-transfer group, and the entire sample. As shown in Table 6, the proportion of employee health transfers is relatively low, with only 21.9% (16320/74645) among employee pension transfers and 2.1% (502/24133) among non-employee pension transfers. There is no clear systematic pattern in medical expenses between transfer and non-transfer cases. However, we find that regardless of employee pension transfer status, the average age of employee health transferees is lower than that of non-transferees. This aligns with the idea that younger individuals have a greater potential to accrue long-term benefits under employee health insurance.

Table 6: Summary Statistics for Employee Health

	Employee Pension Transfer			Employee Pension Non-Transfer		
	Total	Transferred	Non-Transferred	Total	Transferred	Non-Transferred
BMIE Transfer	0.219	-	-	0.017	-	-
	(0.413)	-	-	(0.131)	-	-
Outpatient Clinic	0.230	0.202	0.238	0.250	0.327	0.248
Expense (K Yuan)	(0.563)	(0.468)	(0.586)	(0.562)	(0.856)	(0.554)
Prescribed Disease	0.007	0.006	0.007	0.007	0.009	0.007
Expense (K Yuan)	(0.195)	(0.183)	(0.198)	(0.165)	(0.157)	(0.165)
Hospitalized	0.181	0.138	0.194	0.257	0.305	0.256
Expense (K Yuan)	(1.069)	(0.899)	(1.112)	(1.339)	(1.612)	(1.333)
Social Account	0.558	0.424	0.595	0.876	1.208	0.869
Expense (K Yuan)	(3.624)	(3.051)	(3.768)	(5.445)	(6.656)	(5.416)
Male	0.324	0.248	0.345	0.462	0.452	0.462
	(0.468)	(0.432)	(0.476)	(0.499)	(0.498)	(0.499)
Age	59.691	55.531	60.855	63.917	60.659	63.975
	(8.235)	(6.557)	(8.281)	(10.492)	(6.976)	(10.535)
N	74645	16320	58325	24133	502	23631

Standard deviations are in parentheses.

4. Testing for Adverse Selection

4.1 The Basic Pension Scheme for Employees

4.1.1 The Life Table

Compiling a life table typically requires micro data at the million-person level. As of the end of April 2020, there were a total of 126,377 retired individuals covered by the employee pension in City C, with 65,491 (51.82%) being retired farmers who transitioned to the system through lump-sum payments, and 60,886 (48.18%) being retired workers who made normal contributions. After sample selection and grouping, the number of individuals in each group de-

creases, and the age-specific mortality rates in certain age groups fluctuates significantly due to random factors. Additionally, during the initial phase of implementing the policy transition, there was a waiting period of three to six months from the application for lump-sum payment procedures to the procedure being recorded in the system to the payment actually being paid, resulting in some individuals who had applied for transition but died during the waiting period before becoming official beneficiaries. To mitigate the impact of insufficient total numbers and inaccurate mortality rates of classified groups during the initial phase, this study follows the method of constructing period life tables and combines the micro data of the farmer pension and employee pension in City C from 2011 to 2020 to create a period life table, aiming to obtain more stable and accurate age-specific mortality rates.

In traditional life table construction, the numerator of age-specific mortality rate usually represents the number of deaths in a specific age group during the past year, while the denominator is the "person-years" for that age group, calculated as the product of the number of people and the number of years. Because the calculation period is one year, if the population is closed and mortality is evenly distributed, then person-years would be equal to half the sum of the population at the beginning and end of the year, i.e., the mid-year population. However, in the actual pension scheme cohort, the distribution of death events among individuals may not be uniform, and there may be new retirees joining the insured population every month. Therefore, the formula for period age-specific mortality rate is as follows.

The numerator represents the number of deaths in a specific age group from 2011 to 2020, obtained by summing the annual number of deaths in that age group. The denominator is the person-years in that specific age group from 2011 to 2020. Because beneficiaries receive benefits for each month they survive, the person-years for a specific age group during the period is equal to the total number of months beneficiaries in that age group received benefits during the period. Therefore, by summing the number of months beneficiaries in a specific age group received benefits from 2011 to 2020 and dividing by 12, we can obtain the person-years for that specific age group during the period, and then calculate the age-specific mortality rate.

Based on the age-specific mortality rate m_x, this paper uses the Coale-Demeny method to calculate the probability of death q_x. The Coale-Demeny method calculates the probability of death as follows: ${}_nq_x = n_n m_x / \left(1 + \left(n - {}_na_x\right) {}_nm_x\right)$.

Then, according to the following relevant formulas, the number of deaths ${}_nd_x$, the number of survivors l_x, the average person-years lived ${}_nL_x$, the cumulative average person-years lived T_x can be calculated successively for each age group, eventually yielding the average life expectancy e_x.

the number of deaths ${}_nd_x = l_x * {}_nq_x$

Table 7: The Life Table of Land-Expropriated Males Transferred to the Employee Pension

Age x	The Number of Survivors l_x	Mortality Rate m_x	Death Probability q_x	The Number of Deaths d_x	The Average Person-Years lived L_x	The Average Total Person-Years Lived T_x	Average Life Expectancy e_x
0	100000	0.000000	0.000000	0	100000	8647536	86.48
1-4	100000	0.000000	0.000000	0	400000	8547536	85.48
5-9	100000	0.000000	0.000000	0	500000	8147536	81.48
10-14	100000	0.000000	0.000000	0	500000	7647536	76.48
15-19	100000	0.000000	0.000000	0	500000	7147536	71.48
20-24	100000	0.000000	0.000000	0	500000	6647536	66.48
25-29	100000	0.000000	0.000000	0	500000	6147536	61.48
30-34	100000	0.000000	0.000000	0	500000	5647536	56.48
35-39	100000	0.000000	0.000000	0	500000	5147536	51.48
40-44	100000	0.000000	0.000000	0	500000	4647536	46.48
45-49	100000	0.000000	0.000000	0	500000	4147536	41.48
50-54	100000	0.000000	0.000000	0	500000	3647536	36.48
55-59	100000	0.000000	0.000000	0	500000	3147536	31.48
60-64	100000	0.000000	0.000000	0	500000	2647536	**26.48**
65-69	100000	0.001325	0.006586	659	497050	2147536	21.48
70-74	99341	0.012768	0.060384	5999	469833	1650487	16.61
75-79	93343	0.025147	0.112953	10543	419269	1180654	12.65
80-84	82799	0.047125	0.194250	16084	341299	761384	9.20
85-89	66716	0.097547	0.337576	22522	230880	420086	6.30
90-94	44194	0.159091	0.460163	20336	127829	189206	4.28
95-99	23858	0.238095	0.569476	13586	57063	61377	2.57
100+	10271	1.000000	0.896057	9204	4314	4314	0.42

the number of survivors $l_{x+n} = l_x - {}_nd_x$
the average person-years lived ${}_nL_x = n * l_{x+n} + {}_na_x(l_x - l_{x+n})$
the cumulative average person-years lived $T_x = T_{x+1} + L_x$

the average life expectancy $e_x = T_x/l_x$

This paper compiles a 10-year simplified life table with age groups of 5 years each. Since the focus is on average remaining life expectancy at retirement, mortality data before retirement age does not affect the average remaining life expectancy. Therefore, in the process of compiling the life table, the mortality rate is set to 0 for males under 60 years and females under 50 years. As shown in Table 7, the average remaining life expectancy at retirement age for male land-expropriated farmers who transferred to the employee pension is 26.48 years.

Table 8: The Average Retirement Life Expectancy of Land-Expropriated Farmers

Gender (age)	Average retirement life expectancy (year)		Difference in Average
	Transferred	Non-Transferred	retirement life expectancy
Male (60)	25.89	19.37	6.52
Female (50)	38.39	30.55	7.84

We calculated the retirement-age life expectancy for male and female land-expropriated farmers, comparing those who transferred to the employee pension with those who did not.

First, we find that for individuals who transferred to the employee pension, the average life expectancy at retirement is 25.89 years for males and 38.39 years for females. However, it takes only about five years to break even. It is similar for the farmer pension. This suggests that pension insurance is far from break-even.

Second, for males, the life expectancy at retirement for those who transferred to the employee pension is 6.52 years longer than for those who did not transfer, while for females, it is 7.84 years longer. This indicates that individuals who transferred to the employee pension tend to have longer life expectancy at retirement, providing evidence of adverse selection in the pension transfer process.

One might be concerned that the higher pension benefits could have a treatment effect on longevity. However, it is unlikely that receiving a few hundred yuan more per month would result in a seven-year difference in life expectancy.

4.1.2 The Logit Regression

We employ a logit model to regress the decision on transferring to the employee pension on the medical expense the year before transfer qualification, male, and age, controlling for village-by-year fixed effects. We do not need causality. Correlation is enough to test for adverse selection.

$$\log\left(\frac{\Pr(Y_i=1)}{1-\Pr(Y_i=1)}\right)=\beta_0+\beta_1 X_i+\lambda_{vt}+\epsilon_i$$

Y_i refers to transfer to the employee pension or not. X_i refers to the outpatient clinic expense, prescribed disease expense, hospitalized expense, and social account expense the year before transfer qualification, as well as male and age for farmer i. λ_{vt} indicates village-by-year fixed effects. They account for characteristics that vary across year and village. For example, they include the proportion of farmers transferred to the employee pension within a specific village at a given year, which could affect the decision to transfer through transmission effects.

Table 9: Employee Pension Transfer Regression Result

	Initial Group		Subsequent Group		Total	
	Logit	Probit	Logit	Probit	Logit	Probit
Outpatient Clinic Expense	0.952***	0.463***	-0.456***	-0.231***	0.004	0.002
(Thousand Yuan)	(0.036)	(0.017)	(0.020)	(0.010)	(0.013)	(0.008)
Prescribed Disease Expense	-0.122**	-0.075**	-0.136	-0.052	-0.052	-0.030
(Thousand Yuan)	(0.045)	(0.024)	(0.073)	(0.034)	(0.034)	(0.019)
Hospitalized Expense	-0.027*	-0.013*	-0.161***	-0.092***	-0.034***	-0.021***
(Thousand Yuan)	(0.011)	(0.006)	(0.019)	(0.010)	(0.009)	(0.005)
Social Account Expense	-0.020***	-0.012***	0.004	0.002	-0.019***	-0.011***
(Thousand Yuan)	(0.004)	(0.002)	(0.005)	(0.002)	(0.003)	(0.002)
Male	-0.241***	-0.157***	-0.136***	-0.087***	-0.222***	-0.144***
	(0.016)	(0.011)	(0.020)	(0.013)	(0.012)	(0.008)
Life Expectancy	0.044***	0.024***	0.077***	0.045***	0.056***	0.032***
(Year)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
N	61583	61583	41168	41168	102751	102751
R^2	0.0452	0.0438	0.0936	0.0914	0.0487	0.0482

The reported values in the table are odds ratios rather than regression coefficients.
Robust standard errors in parentheses.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$.

The fifth column of Table 9 [2] presents the results of the Logit regression based on the entire

[2]Due to the time limit, we are not able to update the regression result with village-by-year fixed effects. We will do it later.

sample. The odds ratio of self-paid hospitalization expenses (per thousand yuan) for the employee pension transfer decision is -0.034, significant at the 1% level. This means that, holding other factors constant, for every additional thousand yuan in self-paid hospitalization expenses, the odds of land-expropriated farmers transferring to the employee pension decrease by 3.4% compared to not transferring. Similarly, for every additional thousand yuan in the social account expense, the odds of land-expropriated farmers transferring to the employee pension decrease by 1.9%, significant at the 1% level. The odds of male land-expropriated farmers transferring to the employee pension are 22.2% less than that of females, indicating that females have a higher probability of transferring to the employee pension. This is consistent with the fact that females retire earlier than males, and live longer than males. The odds ratio of life expectancy (in years) for the transfer decision is 0.056, meaning that for each additional year of life expectancy, the odds of land-expropriated farmers transferring to the employee pension increase by 5.61%. In other words, younger individuals have a higher probability of transferring to the employee pension compared to older individuals. The probit regression results also indicate that self-paid hospitalization expenses and social account expenses have significant negative effects on the transfer decision.

Whether using logit or probit regression, self-paid hospitalization expenses, social account expenses, male, and age all have significant negative effects on land-expropriated farmers' transfer decision to employee insurance. This suggests that healthier individuals are more willing to transfer to the employee pension, while those in poorer health prefer to remain in the farmer pension. Additionally, females are more inclined to transfer to employee insurance than males, and younger individuals are more willing to transfer. These findings support the existence of adverse selection during the transfer process.

4.1.3 The Net Present Value Difference

We plan to use the random-effects parametric survival model to estimate hazard ratios, and then estimate the survival function to calculate the expected remaining life expectancy for each individual.

The hazard function is as follows:

$$h\left(t_{ij}\right)=h_0\left(t_{ij}\right)\exp\left(\mathbf{x}_{ij}\boldsymbol{\beta}+\nu_i\right)$$

Where t indicates the survival time, $i=1,\ldots,n$ indicate panels (years), $j=1,\ldots,n_i$, and ν_i s indicate unobservable panel-level random effects that are independent and identically distributed $N\left(0,\sigma_\nu^2\right)$. The panels we use are the years before the decision to transfer or not. $h_0\left(t\right)$ is the baseline hazard function and is assumed to be parametric. x refers to the outpa-

tient self-payment, the prescribed disease expense, hospitalizations, social account expense, male, age, and village-by-year fixed effects.

After estimating the life expectancy for each individual, we calculate the net present value difference of each individual between transferring to the employee pension and staying in the farmer pension. We calculate the average net present value difference for the tranferred and non-tranferred groups, and hope to find that the average net present value difference for the tranferred group is significantly greater than that for the non-tranferred group.

We also plan to use the logit model to regress the decision on transferring to the employee pension on the net present value difference.

$$\log\left(\frac{\Pr(Y_i=1)}{1-\Pr(Y_i=1)}\right) = \beta_0 + \beta_1 X_{1i} + \lambda_{vt} + \epsilon_i$$

X_{1i} refer to the net present value difference for individual i. λ_{vt} indicates village times year fixed effects. It incorporates relevant information such as gender, age, medical expenses, and lump-sum payment, making the coefficients easier to interpret. For example, I can specify that for every additional thousand yuan of the net present value difference, the odds of land-expropriated farmers transferring to the employee pension, compared to not transferring, increase by a certain amount.

We plan to do it year by year, and then do a pooled regression.

4.2 The Basic Medical Insurance for Employees

4.2.1 The Logit Regression

We use the logit model to regress the decision on transferring to the employee health on the medical expense the year before transfer qualification, male, and age, controlling for village-byyear fixed effects.

$$\log\left(\frac{\Pr(Y_i=1)}{1-\Pr(Y_i=1)}\right) = \beta_0 + \beta_1 X_i + \lambda_{vt} + \epsilon_i$$

Y_i refers to transfer to the employee health or not. X_i refers to the outpatient clinic expense, prescribed disease expense, hospitalized expense, and social account expense the year before employee health transfer qualification, as well as male and age for individual i. λ_{vt} indicates village-by-year fixed effects. They account for characteristics that vary across year and village.

We split our sample to employee pension transfer and non-transfer because there was semi-bundling before 2020, joining the employee pension is required to enrolling in the em-

ployee health, and in 2020 the semi-bundling requirement was removed, those who did not transferred to the employee pension could make a lump-sum payment to transfer directly to employee health. The second column of Table 10 indicates that, for those transferred to employee pension, as prescribed disease expense increases one thousand yuan, the odds ratio of transferring to the employee health comparing to not transferring increases by 22.4%, significant at the 1% level. As hospitalized expense increases one thousand yuan, the odds ratio of transferring to the employee health comparing to not transferring increases by 10.9%, significant at the 1% level. This suggests that individuals in worse health are more inclined to transfer to the employee health, while those in poorer health tend to remain in the farmer health. These findings support the existence of adverse selection in the transfer process for employee health.

Table 10: Employee Health Transfer Regression Result

	Employee Pension Transfer		Employee Pension Non-Transfer	
Outpatient Clinic Expense (K Yuan)	-0.138***	-0.388***	0.154**	0.165**
	(0.019)	(0.029)	(0.053)	(0.055)
Prescribed Disease Expense (K Yuan)	0.065	0.224***	-0.030	-0.020
	(0.057)	(0.071)	(0.214)	(0.209)
Hospitalized Expense (K Yuan)	0.025	0.109***	-0.013	-0.021
	(0.018)	(0.029)	0.046	(0.048)
Social Account Expense (K Yuan)	-0.014*	-0.046***	0.008	0.008
	(0.006)	(0.010)	(0.010)	(0.010)
Male	0.060**	-0.031	0.024	0.023
	(0.022)	(0.031)	(0.091)	(0.092)
Age	-0.096***	-0.103***	-0.018***	-0.020***
	(0.001)	(0.002)	(0.005)	(0.005)
Township*Year Fixed Effect	No	Yes	No	Yes
N	74645	60244	24133	21809
R Squared	0.077	0.251	0.005	0.031

Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The regression coefficients for prescribed disease expenses and hospitalized expenses are not significant for individuals who were not transferred to employee pension. To explain this, we proposed four hypotheses.

First, medical insurance in this context is special because it requires a one-time payment at retirement and provides coverage for the rest of one's life. This means that health status at retirement may not strongly influence the transfer decision, as even those who are healthy at retirement could become very ill later in life and require substantial medical reimbursements. However, if this hypothesis were entirely accurate, we would also expect to see insignificance in the first two columns, so it does not fully explain the results.

Second, land-expropriated farmers, particularly those who did not transfer to the employee pension, might be very poor. Their decision could be influenced not just by health conditions but also by income constraints. Individuals with higher incomes typically have better health and can afford the lump-sum transfer payment, which could offset the adverse selection phenomenon where those in worse health are more likely to transfer. The degree of this offset would depend on the income variation and its correlation with health within the sample. We can test this hypothesis once we have the income data. The income data is derived from farmers' employment records. I'll provide more details about the income data in the robustness check. t

Third, farmers who did not transfer to the employee pension might have a stronger bequest motive. They may choose not to seek treatment for serious illnesses, preferring to save money for their offspring. This could make them even less likely to join the employee health, leading to the insignificance of coefficients related to adverse selection. I can't really test this hypothesis.

Last, farmer whose land was expropriated before 2020 and didn't join the employee pension were able to join the emplOyee health directly in 2020. However, this required them to make an additional decision about whether to enroll in the employee health, and if they chose to do so, go to the social security department to make the lump-sum payment. This process involves switching costs, which could make them less likely to join the employee health, leading to the insignificance of coefficients related to adverse selection.

5. Welfare Analysis

5.1 Graphical Representation

Figure 1 presents a graphical analysis of adverse selection and the resulting welfare loss. The downward-sloping marginal cost curve illustrates the key feature of adverse selection: individuals with a higher willingness to pay for insurance also have higher expected costs. Due to the downward-sloping feature of the marginal cost curve, adverse selection leads to underinsurance (Akerlof, 1970). The first-best equilibrium is at point E, where the marginal cost

Figure 1: Efficiency Cost of Adverse Selection (Einav et al., 2010)

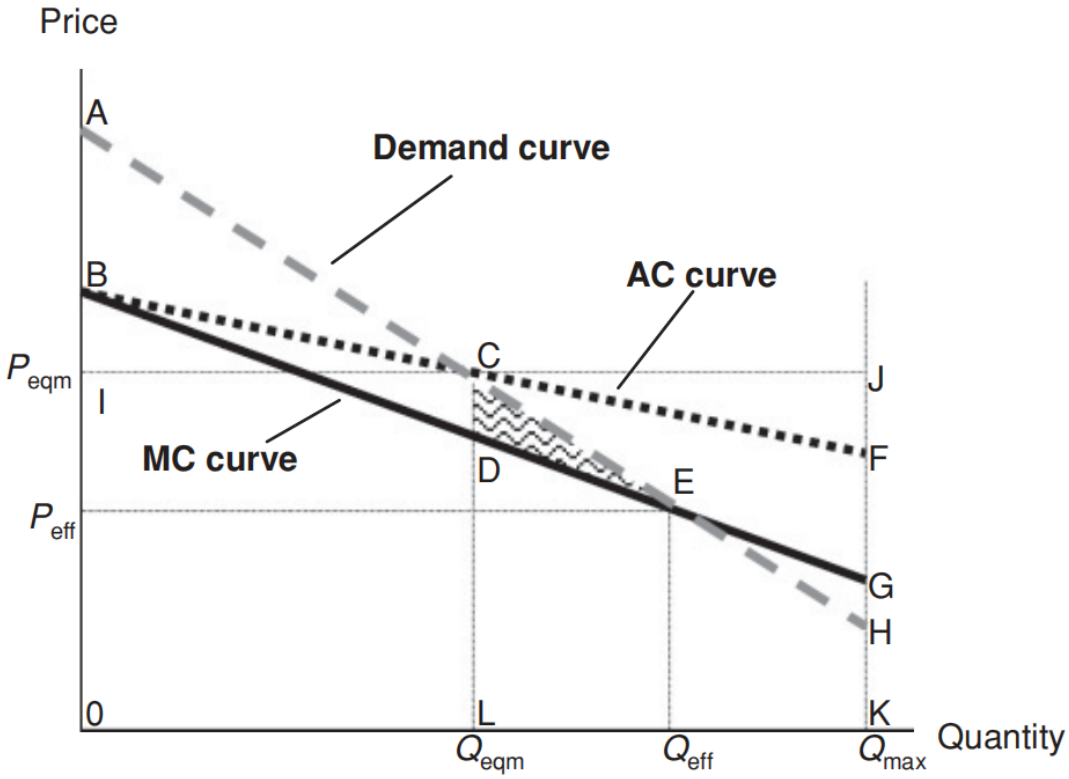


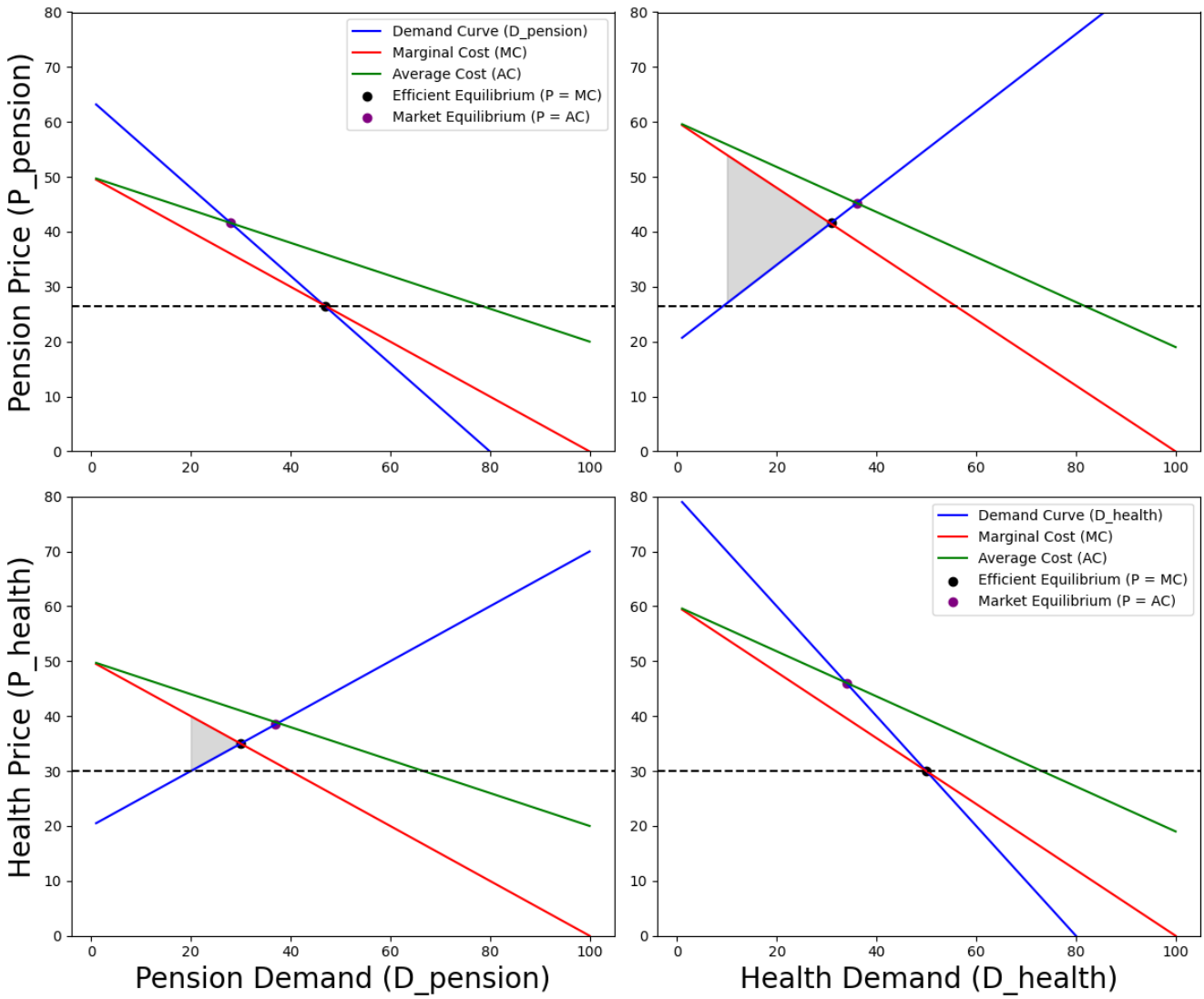
FIGURE I
Efficiency Cost of Adverse Selection

equals the willingness to pay. The market equilibrium is at point C, where the average cost equals the willingness to pay. The welfare loss caused by adverse selection then is represented by the shaded area CDE.

This scenario considers a single insurance type with low and high coverage levels. In contrast, my case involves two distinct insurance types—pension and health insurance—each available at low and high coverage levels. Therefore, I need to modify the graph to reflect this structure.

Let's first examine the upper two subgraphs of Figure 2. Given a fixed level of health price, we can analyze the pension and health demand and cost curves as functions of the pension price. By identifying the efficient points, we observe that the efficient pension price for pension demand may not necessarily be the efficient pension price for health demand. To minimize total welfare loss (pension + health welfare loss), we determine the pension price that results in the lowest combined welfare loss. This process is repeated for different levels of health price, generating new pension and health demand and cost curves at each level. From

Figure 2: Welfare Analysis of Employee Pension and Employee Health



these, we construct a curve representing the lowest combined welfare loss as a function of health price. The global solution is found at the lowest point on this curve.

Next, let's consider the lower two subgraphs of Figure 2. Similarly, given a fixed level of pension price, we can analyze the pension and health demand and cost curves with respect to health price. The efficient health price for pension demand may differ from the efficient health price for health demand. Again, we identify the health price that minimizes the total welfare loss. This process is repeated for different levels of pension price, generating new pension and health demand and cost curves at each level. From these, we construct the curve

representing the lowest combined welfare loss as a function of pension price. The global solution corresponds to the lowest point on this curve.

The global solution should be the same no matter we start from the pension price or health price.

The demand and cost of the employee health depend on the price of employee pension due to the complementarity (or substitution) effect [3]. The demand and cost of the employee pension depend on the price of employee health due to both the complementarity (or substitution) effect and the semi-bundling effect. To illustrate this, let's examine Tables 11.

The numbers are derived from Table 4: 25% remained in the farmer pension and farmer health, 40% transferred to both the employee pension and employee health, and 35% transferred only to the employee pension. I further break down the 25% into two categories: 20% and 5%. The 5% represents farmers who place a low value on the employee pension but a high value on employee health—though not high enough to transfer under semi-bundling. Similarly, I split the 40% into two groups: 10% and 30%. The 10% represents farmers who value the employee pension low but highly value employee health, to the extent that they are willing to purchase the bundled employee pension and employee health package.

Under these assumptions, in a no-bundling scenario in 2020, the 5% plus 10% of farmers would choose only the employee health.

Table 11: The Choice between Employee Pension and Employee Health

Employee Pension Value	Low	Low	High	High
Employee Health Value	Low	High	Low	High
Semi-Bundling	None	None or Pension+Health	Pension	Pension+Health
	20%	5% 10%	35%	30%
No Bundling	None	Health	Pension	Pension+Health
	20%	5%+10%	35%	30%

Under the no bundling scenario, if the price of the employee pension decreases, the demand for the employee pension increases. Some farmers from the 20%, 5%, and 10% groups would choose to enroll in the employee pension. Additionally, a subset of the 25% group might also decide to enroll in employee health due to the complementarity effect. Farmers who transfer to the employee pension anticipate positive cash flows immediately after

[3] Employee pension and employee health can be either complements or substitutes. For illustrative purposes, I will assume they are complements.

retirement, which enables them to afford employee health insurance as well. This, in turn, increases the demand for health insurance.

Similarly, if the price of employee health decreases, some individuals from the 20% and 35% groups would purchase employee health insurance. Additionally, a subset of the 20% group might also decide to enroll in the employee pension program due to the complementarity effect. As they join the employee health program, they feel better protected and are more willing to enroll in the employee pension program.

Under the semi-bundling scenario, if the price of employee pension decreases, the situation is similar to the no-bundling case. Some farmers from the 20% and 5% groups would choose to enroll in the employee pension. Additionally, a subset of the 20% group might also decide to enroll in the employee health due to the complementarity effect.

However, under semi-bundling, a decrease in the price of employee health leads to an additional effect beyond complementarity. Some farmers from the 20% and 5% groups would opt for the bundled employee pension + employee health option solely because of the semi-bundling structure. I refer to this as the semi-bundling effect. There could be an overlap between the two effects, meaning some farmers may choose the employee pension plus employee health option due to both effects.

5.2 Estimating Equations

Assuming that the demand and cost curves are linear in prices, we estimate the demand and average cost curves for employee pension and employee health as follows.

$$
\begin{aligned}
D_i^p &= \alpha^p + \beta_p^p p_i^p + \beta_h^p p_i^h + \beta^p p_i^p p_i^h + \epsilon_i^p \\
c_i^p &= \gamma^p + \delta_p^p p_i^p + \delta_h^p p_i^h + \delta^p p_i^p p_i^h + u_i^p \\
D_i^h &= \alpha^h + \beta_p^h p_i^p + \beta_h^h p_i^h + \beta^h p_i^p p_i^h + \epsilon_i^h \\
c_i^h &= \gamma^h + \delta_p^h p_i^p + \delta_h^h p_i^h + \delta^h p_i^p p_i^h + u_i^h
\end{aligned}
$$

where, $D_i^p(D_i^h)$ is a dummy variable equal to 1 if farmer i chooses to transfer to the employee pension (employee health); $c_i^p(c_i^h)$ is the incremental cost to the government from covering farmer i under the employee pension (employee health) instead of the farmer pension (farmer health); and $p_i^p(p_i^h)$ denotes the incremental lump-sum payment that farmer i is required to pay to transfer to the employee pension (employee health). In all regressions, standard errors are adjusted to account for an arbitrary variance-covariance matrix within each village.

The demand equations are estimated on the entire sample whenever applicable, while the

(average) cost equations are estimated on the sample of farmers who (endogenously) chose to transfer.

Given p^h, rewrite:

$$
\begin{aligned}
D^p &= (\alpha^p + \beta_h^p p^h) + (\beta_p^p + \beta^p p^h)p^p = \eta_p^p + \gamma_p^p p^p \\
c^p &= (\gamma^p + \delta_h^p p^h) + (\delta_p^p + \delta^p p^h)p^p = \lambda_p^p + \zeta_p^p p^p \\
D^h &= (\alpha^h + \beta_h^h p^h) + (\beta_p^h + \beta^h p^h)p^p = \eta_p^h + \gamma_p^h p^p \\
c^h &= (\gamma^h + \delta_h^h p^h) + (\delta_p^h + \delta^h p^h)p^p = \lambda_p^h + \zeta_p^h p^p
\end{aligned}
$$

This allows us to derive the marginal cost of the employee pension with respect to the employee pension price, as well as the marginal cost of employee health with respect to the employee pension price:

$$
\begin{aligned}
\mathrm{MC}_p^p &= \frac{\partial \mathrm{TC}^p}{\partial D^p} = \frac{\partial(\mathrm{AC}^p \cdot D^p)}{\partial D^p} = \left(\frac{\partial D^p}{\partial p^p}\right)^{-1} \frac{\partial(\mathrm{AC}^p \cdot D^p)}{\partial p^p} \\
&= \frac{1}{\gamma_p^p}\left(\frac{\partial(\eta_p^p + \gamma_p^p p^p)(\lambda_p^p + \zeta_p^p p^p)}{\partial p^p}\right) = \frac{1}{\gamma_p^p}(\eta_p^p \zeta_p^p + \lambda_p^p \gamma_p^p + 2\gamma_p^p \zeta_p^p p^p) \\
&= \frac{\eta_p^p \zeta_p^p}{\gamma_p^p} + \lambda_p^p + 2\zeta_p^p p^p \\
\mathrm{MC}_p^h &= \frac{\partial \mathrm{TC}^h}{\partial D^h} = \frac{\partial(\mathrm{AC}^h \cdot D^h)}{\partial D^h} = \left(\frac{\partial D^h}{\partial p^p}\right)^{-1} \frac{\partial(\mathrm{AC}^h \cdot D^h)}{\partial p^p} \\
&= \frac{1}{\gamma_p^h}\left(\frac{\partial(\eta_p^h + \gamma_p^h p^p)(\lambda_p^h + \zeta_p^h p^p)}{\partial p^p}\right) = \frac{1}{\gamma_p^h}(\eta_p^h \zeta_p^h + \lambda_p^h \gamma_p^h + 2\gamma_p^h \zeta_p^h p^p) \\
&= \frac{\eta_p^h \zeta_p^h}{\gamma_p^h} + \lambda_p^h + 2\zeta_p^h p^p
\end{aligned}
$$

This enables us to plot the demand, average cost, and marginal cost curves for the upper two subgraphs in Figure 2.

Next, we identify the p^p that minimizes welfare loss for the given p^h. Repeating this process across different levels of p^h allows up to determine the global minimum welfare loss and the corresponding (p^p, p^h).

Similarly, given p^p, rewrite:

$$
\begin{aligned}
D^p &= (\alpha^p + \beta_p^p p^p) + (\beta_h^p + \beta^p p^p)p^h = \eta_h^p + \gamma_h^p p^h \\
c^p &= (\gamma^p + \delta_p^p p^p) + (\delta_h^p + \delta^p p^p)p^h = \lambda_h^p + \zeta_h^p p^h \\
D^h &= (\alpha^h + \beta_p^h p^p) + (\beta_h^h + \beta^h p^p)p^h = \eta_h^h + \gamma_h^h p^h \\
c^h &= (\gamma^h + \delta_p^h p^p) + (\delta_h^h + \delta^h p^p)p^h = \lambda_h^h + \zeta_h^h p^h
\end{aligned}
$$

This allows us to derive the marginal cost of the employee pension with respect to the employee health price, as well as the marginal cost of employee health with respect to the employee health price:

$$
\begin{aligned}
\mathrm{MC}_h^p &= \frac{\partial \mathrm{TC}^p}{\partial D^p} = \frac{\partial(\mathrm{AC}^p \cdot D^p)}{\partial D^p} = \left(\frac{\partial D^p}{\partial p^h}\right)^{-1} \frac{\partial(\mathrm{AC}^p \cdot D^p)}{\partial p^h} \\
&= \frac{1}{\gamma_h^p}\left(\frac{\partial(\eta_h^p + \gamma_h^p p^h)(\lambda_h^p + \zeta_h^p p^h)}{\partial p^h}\right) = \frac{1}{\gamma_h^p}(\eta_h^p \zeta_h^p + \lambda_h^p \gamma_h^p + 2\gamma_h^p \zeta_h^p p^h) \\
&= \frac{\eta_h^p \zeta_h^p}{\gamma_h^p} + \lambda_h^p + 2\zeta_h^p p^h \\
\mathrm{MC}_h^h &= \frac{\partial \mathrm{TC}^h}{\partial D^h} = \frac{\partial(\mathrm{AC}^h \cdot D^h)}{\partial D^h} = \left(\frac{\partial D^h}{\partial p^h}\right)^{-1} \frac{\partial(\mathrm{AC}^h \cdot D^h)}{\partial p^h} \\
&= \frac{1}{\gamma_h^h}\left(\frac{\partial(\eta_h^h + \gamma_h^h p^h)(\lambda_h^h + \zeta_h^h p^h)}{\partial p^h}\right) = \frac{1}{\gamma_h^h}(\eta_h^h \zeta_h^h + \lambda_h^h \gamma_h^h + 2\gamma_h^h \zeta_h^h p^h) \\
&= \frac{\eta_h^h \zeta_h^h}{\gamma_h^h} + \lambda_h^h + 2\zeta_h^h p^h
\end{aligned}
$$

This enables us to plot the demand, average cost, and marginal cost curves for the lower two subgraphs in Figure 2.

Next, we identify the p^h that minimizes welfare loss for the given p^p. Repeating this process across different levels of p^p allows up to determine the global minimum welfare loss and the corresponding (p^p, p^h).

5.3 Identification Strategy

To perform the welfare analysis described above, we need to estimate the demand and cost curves for the employee pension and employee health. A key challenge is identifying exogenous variation in their prices. Fortunately, the prices faced by farmers are exogenously determined by the government; however, there are important caveats when using these prices as explanatory variables.

The employee pension price faced by farmers is determined by several factors, including the contribution base, the contribution base rate, the contribution rate, the number of years they have worked, and their age. Payments made under the farmer pension scheme are converted into six years of participation in the employee pension program. To meet the 15-year minimum participation requirement, individuals must make an additional lump-sum payment equivalent to nine years of contributions if they have never worked. For example, as shown in Table 1 (taking the period from July 2019 to April 2020), the annual employee pension payment was determined using the 2018 average provincial wage (with a contribution base of 66,432 yuan), multiplied by the contribution base rate (100%) and the contribution rate (18%). This resulted in an annual payment of 12,000 yuan, totaling 108,000 yuan over nine years. The contribution base is adjusted every July, and notably, the contribution base rate increased from 80% to 100% in July 2017. Furthermore, the lump-sum payment is calculated as nine minus the number of years farmers have worked, and it is adjusted for age—each year that a farmer exceeds the age of 60 reduces the lump-sum payment for the employee pension by 5%, up to a maximum discount of 50%.

Because farmers' employee pension payments depend on their work histories, different work histories lead to differences in pension benefits. This is due to the fact that when farmers contribute to the employee pension during their employment, their contribution base is based on their own wages rather than the previous year's average city or provincial wage, and their contribution rate is 8%[4] rather than 18%. As a result, employee pension benefits vary among farmers. To account for these differences, we propose using the cost per net present value (NPV) benefit as our explanatory variable.

$$\text{Cost per NPV Benefit} = \frac{\text{Lump Sum Pension Payment}}{\sum_{t=1}^{T} \frac{1}{(1+r)^t} \text{Annual Pension Benefit}}$$

Where $T =$ remaining life expectancy at retirement age.

This measure is computed as the lump-sum payment divided by the net present value of the farmer's pension benefits, calculated under the assumption that the farmer dies at the average remaining life expectancy at their retirement age. This metric not only accounts for differences in pension benefits but also incorporates information such as retirement age and gender.

The employee health price faced by farmers is determined by several factors, including the contribution base, the contribution base rate, the contribution rate, and the number of

[4]The employer contribution rate is 14%.

years they have worked.[5] Payments made under the farmer pension scheme are converted into ten years of participation in the employee health program. To satisfy the 20-year minimum participation requirement, individuals must make an additional lump-sum payment equivalent to ten years of contributions if they have never worked. For example, as shown in Table 2 (taking the period from July 2019 to April 2020), the annual employee health payment was calculated using the 2018 average city wage (with a contribution base of 66,229 yuan), multiplied by the contribution base rate (100%) and the contribution rate (5%). This resulted in an annual payment of 3,312 yuan, amounting to 33,120 yuan over ten years. The contribution base is adjusted every July; notably, the contribution base rate increased from 80% to 100% in July 2019, while the contribution rate was reduced from 7% to 5%. Furthermore, the lump-sum payment is computed as ten minus the number of years farmers have worked.

Although farmers' employee health payments depend on their work histories, different work histories yield the same health benefits. When farmers contribute to employee health during employment, their contribution base is based on their own wages rather than on the previous year's average city or provincial wage, and their contribution rate is 2%[6] instead of 7% or 5%. Since the health benefit remains uniform across farmers who transfer to employee health, we do not need to introduce a new explanatory variable for the employee health price.

We plan to estimate the demand and cost curves for both semi-bundling and unbundling scenarios using data from before 2020 and from 2020. This process will allow us to test for adverse selection, conduct welfare analyses for each scenario, and determine which option yields lower welfare loss.

Additionally, we intend to develop a model for two reasons. First, to understand the determinants of the demand and cost curves—such as heterogeneity in patience, risk aversion, or income. Second, to analyze counterfactual policies and address policy questions, for example, whether full bundling is a better option, given its potential to pool risk and mitigate adverse selection.

6. Robustness Check

6.1 Moral Hazard

Could the difference in average retirement life expectancy between the two types of land-expropriated farmers be attributed to moral hazard?

In other contexts, such as car or health insurance, moral hazard manifests when individ-

[5] Age-based discounts apply only to the employee pension, not to the employee health plan.
[6] The employer contribution rate is 7%.

uals alter their behavior—for instance, driving more carelessly after obtaining car insurance or neglecting healthy habits after acquiring health insurance. In contrast, social pension insurance requires that beneficiaries reach a specified pensionable age before receiving benefits. Therefore, participants in social pension insurance generally hope to "encounter old-age risks" in order to receive benefits.

However, it is generally believed that longevity is desirable, and an individual would not deliberately exercise or eat healthily just because they participate in social pension insurance, in the hope of living longer and receiving more pension benefits (Abbring et al., 2003a,b). This paper believes that regardless of whether land-expropriated farmers choose to transfer to the employee insurance, they have a desire for healthy longevity. Even if land-expropriated farmers choose not to transfer, they will still pursue healthy longevity. Therefore, the difference in average retirement life expectancy between the two types of land-expropriated farmers should not be attributed to the fact that land-expropriated farmers who transferred become more focused on health care after the transfer.

Even if it were true that land-expropriated farmers who transferred become more focused on health care after the transfer, our Logit regression results using the medical expenditure from the year before transfer qualification indicate the presence of adverse selection, which perfectly aligns with the definition of adverse selection.

6.2 Advantageous Selection

Could the difference in average retirement life expectancy between the two types of land-expropriated farmers be due to Advantageous selection?

Hemenway (1990) first proposed the theory of Advantageous selection, suggesting that individuals with a high aversion to risk not only take more risk-avoidance measures but also have a greater demand for insurance products. Dachraoui et al. (2004) found that individuals with higher risk aversion spend more effort on risk protection when the probability of loss is less than 50%. Jullien et al. (1999) also argue that risk-averse individuals take more risk-avoidance measures. Empirical studies in the health insurance market (Finkelstein and McGarry, 2006), automobile insurance market (Hemenway, 1992; De Meza and Webb, 2001), and life insurance market (Cawley and Philipson, 1999) have all found evidence of Advantageous selection phenomenon.

During the lump-sum payment transfer process for land-expropriated farmers, some of them may not be in good health, but due to their high sensitivity to the risk of elderly poverty, they still choose lump-sum payment transfer instead of staying in the "land security" system. While such transferees may indeed exist, their presence would lower rather than increase the

average retirement life expectancy of land-expropriated farmers who choose lump-sum payment transfer.

Therefore, even if the phenomenon of advantageous selection exists, it does not negate the presence of adverse selection; rather, it may actually reinforce the possibility of adverse selection. This is because the transfer group may include some land-expropriated farmers who choose lump-sum payment transfer due to advantageous selection, and these individuals may have a longer average retirement life expectancy than non-transferees. If these advantageous selection transferees were excluded, the difference in life expectancy between the two groups of land-expropriated farmers would become even more pronounced.

In other words, in the context of pension insurance, advantageous selection means those with shorter lifespans who transfer, while in medical insurance, it means those in better health who are more likely to transfer rather than those in poorer health. This could be driven by extreme risk aversion. The existence of advantageous selection can offset adverse selection. However, we still observe adverse selection results, indicating that the degree of adverse selection is very strong.

6.3 Income Effect

Is the presence of adverse selection caused by health inequality of income inequality? If there are land-expropriated farmers who wish to transfer with lump-sum payment but cannot afford to do so due to insufficient income, and demographic studies have shown a positive correlation between income and average life expectancy (Preston, 1975; Deaton, 2006), then the observed difference in average retirement life expectancy between the two types of land-expropriated farmers could be attributed to income-related factors: lower-income individuals with shorter life expectancies are more likely to stay in BPSLF.

Take pension insurance as an example, the adverse selection phenomenon we see is because those with better health conditions are more likely to transfer. But this result could simply be driven by the fact that richer people have the money to pay the lump-sum payment and rich people happen to be the healthy ones. What we really want to see is that at the same income level, whether those with better health are more likely to transfer. This requires us to get income data and put it in the regression. We plan to use the sample of land-expropriated farmers worked between 1 and 8 years. Because they work for less than 9 years, they still need to make a lump-sum payment to transfer, also we could use their pension contribution data at work to back-tract their income. Though companies have the incentive to underreport employee's income to contribute less to the social pension, the pension contribution data could still recover the income information at some degree.

6.4 Liquidity Constraint

Liquidity constraint is slightly different from income effect. High income doesn't necessarily mean high liquidity. They may have very a lot of mortgage and car loan to pay.

In 2016, the Agricultural Bank of C City launched the "Harvest Pension Loan": land-expropriated farmers in C City who meet the lump-sum payment requirements for transferring to the employee pension and are under 70 years old can obtain loans of up to 50,000 yuan (credit loans for those under 65 years old and family guarantee loans for those over 65 years old) for paying the employee pension, with a maximum loan term of 5 years.

We plan to use a Regression Discontinuity design that compares individuals just below and just above the age of 70 to test whether this policy influences their transfer decision.

The regression result may not be significant because there are only less than 100 land-expropriated farmers used this loan.

7. Conclusion

This paper first examines whether the lump-sum transfer policy in City C from 2011 to 2020 has led to adverse selection.

Based on social pension microdata from City C in Zhejiang Province from 2011 to 2020, we constructed life tables for land-expropriated farmers who transferred to the employee pension and those who did not. The results indicate that the retirement-age life expectancy of male land-expropriated farmers who transferred is 6.52 years longer than those who did not transfer, while for female land-expropriated farmers, it is 7.84 years longer. This provides evidence of adverse selection in the transfer decision.

To address concerns of moral hazard, we conduct an additional test using medical expense data from the year before transfer qualification. The Logit regression analysis shows that for each additional 1,000 yuan in self-paid hospitalization expenses in the year before transfer qualification, the odds of transferring to the employee pension, compared to not transferring, decrease by 3.4%, significant at the 1% level. This suggests that healthier individuals are more likely to transfer to the employee pension, further supporting the presence of adverse selection.

For employee health insurance, the Logit regression analysis reveals that among those who transferred to the employee pension, each additional 1,000 yuan in hospitalization expenses in the year prior to transfer qualification increases the odds of transferring to employee health insurance by approximately 10.9%, significant at the 1% level. This indicates that individuals in worse health are more inclined to transfer to employee health insurance, providing further

evidence of adverse selection in health insurance decisions.

Furthermore, we exploit exogenous price variation set by the government to estimate demand, as well as average cost and marginal cost curves for both the employee pension and employee health.

The estimates of these curves enable us to test for adverse selection by assessing whether the marginal cost curve slopes downward with increasing quantities, indicating that individuals with the highest willingness to pay also have the highest expected costs.

We then extend classic insurance theory (Akerlof, 1970; Rothschild and Stiglitz, 1976; Stiglitz, 1977) from a single insurance market to a setting with two types of insurance (see Figures 1 and 2), quantify the welfare loss caused by adverse selection, and evaluate whether bundling pension and medical insurance mitigates adverse selection. Bundling may help mitigate adverse selection by pooling risk, as healthier individuals are more likely to transfer to the employee pension, while those in poorer health tend to transfer to employee health insurance.

Although Zhejiang Province's policy of land-expropriated farmers participating in employee basic old-age insurance through lump-sum payment has ceased, Zhejiang Province has accumulated 5 million land-expropriated farmers transferred to employee insurance. These land-expropriated farmers who transferred not only have shorter payment periods, lower payment bases, and smaller payment amounts but also have longer lifespans than regular insured employees. Regardless of the extent to which the difference in the average retirement life expectancy between the two types of land-expropriated farmers is caused by adverse selection, it can be confirmed that the transfer policy will have a significant negative impact on the long-term balance of the employee basic old-age insurance fund.

Based on the research findings of this paper, we make the following recommendations. First, promptly cease and prohibit the recurrence of selective "lump-sum" insurance participation policies targeting specific social groups. Second, for the lump-sum participation policies still in effect in other parts of the country—for example, for flexible workers—raise the payment threshold, including increasing the payment base and extending the payment period requirement, and set reasonable lump-sum participation treatment levels and payback periods. Third, local governments should use annual land transfer fees to appropriately increase the treatment levels of basic living security for land-expropriated farmers, narrowing the gap between the treatment levels of basic living security for land-expropriated farmers and employee basic old-age insurance.

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