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

Danli Shen, Zhejiang University

Xiang Zhang, Zhejiang University

Xiaoxin Zhang, University of Southern California

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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 both pension and medical insurance. We also extend classic information asymmetry insurance theory (Akerlof, 1970) from a single-insurance market to a setting with two types of insurance. By exploiting exogenous government-set price variation, we estimate demand as well as average and marginal cost curves for BPSE and BMIE. These curves allow us to quantify the welfare loss caused by adverse selection and evaluate whether bundling pension and medical insurance can mitigate adverse selection through risk pooling.

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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 both 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, and 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, contribution base rate, contribution rate, the number of years worked, and retirement 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 NPV of the farmer's total pension benefits, computed under the assumption that the farmer lives up to the average remaining life expectancy at their retirement age. This metric not only accounts for variations in pension benefits but also incorporates factors such as retirement age and gender.

Similarly, we propose using the cost per NPV benefit as the measure of the employee health price, calculated as the lump-sum payment divided by the NPV of the farmer's total reimbursed medical cost. The NPV is calculated under the assumption that the farmer lives up to the average remaining life expectancy at their retirement age, with the annual reimbursed medical cost averaged for that gender at each specific age. This metric incorporates information on retirement age and gender, so we do not need to control for them in the demand and cost estimation, ensuring that the resulting demand and cost curves apply generally to all individuals.

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.

We estimate the demand and cost curves for both semi-bundling and unbundling scenarios using data from before 2020 and from 2020. This process allows us to test for adverse selection by assessing whether the marginal cost curve slopes downward as quantity increases—indicating that individuals with the highest willingness to pay also face the highest expected costs. With these curves, we can conduct welfare analyses for both scenarios and determine whether semi-bundling yields lower welfare loss. Semi-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.

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.

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—pension and medical insurance—which are the two most important insurance types for the elderly. 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 in which both low- and high-coverage insurance prices are endogenous in a single insurance type, 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) studies the 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 the bundling of 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 the designated retirement age—60 for males and 50 for females—these farmers began receiving monthly benefits for life. At that time, participants were required to contribute 15,000 yuan, 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, slightly above the minimum living standard, and the reimbursement rate for farmer health expenses was approximately 50%.

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

Enrolling in the farmer pension automatically enrolls land-expropriated farmers in the farmer health. Their contributions are converted into ten years of participation in the employee health. 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.

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

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. 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.

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%

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.

Between December 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 in July 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.

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	-

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.

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.

Table 5: The Number of Land-Expropriated Farmers Who Had Not Transferred by April 2020

	Initial Group		Subsequent Group		Total	
Gender	Total	Met the Transfer Criteria	Total	Met the Transfer Criteria	Total	Met the Transfer Criteria
Male	7704	6523	7789	7280	15593	13803
Female	8836	8148	10192	9139	19028	17287
Total	16608	14671	17981	16419	34621	31090

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 paper uses micro-level social pension data from City C, covering 2011 to 2020. The dataset includes basic personal information such as gender, age, and village, as well as detailed pension records, including pension type, enrollment date, transfer date, retirement date, death date, and pension amount. Using this dataset, we compile life tables for individuals who transferred to the employee pension and those who did not.[1]

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).[2] This dataset includes basic personal information such as gender, age, and village, as well as detailed medical insurance records like insurance type, enrollment and transfer dates, various medical expenses, and disease diagnoses.

We use this dataset to test for adverse selection in both pension and medical insurance, estimate the demand and cost curves for employee pension and employee health, and conduct welfare analyses.

3.2 Summary Statistics

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

Table 6 presents summary statistics for the variables, grouped by whether individuals transferred to the employee pension. For both the initial and subsequent groups, prescribed dis-

[1] When a participant passes away, family members submit a death certificate, the participant's pension payments are terminated, and funeral allowances along with condolence payments are issued. Any remaining balance in the individual account is inherited by the participant's heirs. Because of the death certificate requirement, the recorded age at death is highly accurate.

[2] 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 6: 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.

ease expenses, hospitalizations, and social account expenses are significantly higher for non-transfers than for transfers. However, outpatient clinic expenses follow a different pattern: in the initial group, they are higher for transfers, whereas in the subsequent group, they are higher for non-transfers. Compared to prescribed disease expenses, hospitalizations, and social account expenses, outpatient clinic expenses are more likely to reflect minor illnesses.

Table 7 presents summary statistics for the variables, grouped by whether individuals transferred to employee health. The proportion of employee health transfers is relatively low, at 21.9% (16,320/74,645) among employee pension transferees and 2.1% (502/24,133) among non-employee pension transferees. There is no clear systematic pattern in medical expenses between those who transferred and those who did not. However, irrespective of employee pension transfer status, the average age of employee health transferees is lower than that of non-transferees, consistent with the idea that younger individuals may accrue greater long-

Table 7: 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.

term benefits under employee health insurance.

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-level data on the order of millions of individuals. As of April 2020, a total of 126,377 retired land-expropriated farmers in City C were covered by the employee pension, including 65,491 (51.82%) who transferred via lump-sum pay-

ments and 60,886 (48.18%) who had worked more than nine years and therefore did not need to make a lump-sum payment. When grouped by age, the number of individuals in each category decreases, resulting in notable fluctuations in age-specific mortality rates.[3] To address the relatively small sample size within each age group, we adopt a period life table approach, combining micro-level data from City C's social pension between 2011 and 2020 to produce more stable and accurate age-specific mortality rates.

In traditional life table construction, the numerator of the 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 equal half the sum of the population at the beginning and end of the year, i.e., the mid-year population. However, in an actual pension cohort, deaths may not be uniformly distributed, and new retirees may join the insured population every month. Therefore, the formula for the period age-specific mortality rate is as follows.

The numerator is the total number of deaths in a given age group from 2011 to 2020, obtained by summing the annual deaths in that age group. The denominator is the person-years for the same age group over the same period. Since beneficiaries receive monthly benefits for as long as they live, the person-years for a specific age group is the total number of months that beneficiaries in that age group received benefits from 2011 to 2020, divided by 12. This yields the person-years for the age group, from which the age-specific mortality rate can then be calculated.

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

Then, using the following formulas, we can successively compute 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 for each age group, ultimately yielding the average life expectancy e_x.

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

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 $e_x = T_x/l_x$

[3]During the initial phase of the policy transition, there was a three- to six-month interval between the application for lump-sum payments and the official record of the procedure, during which some applicants died and thus never became official beneficiaries.

Table 8: 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

We compile a 10-year simplified life table with five-year age intervals. Because our primary interest is in the average remaining life expectancy at retirement age, mortality data before that age does not affect the calculations. Consequently, the mortality rate is set to

zero for males under 60 and females under 50. As shown in Table 8, the average remaining life expectancy at retirement age for male land-expropriated farmers who transferred to the employee pension is 26.48 years.

Table 9: The Average Retirement Life Expectancy of Land-Expropriated Farmers

Gender (age)	Average retirement life expectancy (year)		Difference in Average retirement life expectancy
	Transferred	Non-Transferred	
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, among individuals who transferred to the employee pension, average retirement-age life expectancy is 25.89 years for males and 38.39 years for females. Since it takes only about five years to break even, the pension appears to be operating at a substantial loss—this pattern is similar for the farmer pension as well.

Second, for males, retirement-age life expectancy is 6.52 years longer among those who transferred than among those who did not, while for females it is 7.84 years longer. This finding suggests that individuals who transfer to the employee pension tend to live longer at retirement, indicating adverse selection in the transfer process.

Moral hazard is less of a concern in pension insurance, as everyone generally desires a long life. One might worry that higher pension benefits could improve longevity, but it is unlikely that receiving only a few hundred yuan more per month would extend life expectancy by seven years.

4.1.2 The Logit Regression

To address potential concerns regarding moral hazard and the treatment effects of higher pension benefits, we employ a logit model to regress the decision on transferring to the employee pension on medical expenses from the year prior to transfer qualification, as well as on gender and age, while controlling for village-by-year fixed effects. We do not need causality; a correlation is sufficient to test for adverse selection.

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

Where Y_i indicates whether farmer i transfers to the employee pension, and X_i includes outpatient clinic expenses, prescribed disease expenses, hospitalized expenses, and social account expenses from the year prior to transfer qualification, as well as male and age for farmer i. λ_{vt} represents village-by-year fixed effects, capturing characteristics that vary across village and year. For example, λ_{vt} accounts for the proportion of farmers transferred to the employee pension within a specific village at a given year, which may affect transfer decisions through transmission effects.

Table 10: 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

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

The fifth column of Table 10[4] shows the logit regression estimates for the full sample. Holding other factors constant, each additional thousand yuan in self-paid hospitalization expenses decreases the odds of transferring to the employee pension by 3.4% relative to not

[4]Due to time constraints, we have not yet updated the regression results to include village-by-year fixed effects, but plan to do so later.

transferring. Similarly, each additional thousand yuan in social account expenses reduces these odds by 1.9%, both significant at the 1% level.

Male land-expropriated farmers are 22.2% less likely to transfer to the employee pension than females, which aligns with the fact that women retire earlier and live longer on average. The odds ratio for life expectancy (in years) is 0.056, implying that each additional year of life expectancy raises the odds of transferring by 5.61%. In other words, younger individuals are more likely to transfer than older ones.

A probit regression yields similar results: self-paid hospitalization expenses and social account expenses both have significant negative effects on the decision to transfer.

Whether using logit or probit, self-paid hospitalization expenses, social account expenses, being male, and age all exert significant negative effects on the choice to transfer to employee insurance. This indicates that healthier individuals are more inclined to transfer, while those in poorer health remain in the farmer pension. In addition, women are more likely to transfer than men, and younger individuals show a higher propensity to transfer. Collectively, these findings support the presence of adverse selection in the pension 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 includes outpatient self-payment, prescribed disease expenses, hospitalization expenses, social account expenses, as well as indicators for male, age, and village-by-year fixed effects.

After estimating each individual's life expectancy, we compute the net present value (NPV) difference between transferring to the employee pension and remaining in the farmer pension for each person. We then calculate the average NPV difference for those who transferred and those who did not. We anticipate that the average NPV difference among the transferred group will be significantly higher than that of the non-transferred 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.

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

WhereX_{1i} represents the net present value difference for individual i, and λ_{vt} denotes village-by-year fixed effects. This specification captures relevant factors—such as gender, age, medical expenses, and lump-sum payment—allowing for a clearer interpretation of β. For instance, this allows us to specify that for every additional thousand yuan in net present value difference, the odds of a land-expropriated farmer transferring to the employee pension, compared to not transferring, increase by a certain percentage. [5]

4.2 The Basic Medical Insurance for Employees

4.2.1 The Logit Regression

We use a logit model to regress the decision on transferring to the employee health on medical expenses from the year before transfer qualification, along with indicators for male, and age, controlling for village-by-year fixed effects.

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

Where Y_i denotes whether individual i transfers to the employee health. X_i includes outpatient clinic expenses, prescribed disease expenses, hospitalization expenses, and social account expenses the year before employee health transfer qualification, as well as indicators for male and age. λ_{vt} represents village-by-year fixed effects, which capture characteristics vary across village and year.

We divide the sample into employee pension transferees and non-transferees because, before 2020, semi-bundling required individuals to join the employee pension before enrolling in employee health. In 2020, this semi-bundling requirement was lifted, allowing those who had not transferred to the employee pension to make a lump-sum payment directly to enroll in employee health.

The second column of Table 11 shows that among those who transferred to the employee pension, each additional thousand yuan in prescribed disease expenses increases the odds ratio of transferring to employee health by about 22.4%, significant at the 1% level. Similarly, each additional thousand yuan in hospitalization expenses raises the odds ratio by about

[5] We plan to run separate regressions for each year and then combine the data for a pooled regression.

10.9%, also significant at the 1% level. The regression coefficient for age is -0.103, indicating that each additional year of age reduces the odds of transferring by approximately 10.3%. In other words, younger individuals are more likely to transfer than older ones.

These findings suggest that individuals in poorer health are more likely to transfer to employee health, while healthier individuals tend to remain in farmer health, indicating adverse selection in the transfer process for employee health.

Table 11: 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 hospitalization expenses are not significant for individuals who did not transfer to the employee pension. To explain this, we propose four hypotheses.

First, in this setting, medical insurance requires a one-time payment at retirement and covers the rest of one's life. Consequently, health status at retirement might not strongly affect the transfer decision, since even those who are healthy at retirement could become very ill later and incur substantial medical costs. However, if this hypothesis fully explained the results, we would also see insignificance in the first two columns, so it does not provide a

complete explanation.

Second, land-expropriated farmers who did not transfer to the employee pension may be very poor. Their decision could be influenced not only by health status but also by income constraints. Higher-income individuals typically have better health and can afford the lump-sum transfer, potentially offsetting the adverse selection effect in which sicker individuals are more likely to transfer. The extent of this offset depends on how income variation correlates with health in the sample. We can test this hypothesis once we have the income data (derived from farmers' employment records). Details will be provided in the robustness checks.

Third, farmers who did not transfer to the employee pension might have stronger bequest motives. They may choose not to seek expensive treatment for severe illnesses, preferring to save money for their offspring. This could make them even less likely to enroll in employee health, leading to insignificant coefficients for adverse selection. We cannot fully test this hypothesis.

Last, farmers whose land was expropriated before 2020 and who did not join the employee pension became eligible to join employee health directly in 2020. However, doing so required an additional decision—whether to enroll in employee health—and, if so, a trip to the social security department to make the lump-sum payment. These switching costs could reduce the likelihood of enrolling in employee health, again leading to insignificant coefficients for 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 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.

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

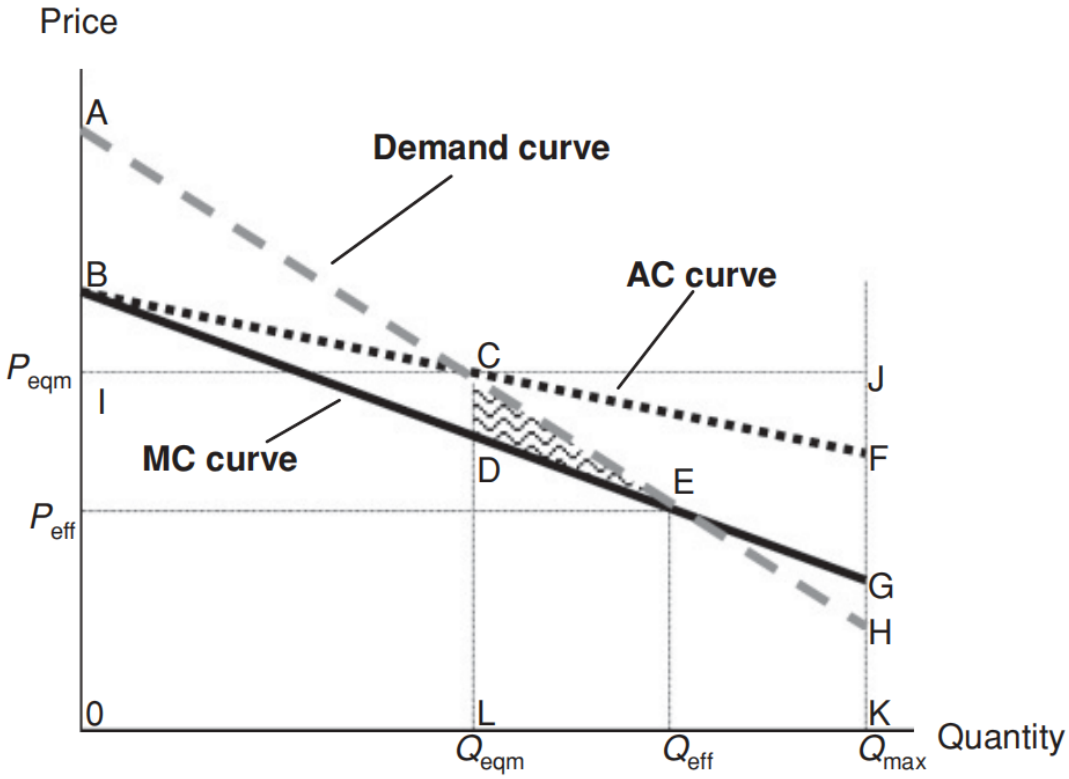
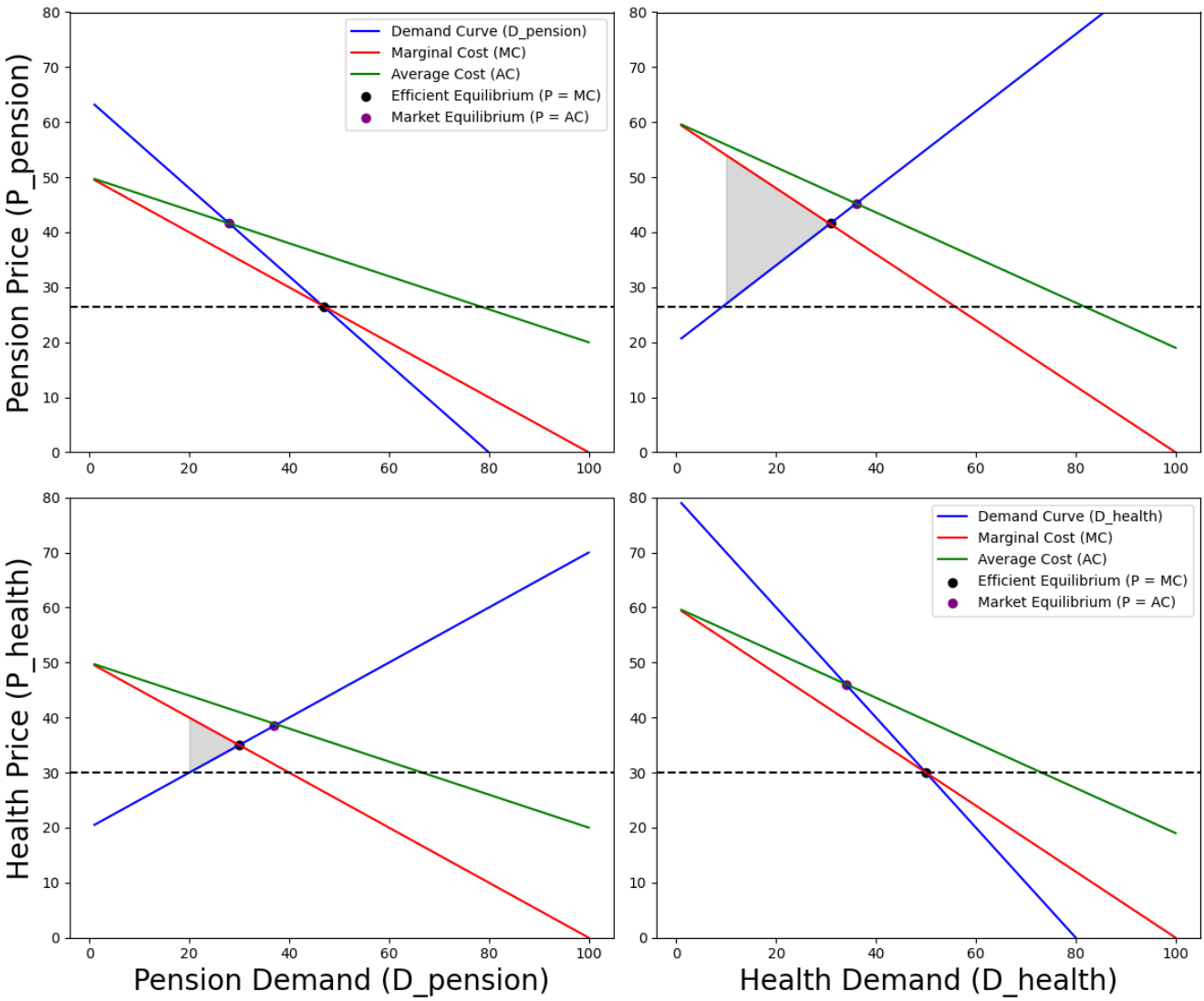


FIGURE I
Efficiency Cost of Adverse Selection

First, consider the upper two subgraphs in Figure 2. For a fixed health price, we examine the pension and health demand and cost curves as functions of the pension price. By identifying the efficient points, we find that the efficient pension price for pension insurance may not necessarily coincide with the efficient pension price for health insurance. To minimize total welfare loss (the sum of pension and health welfare losses), we select the pension price that produces the lowest combined welfare loss. We then repeat this procedure at different health price levels, each time generating new demand and cost curves and identifying the pension price that yields the lowest combined welfare loss. Ultimately, we determine the global minimum total welfare loss across all health price levels.

Next, consider the lower two subgraphs in Figure 2. In a similar fashion, for a fixed pension price, we analyze how the pension and health demand and cost curves vary with the health price. The efficient health price for pension insurance may differ from the efficient health price for health insurance. Again, we identify the health price that minimizes the total welfare loss. We then repeat this process at different pension price levels, each time generating new

Figure 2: Welfare Analysis of Employee Pension and Employee Health



demand and cost curves and identifying the health price that yields the lowest combined welfare loss. Ultimately, we determine the global minimum total welfare loss across all pension price levels.

Whichever route we take—starting from the pension price or the health price—the global solution that minimizes total welfare loss will be the same.

The demand and cost of the employee health depend on the price of employee pension due to the complementarity (or substitution) effect [6]. The demand and cost of the employee

[6] Employee pension and employee health can be either complements or substitutes. For illustrative purposes,

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 12.

The numbers are derived from Table 5: 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 12: 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 20% 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 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.

I will assume they are complements.

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 us 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 us 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 average 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 retirement 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 retirement 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%[7] rather than 18%. As a result, employee pension benefits vary among farmers. To account for these differences, we propose using the price per incremental net present value (NPV) benefit as our explanatory variable, which is computed as

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

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

This measure is calculated by dividing the lump-sum employee pension payment by the NPV of the farmer's total incremental pension benefits (employee pension versus farmer pension), assuming the farmer lives to the average remaining life expectancy at retirement age across all land-expropriated farmers in both employee and farmer pensions. It not only captures differences in pension benefits arising from work history but also incorporates 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 years they have worked.[8] 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),

[7] The employer contribution rate is 14%.

[8] Age-based discounts apply only to the employee pension, not to the employee health.

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.

Different work histories yield the same health benefit rules.[9] However, because the employee health coverage extends for the remainder of an individual's life after retirement, the potential average health benefit depends on both gender and retirement age. We propose using the price per decremental net present value (NPV) cost as our explanatory variable, which is computed as

$$\text{Price per Decremental NPV Cost} = \frac{\text{Lump-Sum Employee Health Payment}}{\sum_{t=1}^{T} \frac{1}{(1+r)^t} \text{Annual Decremental Self-Paid Medical Cost}}$$

Where $T =$ average remaining life expectancy at retirement age, and the annual decremental self-paid medical cost is the difference between employee health and farmer health costs, averaged by gender at each specific age.

In other words, we calculate this measure by dividing the lump-sum employee health payment by the NPV of the farmer's total decremental self-paid medical cost (employee health vs. farmer health), assuming the farmer lives to the average remaining life expectancy at retirement. The annual decremental cost is averaged by age and gender across all land-expropriated farmers in both employee and farmer health.[10] Because this metric already incorporates retirement age and gender, we do not need to control for these factors in the demand and cost estimation, ensuring that the resulting demand and cost curves are broadly applicable to all individuals.

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 ex-

[9]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% (instead of 7% or 5%). The employer contribution rate is 7%.

[10]We compute each individual's hypothetical medical costs under the alternative insurance based on their current medical costs and the relevant employee or farmer health policies.

ample, whether full bundling is a better option, given its potential to pool risk and mitigate adverse selection.

6. Robustness Check

6.1 Moral Hazard and Treatment Effect

Pension insurance requires beneficiaries to reach a specified age before receiving benefits. It is generally assumed that individuals desire a longer life and would not deliberately adopt healthier behaviors solely to prolong their lifespan and collect more pension benefits (Abbring et al., 2003a,b). Therefore, moral hazard is less of a concern in pension insurance. Still, a higher pension benefit from transferring to the employee pension could theoretically affect longevity, although it is unlikely to account for a seven-year difference.

By contrast, moral hazard in health insurance can arise when individuals alter their behavior—such as neglecting healthy habits—after obtaining coverage.

Even if moral hazard and treatment effects exist, our logit regression results, which use medical expenditure data from the year before transfer qualification, isolate the presence of adverse selection, aligning closely with its standard definition.

6.2 Advantageous Selection

Hemenway (1990) introduced the theory of advantageous selection, proposing that more risk-averse individuals not only take additional risk-avoidance measures but also have higher insurance demand. Subsequent studies (Dachraoui et al., 2004; Jullien et al., 1999) confirm that risk-averse individuals invest more effort in risk protection. Empirical evidence from health (Finkelstein and McGarry, 2006), automobile (Hemenway, 1992; De Meza and Webb, 2001), and life insurance markets (Cawley and Philipson, 1999) supports the existence of advantageous selection.

In the pension transfer process, some land-expropriated farmers in poor health may still choose to transfer to the employee pension because they are highly sensitive to the risk of poverty in old age. Meanwhile, in the health transfer process, certain farmers in good health may opt for employee health due to their strong concern about severe illnesses. Such advantageous selection can offset adverse selection. Nonetheless, we continue to observe evidence of adverse selection, indicating that its magnitude is substantial.

6.3 Income Effect

For pension insurance, the apparent adverse selection—where healthier individuals are more likely to transfer—could be explained by richer individuals having the means to pay the lump sum and also being healthier. Ideally, we want to compare individuals at the same income level to see whether healthier ones are more inclined to transfer. This requires incorporating income data into our regressions. We plan to focus on land-expropriated farmers who worked between 1 and 8 years. Because they worked fewer than 9 years, they still need to make a lump-sum payment, and we can use their pension contribution data from employment to approximate their income. Although companies have an incentive to underreport wages to reduce pension contributions, these data should still provide a reasonable proxy for income.

6.4 Liquidity Constraint

Liquidity constraints differ from income effects. High income does not necessarily imply high liquidity if individuals are burdened by mortgage or car loans.

In 2016, the Agricultural Bank of C City introduced the Harvest Pension Loan. Land-expropriated farmers in C City who qualify for a lump-sum payment to transfer to the employee pension and are under 70 years old can borrow up to 50,000 yuan to cover the employee pension premium.[11] The loan has a maximum term of five years. We plan to use a regression discontinuity design, comparing individuals just below and just above age 70, to test whether this policy affects their transfer decisions. However, the regression result may not be significant, as fewer than 100 land-expropriated farmers have used this loan.

7. Conclusion

This paper first demonstrates that City C's transfer policy from 2011 to 2020 has led to adverse selection. We extend classic information asymmetry insurance theory (Akerlof, 1970) from a single-insurance market to a setting with two types of insurance. By exploiting exogenous government-set price variation, we estimate demand as well as average and marginal cost curves for both the employee pension and employee health. These curves allow us to test for adverse selection by examining whether the marginal cost curve slopes downward as quantity increases. We then quantify the welfare loss caused by adverse selection and evaluate whether bundling pension and medical insurance can mitigate it through risk pooling.

[11] Those under 65 receive a credit loan, while those over 65 must provide a family guarantee.

Although the transfer policy has ended, Zhejiang Province now has five million land-expropriated farmers who transferred to employee insurance. These farmers pay lower amounts but incur higher costs than regular insured employees, posing a significant challenge to the long-term balance of the employee insurance fund.

We offer three recommendations. First, promptly discontinue and prohibit further selective lump-sum insurance participation policies targeting specific social groups. Second, for any remaining lump-sum policies in other regions—such as those for flexible workers—increase the payment threshold (for instance, raising the contribution base and extending the required payment period) and set reasonable lump-sum participation benefits and repayment periods. Third, local governments should allocate annual land transfer fees to appropriately raise social security benefits for land-expropriated farmers, thereby narrowing the gap between their benefits and those of employee insurance participants.

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