Reconciling the Insurance-Wealth Puzzle: Evidence from Chinese Households

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ABSTRACT

Recent empirical studies document a positive relationship between household wealth level and insurance demand, contrary to classic theoretical predictions and known in the literature as the "Insurance-Wealth Puzzle". To reconcile evidence and theory, we present a general life-cycle model showing wealth affects life insurance ownership (extensive margin) and coverage (intensive margins) differently, with both effects varying by household's bequest motive intensity. We support our predictions with nationally representative Chinese household data. Employing a two-stage sample selection framework and leveraging family structure to identify variations in bequest motive intensity, we find that wealthier households are more likely to own insurance but tend to have smaller coverage size.

JEL classification: G51, G52, D15.

Keywords: Household Finance, Life Insurance, Wealth, Bequest Motive

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Over the past decade, global insurance premiums have accounted for 7% of the world's gross domestic product (Swiss Re Institute (2024)). Beyond this macroeconomic significance of the insurance market lies a fundamental microeconomic question: Why do some households purchase large amounts of insurance while some others remain uninsured?

Classic frameworks of household insurance demand (Mossin (1968), Mayers and Smith (1983) and Lewis (1989)) and recent theoretical models (Gollier (2003), Davidoff (2010), Koijen, Van Nieuwerburgh, and Yogo (2016)) predict a negative relationship between household wealth level and demand for life and non-life insurance. In the canonical benchmark, insurance and self-insurance through wealth accumulation are substitutes: wealthier households optimally purchase less insurance to avoid frictions in the insurance market such as transaction and monitoring costs, since they can take losses directly with their wealth.

On the other hand, recent empirical studies document a positive relationship between household wealth level and insurance coverage size (for car insurance (Armantier, Foncel, and Treich (2023)) and term life insurance (Gropper and Kuhnen (2025))). These findings remain robust across a wide range of controls, including household characteristics and related frictions, which challenge the theoretical prediction of a negative insurance-wealth relationship. The literature refers to this divergence between theory and evidence as the "Insurance-Wealth Puzzle".

In this paper, we provide the first unified framework to reconcile this puzzle. We focus on term life insurance because it provides an ideal laboratory to identify the structural mechanisms of household choice. As a pure risk-transfer contract with no savings or investment components, term life insurance allows for a clean analysis of the insurance-wealth relationship. We start with a life-cycle model with minimalistic and general assumptions regarding household preferences to ensure that the model implications do not rely on specific utility functional forms or risk preferences. We show that the relationship between household wealth level and insurance demand is non-monotonic and endogenously determined by the intensity of the household's bequest motive. Specifically, the likelihood of insurance ownership (the extensive margin of insurance demand) and the chosen coverage size (the intensive margin) vary with the bequest motive intensity

differently. Depending on the degree of this intensity, wealth level can be positively or negatively associated with insurance demand across both margins.

To illustrate our model mechanism, we describe two possible scenarios based on how the intensity of the bequest motive interacts with the household's ability to self-insure. In the first scenario, when the bequest motive is relatively weak, households derive little utility from leaving assets behind. At low wealth levels, these households prioritize savings over insurance. As they become richer, the marginal gain derived from savings decreases, increasing the relative utility provided by insurance. As a result, both the likelihood of owning an insurance policy and the chosen coverage size tend to rise with the wealth level. In the second scenario, when the bequest motive intensity is relatively high, poor households have a stronger desire to guarantee a bequest since they have insufficient savings otherwise. As these households accumulate wealth, their savings grow and they can rely more on their own assets and less on insurance to fund their bequests. The self-insurance effect becomes stronger as these households become richer, resulting in lower demand for insurance at both margins.

However, testing these theoretical implications empirically faces two distinct challenges. First, although our model implies that the wealth effect on both margins changes sign based on the intensity of the bequest motive, this intensity is a latent variable that is not directly observable in the data. Besides, we show that the threshold of the bequest motive intensity that flips the sign of the wealth effect for the insurance ownership decision is distinct from the threshold that changes the sign for the chosen coverage size. Because these thresholds do not align, estimating the wealth effect on the coverage decision requires correction for sample selection bias.

We address both empirical identification challenges by exploiting the institutional and socio-cultural setting of China. We employ a rich set of household panel data from the China Health and Retirement Longitudinal Study (CHARLS). CHARLS is a nationally representative panel dataset that has detailed demographics, assets, and debt data at the individual- and household-level. It also contains information about respondents' insurance profile, which is not available in other surveys or representative datasets in China. Our sample consists of surveyed adults aged 45–70, covering three survey waves (year

2013, 2015, and 2018) and yielding over 20,000 household-year observations. This setting is highly advantageous because life insurance in China is neither government-mandated nor a standard employment benefit for our sampled respondents during our sample period, ensuring that participation and coverage choices reflect household optimization.

To deal with the unobservability of the bequest motive intensity, prior studies have relied on binary proxies such as marital status or the presence of children (Hurd (1987), Bernheim (1991), Brown (2001), and Inkmann, Lopes, and Michaelides (2011)), or survey-based measures of subjective bequest probabilities (Hurd and Smith (1999) and Inkmann and Michaelides (2012)). However, these proxies suffer from limitations such as measurement error, collinearity with wealth, weak cross-sectional comparability, and scarce availability in large datasets. In our paper, we exploit cross-sectional variations in family structure. Specifically, we measure the household son ratio, defined as the number of sons divided by the total number of children of the survey respondent. In the context of China, a higher son ratio increases the demand for household savings through a stronger competitive saving motive in the housing and marriage markets, as social norms require families with sons to bear greater financial obligations for marriage and home purchases (Wei and Zhang (2011)). In addition, having sons reduces the need for formal life insurance because sons are expected to provide intergenerational old age support, a traditional norm known in Chinese as "yang er fang lao", or "raising sons for old age support", thereby functioning as an informal insurance substitute (Guo and Zhang (2020)). These dual forces increase the valuation of survival-state wealth and crowd out the necessity for formal death-state transfers, thereby lowering the bequest motive intensity. Furthermore, institutional factors such as the "One-Child Policy" and restrictions on prenatal gender selection in China help address concerns that gender composition is plausibly correlated with household wealth level.

For empirical specification, we employ a two-stage sample selection model to the household data to address the potential sample selection bias and capture the two-stage decision-making process of insurance demand. Our empirical estimation finds strong evidence of selection bias in the Chinese household data, justifying the necessity to estimate the insurance demand at two margins separately. After correcting this bias, we find that

household wealth is statistically significant but negatively associated with the term life insurance coverage size conditional on insurance ownership, while it is significantly and positively associated with the likelihood of insurance ownership. These findings underscore the importance of distinguishing between the two margins of insurance demand and suggest that factors beyond wealth may be critical in determining the coverage limit.

Our empirical findings of wealth level being positively associated with term life insurance ownership and negatively associated with the coverage size support the high-bequest motive intensity case among Chinese households. In contrast, existing empirical studies, most of which focus on U.S. or European samples, find a positive relationship between wealth and insurance at both the extensive and intensive margins. These findings likely correspond to our model's low-bequest motive intensity scenario, where bequest motives are present but not sufficiently strong to curb wealthier households' demand for larger coverage sizes. It is possible that cultural differences in the bequest motive produce distinct insurance-wealth patterns that are fully consistent with our theoretical framework. We also find that our measure of son ratio, a proxy of the inverse of the bequest motive intensity, is negatively associated with both policy ownership and coverage limits, consistent with our model predictions. Our results remain consistent across robustness checks, which include a series of tests with a wide range of control variables identified in the literature, such as insurance contract pricing, risk preference, education level, liquidity, debt level, occupational status, and physical and mental health conditions.

Related literature. The relationship between household wealth level and insurance demand remains relatively understudied in household finance, largely due to limited availability of granular and representative data. Recent survey articles (Gomes, Haliassos, and Ramadorai (2021) and Koijen and Yogo (2022)) call for more detailed micro-level evidence to clarify how wealth shapes the demand for insurance across different policy types, and what mechanisms, such as bequest motives, drive this demand.

Early empirical efforts to study the life insurance-wealth relationship, or relatedly the life insurance-income relationship, have largely relied on high-level survey data in the U.S. and focus on the intensive margin. Pioneering work by Fortune (1973) and Showers and Shotick (1994) used pre-1980s survey data to show that higher-income households

spend more on life insurance. Eisenhauer and Halek (1999) find that wealthier households purchase more life insurance. More recently, Fang and Kung (2021) use the Health and Retirement Survey (HRS) to show that higher-income individuals are more likely to own and retain life insurance, but their analysis does not explicitly account for the possibility that wealth itself might shape insurance demand beyond income effects.

Our work contributes to the new strand of empirical work seeking to disentangle insurance demand along the extensive and intensive margins. Our paper is closely related to the recent paper by Gropper and Kuhnen (2025). They exploit granular administrative data of U.S. households provided by a financial institution to investigate the determinants of term life insurance coverage, thereby providing fresh empirical insights. Another related study by Armantier, Foncel, and Treich (2023) examines the effect of wealth on auto insurance decisions using the U.S. Survey of Consumer Expectations (SCE) and administrative records from a French bank. Consistent with other studies, they find that wealthier individuals generally hold larger insurance coverage in both the U.S. and French samples, after controlling for risk and time preferences, objective and subjective risks, and financial literacy. They observe that the relationship turns negative while accounting for behavioral factors such as regret avoidance and nonperformance risk[1], suggesting that the empirical evidence regarding the insurance-wealth relationship remains inconclusive.

Our work also speaks to a longstanding line of inquiry on how bequest motives shape household financial choices. Early research in this area has analyzed the extent to which household bequest motives drive wealth accumulation and savings, often by contrasting households with and without children (Kotlikoff and Summers (1981), Hurd (1987), Hurd (1989) and Modigliani (1988)). More recent studies incorporate insurance and annuity markets to measure the strength of bequest motives (Bernheim (1991), Brown (2001), Inkmann, Lopes, and Michaelides (2011) and Inkmann and Michaelides (2012)), highlighting that life insurance in particular serves as a potential vehicle to fulfill bequest intentions. For instance, Inkmann and Michaelides (2012) and Koijen, Van Nieuwerburgh, and Yogo (2016) find that households with stronger bequest motives have higher

[1]Regret avoidance refers to the negative emotion of feeling regret from under-insuring and over-insuring, and nonperformance risk captures the risk that the insurance company will not pay a claim in full and in time.

demand for life insurance. Our contribution to these studies is twofold. First, we propose the household son ratio as a new proxy for the inverse of bequest motive intensity that is plausibly unrelated to wealth level. This proxy is particularly salient in the Chinese context, where cultural norms and gender imbalances in economic opportunities strongly influence parental preferences and financial decisions (Wei and Zhang (2011)). Second, we provide empirical evidence that bequest motive intensity are likely to be positively associated with life insurance demand at both the extensive and intensive margins.

The rest of the paper is organized as follows. Section 1 presents the general life-cycle model from which we derive our empirical strategy. Section 2 outlines our econometric model and empirical specifications. Section 3 introduces the data sample. Section 4 reports our main results, followed by a battery of robustness tests reported in Section 5. We discuss the implications and limitations of our results in Section 6. Section 7 concludes.

I. A General Model of Life Insurance Demand

In this section, we develop a structural model to characterize household life insurance decisions. Our primary objective is to determine the sign of the wealth effect on insurance demand across both the extensive and intensive margins, and to demonstrate how these signs are governed by the interplay between wealth levels and bequest motive intensity.

A. Model Framework

We follow the household finance literature by modeling household preferences within a dynamic life-cycle framework that incorporates a bequest motive.[2] The household maximizes lifetime utility by making sequential decisions regarding consumption and life insurance coverage. We assume the household value function V_t follows a recursive

[2]Following De Nardi et al. (2025), our choice of the bequest motive specification is driven by both tractability and flexibility, given the lack of analytical consensus regarding the underlying drivers of bequests. Consistent with our narrative, we focus on dynastic considerations. However, our functional form is sufficiently general to encompass spouse-related, strategic, or "warm-glow" motives. Full derivation details are provided in Appendix A.

structure in a discrete-time setting:

$$V_t = u(C_t) + \beta\Big\{ \phi_{t+1}\, \mathbb{E}_t(V_{t+1}) + (1-\phi_{t+1})\, \theta_t(\zeta_t)\, \mathbb{E}_t\big[\, u(W_{t+1} + I_t B_t)\,\big] \Big\}, \tag{1}$$

where $C_t > 0$ is the consumption level chosen by the household in period t, and the utility function $u(\cdot)$ is strictly increasing, strictly concave, and twice continuously differentiable, with a constant discount factor $\beta \in (0,1)$. This specification of $u(\cdot)$ is deliberately left general so that the comparative statics results do not rely on a particular functional form.

Following the literature, we model the bequest motive as an intensity variable, $\theta_t \geq 0$, which is independent of wealth level and non-household specific conditions, thus allowing us to isolate wealth or investment return driven changes in insurance demand from those operating through the bequest motive.[3] Although the bequest motive intensity θ_t is fundamentally unobservable, institutional and cultural constraints allow us to map this preference to observable household characteristics. Specifically, we treat θ_t as a monotonic function of an observable household characteristic, ζ_t: for any two otherwise identical households, a difference in their observable trait ζ_t allows for a comparative ranking of their respective bequest motive intensity θ_t. We also interpret $\theta_t(\zeta_t)$ not merely as a measure of altruistic affection, but as the relative weight the household assigns to death-state transfers compared to survival-state wealth preservation (i.e., savings). In line with the literature, we continue to refer to this weight as the bequest motive intensity. We elaborate on assumptions related to bequest motive in Section 1.2.

As in typical life-cycle models, we denote $\phi_{t+1} \in (0,1)$ as the household's survival probability from period t to $t+1$, which is assumed to be known at time t and independent of wealth and choice variables for tractability. Household wealth, W_t, is measured at the beginning of period t and follows:

$$W_{t+1} = S_t R_{t+1} = \Big[\, W_t - C_t - p_t\, I_t\, B_t \,\Big]\, R_{t+1}, \tag{2}$$

[3] We model the bequest motive intensity in a parsimonious form as in Cocco, Gomes, and Maenhout (2005), Inkmann, Lopes, and Michaelides (2011), Inkmann and Michaelides (2012), Yogo (2016) and Koijen, Van Nieuwerburgh, and Yogo (2016). Other approaches (e.g. De Nardi (2004), Kopczuk and Lupton (2007), Lockwood (2012)) focus on other or multiple dimensions of bequest motive which are less relevant in our set up, such as the degree of how household considers bequests are luxury, or assume the utility from bequeathing is a function increasing in wealth.

where S_t denotes net household savings, and the gross return on savings, $R_{t+1} > 0$, is stochastic and assumed to be independent of insurance and survival outcomes. The variable $I_t \in \{0, 1\}$ is an indicator for life insurance participation, and $B_t > 0$ represents the insurance benefit level (i.e., coverage amount) chosen at the beginning of period t, conditional on $I_t = 1$. The per-unit insurance premium $p_t > 0$ reflects mortality risk and may include a bounded loading (representing the insurer's markup over the actuarially fair premium) $0 \leq \ell_t \leq \bar{\ell}$, such that $p_t \, \mathbb{E}_t[R_{t+1}] = (1 - \phi_{t+1})(1 + \ell_t)$.[4]

B. Bequest Motive and Household Characteristics

Under our structural interpretation, the bequest motive intensity $\theta_t(\zeta_t)$ reflects two trade-offs. First, it accounts for the opportunity cost of savings. For households facing stronger saving needs (for example, due to a higher son-ratio by Wei and Zhang (2011)), the weight assigned to the bequest is lower, reflecting a relatively higher valuation of survival-state wealth. Second, the intensity variable incorporates the presence of informal life insurance substitutes. For instance, certain family structure conditions in the East Asian context, such as the presence of sons, tend to provide stronger "indirect insurance" via old-age support or intergenerational risk-sharing (e.g. Guo and Zhang (2020)), thereby reducing the necessity for formal financial transfers in the death state. Consequently, measures of observable family structure conditions can be mapped to the latent bequest motive intensity to allows us to identify how unobservable preferences interact with wealth levels to govern life insurance demand at both the intensive and extensive margins.

Given wealth level W_t at the beginning of time t, the household maximizes its value function V_t by jointly choosing consumption level C_t, the insurance ownership decision I_t, and, conditional on ownership, the coverage level B_t. Given the discrete nature of I_t and that the saving return R_{t+1} is independent of insurance and survival outcomes, the household problem can be decomposed into two margins, both of which admit a unique solution.[5] At the intensive margin, the household chooses (C_t, B_t) conditional on $I_t = 1$. At the extensive margin, the household compares the value of participating in the

[4]To ensure well-behaved comparative statics, we assume the loading is bounded such that $p_t \, \mathbb{E}_t[R_{t+1}] < 1$, which implies $\ell_t \leq \bar{\ell} \equiv \phi_{t+1}/(1 - \phi_{t+1})$. This is a generous bound for realistic survival probabilities and ensures the existence of a unique solution for the household problem.

[5]Our problem satisfies the conditions in Stokey, Lucas, and Prescott (1989) and Marinacci and Montrucchio (2010). See Appendix A for details.

insurance market versus remaining uninsured, where in the participation case (C_t, B_t) are chosen optimally given $I_t = 1$. This decomposition allows us to analyze each margin separately in the following subsections.

C. Intensive Margin of Insurance Demand: Comparative Statics

We first present the comparative statics at the intensive margin, in which the household optimizes the joint choice of (C_t, B_t) conditional on insurance participation $(I_t = 1)$. We apply the Implicit Function Theorem (IFT) to the system of first-order conditions (FOCs) to derive the total derivative of the optimal coverage level (B_t^*) with respect to wealth. This comparative static result is expressed as:

$$\frac{\mathrm{d}B_t^*}{\mathrm{d}W_t} \;=\; -\,\frac{\mathcal{J}_{BW}\,\mathcal{J}_{CC} - \mathcal{J}_{BC}\,\mathcal{J}_{CW}}{\mathcal{J}_{BB}\,\mathcal{J}_{CC} - \mathcal{J}_{BC}^2}, \tag{3}$$

where $\mathcal{J}_{ab} \equiv \frac{\partial^2 \mathcal{J}}{\partial a_t \partial b_t}$ denotes the second-order partial derivatives of the household's objective function with respect to the variables a_t and b_t. This formulation captures the total equilibrium response of insurance demand to wealth changes, accounting for the simultaneous adjustment in optimal consumption. We provide the derivation and the verification of the second-order conditions in Appendix A.

To facilitate the interpretation of the comparative statics, we define two second-order curvature terms that characterize the household's marginal utility of wealth across states: Λ_t^{surv} and Λ_t^{beq}. These terms are strictly negative under the standard assumption of preference concavity:

$$\begin{aligned} \Lambda_t^{\text{surv}} &\equiv \mathbb{E}_t\big[\, V''_{t+1}(W_{t+1})\, R_{t+1}^2 \big] < 0, \\ \Lambda_t^{\text{beq}} &\equiv \mathbb{E}_t\big[\, u''(W_{t+1} + B_t)\, R_{t+1} \left(1 - p_t R_{t+1}\right) \big] < 0. \end{aligned} \tag{4}$$

The term Λ_t^{surv} represents the curvature of the value function in the survival state, while Λ_t^{beq} captures the utility curvature in the death state. Using these definitions and the FOCs, the sign of the marginal wealth effect on optimal insurance coverage is given by:

$$\operatorname{sgn}\!\left(\frac{\mathrm{d}B_t^*}{\mathrm{d}W_t}\right) \;=\; \operatorname{sgn}\Big[\underbrace{-\,\phi_{t+1} p_t\, \Lambda_t^{\text{surv}}}_{\text{Marginal Wealth Preservation}} \;+\; \underbrace{(1 - \phi_{t+1})\, \theta_t(\zeta_t)\, \Lambda_t^{\text{beq}}}_{\text{Self-Insurance Effect}} \Big]. \tag{5}$$

The ambiguity of this sign arises from two competing economic forces. The first term is positive and reflects the household's desire to preserve the marginal utility of future survival-state wealth. The second term is negative and represents the self-insurance effect: as wealth increases, the household relies more on its own assets to satisfy the bequest motive, crowding out the marginal benefit of insurance.

We define the threshold bequest motive intensity θ_t^{thres} as the preference level where these motives exactly offset:

$$\theta_t^{\text{thres}} \equiv \frac{\phi_{t+1} p_t \, \Lambda_t^{\text{surv}}}{(1-\phi_{t+1}) \, \Lambda_t^{\text{beq}}} > 0. \tag{6}$$

Given the monotonic mapping of $\theta_t(\zeta_t)$, the sign of the intensive-margin wealth effect is uniquely determined by the observable characteristic ζ_t such that:

$$\frac{\mathrm{d}B_t^*}{\mathrm{d}W_t} \gtreqless 0 \iff \theta_t(\zeta_t) \lesseqgtr \theta_t^{\text{thres}}. \tag{7}$$

Equation (7) provides the structural foundation for our empirical identification. While standard demographic indicators (e.g., marital status or binary child dummies) signal the existence of a bequest motive, they are insufficient to capture the variation in its intensity required to identify the sign-flip in the wealth effect. By utilizing an observable proxy for ζ_t, we can empirically account for the relative strength of the latent intensity θ_t. This allows us to resolve the "Insurance-Wealth Puzzle" by distinguishing between households where insurance is a normal good and those renders it an inferior good.

Proposition 1 (Wealth Level and the Intensive Margin Threshold)**.** *The marginal effect of wealth on the optimal insurance coverage is positive if the household has a relatively weak bequest motive intensity, and negative if the intensity is relatively strong:*

$$\frac{\mathrm{d}B_t^*}{\mathrm{d}W_t} \begin{cases} \geq 0, & \text{if } \theta_t(\zeta_t) \leq \theta_t^{\text{thres}}, \\ < 0, & \text{if } \theta_t(\zeta_t) > \theta_t^{\text{thres}}. \end{cases} \tag{8}$$

This is the first counterintuitive implication of our model that, in fact, can be derived from model frameworks that share the same basic assumptions, even without imposing

specific risk preferences, such as CARA or CRRA utility. This implication is the first to highlight that when the bequest motive intensity is strong enough, the household prefers to buy more insurance when its wealth level falls, holding all else constant, and vice versa.

This proposition also suggests that any empirical investigation of the observed cross-sectional relationship between wealth and life insurance demand at the intensive margin should account for heterogeneity in measures of bequest motive intensity, in addition to controlling for the presence of such motive only. Next, we apply a similar approach to investigate the effect of wealth at the extensive margin.

D. Extensive Margin of Insurance Demand: Comparative Statics

Choosing to participate in the life insurance market is a discrete decision. Therefore, we evaluate the marginal gain from introducing a small amount of coverage at the optimal uninsured allocation. Given that the household's objective function is concave in B_t, the marginal value of coverage is decreasing in the benefit amount. Consequently, if $\frac{\partial V_t}{\partial B_t}\Big|_{B_t=0} < 0$, zero coverage is optimal ($I_t = 0$). Conversely, if $\frac{\partial V_t}{\partial B_t}\Big|_{B_t=0} > 0$, the household optimally chooses strictly positive coverage ($I_t = 1$). The FOC at the corner is given by:

$$\frac{\partial V_t}{\partial B_t}\bigg|_{B_t=0} = \beta\Big\{-\phi_{t+1}\, p_t\, \mathbb{E}_t\big[V'_{t+1}\big(W_{t+1}\big)\, R_{t+1}\big] + (1-\phi_{t+1})\, \theta_t(\zeta_t)\, \mathbb{E}_t\big[u'(W_{t+1})\, \big(1-p_t R_{t+1}\big)\big]\Big\}. \tag{9}$$

Consistent with our previous analysis, we define the wealth-dependent insurance adoption hurdle, θ_t^{adopt}, as:

$$\theta_t^{\text{adopt}} \;\equiv\; \frac{\phi_{t+1}\, p_t\, \mathbb{E}_t\big[V'_{t+1}\big(W_{t+1}\big)\, R_{t+1}\big]}{(1-\phi_{t+1})\, \mathbb{E}_t\big[u'(W_{t+1})\, \big(1-p_t R_{t+1}\big)\big]} \;>\; 0. \tag{10}$$

The adoption hurdle represents the ratio between the marginal cost of the first unit of coverage in the survival state and the marginal benefit in the death state. Because the participation decision is governed by the comparison between the bequest motive intensity $\theta_t(\zeta_t)$ and the state-dependent threshold θ_t^{adopt}, the sign of the wealth effect on the extensive margin depends on how θ_t^{adopt} responds to wealth shocks.

Proposition 2 (Wealth Level and the Extensive Margin Hurdle)**.** *The sign of the marginal effect of wealth on insurance adoption is ambiguous and is determined by the directional*

shift of the adoption hurdle θ_t^{adopt} *rather than the intensive margin threshold* θ_t^{thres}*. Since the adoption decision is defined by:*

$$B_t^*(W_t) > 0 \iff \theta_t(\zeta_t) > \theta_t^{\text{adopt}}, \tag{11}$$

an increase in wealth promotes insurance adoption if and only if it lowers the adoption hurdle. Formally:

$$\frac{\mathrm{d}\theta_t^{\text{adopt}}}{\mathrm{d}W_t} \begin{cases} < 0, & \textit{if wealth increases insurance adoption,} \\ > 0, & \textit{if wealth decreases insurance adoption.} \end{cases} \tag{12}$$

Wealth influences the adoption decision through the relative sensitivities of marginal utilities across states. While an increase in wealth reduces the marginal utility of consumption in both the survival and death states, the net impact on participation depends on which state's marginal utility declines more rapidly. If the marginal utility of wealth in the survival state (the cost of insurance) falls faster than the marginal utility of the bequest (the benefit), wealth reduces the adoption hurdle and encourages market entry. If the reverse holds, wealth increases the hurdle, potentially crowding households out of the insurance market. This mechanism highlights that the extensive margin may respond to wealth in a manner that is qualitatively distinct from the intensive margin.

E. A Unified Theory of Bequest-Driven Insurance Demand

The preceding comparative statics establish that the relationship between household wealth and life insurance is governed by two distinct, state-dependent hurdles: the adoption hurdle (θ_t^{adopt}) and the coverage threshold (θ_t^{thres}). By evaluating these thresholds at the margin of adoption (where $B_t \to 0$), our model provides a unified theoretical framework to characterize the cross-sectional distribution of insurance demand. Without loss of generality, the interaction between these hurdles yields two possible regimes:[6]

$$\begin{aligned} &\text{Case (1):} \quad \theta_t^{\text{thres}} \leq \theta_t^{\text{adopt}}, \\ &\text{Case (2):} \quad \theta_t^{\text{thres}} > \theta_t^{\text{adopt}}. \end{aligned} \tag{13}$$

[6] If preferences satisfy CRRA, then only Case (2) is possible. See Appendix A for the formal proof.

In Case (1), the entry hurdle is so high that any household with a bequest motive intensity sufficiently high to enter the market is already above the coverage threshold. In this regime, the self-insurance effect is globally dominant. These insured households exhibit a strictly negative relationship between wealth and optimal coverage.

In Case (2), the coverage threshold is above the adoption hurdle, creating a non-empty interval $\theta(\zeta) \in (\theta_t^{\text{adopt}}, \theta_t^{\text{thres}}]$ in which households choose to adopt insurance and also treat insurance as a normal good. The self-insurance effect takes over if the bequest motive intensity is stronger than θ_t^{thres}, rendering insurance an inferior good instead. This regime provides the structural basis for the heterogeneous wealth effects observed in data. We formalize this result in the following theorem.

Theorem 1 (The Signs of Wealth Effects on Insurance Demand)**.** *The sign of the marginal effect of wealth on insurance adoption (extensive margin) is ambiguous and is determined by the adoption hurdle θ_t^{adopt}. Conditional on adoption ($I_t^* = 1$), the sign of the marginal effect of wealth on optimal coverage (intensive margin) is a function of the household's bequest motive intensity relative to the coverage threshold θ_t^{thres}:*

$$I_t^* = 1 \implies \begin{cases} \frac{\mathrm{d}B_t^*}{\mathrm{d}W_t} \geq 0, & \text{if } \theta_t^{\text{adopt}} < \theta_t(\zeta_t) \leq \theta_t^{\text{thres}}, \\ \frac{\mathrm{d}B_t^*}{\mathrm{d}W_t} < 0, & \text{if } \theta_t(\zeta_t) > \theta_t^{\text{thres}}. \end{cases} \tag{14}$$

Theorem 1 yields two key implications for the "Insurance-Wealth Puzzle". First, it shows that the extensive margin is governed by a distinct threshold mechanism, allowing wealth to increase insurance participation while simultaneously decreasing the optimal coverage level for high-θ households. Second, it proves that the sign of the marginal wealth effect on the intensive margin is ambiguous without knowing the latent intensity of the bequest motive, as illustrated in Figure 1.

From an identification perspective, this unified theory suggests that any empirical specification estimating the relationship between wealth and life insurance demand that omits a proxy for ζ is likely misspecified. By pooling households across these distinct regimes, standard linear models produce an uninformative average coefficient that masks the underlying structural heterogeneity.

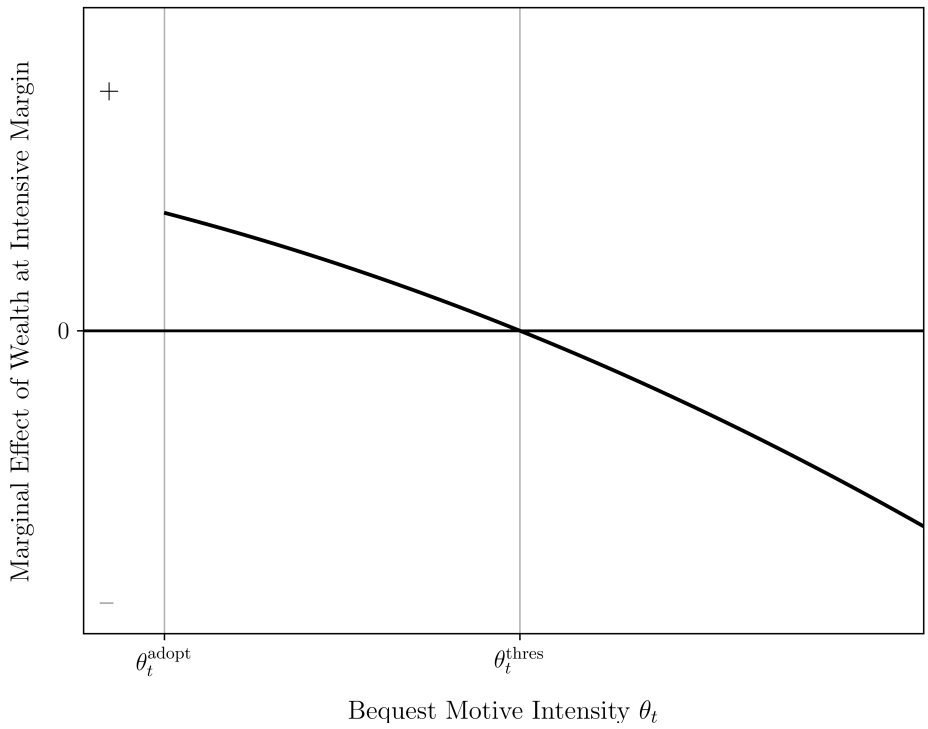


Figure 1: Illustration of the sign of the marginal effect of wealth on optimal coverage

II. Empirical Framework

Following from our theoretical framework, we hypothesize that household insurance demand involves a two-stage decision-making process. The insurance decision naturally implies a dual choice: whether to have coverage at all (the extensive margin) and the optimal coverage amount to purchase (the intensive margin). Conflating both choice dimensions can result in biased estimations if a sample selection bias is present (Heckman (1979)).

A. Two-Stage Sample Selection Model

The first stage estimates the probability P that a household owns a term life insurance policy using a standard Probit model:

$$P(D_{i,t} = 1|Z_{i,t}) = P(D^*_{i,t} > 0) = P(Z'_{i,t}\eta + \varepsilon_{1,i,t} > 0) = \Phi(Z'_{i,t}\eta) \tag{15}$$

where $D_{i,t}$ is a binary indicator equal to 1 if household i observed in year t owns a term life insurance policy, and 0 otherwise. This decision is determined by the latent variable $D^*_{i,t}$, which represents the household's propensity to own insurance. Specifically, $D_{i,t}$ equals 1 when $D^*_{i,t} > 0$ and equals 0 when $D^*_{i,t} \leq 0$. $Z_{i,t}$ is a vector of explanatory variables influencing the decision to own the insurance policy, which includes household wealth and our proxy that has monotonic effect on the bequest motive intensity. η is the vector of coefficients to be estimated, and $\varepsilon_{1,i,t}$ is the error term. $\Phi(\cdot)$ denotes the cumulative distribution function of a standard normal distribution.

B. Stage 2: Outcome Equation

In the second stage, we assume the term life insurance coverage limit in latent form $Y^*_{i,t}$ follows:

$$Y^*_{i,t} = X'_{i,t}\beta + \alpha_p + \alpha_t + \varepsilon_{2,i,t} \tag{16}$$

where $X_{i,t}$ is the vector of explanatory variables influencing the coverage decision (importantly, this includes wealth and the son ratio, but excludes the instrument). β is the vector of coefficients that capture the marginal effects of the explanatory variables on insurance coverage. α_p are province fixed effects absorbing time-invariant provincial heterogeneity, and α_t are year fixed effects accounting for year-specific shocks common to all households. $\varepsilon_{2,i,t}$ is the error term.

We observe the actual term life insurance coverage limit $Y_{i,t}$ such that:

$$Y_{i,t} = \begin{cases} Y^*_{i,t} & \text{if } D_{i,t} = 1 \\ \text{missing} & \text{if } D_{i,t} = 0 \end{cases} \tag{17}$$

To obtain consistent and efficient estimates, we utilize a Maximum Likelihood approach. We assume the error terms $\varepsilon_{1,i,t}$ and $\varepsilon_{2,i,t}$ follow a bivariate normal distribution with a correlation coefficient ρ. The maximum likelihood method jointly estimates the two stages, yielding more asymptotically efficient estimates than the traditional Heckman two-step procedure[7] by fully accounting for heterogeneity in the second stage.

[7]See Heckman (1976), Heckman (1979) and Heckman (2001) for details.

C. *Exclusion Restriction Variables*

Identification requires an exclusion restriction: a variable that strongly predicts selection into insurance ownership (relevance) but has no direct effect on the chosen coverage limit other than through the ownership decision (exclusion). This variable must be included in the first-stage vector $Z_{i,t}$ but excluded from the second-stage vector $X_{i,t}$.

Specifically, we use the equal-weighted distance to the regional headquarters branches of the top 5 life insurance companies by sales volume, applying an inverse hyperbolic sine (IHS) transformation to account for skewness and zero-distance observations.

Geographic distance to major insurance headquarters acts as an arguably powerful proxy for institutional access, search costs, and local financial penetration. Households located further from these hubs face higher informational and physical frictions, reducing their likelihood of purchasing a policy. However, once these entry barriers are overcome and a household decides to participate in the insurance market, the physical distance to the insurer's headquarters does not plausibly dictate the specific monetary coverage limit they choose to buy. By employing this spatial exclusion restriction, the model achieves a clean separation of the selection mechanism from the outcome, allowing for unbiased parameter estimates. A statistically significant estimate of the inverse Mills ratio (λ) in this framework will formally indicate the presence of sample selection bias, confirming the necessity of our two-stage approach. More technical details on the estimation are provided in Appendix B.

III. Data Sample

A. *China Health and Retirement Longitudinal Study (CHARLS)*

CHARLS is a nationally representative longitudinal study designed to provide detailed data on the demographics, health conditions, family structure, financial information, and employment status of middle-aged and older adults (age $\geq$ 45) in China (Zhao et al. (2020)). Initiated in 2011, CHARLS aims to support academic research on aging and retirement, covers individuals in 28 provinces, and is structured to ensure comparability

with similar international surveys[8] (Phillips et al. (2021)). The survey is conducted by the National School of Development at Peking University and aims to support academic research on aging and retirement. It covers individuals in 28 provinces in Mainland China.

CHARLS follows the sampled individuals every two or three years. We obtained all waves of surveys with commercial life insurance data, which were conducted in 2013, 2015 and 2018. We focus on the family respondent in each household, who is the typical main income earner of the household and the individual who owns the life insurance policy if the household has any. We obtain a panel of over 20,000 household-survey year observations with valid demographic, financial and insurance information following the data cleaning procedure documented in Li et al. (2024). Each survey wave offers 7,500-8,200 observations. Table 1 reports the summary statistics.

B. Exclusion Restriction Variable

To achieve valid identification in our two-stage Heckman selection model, we require an exclusion restriction that affects a household's propensity to participate in the term life insurance market (the extensive margin) but is uncorrelated with the unobserved determinants of their chosen coverage amount (the intensive margin). We construct a novel instrumental variable: the geographic friction to access major life insurance providers, proxied by the distance to the regional headquarters or main branches of the top five national life insurers.

To prevent contemporaneous bias and ensure the instrument predates the households' insurance decisions observed in the CHARLS survey waves (2013, 2015, and 2018), we identify the top five life insurers by national sales volume in the life insurance category using the China Insurance Yearbook from the year immediately preceding each wave (2012, 2014, and 2017, respectively). We map the geographic coordinates of these insurers' regional headquarters, which are typically established in the capital or tier-one cities.

We then calculate the base distance from the geographic center of the household's residential location to the nearest top-five insurer branch. To accurately capture the

[8]These surveys include the Health and Retirement Study (HRS) in the U.S., the English Longitudinal Study of Aging (ELSA) and the Survey of Health, Aging and Retirement in Europe (SHARE).

true travel frictions and search costs, which are starkly different across the urban and rural households, we apply a penalty multiplier to the city radius. The final exclusion restriction variable is defined as the base distance plus multiplier $\times$ city radius , where multiplier $= 1$ for non-rural households and multiplier $= 2$ for rural households. This structural adjustment accounts for the compounded transportation frictions, poorer infrastructure, and higher round-trip opportunity costs that rural residents face when accessing centralized financial institutions. This instrument is plausibly exogenous. The locations of major insurers' regional headquarters were determined decades ago based on macro-demographic and political considerations, making them strictly independent of a contemporaneous household's idiosyncratic wealth shocks or unobserved health preferences. Furthermore, once the fixed cost of market entry is overcome (traveling to the branch, establishing trust, and opening a policy), the physical distance to the insurer does not dictate the nominal face value of the policy purchased, satisfying the exclusion restriction. In robustness checks, we substitute this equal-weighted distance with the distance to the single largest insurer and the sales-weighted distance to the top five insurers; our baseline results remain highly consistent. Figure 2 illustrates the construction of the instrument.

C. Sample characteristics

C.1. Demographic background

Since term life insurance in China is typically eligible for individuals aged less than 70 and the age of term life insurance policyholder at the 99th percentile in the CHARLS dataset is 73, we limit our sample to individuals aged 70 or less. This results in an overall 48:52 male-to-female ratio in our sample.

To ensure the sample representativeness, we compare it to national demographic statistics. Figure 3 shows that the age and gender distributions of the initial sample included in the first CHARLS survey in 2011, which are highly comparable to the national distributions based on the census conducted in 2010 (hereafter, 2010 Census) China Bureau Statistics (2011). As CHARLS is a longitudinal study conducted with the same sampling methodology in all survey waves, the sample included in our study remains highly representative at the national level.

Regarding the residential area, a significant portion of the sampled households resides in rural areas (60%), which is higher than the national percentage range of 43-47% during the sample period between 2013 to 2018 estimated by World Bank (2024). This reflects the middle-aged to older population in our sample has a stronger rural presence. In particular, 38% of the sampled individuals engage in agricultural works, underscoring the high reliance on agriculture among Chinese households. Figure 4 shows the distribution of the residing provinces of the sampled households, which represents a similar distribution compared to that reported in the 2010 Census.

C.2. Term life insurance

As China is still a developing country with moderate financial developments among retail financial products, including commercial life insurance products, it is not surprising that the insurance ownership rate is low. In preparing our sample, we focus on individuals with term life insurance policies, which represents about 3% of the entire sample as reported in Panel B of Table . We exclude observations of individuals who only have other type(s) of life insurance products, as the determinants of demand for these products are largely similar to those for term life insurance. Unlike the term life ownership rate of around 70% in the U.S. (Koijen, Van Nieuwerburgh, and Yogo (2016)) among middle-aged to older individuals, the low insurance ownership rate in China allows us to study both the extensive and intensive margins simultaneously.

C.3. Financial variables

Since our sample covers a nationally representative sample, most monetary variables, including household wealth and the insurance coverage limit, span a wide range. We adjust them to the price level as in 2010, take logarithm, and winsorize them at 1% by survey wave to limit the impacts of extreme values, in line with the standard practice in literature. In taking logarithm, we follow Armantier, Foncel, and Treich (2023) to transform the monetary variables to the inverse hyperbolic form ($\sin^{-1}(x) = \ln\left(x + \sqrt{1+x^2}\right)$), in order to keep the negative and zero values while mimicking the shape of the log function on the real line. These transformed values are reported in Table 1.

We define net wealth as household's total assets minus its total debts. Total assets include financial assets and nonfinancial assets, the latter of which mainly comprise res-

idential properties, which account for about 75% of an average household's total assets, aligning the findings of Li et al. (2020) and reflecting the importance of home ownership in China. Similar to the low insurance ownership rate, the stock participation rate in China, especially among the middle-aged and old population, is low and is about 5% in our sample.

Figure 5 presents the average household net wealth by province, normalized in the scale from 0 to 100, highlighting a significant wealth concentration in certain areas, such as Beijing and Shanghai, and the necessity to transform the monetary variables.

C.4. Family structure

The average sample household size is about 3 people. The mean and median number of children is about 2. These are largely attributed to the "One-Child Policy", which was in place from 1980 to 2015 and limited the number of children for most families. Families typically had to pay a fine to have more than one child in urban areas, while the policy was less restrictive in rural areas, where families were often allowed to have more than one child, especially when they had not had a son yet. We employ the household-level son ratio as a proxy for the unobserved bequest motive and informal intra-family insurance. In traditional patriarchal societies, sons are culturally and practically expected to inherit family wealth, serve as primary breadwinners, and provide old-age support. Conversely, due to patrilocal traditions, daughters typically 'marry out' of the household. Consequently, if a primary breadwinner dies unexpectedly, adult sons are expected to absorb the financial shock and support the surviving household members. A family with a high proportion of male offspring therefore possesses an embedded 'informal insurance policy' derived from the future labor and earning capacity of its sons. Endowed with this demographic safety net, the household's reliance on formal commercial term life insurance is substantially diminished. In this context, male offspring and term life insurance function as formal economic substitutes.

The average son ratio in our sample is 0.55, which suggests a significant gender inequality at birth among the sample households, noting that China ranks the first among large economies in the sex ratio (male to female ratio) at 1.11 at birth estimated by Central Intelligence Agency (2017). Figure 6 plots the average sample children gender

ratio by province. From a high-level inspection together with Figure 5, this ratio is not strongly associated with wealth level.

IV. Empirical Findings

A. Insurance-wealth puzzle in China

Table 2 reports the unconditional correlation estimates between insurance demand and wealth in our sample using a setting similar to that of Gropper and Kuhnen (2025). The results support that net wealth is positively associated with both insurance ownership and coverage limit (all variables in monetary amounts hereafter in the inverse hyperbolic form) in OLS. However, our two-stage conditional theoretical framework that corrects for the potential sample selection bias and features the strength of the bequest motive likely reveals a more complete story of the wealth effects at two margins, which we empirically test next.

B. Main results of Two-stage estimation

In this section, we discuss the empirical findings of our main specification, in which we include the household net wealth level as the explanatory variable in both stages along with the distance-based exclusive restriction variables. The estimation results are summarized in Table 3. We find wealth level plays different roles at the extensive and intensive margins of insurance demand after correcting the sample selection bias.

More precisely, we show that a higher level of household net wealth is significantly positively associated with the likelihood of insurance ownership, but is significantly negatively related to the coverage limit of term life insurance conditional on insurance ownership. We also observe that the household-level son ratio is significantly and negatively associated with insurance demand at both the extensive and intensive margins, aligning with our model implication.

B.1. Existence of sample selection bias

The estimated inverse Mills ratios reported in Table 3 across all columns are statistically negative at 1% significance level, confirming the presence of sample selection bias.

This statistical significance indicates severe sample selection bias: the unobserved characteristics driving households to overcome frictions and participate in the market simultaneously drive them to purchase smaller coverage amounts. Moreover, the negative sign indicates that among households who choose to own a policy, those with characteristics associated with a lower probability of owning insurance tend to select higher coverage limits once they own an insurance policy.

This selection bias effect highlights the importance of using the two-stage framework rather than OLS, as OLS, which relies solely on the 621 insured households, would ignore the systematic differences between households that own insurance and those that do not, leading to biased and inconsistent estimates.

C. First-Stage Selection: The Extensive Margin

Table 3 presents the results of the Heckman two-stage estimation using our full sample of 23,562 households, of which 621 hold a term life insurance policy. We focus on Column (1) for interpretation below. The first-stage Probit model evaluates the extensive margin, capturing the probability of term life insurance market participation. Our exclusion restriction, the adjusted geographic distance to top insurers, has a negative coefficient that is statistically significant at the 5% level. This confirms that geographic and infrastructural frictions act as meaningful barriers to entering the formal insurance market.

Evaluating our primary variables of interest, we find that household net wealth has a positive coefficient and is highly significant at the 1% level. To assess the economic magnitude, we evaluate a one-standard-deviation increase in transformed net wealth, which corresponds to an increase of roughly 0.96 percentage points in the probability of term life insurance ownership. Given that the unconditional participation rate in our sample is merely 2.6%, this wealth effect is economically substantial, representing a nearly 36% relative increase in the likelihood of market entry.

Conversely, the son ratio—our proxy for the informal bequest and family support motive—has a negative coefficient and is statistically significant at the 1% level. Economically, a one-standard-deviation increase in the son ratio reduces the likelihood of holding a policy by 0.28 percentage points. This finding strongly supports the substi-

tution narrative: families with a higher proportion of male offspring rely on the future labor and support of those sons as an informal safety net, which meaningfully dampens their demand for formal commercial life insurance products.

D. Second-Stage Outcome: The Intensive Margin

The second stage model the chosen coverage limit conditional on the household owning a policy. Strikingly, the effect of wealth sharply reverses at the intensive margin. In Column (1), conditional on market participation, net wealth has a negative coefficient that is statistically significant at the 1% level. A one-standard-deviation increase in wealth decreases the transformed conditional coverage limit by 0.30 units. Relative to the dependent variable's mean of 10.46, this is a sizable reduction. The economic implication is that while wealth allows households to overcome the initial fixed costs of market entry, the wealthiest participants use formal insurance less intensively. Once insured, they likely substitute formal coverage with self-insurance through their broader asset portfolios to absorb mortality shocks.

The son ratio continues to exert a negative effect at the intensive margin, with a coefficient that is statistically significant at the 10% level. Among the subset of insured households, a one-standard-deviation increase in the son ratio reduces the transformed coverage limit by approximately 0.11 units, further corroborating that sons and formal insurance act as substitutes even after market entry.

We also examine the unconditional expected marginal effects to capture the net population-wide dynamics. Because the strong positive extensive, margin effect of wealth outweighs its negative intensive-margin effect, the net unconditional effect of wealth on expected coverage is positive and statistically significant at the 1% level. A one-standard-deviation increase in wealth raises the expected unconditional coverage by roughly 0.10 units. Conversely, for the son ratio, the dual negative effects compound. A one-standard-deviation increase in the son ratio yields a net decrease of 0.03 units in overall expected coverage, an effect that is statistically significant at the 1% level.

To ensure our baseline findings are not driven by omitted variable bias related to a household's general standard of living or cash flow, Column (2) introduces household consumption as an additional control. In the first-stage selection model, consumption

exhibits a positive coefficient that is statistically significant at the 1% level, suggesting that households with higher expenditures or more expensive lifestyles have a greater baseline propensity to acquire formal life insurance. Crucially, however, absorbing this consumption effect does not alter our primary narrative. Household net wealth continues to drive market participation positively and significantly, while negatively predicting the conditional coverage limit at the 1% level. Furthermore, the son ratio maintains its dual negative impact across both the extensive and intensive margins. This confirms that the distinct mechanisms of wealth accumulation and the informal bequest motive operate independently of a household's day-to-day expenditure levels.

Columns (3) and (4) test the sensitivity of our first-stage identification strategy by deploying alternative constructions of the geographic exclusion restriction. While the baseline specification utilizes an equal-weighted distance to the top five insurers, Column (3) replaces this with the distance to the single nearest branch among those top insurers. Column (4) introduces a sales-weighted distance metric, which accounts for the relative market dominance and footprint of each respective insurer.

Both alternative instruments yield negative coefficients that are statistically significant at the 5% level, reaffirming our hypothesis that geographic and infrastructural frictions act as robust, structural deterrents to formal insurance market participation. Most importantly, across both alternative instrumental specifications, the economic magnitudes and statistical significance of our primary variables, net wealth and the son ratio, remain virtually identical to the baseline estimates. The inverse Mills ratio also remains strongly negative and significant at the 1% level across all columns, confirming that the severe sample selection bias is a persistent feature of the data. Taken together, these robustness checks provide compelling evidence that our dual-margin findings are fundamental economic behaviors, rather than artifacts of a specific instrumental variable construction.

E. Wealth Effects at Both Margins by the Strength of the Bequest Motive

To investigate how the latent intensity of the formal bequest motive (θ_t) alters the wealth effect across both margins, we partition our sample based on the presence of independent male offspring. Crucially, in this analysis, we restrict both subsamples exclusively to households with zero dependent children (neither sons nor daughters).

The zero-dependent-children restriction serves a crucial identification purpose. In standard life-cycle models, insurance demand is confounded by the "income replacement" motive, that is, the immediate necessity to protect dependent children from the sudden loss of a breadwinner's earnings. Furthermore, dependent children impose short-term liquidity constraints that distort optimal savings trajectories. By explicitly filtering out households with dependents, we shut down this income-replacement channel. Consequently, it is more convincing to argue that the observed insurance demand in our subsamples is driven purely by the structural wealth-transfer bequest motive, allowing for a clean test of our bequest motive intensity parameter.

Having isolated the pure bequest motive, we partition these households into two cohorts: those with zero independent sons and those with at least one independent son. Following our theoretical framework, this split captures the dual economic forces shaping θ_t. Recall that households with at least one independent son face immense competitive savings pressures for their son's housing and marriage (raising the survival-state opportunity cost of having insurance) while simultaneously possessing a built-in demographic safety net for old-age support (lowering the death-state necessity of owning insurance). Thus, they exhibit a *low* formal bequest motive intensity (θ_t is low). Conversely, households with zero independent sons lack this informal safety net and face different survival-state liquidity pressures, resulting in a *high* formal bequest motive intensity (θ_t is high).

Table 4 presents the split-sample Heckman estimates. Column (1) uses households with zero independent sons and zero dependent children, while Column (2) contains those with non-zero independent sons and zero dependent children. At the extensive margin, wealth positively predicts market participation for two subsamples at 1% significance level. While the point estimate for zero-independent-son households is nearly double that of households with independent sons, a formal test reveals the difference in wealth coefficients is not significant at 10% confidence level. This indicates that while the economic magnitude points to a stronger adoption urgency for highly vulnerable households, statistical power at the selection stage limits definitive cross-group separation.

Crucially, the divergence at the intensive margin of wealth effect is statistically validated. Conditional on owning a policy, zero-son households in Column (1) exhibit a

negative wealth effect that is significant at 1% level, whereas the effect for households with sons in Column (2) is less negative. A post-estimation test confirms that the coefficient differences in intensive-margin wealth effects is statistically significant at the 10% level. This formal statistical separation corroborates the mechanism outlined in Theorem 1. Because zero-son households possess a highly intense formal bequest motive, they operate deep within the $\theta_t > \theta_t^{thres}$ regime. In this structural space, the self-insurance effect strictly dominates: as these highly vulnerable households accumulate wealth, they rapidly substitute formal term coverage with their own growing asset portfolios to guarantee their outsized bequest needs significantly faster than households operating with a lower θ_t.

Finally, the spatial exclusion restriction reveals a behavioral divergence. For households with at least one independent son, geographic distance to major insurers acts as a standard physical friction, significantly deterring market entry. However, for zero-son households, the distance coefficient becomes positive and highly significant. We interpret this through the lens of extreme demographic vulnerability. A household devoid of both dependent children and independent sons that is located far from urban centers faces compounded exposure, lacking both formal financial infrastructure and a local informal safety net. For these highly isolated households, the severe necessity of acquiring financial protection overrides the physical friction of distance, driving an outsized demand for formal insurance that aggressively eclipses typical search costs.

V. Robustness Checks

To ensure that our baseline findings are not driven by omitted variable bias or spurious correlations, we conduct a comprehensive battery of robustness checks. We sequentially introduce controls for insurance pricing, risk preferences, financial literacy, liquidity constraints, household debt, occupational status, and health conditions, as identified in the recent empirical household finance literature. Across all specifications (Tables 5 through 11), the structural predictions of our model remain highly robust: household wealth consistently exhibits a positive effect on the extensive margin (market entry) and a negative effect on the intensive margin (conditional coverage), while the son ratio, our proxy for

bequest motive intensity, exerts a negative substitution effect across both margins.

A. Insurance Pricing

The unit cost of insurance is a fundamental determinant of coverage demand. A high premium relative to the policy's face value should logically deter households from participating or opting for large coverage limits, reflecting the pricing friction in our theoretical framework. We control for this by introducing the premium-to-coverage-limit ratio, which is defined as the annual premium for term life insurance contract divided by the its coverage limit.

The results in Table 5 reveal a negative relationship between the premium-to-coverage-limit ratio and the chosen coverage limit, which is statistically significant at the 1% level. However, the inclusion of this pricing control does not absorb the wealth effects. Household net wealth remains a positive predictor of market entry and a negative predictor of coverage size. The son ratio persistently dampens demand across both margins, confirming that informal intra-family insurance substitutes for formal coverage regardless of the policy's pricing structure.

B. Risk Preference

Risk preferences fundamentally shape a household's valuation of low-probability, high-impact mortality shocks. Classic models of insurance demand, which typically rely on the assumption of Decreasing Absolute Risk Aversion (DARA), predict a negative correlation between wealth and insurance precisely because wealthier households are less risk-averse and better equipped to absorb shocks. Consequently, it is crucial to verify that our documented structural wealth effects are not merely capturing unobserved cross-sectional variations in household risk tolerance.

To empirically isolate this, we construct two proxies for household risk preference: the share of risky assets (defined as non-cash and non-deposit instruments) as a proportion of total financial wealth, and as a proportion of total net wealth. As illustrated in the standard portfolio choice literature, a higher risky asset share reveals a higher underlying tolerance for financial risk, which systematically aligns with the DARA assumption as wealth increases.

Table 6 presents the Heckman two-stage estimation incorporating these risk preference proxies. Across both the extensive margin (the first stage) and the intensive margin (the second stage), we find that neither proxy for household risk preference exhibits a statistically significant relationship with term life insurance demand. The coefficients for the risky asset share in financial wealth (Column 1) and in net wealth (Column 2) remain statistically indistinguishable from zero at 10% levels. While pure utility-based frameworks emphasize the central role of risk tolerance in shaping insurance purchases, this lack of significance suggests that in our empirical context, market access frictions and dynastic bequest objectives dominate baseline financial risk preferences in driving insurance decisions.

Most importantly, the inclusion of these risk preference controls does not alter our primary findings. The dual-margin wealth effect remains highly robust: household net wealth continues to be a positive predictor of market entry (significant at the 1% level) and a negative predictor of the conditional coverage size (significant at the 1% and 5% levels in Columns (1) and (2), respectively). Furthermore, our proxy for the bequest motive, the son ratio, exerts a negative effect in the extensive margins that is significant at 1% level while the its effect on the intensive margin is not significant at 10% level in Column (1) and is significant at 10% level in Column (2).

C. Financial Literacy

Financial literacy plays a critical role in shaping household insurance decisions by altering an individual's capacity to comprehend complex financial products, evaluate long-term mortality risks, and navigate market search costs. In developing economies with nascent private insurance markets, such cognitive and informational barriers to entry can be particularly steep. Following the established empirical household finance literature, we utilize formal educational attainment as a proxy for financial knowledge and capability. While studies using Western data often distinguish individuals by college degree status, the demographic landscape of our middle-aged and older Chinese household panel necessitates granular indicators at the lower end of the educational spectrum. We therefore construct three distinct indicator variables: *Illiterate*, *Elementary School Graduate*, and *Middle School Graduate*, and sequentially introduce them into our two-stage empirical

framework.

Table 7 reports the results of these specifications across Columns (1) through (3). At the extensive margin (the first stage), financial literacy acts as a powerful determinant of market entry. In Column (1), the coefficient on the *Illiterate* indicator is negative and highly statistically significant at the 1% level, indicating that a lack of basic literacy creates a profound barrier to market entry, severely compounding informational frictions. Conversely, having completed elementary school in Column (2) or middle school in Column (3) significantly increases the probability of insurance ownership, with coefficients both significant at the 1% level. These first-stage results strongly corroborate the hypothesis that basic financial literacy enables households to efficiently overcome initial transaction and cognitive frictions, thereby lowering the hurdle for insurance market adoption.

At the intensive margin (the second stage), conditional on owning a term life policy, we document a striking reversal that closely mirrors our primary wealth effect. Households designated as illiterate choose significantly higher coverage limits, significant at the 1% level, while those with an elementary or middle school education select significantly lower coverage limits, both significant at the 1% level). This intensive-margin behavior can be understood through a portfolio-diversification and alternative asset-allocation channel. Sophisticated, educated households face low entry barriers and easily purchase a baseline contract, but they also possess the financial literacy required to build diversified portfolios and accumulate alternative personal assets. Consequently, they aggressively rely on self-insurance, which heavily crowds out their conditional demand for massive insurance face values. In contrast, illiterate households encounter severe entry barriers; those rare individuals who successfully cross the selection threshold are often driven by acute, unhedged mortality exposures and lack access to or understanding of alternative self-insurance instruments, compelling them to buy outsized coverage face values.

Crucially, the inclusion of these financial literacy proxies does not change the structural validity of our main findings. Across all three specifications, the opposing wealth effects remain perfectly robust: household net wealth systematically drives market participation positively in the first stage (≈ 0.020, significant at the 1% level) and depresses

the conditional coverage limit in the second stage (≈ -0.036, significant at the 1% level). Furthermore, the son ratio maintains its highly significant negative impact on the selection margin (≈ -0.140, significant at the 1% level) and a negative, marginally significant impact on the intensive margin (≈ -0.300, significant at the 10% level). This resilience confirms that the demographic substitution effect of male offspring and the dual-margin wealth mechanism operate fundamentally across the population, independent of variations in household financial literacy.

D. Liquidity Constraints

Liquidity represents a critical dimension of household financial flexibility, reflecting a family's immediate capacity to absorb unexpected expenses or settle premium obligations without disrupting day-to-day consumption. In the context of Chinese households, isolating liquidity from total net wealth is highly pertinent. As documented in the summary statistics, non-financial assets, predominantly residential property, constitute approximately 75% of the average household's total asset portfolio. Because real estate wealth is highly illiquid, a household might boast a high level of total net wealth while simultaneously suffering from binding cash-flow constraints. Conversely, highly liquid households may possess an enhanced ability to short-term self-insure against immediate consumption shocks, potentially lowering their baseline demand for formal insurance.

To ensure our baseline wealth effects are not merely picking up short-term cash-flow availability or binding borrowing constraints, we construct four distinct liquidity proxies: (1) absolute *Liquid Assets* (defined as cash and deposits), (2) the *Liquid Asset Ratio* (the ratio of liquid assets to total net wealth), (3) the *Cash-to-Consumption Ratio* (the ratio of liquid assets to total annual household consumption), and (4) the *Cash-to-Average-Consumption Ratio* (the ratio of liquid assets to per capita household consumption).

Table 8 presents the two-stage sample selection model results incorporating these liquidity measures. At the extensive margin (the first stage), we document a robust, positive relationship between household liquidity and market participation. The absolute amount of liquid assets in Column (1), alongside both consumption-scaled ratios in Columns (3) and (4), exerts positive and highly statistically significant effects (at the 1% level) on the propensity to adopt term life insurance. This strongly validates a cash-flow affordability

channel: households with larger short-term liquidity cushions relative to their baseline consumption expenditures can readily commit to periodic, discretionary insurance premium payments without risking near-term consumption distress. The Liquid Asset Ratio in Column (2) also carries a positive coefficient, though it is statistically insignificant, suggesting that premium affordability is governed more by absolute cash reserves and consumption outflows than by the composition of the broader asset portfolio.

At the intensive margin (the second stage), conditional on market entry, we observe a reversal. Absolute cash and deposits, as well as both cash-to-consumption ratios, exhibit strongly negative relationships with the chosen coverage limit, all statistically significant at the 1% level. This conditional divergence yields an economic insight: while short-term liquidity is required to overcome initial administrative hurdles and premium commitments to facilitate entry, a massive cash reserve ultimately serves as a highly liquid self-insurance buffer. Once a household clears the market entry threshold, those with vast cash-to-consumption cushions require significantly smaller formal death-state payouts, aggressively substituting away from commercial coverage limits.

As before, our core empirical findings remain robust to the inclusion of these stringent liquidity controls. The dual-margin wealth effect persists with high statistical precision: net wealth remains a positive predictor of insurance adoption in the first stage (significant at the 1% level) from Column (1) to (4), and a strictly negative predictor of conditional coverage size in the second stage (significant at the 1% level in Column (1), (2), (4); and 5% levels in Column (2)). Furthermore, our proxy for the latent bequest motive, the son ratio, persistently dampens term life insurance demand across both specifications. It holds a significant negative coefficient at the extensive margin across all models (at the 1% level), while the point estimates at the intensive margin remain consistently negative, maintaining statistical significance in Columns (1) and (2).

E. Household Debt Level

Household debt, particularly mortgages, creates specific, rigid financial liabilities that are transferred to surviving members upon a breadwinner's death. Individuals with significant debt may therefore exhibit a disproportionately high demand for life insurance to hedge against this specific liability risk. We control for this potential confounding channel

by incorporating absolute total debt and the debt-to-wealth ratio into our estimation.

Table 9 presents the two-stage Heckman estimations incorporating these debt measures. At the extensive margin (the first stage), the two debt proxies exhibit diverging effects. In Column (1), the absolute level of total debt is positively associated with market entry (significant at the 1% level), likely capturing a baseline liability-hedging motive or proxying for broader credit market participation and financial sophistication. Conversely, in Column (2), a high debt-to-wealth ratio strongly deters market entry (significant at the 1% level). This suggests that when debt burdens become disproportionately large relative to the household's underlying asset base, severe affordability and cash-flow constraints dominate, preventing households from securing formal coverage.

At the intensive margin (the second stage), conditional on purchasing insurance, absolute total debt in Column (1) shows no statistically significant relationship with the chosen coverage limit. However, the debt-to-wealth ratio in Column (2) positively and significantly drives the coverage size (significant at the 1% level). This conditional dynamic is highly intuitive: heavily indebted households that manage to overcome initial affordability frictions and enter the market purchase significantly larger coverage limits to adequately hedge their massive outstanding liability overhang.

Most importantly, even after accounting for this strong liability-hedging motive and debt-related liquidity constraints, our core structural findings are fully preserved. The dual-margin wealth effect remains highly robust: household net wealth is consistently a positive predictor of market entry (significant at the 1% level in both columns) and a strongly negative predictor of conditional coverage size (significant at the 1% level in both columns). Furthermore, the son ratio persistently dampens demand, exhibiting a negative and highly significant effect at the extensive margin (1% level) and a negative coefficient at the intensive margin (significant at the 10% level in Column 1). These results underscore the robustness of our model's key predictions, confirming that the self-insurance crowd-out and demographic substitution mechanisms operate robustly alongside household liability considerations.

F. Occupational Status

Occupational stability and state-linked employment often provide bundles of informal welfare benefits, pension security, and steady income streams, which fundamentally alter a household's baseline need for private insurance. To account for these potential confounding welfare and income-stability effects, we incorporate specific indicators for whether the respondent is currently working, is a Communist Party member, or is a civil servant.

Table 10 presents the two-stage Heckman estimations controlling for these working conditions across four distinct specifications. At the extensive margin (the first stage), both active employment and Party membership significantly facilitate market participation. Specifically, the indicator for working in Column (1) and Column (4), as well as the indicator for being a Party member in Column (2) and Column (4), exhibit positive coefficients that are statistically significant at the 1% level. This aligns with the expectation that active employment and state-affiliated networks proxy for greater income stability, financial literacy, and improved access to formal financial markets, thereby lowering the friction of initial policy adoption. Conversely, the indicator for being a civil servant in Column (3) and Column (4) does not show a statistically significant relationship with market entry.

At the intensive margin (the second stage), a clear substitution effect emerges among the significant occupational indicators. Conditional on market entry, active employment negatively impacts the chosen coverage limit, remaining statistically significant at the 5% level in both Column (1) and Column (4). Similarly, Party membership is negatively correlated with the coverage size, significant at the 5% level in Column (2) and the 10% level in the fully specified Column (4). These negative intensive-margin effects suggest that the robust, state-provided or employment-linked safety nets associated with these statuses crowd out the demand for massive private death-state payouts, functioning analogously to our hypothesized wealth mechanism. As in the first stage, the civil servant indicator remains statistically insignificant.

Most importantly, the inclusion of these occupational controls does not compromise our primary findings. The wealth effect at two margins persists across all four columns:

household net wealth increases the propensity for insurance adoption in the first stage (significant at the 1% level) and strictly decreases the conditional coverage size in the second stage (significant at the 1% level). Furthermore, the son ratio continues to exert an independent substitution effect, carrying a negative coefficient in the first stage (significant at the 1% and 5% levels) and a negative coefficient in the second stage (significant at the 10% level). These results confirm that private wealth accumulation and demographic family structure exert distinct, powerful forces on insurance demand that operate well beyond the confines of occupational welfare and state-linked employment benefits.

G. Health Conditions

Physical and cognitive well-being introduces a unique push-pull dynamic in life insurance markets. While declining health might theoretically increase a household's subjective desire for financial protection, it simultaneously triggers severe supply-side underwriting frictions, such as prohibitive premium markups, strict medical examinations, or outright application rejections. Therefore, it is essential to parse out how health-related selection biases might be influencing our core wealth and bequest findings.

To capture this, Table 11 incorporates three standardized, self-reported metrics of household well-being: memory score (Column 1), mental health score (Column 2), and living satisfaction score (Column 3). At the extensive margin (the first stage), the results strongly suggest that supply-side underwriting forces dominate market entry. Across all three columns, higher health and well-being scores are highly predictive of term life insurance ownership, with positive coefficients significant at the 1% level. This confirms that healthier households face drastically lower administrative and cost barriers to entry, successfully navigating the underwriting process that likely filters out more vulnerable individuals.

However, conditional on successfully securing a policy, the demand-side logic takes precedence at the intensive margin. In the second stage, superior cognitive function (Column 1) and better mental health (Column 2) significantly reduce the chosen coverage limits, at the 10% and 5% levels, respectively. This inverse relationship intuitively aligns with life-cycle expectations: households in robust mental and physical condition

anticipate a longer horizon for continued human capital deployment and asset accumulation. Consequently, their urgency to secure massive, immediate face-value payouts to protect against premature death is significantly diminished. General living satisfaction in Column (3), while exhibiting a negative point estimate, does not reach statistical significance at this intensive margin.

Controlling for these complex health-related selection dynamics does not compromise our primary results. The wealth effect remains similar in the two margins. Net wealth positively drives policy adoption and strictly crowds out required coverage sizes, maintaining significance at the 1% level across all specifications. Likewise, our proxy for the informal demographic safety net, the son ratio, consistently depresses market entry (significant at the 1% level) and exerts a negative substitution effect on coverage sizes, which retains statistical significance at the 10% level in Columns (1) and (2). These findings reaffirm that the self-insurance crowd-out and demographic substitution pathways are fundamental forces, operating persistently regardless of a household's idiosyncratic health status.

VI. Discussion of Findings

Our empirical findings shed new light on the long-standing insurance-wealth puzzle, providing a robust structural framework that demonstrates how household wealth influences life insurance demand differently across two distinct operational margins. Contrary to the predictions of canonical microeconomic models that assume a uniform negative relationship, and advancing beyond recent Western studies documenting entirely positive correlations, we show that the direction of the wealth effect is non-monotonic and structurally bifurcated. In the Chinese household context, net wealth exerts a highly significant positive effect on the decision to own insurance (the extensive margin) but a strictly negative and statistically significant impact on the chosen coverage limit (the intensive margin). Below, we outline the economic mechanisms underlying these divergent patterns and highlight how the interaction between wealth accumulation and latent bequest motive intensities reconciles these cross-sectional anomalies.

A. Frictions and the Positive Wealth Effect at the Extensive Margin

Our finding that wealth positively dictates the household's propensity to participate in the term life insurance market aligns with contemporary empirical literature while offering a distinct structural interpretation. Rather than indicating that term life insurance behaves globally as a normal good, our framework establishes that the extensive margin is heavily governed by market access barriers and search costs. In our empirical setting, lower-wealth households are systematically constrained by severe informational, cognitive, and physical frictions. These institutional frictions include high geographic search costs—manifested in the significant physical distance to centralized insurance hubs—alongside lower average financial literacy and limited institutional trust.

Because navigating these search and administrative costs requires an upfront expenditure of human and financial capital, lower-wealth households are frequently priced out of market entry. Wealth accumulation relaxes these liquidity and cognitive constraints, allowing wealthier households to absorb these entry costs and successfully cross the adoption hurdle. This transactional mechanism explains why wealth positively correlates with initial policy ownership in our first-stage Probit estimation. Wealthier families do not necessarily possess a structurally higher baseline preference for formal insurance; rather, they are simply capable of overcoming the severe market frictions that stall participation among poorer cohorts.

B. The Self-Insurance Mechanism and the Negative Intensive Margin Wealth Effect

Conditional on crossing the selection threshold and entering the insurance market, the impact of household wealth sharply reverses. Our finding of a highly significant negative wealth effect on the chosen coverage limit constitutes a key structural insight of this study, presenting a stark contrast to Western administrative data. Through the lens of our life-cycle framework, once the entry barriers are cleared, the marginal utility of formal death-state insurance protection must compete directly with the household's capacity to accumulate personal survival-state wealth.

Our theoretical framework proves that when a household's formal bequest motive intensity operates above a critical structural threshold ($\theta_t > \theta_t^{thres}$), the self-insurance crowd-out effect strictly dominates the marginal wealth preservation channel. In this

regime, commercial term life insurance effectively becomes an inferior good at the intensive margin. Wealthier households increasingly recognize that direct asset accumulation is a more flexible, cost-effective vehicle for fulfilling intergenerational transfer goals than paying ongoing commercial insurance premiums. In China's specific economic landscape, this self-insurance buffer is heavily concentrated in non-financial holdings, particularly residential property assets, which comprise approximately 75% of the average household's balance sheet. As households accumulate these robust physical and financial assets, their structural reliance on formal commercial mortality risk transfers diminishes, driving down their optimal coverage limit.

C. The Role of the Demographic Safety Net and the Son Ratio

A central contribution of our paper is mapping the latent, unobservable parameter of bequest motive intensity (θ_t) to observable variations in household family structure. By utilizing the household-level son ratio, we capture a powerful, culturally embedded mechanism that governs financial optimization in East Asia. Under our structural interpretation, traditional patrilineal inheritance norms and the socio-economic realities of the Chinese housing and marriage markets dictate that male offspring act as a direct informal substitute for formal financial risk-transfer contracts.

Our results demonstrate that a higher son ratio systematically depresses both the probability of policy ownership and the conditional coverage face values. Mechanistically, this occurs because a higher concentration of sons introduces a dual economic force: it amplifies competitive saving pressures during life (survival-state wealth needs) while simultaneously establishing a robust intergenerational old-age support network to absorb unexpected mortality shocks (informal death-state protection). Families endowed with this demographic safety net experience a sharp reduction in their latent formal bequest motive intensity. This intra-family risk-sharing network effectively crowds out the marginal utility of purchasing commercial term policies, reinforcing the structural narrative that demographic safety nets and formal insurance policies function as formal economic substitutes.

D. Reconciling Chinese and Western Empirical Evidence

The structural thresholds developed in Theorem 1 provide a unified global interpretation that successfully reconciles our unique Chinese findings with the predominantly positive wealth-insurance correlations documented in the U.S. and Europe. Our model demonstrates that the direction of the intensive-margin wealth effect is entirely determined by where a population sits relative to the coverage threshold θ_t^{thres}.

In typical U.S. and European samples, private insurance markets are highly mature, entry frictions are lower, and traditional intra-family demographic risk-sharing lines are less rigid. These conditions place Western households predominantly within the low-bequest motive intensity scenario ($\theta_t \leq \theta_t^{thres}$), where commercial life insurance behaves as a standard normal good across both margins. Wealth accumulation in those societies expands both market entry and conditional coverage size because the self-insurance crowd-out effect is not strong enough to curve demand.

Conversely, the Chinese institutional and cultural setting pushes households into the high-bequest motive intensity regime. Due to deep-seated patrilineal wealth transfer desires and acute financial exposures, vulnerable households (such as those with no male heirs) harbor intense formal bequest needs that push them deep into the negative conditional wealth effect zone. By accounting for these latent preference intensities, our framework unifies these superficially contradictory global data streams into a single, cohesive economic theory.

E. Caution in Interpreting Our Results

While our study offers key empirical and theoretical insights into household portfolio optimization, several distinct limitations warrant a careful interpretation of our conclusions. First, although our empirical strategy relies on a Maximum Likelihood two-stage framework to rigorously control for sample selection bias, our reliance on observational panel data from household surveys limits our ability to make absolute, unassailable causal claims.

Second, our identification strategy heavily exploits the unique socio-cultural and institutional environment of China, including the historical enforcement of the One-Child Policy and explicit regional patrilineal inheritance traditions. While these institutional

features provide a clean natural experiment that guarantees the statistical exogeneity of the son ratio relative to contemporaneous household wealth shocks, they potentially restrict the external validity of our results when applied to economies characterized by alternative social safety nets, different family structure developments, or perfectly friction-free financial systems.

Finally, our life-cycle model is deliberately parsimonious to ensure elegant tractability and sharp comparative statics. Consequently, it abstracts away from alternative unobserved microeconomic frictions, such as asymmetric intergenerational bargaining power within the household, cognitive framing effects, or behavioral regret aversion. Although our extensive robustness checks confirm that our primary wealth and demographic coefficients remain highly precise when controlling for education, risk aversion, and physical health, these unobserved psychological and behavioral variables represent fertile ground for future research seeking to further refine the global boundaries of our framework.

VII. Conclusion

In this paper, we provide a unified theoretical and empirical framework to reconcile the "Insurance-Wealth Puzzle"—the empirical anomaly where household wealth levels positively correlate with commercial insurance demand, directly challenging canonical microeconomic models. By shifting the analytical focus to a pure risk-transfer laboratory—term life insurance—we demonstrate that the insurance-wealth relationship is non-monotonic, operating along distinct structural paths at the extensive and intensive margins.

Theoretically, we develop a dynamic life-cycle framework with minimalistic preference assumptions to show that household wealth accumulation affects market entry and conditional coverage choice differently. The directional shifts of these wealth effects are endogenously governed by two state-dependent parameters: the adoption hurdle (θ_t^{adopt}) and the coverage threshold (θ_t^{thres}), both of which interact directly with the latent intensity of the household's bequest motive. When the formal bequest motive is intensely held, accumulating survival-state wealth rapidly acts as a cost-effective vehicle for self-insurance, crowding out the marginal utility of formal commercial coverage face values and rendering insurance an inferior good conditional on market entry.

Empirically, we validate the model's structural predictions by exploiting the institutional and socio-cultural environment of China using nationally representative panel data from the China Health and Retirement Longitudinal Study (CHARLS). To correct for pervasive sample selection bias and map unobservable preferences to observable microdata, we employ a Maximum Likelihood two-stage selection model. We isolate the selection margin using a novel spatial exclusion restriction: the inverse hyperbolic sine of the geographic distance to the regional headquarters branches of the top five national life insurers, which captures initial physical and informational frictions without confounding the conditional coverage choice. Furthermore, we utilize the household-level son ratio as a granular proxy for the inverse of formal bequest motive intensity, rooted in East Asian patrilineal inheritance norms and competitive savings pressures.

Our two-stage empirical estimations deliver two central insights that support the high-bequest motive intensity regime. First, we document that household wealth exerts a robust positive effect on the extensive margin (the propensity to own a policy) because wealthier households possess the financial and cognitive resources to clear initial transaction and search frictions. Second, conditional on market entry, wealth carries a strictly negative and statistically significant coefficient at the intensive margin. Wealthier insured households in China aggressively substitute commercial term coverage limits with self-insurance buffers, which are heavily concentrated in illiquid housing assets. Concurrently, the son ratio significantly dampens demand across both margins, confirming that male offspring function as an embedded, informal intra-family safety net that acts as a structural substitute for formal financial risk-transfer contracts. These dynamics remain highly precise across an extensive battery of robustness checks controlling for insurance contract pricing, risk tolerance, educational attainment, liquidity constraints, outstanding household debt levels, occupational welfare benefits, and physical and psychological health conditions.

Ultimately, our framework provides a cohesive global synthesis that harmonizes seemingly contradictory empirical evidence. While Western administrative data typically document entirely positive wealth-insurance correlations—corresponding to our model's low-bequest intensity scenario where insurance behaves globally as a normal good—the unique

demographic and institutional landscape of China pushes households into a high-bequest intensity regime characterized by dual-margin divergence.

Beyond resolving an academic puzzle in household finance, our findings yield important policy and practical implications for emerging markets. As developing economies navigate rapid demographic transitions and formalize their financial sectors, understanding the structural interplay between formal financial products and informal family safety nets becomes essential. Our evidence highlights that private commercial insurance adoption cannot be expanded merely through general wealth accumulation; rather, it requires policy interventions aimed at lowering regional informational and physical frictions, enhancing base-level financial literacy, and designing flexible risk-management instruments that complement, rather than awkwardly crowd out, the traditional socio-cultural structures of the household.

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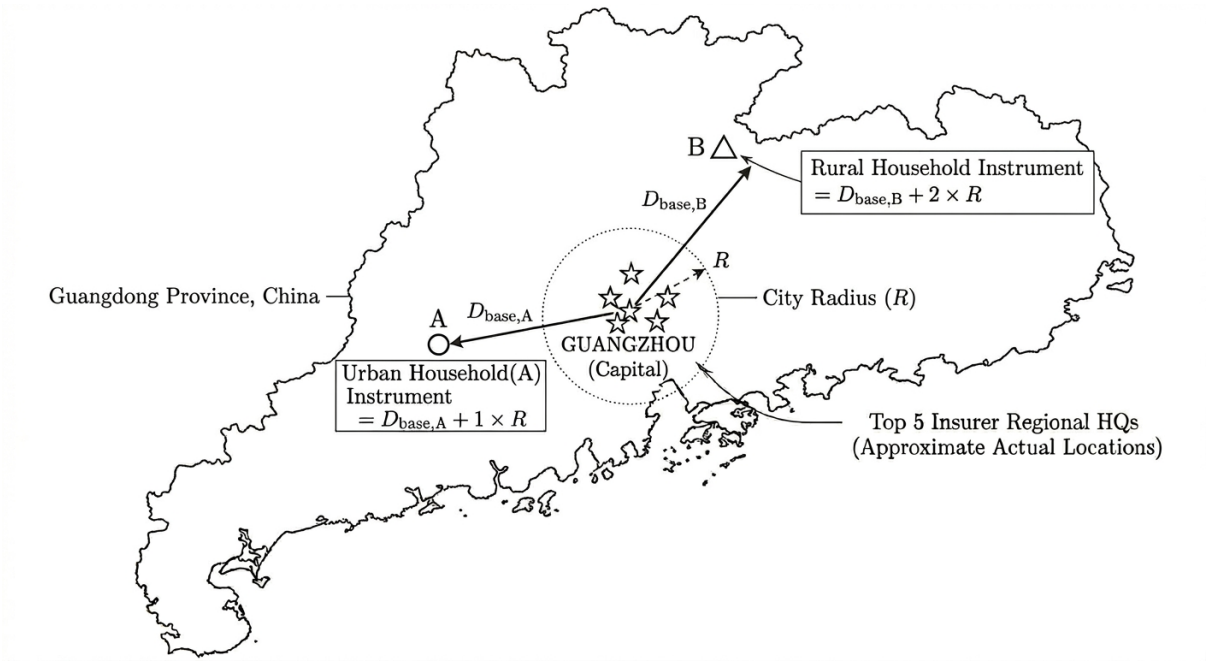


Figure 2: Illustration of the construction of the Exclusion Restriction Variable

This figure illustrates the geographic construction of the excluded instrument for two sampled households, Urban (A) and Rural (B), in Guangdong Province relative to insurer regional headquarters clustered in Guangzhou.

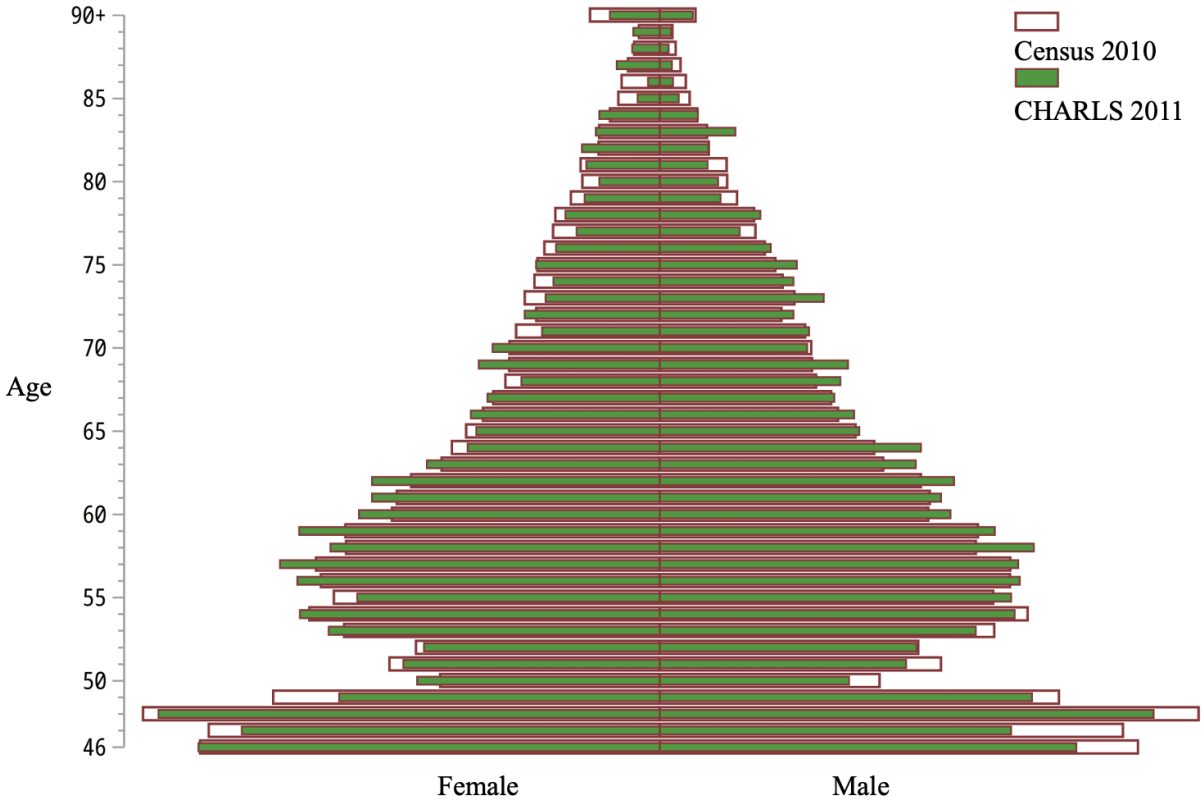


Figure 3: Distribution of age and gender of CHARLS 2011 sample and 2010 Census

This figure plots the distribution of ages and genders in the initial sample of individuals included in the first CHARLS (China Health and Retirement Longitudinal Study) survey conducted in 2011 and the 2010 Census. Source: CHARLS team.

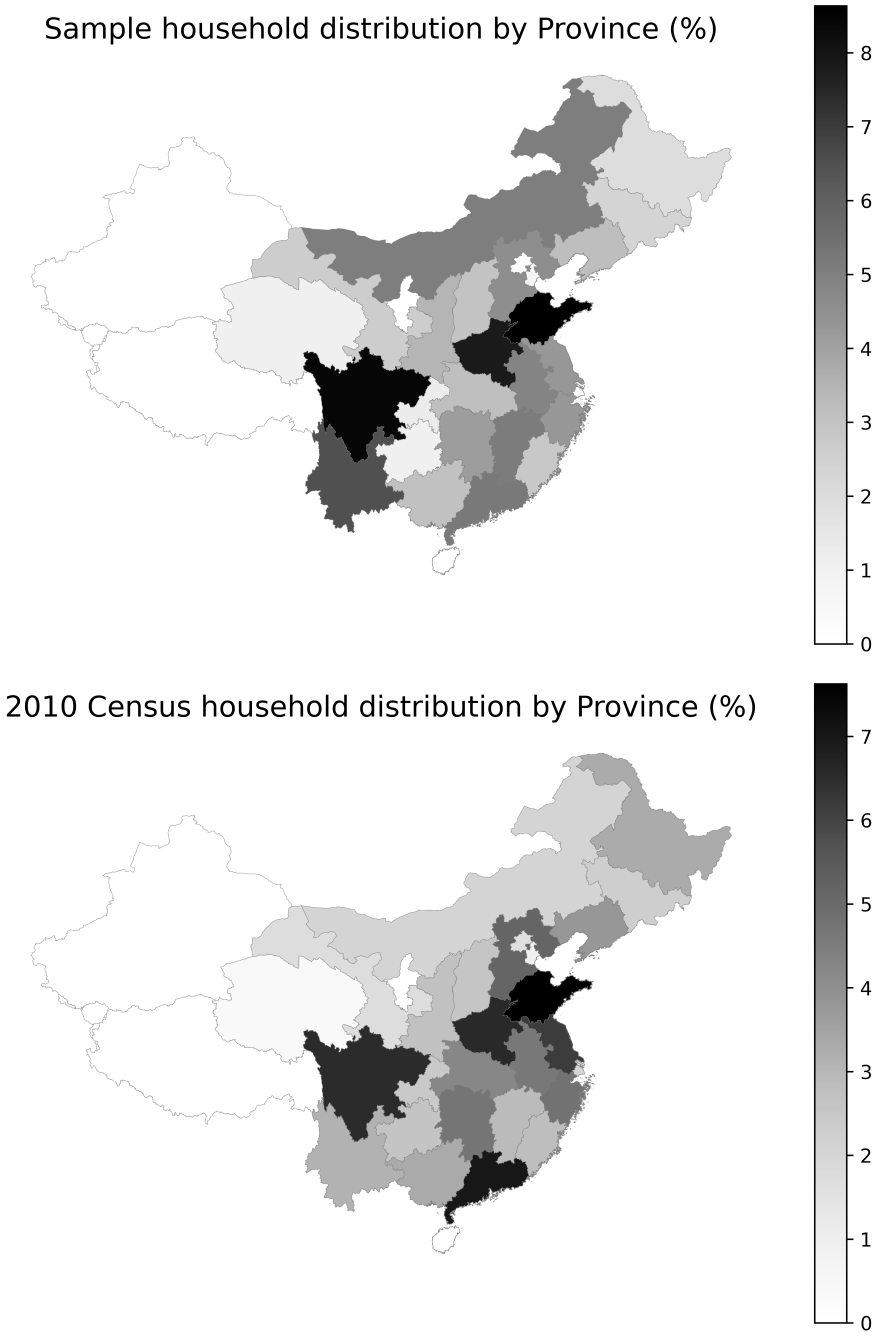


Figure 4: Distribution of households in Sample and 2010 Census by Province

This figure plots the distribution of households in the sample data and the 2010 national census. Source: CHARLS (China Health and Retirement Longitudinal Study) and China Bureau Statistics (2011).

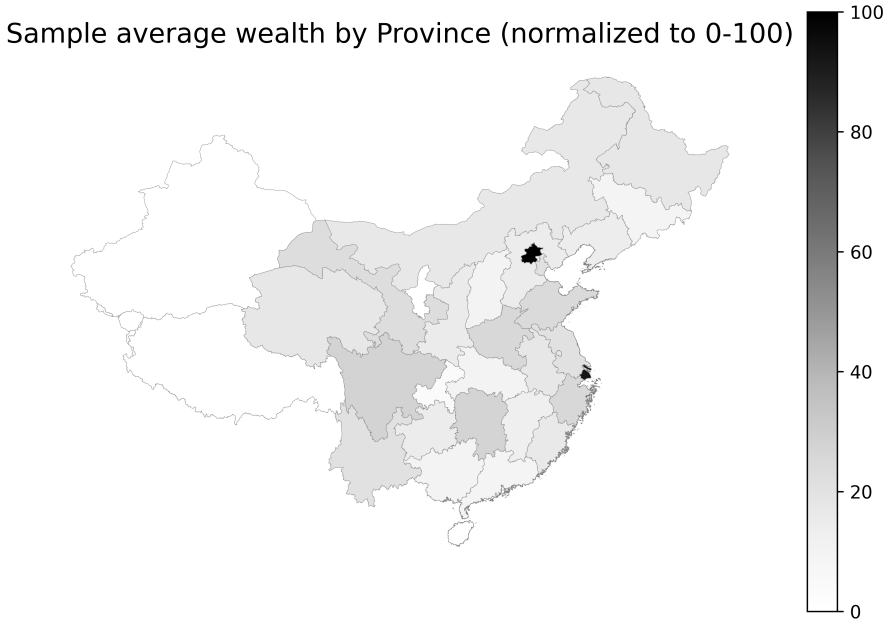


Figure 5: Average scaled (into 0-100) net wealth level of sample households by Province

This figure plots the average scaled net wealth (into 0-100) of Sample households by province. Source: CHARLS (China Health and Retirement Longitudinal Study).

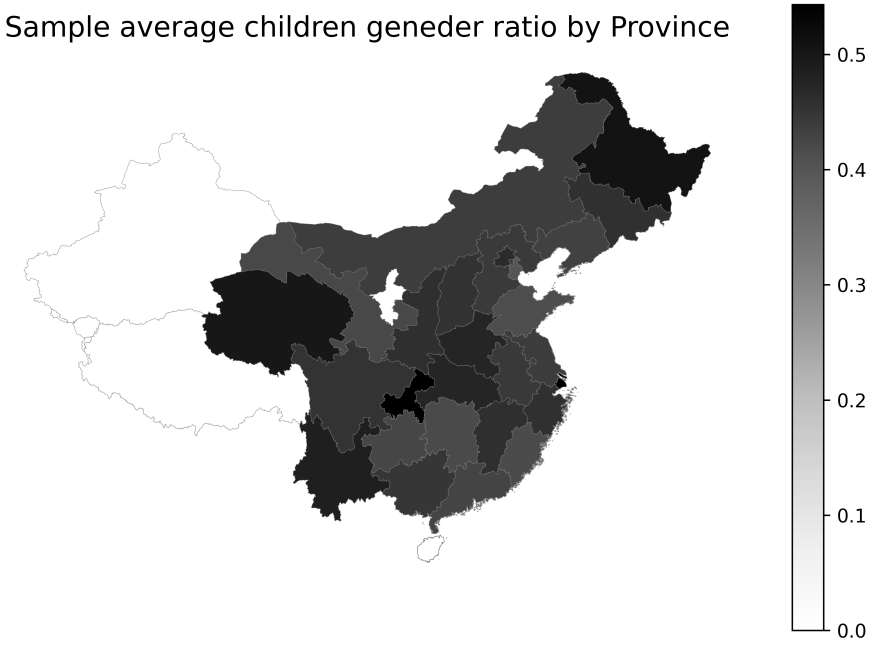


Figure 6: Average children gender ratio of Sample households by Province

This figure plots the average children gender ratio (daughter number to total children number ratio) of Sample households by province. Source: CHARLS (China Health and Retirement Longitudinal Study).

Table 1: Summary statistics

The table provides the summary statistics for our sample. Panel A to E are based on the China Health and Retirement Longitudinal Study (CHARLS), which is nationally representative of residents aged 45 or more in China. The sample we use includes three survey waves in 2013, 2015, and 2018. We restrict the sample to respondents aged 45-70 since it is not possible for older respondents to own term life insurance contracts. Panel A contains the individual-level demographic information, Panel B records the individual-level insurance information, Panel C has family structure information, Panel D is for household-level wealth information, and Panel E is for household-level consumption and income information. Panel F contains household-level distance measures to life insurance firms based on China Insurance Yearbook in 2012, 2014 and 2017.

	Unit	Mean	Min.	Median	Max.	Std.	Count
Panel A: Sample individual level demographic information							
Age	(Year)	57.59	45.00	58.00	70.00	7.18	23562
Gender	(1: Male)	0.48	0.00	0.00	1.00	0.50	23562
Married	(1: Yes)	0.84	0.00	1.00	1.00	0.36	23562
Education:							
Illiterate	(1: Yes)	0.20	0.00	0.00	1.00	0.40	23562
Elementary school graduate	(1: Yes)	0.63	0.00	1.00	1.00	0.48	23562
Middle school graduate	(1: Yes)	0.35	0.00	0.00	1.00	0.48	23562
Occupation:							
Working currently	(1: Yes)	0.70	0.00	1.00	1.00	0.46	23315
Party member	(1: Yes)	0.10	0.00	0.00	1.00	0.30	23274
Civil servant	(1: Yes)	0.02	0.00	0.00	1.00	0.14	23265
Health score (1 being the healthiest):							
Memory score	(Score: [0,1])	0.23	0.00	0.25	1.00	0.21	23215
Mental health score	(Score: [0,1])	0.77	0.00	0.72	1.00	0.21	23046
Living satisfaction score	(Score: [0,1])	0.55	0.00	0.50	1.00	0.20	22984
Panel B: Sample individual level insurance information							
Has term life insurance	(1: Yes)	0.03	0.00	0.00	1.00	0.16	23562
Term life insurance coverage	($\sin^{-1}$(Yuan))	0.28	0.00	0.00	13.62	1.69	23562

Table 1: Summary statistics (continue)

	Unit	Mean	Min.	Median	Max.	Std.	Count
Panel C: Sample family structure information							
Number of household members	(#)	3.20	1.00	3.00	15.00	1.58	23562
Number of alive children	(#)	2.38	0.00	2.00	10.00	1.18	23562
Number of dependent children	(#)	0.33	0.00	0.00	5.00	0.60	23562
Number of alive son(s)	(#)	1.24	0.00	1.00	7.00	0.87	23562
Number of alive daughters(s)	(#)	1.14	0.00	1.00	8.00	0.99	23562
Son ratio	(%)	0.55	0.00	0.50	1.00	0.34	23562
Panel D: Sample household level wealth information							
Net wealth	$(\sin^{-1}(\text{Yuan}))$	8.92	-13.39	11.50	17.26	7.42	23562
Total assets	$(\sin^{-1}(\text{Yuan}))$	11.28	0.00	11.77	17.31	2.54	23562
Total financial assets	$(\sin^{-1}(\text{Yuan}))$	6.52	0.00	7.56	13.67	4.38	23562
Financial assets: cash and deposits	$(\sin^{-1}(\text{Yuan}))$	6.20	0.00	7.41	13.21	4.34	23562
Financial assets: stocks	$(\sin^{-1}(\text{Yuan}))$	0.15	0.00	0.00	10.99	1.24	23562
Total nonfinancial assets	$(\sin^{-1}(\text{Yuan}))$	10.96	0.00	11.49	17.31	2.76	23562
Total nonfinancial assets: properties	$(\sin^{-1}(\text{Yuan}))$	8.13	0.00	10.90	17.09	5.74	23562
Total debts	$(\sin^{-1}(\text{Yuan}))$	2.45	0.00	0.00	13.40	4.59	23562
Panel E: Sample household level consumption and income information							
Annual consumption	$(\sin^{-1}(\text{Yuan}))$	10.01	0.00	10.56	13.06	2.53	23562
Annual consumption per capita	$(\sin^{-1}(\text{Yuan}))$	9.02	0.00	9.49	12.09	2.32	23562
Panel F: Sample household-level Distance to Insurer							
Distance to Nearest Branch	$(\sin^{-1}(\text{Km}))$	6.22	4.52	6.29	8.13	0.70	23562
Equal-weighted Distance to Branches	$(\sin^{-1}(\text{Km}))$	6.24	4.60	6.31	8.14	0.69	23562
Sale-weighted Distance to Branches	$(\sin^{-1}(\text{Km}))$	6.24	4.57	6.31	8.14	0.69	23562

Table 2: Replication: Wealth and Insurance Demand

All columns are estimated via OLS. The dependent variable for Columns (1) and (2) is an indicator equal to 1 if the household owns a term life insurance contract and 0 otherwise. The dependent variable for Columns (3) to (6) is the net wealth with inverse hyperbolic transformation. Column (1) to (4) use the full cleaned sample, while Columns (5) to (6) use the sample with non-zero coverage limit. Columns (2), (4), (6) contain a set of controls including an indicator of living in rural area, an indicator of stock ownership, total debt with inverse hyperbolic transformation, liquidity constraint, children gender ratio, indicators of high school education level, indicators of employment status for working or being a party member, standardized health variables for self-reported health scores and score of mental health, province-gender-age-specific death probability. Standard errors are clustered by province and year, and are shown in parentheses. , , and indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Net Wealth	0.00100***	0.00394***	0.0107***	0.00867***	0.0141*	0.0582
	(0.000132)	(0.000541)	(0.00135)	(0.00179)	(0.00788)	(0.0442)
Province FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Clustering	Y	Y	Y	Y	Y	Y
Control	N	Y	N	Y	N	Y
N	23562	16369	23562	16369	618	466

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Main specification on Insurance Demand

In each column, the dependent variable in the first stage is an indicator equal to 1 if the household owns a term life insurance contract and 0 otherwise and the dependent variable in the second stage is the coverage limit with inverse hyperbolic transformation. All columns are estimated via the maximum likelihood method in the sample selection model framework. Son ratio refers to the ratio of son among children of a household, which takes a value between 0 and 1. Exclusion restriction variable in the first stage in Column (1) and (2) is the equal-weighted distance to the top-5-life-insurance-sales-volume insurers' regional headquarters branches, with inverse hyperbolic transformation. Similarly, the exclusion restriction variable in Column (3) and (4) are the distance to the largest-life-insurance-sales-volume insurers and sale-weighted distance to the top-5-life-insurance-sales-volume insurers, separately. All columns include the probability of death in the next year for the respondent as an additional control. Standard errors are adjusted by the observed information matrix, and are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
2nd stage: Coverage Limit				
Net Wealth	-0.0403***	-0.0329***	-0.0403***	-0.0404***
	(0.0116)	(0.0112)	(0.0116)	(0.0116)
Son Ratio	-0.313*	-0.324*	-0.313*	-0.312*
	(0.175)	(0.171)	(0.175)	(0.175)
Death Probability(‰)	0.0217**	0.0180*	0.0218**	0.0218**
	(0.0103)	(0.0102)	(0.0103)	(0.0103)
Consumption		-0.0532		
		(0.0329)		
1st stage: Selection				
Net Wealth	0.0220***	0.0197***	0.0220***	0.0221***
	(0.00309)	(0.00306)	(0.00309)	(0.00309)
Son Ratio	-0.137***	-0.132***	-0.137***	-0.137***
	(0.0506)	(0.0507)	(0.0506)	(0.0506)
Equal-weighted Distance to Branches	-0.0522**	-0.0466*		
	(0.0249)	(0.0254)		
Death Probability(‰)	-0.0155***	-0.0148***	-0.0155***	-0.0154***
	(0.00289)	(0.00290)	(0.00289)	(0.00289)
Consumption		0.0451***		
		(0.00950)		
Distance to Nearest Branch			-0.0511**	
			(0.0244)	
Sale-weighted Distance to Branches				-0.0513**
				(0.0249)
Inverse Mills ratio	-2.564 ***	-2.454 ***	-2.566 ***	-2.566 ***
	(0.255)	(0.268)	(0.254)	(0.255)
Province FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Control	Y	Y	Y	Y
N	23562	23562	23562	23562

Table 4: Insurance Demand: Wealth Effects by Bequest Motive Intensity

The dependent variable in the first stage is an indicator equal to 1 if the household owns a term life insurance contract and 0 otherwise and the dependent variable in the second stage is the coverage limit with inverse hyperbolic transformation. All columns are estimated via the maximum likelihood method in the sample selection model framework. Son ratio refers to the ratio of son among children of a household, which takes a value between 0 and 1. Exclusion restriction variable in the first stage in Column (1) and (2) is the equal-weighted distance to the top-5-life-insurance-sales-volume insurers' regional headquarters branches, with inverse hyperbolic transformation. Additional controls include the probability of death in the next year for the respondent. Column (1) uses the subsample of "zero-independent-son, zero-dependent-son and zero-dependent-daughter" and Column (2) uses the subsample of "non-zero-independent-son, zero-dependent-son and zero-dependent-daughter". Standard errors are adjusted by the observed information matrix, and are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)
2nd stage: Coverage Limit		
Net Wealth	-0.131***	-0.0370***
	(0.0494)	(0.0144)
1st stage: Selection		
Net Wealth	0.0360***	0.0184***
	(0.0110)	(0.00395)
Equal-weighted Distance to Branches	0.110***	-0.0500*
	(0.0281)	(0.0263)
Inverse Mills ratio	-4.082***	-2.470***
	(0.444)	(0.351)
Year FE	Y	Y
Control	Y	Y
N with Insurance Contract	110	321
N	2906	14285

Table 5: Insurance Demand: Wealth, Son Ratio, Insurance Pricing

In each column, the dependent variable in the first stage is an indicator equal to 1 if the household owns a term life insurance contract and 0 otherwise and the dependent variable in the second stage is the coverage limit with inverse hyperbolic transformation. All columns are estimated via the maximum likelihood method in the sample selection model framework. Son ratio refers to the ratio of son among children of a household, which takes a value between 0 and 1. Premium-to-Coverage-Limit Ratio is the ratio of annual premium to coverage limit (both in inverse hyperbolic transformation). Exclusion restriction variable in the first stage in Column (1) is the equal-weighted distance to the top-5-life-insurance-sales-volume insurers' regional headquarters branches, with inverse hyperbolic transformation. Similarly, the exclusion restriction variable in Column (2) and (3) are the distance to the largest-life-insurance-sales-volume insurers and sale-weighted distance to the top-5-life-insurance-sales-volume insurers, separately. All columns include the probability of death in the next year for the respondent as an additional control. Standard errors are adjusted by the observed information matrix, and are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)
2nd stage: Coverage Limit			
Net Wealth	-0.0294***	-0.0295***	-0.0294***
	(0.0108)	(0.0108)	(0.0108)
Son Ratio	-0.329**	-0.329**	-0.329**
	(0.157)	(0.157)	(0.157)
Premium-to-Coverage-Limit Ratio	-3.665***	-3.664***	-3.664***
	(0.452)	(0.453)	(0.452)
1st stage: Selection			
Net Wealth	0.0223***	0.0223***	0.0223***
	(0.00314)	(0.00314)	(0.00314)
Son Ratio	-0.139***	-0.139***	-0.139***
	(0.0511)	(0.0511)	(0.0511)
Equal-weighted Distance to Branches	-0.0593**		
	(0.0265)		
Distance to Nearest Branch		-0.0577**	
		(0.0260)	
Sale-weighted Distance to Branches			-0.0582**
			(0.0265)
Inverse Mill Ratios	-2.096***	-2.099***	-2.097***
	(0.258)	(0.259)	(0.258)
Province FE	Y	Y	Y
Year FE	Y	Y	Y
Control	Y	Y	Y
N	23546	23546	23546

Table 6: Insurance Demand: Wealth, Son Ratio, Risk Aversion

The dependent variable in the first stage is an indicator equal to 1 if the household owns a term life insurance contract and 0 otherwise and the dependent variable in the second stage is the coverage limit with inverse hyperbolic transformation. All columns are estimated using the maximum-likelihood method within the sample-selection model framework. Son ratio refers to the ratio of son among children of a household, which takes a value between 0 and 1. Risk Share in Financial Wealth in Column (1) and Risk Share in Net Wealth Column (2) are defined as the inverse hyperbolic sine of non-cash, non-deposit financial assets divided by the inverse hyperbolic sine of total financial wealth and total net wealth, respectively. Exclusion restriction variable in the first stage in Column (1) and (2) is the equal-weighted distance to the top-5-life-insurance-sales-volume insurers' regional headquarters branches, with inverse hyperbolic transformation. All columns include the probability of death in the next year for the respondent as an additional control. Standard errors are adjusted by the observed information matrix, and are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)
2nd stage: Coverage Limit		
Net Wealth	-0.0350***	-0.0290**
	(0.0121)	(0.0137)
Son Ratio	-0.179	-0.296*
	(0.195)	(0.175)
Risky Share in Financial Wealth	0.0733	
	(0.378)	
Risky Share in Net Wealth		0.231
		(0.170)
1st stage: Selection		
Net Wealth	0.0189***	0.0205***
	(0.00337)	(0.00372)
Son Ratio	-0.164***	-0.138***
	(0.0576)	(0.0509)
Equal-weighted Distance to Branches	-0.0598**	-0.0527**
	(0.0286)	(0.0249)
Risky Share in Financial Wealth	0.0693	
	(0.109)	
Risky Share in Net Wealth		-0.0220
		(0.0486)
Inverse Mill Ratios	-2.587***	-2.582***
	(0.271)	(0.246)
Province FE	Y	Y
Year FE	Y	Y
Control	Y	Y
N	17273	23116

Table 7: Insurance Demand: Wealth, Son Ratio, Financial Literacy

In each column, the dependent variable in the first stage is an indicator equal to 1 if the household owns a term life insurance contract and 0 otherwise and the dependent variable in the second stage is the coverage limit with inverse hyperbolic transformation. All columns are estimated via the maximum likelihood method in the sample selection model framework. Son ratio refers to the ratio of son among children of a household, which takes a value between 0 and 1. We measure financial literacy with indicators of educational attainment: Column (1), (2), (3) include an indicator of Illiterate, Elementray School, and Middle School, respectively. Exclusion restriction variable in the first stage in Column (1) and (2) is the equal-weighted distance to the top-5-life-insurance-sales-volume insurers' regional headquarters branches, with inverse hyperbolic transformation. All columns include the probability of death in the next year for the respondent as an additional control. Standard errors are adjusted by the observed information matrix, and are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)
2nd stage: Coverage Limit			
Net Wealth	-0.0363***	-0.0353***	-0.0358***
	(0.0114)	(0.0113)	(0.0114)
Son Ratio	-0.292*	-0.300*	-0.295*
	(0.174)	(0.175)	(0.174)
Indicator: Illiterate	1.106***		
	(0.226)		
Indicator: Elementary School		-0.974***	
		(0.178)	
Indicator: Middle School			-0.673***
			(0.157)
1st stage: Selection			
Net Wealth	0.0206***	0.0200***	0.0205***
	(0.00306)	(0.00305)	(0.00307)
Son Ratio	-0.142***	-0.137***	-0.143***
	(0.0506)	(0.0506)	(0.0506)
Equal-weighted Distance to Branches	-0.0371	-0.0293	-0.0289
	(0.0247)	(0.0245)	(0.0249)
Indicator: Illiterate	-0.399***		
	(0.0586)		
Indicator: Elementary School		0.369***	
		(0.0432)	
Indicator: Middle School			0.305***
			(0.0366)
Inverse Mill Ratios	-2.559***	-2.584***	-2.529***
	(0.251)	(0.248)	(0.264)
Province FE	Y	Y	Y
Year FE	Y	Y	Y
Control	Y	Y	Y
N	23562	23562	23562

Table 8: Insurance Demand: Wealth, Son Ratio, Liquidity Constraint

In each column, the dependent variable in the first stage is an indicator equal to 1 if the household owns a term life insurance contract and 0 otherwise and the dependent variable in the second stage is the coverage limit with inverse hyperbolic transformation. All columns are estimated via the maximum likelihood method in the sample selection model framework. Son ratio refers to the ratio of son among children of a household, which takes a value between 0 and 1. We construct four liquidity variables: the amount of liquid assets (defined as cash and deposits with inverse hyperbolic transformation) in Column (1), the ratio of liquid assets net wealth with inverse hyperbolic transformation in Column (2), and the ratio of liquid assets, to household annual consumption with inverse hyperbolic transformation in Column (3), and the ratio of liquid assets, to household consumption per capita with inverse hyperbolic transformation in Column (4). Exclusion restriction variable in the first stage is the equal-weighted distance to the top-5-life-insurance-sales-volume insurers' regional headquarters branches, with inverse hyperbolic transformation. All columns include the probability of death in the next year for the respondent as an additional control. Standard errors are adjusted by the observed information matrix, and are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
2nd stage: Coverage Limit				
Net Wealth	-0.0302***	-0.0290**	-0.0312***	-0.0313***
	(0.0111)	(0.0137)	(0.0111)	(0.0111)
Son Ratio	-0.329*	-0.296*	-0.262	-0.260
	(0.173)	(0.175)	(0.175)	(0.175)
Cash and Deposit	-0.0634***			
	(0.0166)			
Liquid Asset Ratio		-0.231		
		(0.170)		
Cash-to-Consumption Ratio			-0.541***	
			(0.169)	
Cash-to-Average-Consumption Ratio				-0.467***
				(0.151)
1st stage: Selection				
Net Wealth	0.0183***	0.0205***	0.0185***	0.0185***
	(0.00307)	(0.00372)	(0.00314)	(0.00314)
Son Ratio	-0.133***	-0.138***	-0.138***	-0.139***
	(0.0509)	(0.0509)	(0.0517)	(0.0518)
Equal-weighted Distance to Branches	-0.0522**	-0.0527**	-0.0557**	-0.0562**
	(0.0255)	(0.0249)	(0.0259)	(0.0259)
Cash and Deposit	0.0308***			
	(0.00433)			
Liquid Asset Ratio		0.0220		
		(0.0486)		
Cash-to-Consumption Ratio			0.269***	
			(0.0465)	
Cash-to-Average-Consumption Ratio				0.238***
				(0.0414)
Inverse Mills ratio	-2.502***	-2.582***	-2.5633***	-2.502***
	(0.265)	(0.246)	(0.250)	(0.256)
Province FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Control	Y	Y	Y	Y
N	23562	23116	22376	22376

Table 9: Insurance Demand: Wealth, Son Ratio, Debt

In each column, the dependent variable in the first stage is an indicator equal to 1 if the household owns a term life insurance contract and 0 otherwise and the dependent variable in the second stage is the coverage limit with inverse hyperbolic transformation. All columns are estimated via the maximum likelihood method in the sample selection model framework. Son ratio refers to the ratio of son among children of a household, which takes a value between 0 and 1. We measure the debt level using the amount of hyperbolic-transformed total debt in Column (1) and the ratio of hyperbolic-transformed total debt to hyperbolic-transformed net wealth in Column (2). Exclusion restriction variable in the first stage in Column (1) and (2) is the equal-weighted distance to the top-5-life-insurance-sales-volume insurers' regional headquarters branches, with inverse hyperbolic transformation. All columns include the probability of death in the next year for the respondent as an additional control. Standard errors are adjusted by the observed information matrix, and are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)
2nd stage: Coverage Limit		
Net Wealth	-0.0388***	-0.0623***
	(0.0139)	(0.0150)
Son Ratio	-0.308*	-0.285
	(0.170)	(0.175)
Total Debt	-0.0125	
	(0.0162)	
Debt-to-Wealth Ratio		0.509***
		(0.193)
1st stage: Selection		
Net Wealth	0.0276***	0.0282***
	(0.00327)	(0.00402)
Son Ratio	-0.140***	-0.137***
	(0.0508)	(0.0509)
Equal-weighted Distance to Branches	-0.0537**	-0.0504**
	(0.0257)	(0.0248)
Total Debt	0.0193***	
	(0.00420)	
Debt-to-Wealth Ratio		-0.154***
		(0.0577)
Inverse Mill Ratios	-2.422***	-2.578***
	(0.278)	(0.247)
Province FE	Y	Y
Year FE	Y	Y
Control	Y	Y
N	23562	23116

Table 10: Insurance Demand: Wealth, Son Ratio, Working Conditions

In each column, the dependent variable in the first stage is an indicator equal to 1 if the household owns a term life insurance contract and 0 otherwise and the dependent variable in the second stage is the coverage limit with inverse hyperbolic transformation. All columns are estimated via the maximum likelihood method in the sample selection model framework. Son ratio refers to the ratio of son among children of a household, which takes a value between 0 and 1. We measure the working conditions by the indicator of having a job, being a party member, or being a civil servant. Exclusion restriction variable in the first stage in Column (1) and (2) is the equal-weighted distance to the top-5-life-insurance-sales-volume insurers' regional headquarters branches, with inverse hyperbolic transformation. All columns include the probability of death in the next year for the respondent as an additional control. Standard errors are adjusted by the observed information matrix, and are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
2nd stage: Coverage Limit				
Net Wealth	-0.0392***	-0.0375***	-0.0377***	-0.0355***
	(0.0117)	(0.0116)	(0.0117)	(0.0116)
Son Ratio	-0.302*	-0.316*	-0.320*	-0.314*
	(0.176)	(0.175)	(0.175)	(0.176)
Indicator: Working	-0.385**			-0.374**
	(0.156)			(0.156)
Indicator: Party Member		-0.430**		-0.370*
		(0.194)		(0.204)
Indicator: Civil Servant			-0.577	-0.327
			(0.383)	(0.403)
1st stage: Selection				
Net Wealth	0.0215***	0.0212***	0.0213***	0.0207***
	(0.00309)	(0.00308)	(0.00309)	(0.00309)
Son Ratio	-0.136***	-0.130**	-0.130**	-0.130**
	(0.0513)	(0.0511)	(0.0511)	(0.0517)
Equal-weighted Distance to Branches	-0.0563**	-0.0512**	-0.0520**	-0.0530**
	(0.0256)	(0.0254)	(0.0254)	(0.0261)
Indicator: Working	0.145***			0.145***
	(0.0427)			(0.0433)
Indicator: Party Member		0.179***		0.175***
		(0.0545)		(0.0564)
Indicator: Civil Servant			0.141	0.0272
			(0.110)	(0.115)
Inverse Mill Ratios	-2.542***	-2.523***	-2.525***	-2.477***
	(0.265)	(0.261)	(0.268)	(0.272)
Province FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Control	Y	Y	Y	Y
N	23315	23274	23265	23020

Table 11: Insurance Demand: Wealth, Son Ratio, Health Conditions

In each column, the dependent variable in the first stage is an indicator equal to 1 if the household owns a term life insurance contract and 0 otherwise and the dependent variable in the second stage is the coverage limit with inverse hyperbolic transformation. All columns are estimated via the maximum likelihood method in the sample selection model framework. Son ratio refers to the ratio of son among children of a household, which takes a value between 0 and 1. Health conditions are measured by three standardized health variables ranging in 0 and 1, including memory score, mental health score, and living satisfaction score. Exclusion restriction variable in the first stage in all columns is the equal-weighted distance to the top-5-life-insurance-sales-volume insurers' regional headquarters branches, with inverse hyperbolic transformation. All columns include the probability of death in the next year for the respondent as an additional control. Standard errors are adjusted by the observed information matrix, and are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)
2nd stage: Coverage Limit			
Net Wealth	-0.0337***	-0.0325***	-0.0357***
	(0.0113)	(0.0110)	(0.0114)
Son Ratio	-0.303*	-0.294*	-0.283
	(0.176)	(0.176)	(0.177)
Memory Score	-0.623*		
	(0.328)		
Mental Health Score		-0.755**	
		(0.360)	
Living Satisfaction Score			-0.502
			(0.353)
1st stage: Selection			
Net Wealth	0.0195***	0.0180***	0.0199***
	(0.00308)	(0.00308)	(0.00311)
Son Ratio	-0.136***	-0.138***	-0.134***
	(0.0512)	(0.0513)	(0.0514)
Equal-weighted Distance to Branches	-0.0480*	-0.0408*	-0.0503**
	(0.0249)	(0.0247)	(0.0247)
Memory Score	0.307***		
	(0.0840)		
Mental Health Score		0.561***	
		(0.0962)	
Living Satisfaction Score			0.321***
			(0.0956)
Inverse Mill Ratios	-2.561***	-2.590***	-2.604***
	(0.252)	(0.231)	(0.238)
Province FE	Y	Y	Y
Year FE	Y	Y	Y
Control	Y	Y	Y
N	23081	23046	22984

I. Appendix A

A. *Details of the Theoretical Framework*

The problem in Section 1 follows the household finance literature and provides a tractable framework in which the life insurance decision is the focal point of analysis. The technical conditions imposed are that the utility function u is strictly increasing, strictly concave, and twice continuously differentiable (C^2), the discount factor satisfies $\beta \in (0,1)$, the feasible set is compact, and the continuation value is finite, increasing, and concave in wealth. These are typical assumptions in the economic and finance literature and ensure that the recursive problem is well defined, the value function is uniquely pinned down under standard recursive arguments, and the household's optimal choice exists and is unique (see Stokey, Lucas, and Prescott (1989) and Marinacci and Montrucchio (2010)).

A.1. *Intensive Margin Analysis*

Setting. We take the household as already insured this period, that is $I_t = 1$. Given beginning-of-period wealth W_t, next period's wealth is

$$W_{t+1} = \Big[W_t - C_t - p_t B_t \Big] R_{t+1},$$

and the period-t objective function is

$$V_t = u(C_t) + \beta \Big\{ \phi_{t+1} \mathbb{E}_t(V_{t+1}) + (1 - \phi_{t+1}) \theta_t(\zeta_t) \mathbb{E}_t \big[u(W_{t+1} + B_t) \big] \Big\}.$$

Relevant assumptions. We maintain the standard conditions from the main text: (i) the utility function u is strictly increasing, strictly concave, and is C^2; (ii) survival probability ϕ_{t+1} is known at t; (iii) the portfolio gross return $R_{t+1} > 0$ is stochastic, exogenous, and independent of insurance or survival, with support contained in $[0, \overline{R}_{t+1})$ where $0 < p_t \overline{R}_{t+1} < 1$; and (iv) V_{t+1} is increasing and concave in wealth by backward induction. We impose the usual solvency requirement $W_t \geq 0$ a.s.

Compactness of feasible choices. Because the premium amount $B_t p_t$ must be paid out of W_t, the household cannot select arbitrarily large coverage levels. For any con-

sumption choice $C_t \in (0, W_t]$, the budget constraint requires that enough wealth remains to pay the insurance premium. This implies an upper bound on the insurance coverage:

$$0 \;\leq\; B_t \;\leq\; \frac{W_t - C_t}{p_t}.$$

In other words, the beginning-of-period wealth W_t determines the size of the feasible set of choices. Formally, the set of admissible pairs (C_t, B_t) at time t is

$$\mathcal{F}_t(W_t) \;=\; \Big\{(C_t, B_t) :\; 0 \leq C_t \leq W_t, \quad 0 \leq B_t \leq (W_t - C_t)/p_t \Big\}.$$

Therefore, the feasible set is closed, bounded, and convex, providing a well-defined domain for the household's optimization problem.

Existence of unique solution (C_t, B_t). Define the period t objective as

$$\mathcal{J}_t(C_t, B_t) \equiv u(C_t) + \beta \Big\{ \phi_{t+1} \mathbb{E}_t[V_{t+1}(W_{t+1})] + (1 - \phi_{t+1}) \theta_t(\zeta_t) \mathbb{E}_t\big[\, u(W_{t+1} + B_t) \,\big] \Big\}.$$

Given wealth W_t and the closed and bounded feasible set $\mathcal{F}_t(W_t)$, the objective $\mathcal{J}_t(C_t, B_t)$ is continuous in (C_t, B_t). Since $u(\cdot)$ is C^2, $V_{t+1}(\cdot)$ is continuous and concave by induction, and expectations preserve continuity. By the Extreme Value Theorem (EVT), a continuous function on a compact set attains a maximum. Hence there exists a solution $(C_t^\star, B_t^\star) \in \mathcal{F}_t(W_t)$, which is unique by Marinacci and Montrucchio (2010).

Comparative statics: Effect of wealth W_t on the optimal coverage choice $B_t^\star$. We study the sign of the slope of the optimal coverage with respect to wealth, $\frac{\mathrm{d}B_t^\star}{\mathrm{d}W_t}$. Let

$$\mathcal{J}_B \;\equiv\; \frac{\partial \mathcal{J}_t}{\partial B_t}, \qquad \mathcal{J}_{BB} \;\equiv\; \frac{\partial^2 \mathcal{J}_t}{\partial B_t^2}, \qquad \mathcal{J}_{BW} \;\equiv\; \frac{\partial^2 \mathcal{J}_t}{\partial B_t \, \partial W_t}.$$

$$\mathcal{J}_C \;\equiv\; \frac{\partial \mathcal{J}_t}{\partial C_t}, \qquad \mathcal{J}_{CC} \;\equiv\; \frac{\partial^2 \mathcal{J}_t}{\partial C_t^2}, \qquad \mathcal{J}_{CW} \;\equiv\; \frac{\partial^2 \mathcal{J}_t}{\partial C_t \, \partial W_t}.$$

At an interior optimum the first-order conditions are

$$\mathcal{J}_B(C_t^\star, B_t^\star; W_t) = 0, \qquad \mathcal{J}_C(C_t^\star, B_t^\star; W_t) = 0.$$

Differentiating this system with respect to W_t and applying the implicit function theorem (IFT) gives

$$\begin{bmatrix} \mathcal{J}_{BB} & \mathcal{J}_{BC} \\ \mathcal{J}_{CB} & \mathcal{J}_{CC} \end{bmatrix} \begin{bmatrix} \dfrac{\mathrm{d}B_t^\star}{dW_t} \\ \dfrac{\mathrm{d}C_t^\star}{dW_t} \end{bmatrix} = - \begin{bmatrix} \mathcal{J}_{BW} \\ \\ \mathcal{J}_{CW} \end{bmatrix},$$

so by Cramer's rule

$$\frac{\mathrm{d}B_t^\star}{\mathrm{d}W_t} \;=\; - \frac{\mathcal{J}_{BW}\,\mathcal{J}_{CC} - \mathcal{J}_{BC}\,\mathcal{J}_{CW}}{\mathcal{J}_{BB}\,\mathcal{J}_{CC} - \mathcal{J}_{BC}^2}.$$

We then compute the partial derivatives that enter the numerator and denominator. Recall

$$W_{t+1} = \big[\, W_t - C_t - p_t B_t \,\big] R_{t+1}, \qquad \frac{\partial W_{t+1}}{\partial W_t} = R_{t+1},\; \frac{\partial W_{t+1}}{\partial C_t} = -R_{t+1},\; \frac{\partial W_{t+1}}{\partial B_t} = -p_t R_{t+1}.$$

Let $X_{t+1} \equiv W_{t+1} + B_t$, and denote derivatives by u', u'' and V'_{t+1}, V''_{t+1}. Then

$$\begin{aligned}
\mathcal{J}_{CC} &= u''(C_t) + \beta\,\mathbb{E}_t\Big[\phi_{t+1}\,V''_{t+1}(W_{t+1})\,R_{t+1}^2 \;+\; (1-\phi_{t+1})\,\theta_t(\zeta_t)\,u''(X_{t+1})\,R_{t+1}^2\Big] \;<\; 0, \\
\mathcal{J}_{BC} &= \beta\,\mathbb{E}_t\Big[\phi_{t+1}\,V''_{t+1}(W_{t+1})\,p_t R_{t+1}^2 \;-\; (1-\phi_{t+1})\,\theta_t(\zeta_t)\,u''(X_{t+1})\,R_{t+1}\,(1-p_t R_{t+1})\Big], \\
\mathcal{J}_{CW} &= -\,\beta\,\mathbb{E}_t\Big[\phi_{t+1}\,V''_{t+1}(W_{t+1})\,R_{t+1}^2 \;+\; (1-\phi_{t+1})\,\theta_t(\zeta_t)\,u''(X_{t+1})\,R_{t+1}^2\Big], \\
\mathcal{J}_{BW} &= \beta\,\mathbb{E}_t\Big[\phi_{t+1}\,V''_{t+1}(W_{t+1})\,(-p_t R_{t+1})\,R_{t+1} \;+\; (1-\phi_{t+1})\,\theta_t(\zeta_t)\,u''(X_{t+1})\,R_{t+1}\,(1-p_t R_{t+1})\Big].
\end{aligned}$$

Insurance pricing condition. With the aforementioned no-overpricing condition:

$$p_t\,\mathbb{E}_t[R_{t+1}] \;<\; 1,$$

which can be rewritten, using an expected loading $\ell_t \geq 0$ factor, as:

$$p_t\,\mathbb{E}_t[R_{t+1}] \;<\; (1-\phi_{t+1})(1+\ell_t),$$

this implies a generous bound which is necessary for deriving the next results:

$$0 \;\leq\; \ell_t \;<\; \frac{\phi_{t+1}}{1-\phi_{t+1}}.$$

Details of Proposition 1. Following from the above, we define:

$$\Lambda_t^{\text{surv}} \;\equiv\; \mathbb{E}_t\big[\, V''_{t+1}(W_{t+1})\, R_{t+1}^2\big] \;<\; 0, \quad \Lambda_t^{\text{beq}} \;\equiv\; \mathbb{E}_t\big[\, u''(X_{t+1})\, R_{t+1}\left(1 - p_t R_{t+1}\right)\big] < 0,$$

Using these definitions and the expressions above for the partial derivatives, we obtain

$$\operatorname{sgn}\!\left(\frac{\mathrm{d}B_t^\star}{\mathrm{d}W_t}\right) \;=\; \operatorname{sgn}\Big[-\phi_{t+1} p_t\, \Lambda_t^{\text{surv}} \;+\; (1-\phi_{t+1})\, \theta_t(\zeta_t)\, \Lambda_t^{\text{beq}}\Big].$$

Proof. By Cramer's rule,

$$\frac{\mathrm{d}B_t^\star}{\mathrm{d}W_t} \;=\; -\,\frac{\mathcal{J}_{BW}\,\mathcal{J}_{CC} - \mathcal{J}_{BC}\,\mathcal{J}_{CW}}{\mathcal{J}_{BB}\,\mathcal{J}_{CC} - \mathcal{J}_{BC}^2}.$$

Using Λ_t^{surv} and Λ_t^{beq}, we find

$$\begin{aligned}
\mathcal{J}_{BW} \;&=\; \beta\Big[-\phi_{t+1} p_t\, \Lambda_t^{\text{surv}} \;+\; (1-\phi_{t+1})\, \theta_t(\zeta_t)\, \Lambda_t^{\text{beq}}\Big], \\
\mathcal{J}_{BC} \;&=\; \beta\Big[\phi_{t+1}\, p_t\, \Lambda_t^{\text{surv}} \;-\; (1-\phi_{t+1})\, \theta_t(\zeta_t)\, \Lambda_t^{\text{beq}}\Big] \;=\; -\,\mathcal{J}_{BW}.
\end{aligned}$$

Moreover, from the formulas for $\mathcal{J}_{CC}$ and $\mathcal{J}_{CW}$ it follows that

$$\mathcal{J}_{CC} + \mathcal{J}_{CW} \;=\; u''(C_t) \;<\; 0.$$

Using $\mathcal{J}_{BC} = -\mathcal{J}_{BW}$ and $\mathcal{J}_{CC} + \mathcal{J}_{CW} = u''(C_t)$,

$$\mathcal{J}_{BW}\,\mathcal{J}_{CC} - \mathcal{J}_{BC}\,\mathcal{J}_{CW} \;=\; \mathcal{J}_{BW}\big(\mathcal{J}_{CC} + \mathcal{J}_{CW}\big) \;=\; \mathcal{J}_{BW}\, u''(C_t).$$

Since the denominator $\mathcal{J}_{BB}\mathcal{J}_{CC} - \mathcal{J}_{BC}^2 > 0$ by strict concavity (negative definiteness of the Hessian), and $u''(C_t) < 0$, the sign of $\frac{\mathrm{d}B_t^\star}{\mathrm{d}W_t}$ equals the sign of $\mathcal{J}_{BW}$. Substituting the expression for $\mathcal{J}_{BW}$ in terms of Λ_t^{surv} and Λ_t^{beq} yields the stated result. □

The terms Λ_t^{surv} and Λ_t^{beq} summarize the strength of the survival and bequest channels in the wealth effect. A larger magnitude of Λ_t^{surv} strengthens the survival channel and makes it more likely that higher wealth increases insurance coverage. Conversely, a larger magnitude of Λ_t^{beq} strengthens the bequest channel and makes it more likely that higher

wealth reduces insurance coverage. Given $\Lambda_t^{\text{beq}} < 0$, we define the critical bequest motive intensity:

$$\theta_t^{\text{thres}} \;\equiv\; \frac{\phi_{t+1} p_t \, \Lambda_t^{\text{surv}}}{(1-\phi_{t+1})\, \Lambda_t^{\text{beq}}} \;>\; 0,$$

and obtain the threshold characterization:

$$\frac{\mathrm{d}B_t^\star}{\mathrm{d}W_t} \begin{cases} \geq 0, & \text{if } \theta_t(\zeta_t) \leq \theta_t^{\text{thres}}, \\ < 0, & \text{if } \theta_t(\zeta_t) > \theta_t^{\text{thres}}. \end{cases}$$

Comparative statics in p_t, and ϕ_{t+1}. Keeping primitives other than the one varied fixed, we show how the insurance premium p_t and the survival probability ϕ_{t+1} affect the critical threshold θ_t^{thres} and thus the sign of $\frac{\mathrm{d}B_t^\star}{\mathrm{d}W_t}$.

1. **Insurance Premium p_t.** Since p_t does not enter Λ_t^{surv} and

$$\frac{\partial \Lambda_t^{\text{beq}}}{\partial p_t} \;=\; -\mathbb{E}_t\big[u''(X_{t+1})\, R_{t+1}^2\big] \;>\; 0,$$

   hence

$$\frac{\partial \theta_t^{\text{thres}}}{\partial p_t} \;=\; \frac{\phi_{t+1}\Lambda_t^{\text{surv}}}{(1-\phi_{t+1})\, \Lambda_t^{\text{beq}}} \;+\; \frac{\phi_{t+1} p_t \, \Lambda_t^{\text{surv}}}{(1-\phi_{t+1})} \frac{-\,\partial \Lambda_t^{\text{beq}}/\partial p_t}{\big(\Lambda_t^{\text{beq}}\big)^2} \;>\; 0.$$

   A higher premium scales up the survival term and shrinks the pricing wedge inside Λ_t^{beq}, raising θ_t^{thres} and tilting the wealth effect toward the $\frac{dB_t^\star}{dW_t} \geq 0$ zone.

2. **Survival probability ϕ_{t+1}.** Since ϕ_{t+1} does not enter Λ_t^{surv} and Λ_t^{beq},

$$\frac{\partial \theta_t^{\text{thres}}}{\partial \phi_{t+1}} \;=\; \frac{p_t}{(1-\phi_{t+1})^2} \frac{\Lambda_t^{\text{surv}}}{\Lambda_t^{\text{beq}}} \;>\; 0$$

   Higher survival (younger age and/or healthier condition) raises the relative weight of the survival branch and lowers the death weight, yielding a similar effect.

A.2. Extensive Margin Analysis

Setting. The household faces a discrete decision of whether to adopt insurance. Let

$$V_t^0(W_t) \equiv \max_{C_t \in [0, W_t]} \left\{ u(C_t) + \beta \left[\phi_{t+1} \, \mathbb{E}_t\big(V_{t+1}(W_{t+1}^0)\big) + (1 - \phi_{t+1}) \, \theta_t(\zeta_t) \, \mathbb{E}_t\big(u(W_{t+1}^0)\big) \right] \right\},$$

subject to $W_{t+1}^0 = [\, W_t - C_t \,] R_{t+1}$, and

$$V_t^1(W_t) \equiv \max_{\substack{C_t \in [0, W_t] \\ B_t \geq 0}} \left\{ u(C_t) + \beta \left[\phi_{t+1} \, \mathbb{E}_t\big(V_{t+1}(W_{t+1}^1)\big) + (1 - \phi_{t+1}) \, \theta_t(\zeta_t) \, \mathbb{E}_t\big(u(W_{t+1}^1 + B_t)\big) \right] \right\}.$$

subject to $W_{t+1}^1 = (W_t - C_t - p_t B_t) R_{t+1}$. Then the extensive margin decision is

$$I_t^\star(W_t) = \mathbf{1}\{\Delta_t(W_t) > 0\}, \qquad \text{where} \qquad \Delta_t(W_t) \equiv V_t^1(W_t) - V_t^0(W_t).$$

Relevant assumptions. The same set of general assumptions from the intensive-margin analysis applies in the extensive-margin analysis.

Details of Proposition 2. We evaluate the marginal gain from introducing a small amount of coverage at the uninsured optimum, that is, at $C_t = C_t^{0\star}(W_t)$ and $B_t = 0$:

$$\mathcal{M}_t(W_t) \equiv \left. \frac{\partial}{\partial B_t} \right|_{B_t = 0} \left\{ u(C_t) + \beta \left[\phi_{t+1} \, \mathbb{E}_t\big(V_{t+1}(W_{t+1}^1)\big) + (1 - \phi_{t+1}) \, \theta_t(\zeta_t) \, \mathbb{E}_t\big(u(W_{t+1}^1 + B_t)\big) \right] \right\}.$$

Evaluating at the uninsured optimum and using $W_{t+1} = (W_t - C_t^{0\star}) R_{t+1}$, we obtain

$$\mathcal{M}_t(W_t) = \beta \Big\{ -\phi_{t+1} \, p_t \, \mathbb{E}_t\big[V_{t+1}'(W_{t+1}) \, R_{t+1}\big] + (1 - \phi_{t+1}) \, \theta_t(\zeta_t) \, \mathbb{E}_t\big[u'(W_{t+1}) \, (1 - p_t R_{t+1})\big] \Big\}.$$

Insurance is adopted if the marginal gain is positive, that is, if $\mathcal{M}_t(W_t) > 0$. Setting $\mathcal{M}_t(W_t) = 0$ defines the wealth-dependent adoption threshold

$$\theta_t^{\text{adopt}} \equiv \frac{\phi_{t+1} \, p_t \, \mathbb{E}_t\big[V_{t+1}'(W_{t+1}) \, R_{t+1}\big]}{(1 - \phi_{t+1}) \, \mathbb{E}_t\big[u'(W_{t+1}) \, (1 - p_t R_{t+1})\big]}.$$

Then

$$B_t^\star(W_t) > 0 \iff \mathcal{M}_t(W_t) > 0 \iff \theta_t(\zeta_t) > \theta_t^{\text{adopt}}.$$

Therefore, to evaluate how household wealth affects the adoption decision, it is sufficient to study how wealth shifts the adoption threshold θ_t^{adopt}. Since insurance is adopted if and only if $\theta_t(\zeta_t) > \theta_t^{\text{adopt}}$, an increase in wealth raises adoption whenever it lowers the threshold, and lowers adoption whenever it raises the threshold. We now derive $\frac{\mathrm{d}\theta_t^{\text{adopt}}}{\mathrm{d}W_t}$ explicitly. Let

$$N(W_t) \equiv \phi_{t+1} p_t \, \mathbb{E}_t\big[V'_{t+1}(W_{t+1}) R_{t+1}\big], \qquad D(W_t) \equiv (1-\phi_{t+1}) \, \mathbb{E}_t\big[u'(W_{t+1})(1 - p_t R_{t+1})\big],$$

so that

$$\theta_t^{\text{adopt}} = \frac{N(W_t)}{D(W_t)} \gtrless 0.$$

Proof. At the uninsured optimum,

$$W_{t+1} = \big[W_t - C_t^{0\star}(W_t)\big] R_{t+1},$$

$$\frac{\mathrm{d}W_{t+1}}{\mathrm{d}W_t} = \left(1 - \frac{\mathrm{d}C_t^{0\star}(W_t)}{\mathrm{d}W_t}\right) R_{t+1}.$$

Differentiating $N(W_t)$ and $D(W_t)$ with respect to W_t, we obtain

$$\begin{cases} \frac{\mathrm{d}N(W_t)}{\mathrm{d}W_t} = \phi_{t+1} p_t \left(1 - \frac{\mathrm{d}C_t^{0\star}(W_t)}{\mathrm{d}W_t}\right) \mathbb{E}_t\big[V''_{t+1}(W_{t+1}) R_{t+1}^2\big], \\ \frac{\mathrm{d}D(W_t)}{\mathrm{d}W_t} = (1-\phi_{t+1}) \left(1 - \frac{\mathrm{d}C_t^{0\star}(W_t)}{\mathrm{d}W_t}\right) \mathbb{E}_t\big[u''(W_{t+1}) R_{t+1}(1 - p_t R_{t+1})\big]. \end{cases}$$

Applying the quotient rule gives

$$\begin{aligned} \frac{\mathrm{d}\theta_t^{\text{adopt}}}{\mathrm{d}W_t} &= \frac{\frac{\mathrm{d}N(W_t)}{\mathrm{d}W_t} D(W_t) - N(W_t) \frac{\mathrm{d}D(W_t)}{\mathrm{d}W_t}}{D(W_t)^2} \\ &= \frac{\phi_{t+1} p_t (1-\phi_{t+1})}{D(W_t)^2} \times \left(1 - \frac{\mathrm{d}C_t^{0\star}(W_t)}{\mathrm{d}W_t}\right) \\ &\quad \times \Big\{ \mathbb{E}_t\big[V''_{t+1}(W_{t+1}) R_{t+1}^2\big] \mathbb{E}_t\big[u'(W_{t+1})(1 - p_t R_{t+1})\big] \\ &\qquad - \mathbb{E}_t\big[V'_{t+1}(W_{t+1}) R_{t+1}\big] \mathbb{E}_t\big[u''(W_{t+1}) R_{t+1}(1 - p_t R_{t+1})\big] \Big\} \gtrless 0. \end{aligned}$$

□

In other words, the effect of wealth on insurance adoption at the extensive margin is in general ambiguous. An increase in wealth raises adoption if it lowers the adoption threshold θ_t^{adopt}, and lowers adoption if it raises the threshold.

From the expression above, the sign of $\frac{\mathrm{d}\theta_t^{\text{adopt}}}{\mathrm{d}W_t}$ is determined by the term inside the braces. Intuitively, wealth increases adoption if the marginal utility cost of paying insurance premia in the survival state declines sufficiently fast with wealth, relative to the decline in the marginal utility benefit of insurance payouts in the death state. Conversely, wealth decreases adoption if the marginal utility benefit in the death state declines faster than the marginal cost in the survival state. Hence, the overall effect depends on the relative strength of these two opposing forces, and is therefore theoretically ambiguous.

A.3. Comparing Adoption and Coverage Thresholds

Details of Theorem 1. We characterize the joint implications of the two thresholds θ_t^{adopt} and θ_t^{thres} for the relationship between wealth and insurance demand across the extensive and intensive margins. Recall first that the adoption decision satisfies

$$I_t^\star = 1 \iff \theta_t(\zeta_t) > \theta_t^{\text{adopt}}.$$

Hence, conditional on observing an insured household, it must be that $\theta_t(\zeta_t) > \theta_t^{\text{adopt}}$.

Next, the sign of the marginal effect of wealth on optimal coverage is given by

$$\begin{cases} \frac{\mathrm{d}B_t^\star}{\mathrm{d}W_t} \geq 0, & \text{if } \theta_t(\zeta_t) \leq \theta_t^{\text{thres}}, \\ \frac{\mathrm{d}B_t^\star}{\mathrm{d}W_t} < 0, & \text{if } \theta_t(\zeta_t) > \theta_t^{\text{thres}}. \end{cases}$$

Combining these two conditions, we restrict attention to the set of insured households, i.e. those satisfying $\theta_t(\zeta_t) > \theta_t^{\text{adopt}}$. Within this set, two cases arise:

Case 1: $\theta_t^{\text{adopt}} < \theta_t(\zeta_t) \leq \theta_t^{\text{thres}}$.
Households adopt insurance and the marginal effect of wealth on coverage is non-negative.

Case 2: $\theta_t(\zeta_t) > \theta_t^{\text{thres}}$.
Households adopt insurance but the marginal effect of wealth on coverage is negative.

This establishes that, conditional on adoption, the sign of the wealth effect on coverage

depends on the position of $\theta_t(\zeta_t)$ relative to the coverage threshold θ_t^{thres}, while adoption itself depends on the lower threshold θ_t^{adopt}.

Finally, since the adoption threshold θ_t^{adopt} is itself a function of wealth, the marginal effect of wealth on the extensive margin is governed by

$$\frac{\mathrm{d}I_t^\star}{\mathrm{d}W_t} \gtrless 0 \iff \frac{\mathrm{d}\theta_t^{\text{adopt}}}{\mathrm{d}W_t} \lessgtr 0,$$

which is generally ambiguous.

Therefore, the model admits all combinations of wealth effects at the extensive and intensive margins, completing the characterization.

A special case if utility function u is assumed satisfying CRRA . Under CRRA preferences and multiplicative wealth dynamics, the continuation value inherits the same curvature ratio as instantaneous utility. Since the portfolio return R_{t+1} is not risk free and is assumed independent, it follows that, for any W_t,

$$\theta_t^{\text{thres}} > \theta_t^{\text{adopt}}.$$

Proof.

$$\begin{aligned}
&\theta_t^{\text{thres}} - \theta_t^{\text{adopt}} \\
&= \frac{\phi_{t+1} p_t \, \mathbb{E}_t\big[\, V''_{t+1}(W_{t+1})\, R_{t+1}^2\big]}{(1-\phi_{t+1})\, \mathbb{E}_t\big[\, u''(W_{t+1})\, R_{t+1}\, \big(1 - p_t R_{t+1}\big)\big]} - \frac{\phi_{t+1}\, p_t\, \mathbb{E}_t\big[V'_{t+1}\big(W_{t+1}\big)\, R_{t+1}\big]}{(1-\phi_{t+1})\, \mathbb{E}_t\big[u'(W_{t+1})\, \big(1 - p_t R_{t+1}\big)\big]} \\
&= \frac{\phi_{t+1} p_t \mathbb{E}_t\big[R_{t+1}\big]}{(1-\phi_{t+1})\mathbb{E}_t\big[1 - p_t R_{t+1}\big]} \cdot \left\{ \frac{\mathbb{E}_t\big[V''_{t+1}(W_{t+1})\big]}{\mathbb{E}_t\big[u''(W_{t+1})\big]} \cdot K \;-\; \frac{\mathbb{E}_t\big[V'_{t+1}(W_{t+1})\big]}{\mathbb{E}_t\big[u'(W_{t+1})\big]} \right\} > 0 \\
&\quad \text{where } \; K = \frac{\mathbb{E}_t\big[R_{t+1}^2\big]\, \mathbb{E}_t\big[1 - p_t R_{t+1}\big]}{\mathbb{E}_t\big[R_{t+1}\big]\, \mathbb{E}_t\big[R_{t+1}(1 - p_t R_{t+1})\big]} > 1
\end{aligned}$$

□

Comparative statics in p_t and ϕ_{t+1}. Keeping primitives other than the one varied fixed, we show how the premium p_t and the survival probability ϕ_{t+1} affect the wealth-dependent adoption threshold:

1. **Premium p_t.** The numerator is linear in p_t, while the denominator depends on p_t through the wedge $(1 - p_t R_{t+1})$, so similar to that at the intensive margin,

$$\frac{\partial \theta_t^{\text{adopt}}}{\partial p_t} \;>\; 0.$$

A higher premium raises the marginal cost of coverage and shrinks the death-branch pricing wedge, so the adoption threshold increases and adoption becomes less likely.

2. **Survival probability ϕ_{t+1}.** Similarly, since θ_t^{adopt} is a function of $\frac{\phi_{t+1}}{1-\phi_{t+1}}$,

$$\frac{\partial \theta_t^{\text{adopt}}}{\partial \phi_{t+1}} \;>\; 0.$$

When survival is more likely (e.g., younger/healthier), the survival branch receives more weight and the death branch less, making adoption harder to justify and thus less likely, ceteris paribus.

A.4. Comparative Statics in Bequest Motive across both Intensive and Extensive Margins

Intensive margin. Recall the household problem is:

$$\max_{(C_t, B_t) \in \mathcal{F}_t(W_t)} \; \mathcal{J}_t(C_t, B_t; \theta_t(\zeta_t)) \;=\; u(C_t) + \beta \Big\{ \phi_{t+1}\, \mathbb{E}_t\big[V_{t+1}(W_{t+1})\big] + (1-\phi_{t+1})\, \theta_t(\zeta_t)\, \mathbb{E}_t\big[u(X_{t+1})\big] \Big\},$$

with $W_{t+1} = [\, W_t - C_t - p_t B_t \,] R_{t+1}$ and $X_{t+1} = W_{t+1} + B_t$. The first order conditions at an interior optimum $(C_t^\star, B_t^\star)$ are

$$\mathcal{J}_B = \beta \Big\{ -\, \phi_{t+1}\, p_t\, \mathbb{E}_t\big[V'_{t+1}(W_{t+1})\, R_{t+1}\big] + (1-\phi_{t+1})\, \theta_t(\zeta_t)\, \mathbb{E}_t\big[u'(X_{t+1})\,(1 - p_t R_{t+1})\big] \Big\} = 0,$$
$$\mathcal{J}_C = u'(C_t) - \beta\, \mathbb{E}_t\Big[\big(\phi_{t+1}\, V'_{t+1}(W_{t+1}) + (1-\phi_{t+1})\, \theta_t(\zeta_t)\, u'(X_{t+1}) \big) R_{t+1} \Big] = 0.$$

Differentiating the FOCs w.r.t. $\theta_t(\zeta_t)$ and applying the IFT yields

$$\begin{bmatrix} \mathcal{J}_{BB} & \mathcal{J}_{BC} \\ \mathcal{J}_{CB} & \mathcal{J}_{CC} \end{bmatrix} \begin{bmatrix} \dfrac{\mathrm{d}B_t^\star}{\mathrm{d}\theta_t(\zeta_t)} \\ \dfrac{\mathrm{d}C_t^\star}{\mathrm{d}\theta_t(\zeta_t)} \end{bmatrix} = - \begin{bmatrix} \mathcal{J}_{B\theta} \\ \mathcal{J}_{C\theta} \end{bmatrix}, \qquad \frac{\mathrm{d}B_t^\star}{\mathrm{d}\theta_t(\zeta_t)} = - \frac{\mathcal{J}_{B\theta}\, \mathcal{J}_{CC} - \mathcal{J}_{BC}\, \mathcal{J}_{C\theta}}{\mathcal{J}_{BB}\, \mathcal{J}_{CC} - \mathcal{J}_{BC}^2}.$$

Here the mixed partials with respect to $\theta_t(\zeta_t)$ are

$$\begin{aligned}\mathcal{J}_{B\theta} &= \beta(1-\phi_{t+1})\,\mathbb{E}_t\big[u'(X_{t+1})\,(1-p_tR_{t+1})\big] > 0,\\ \mathcal{J}_{C\theta} &= -\,\beta(1-\phi_{t+1})\,\mathbb{E}_t\big[u'(X_{t+1})\,R_{t+1}\big] \;<\; 0.\end{aligned}$$

Strict concavity of $\mathcal{J}_t$ in (C_t, B_t) implies $\mathcal{J}_{BB} < 0$, $\mathcal{J}_{CC} < 0$, and $\mathcal{J}_{BB}\mathcal{J}_{CC} - \mathcal{J}_{BC}^2 > 0$, so the denominator is strictly positive. However, since $\mathcal{J}_{B\theta} > 0$, $\mathcal{J}_{CC} < 0$, and $\mathcal{J}_{C\theta} < 0$, the sign of the numerator remains indeterminate because $\mathcal{J}_{BC}$ can have either sign.

Nevertheless, if we know a household's marginal effect of wealth on insurance demand at the intensive margin is positive, then Proposition 1 implies that the sign of $\mathcal{J}_{BC}$ is negative. When $\mathcal{J}_{BC}$ is negative, the numerator of $\frac{\mathrm{d}B_t^\star}{\mathrm{d}\theta_t(\zeta_t)}$ becomes negative, resulting in the overall sign of $\frac{\mathrm{d}B_t^\star}{\mathrm{d}\theta_t(\zeta_t)}$ positive. On the other hand, when marginal effect of wealth on insurance demand at the intensive margin is negative, then the sign of $\frac{\mathrm{d}B_t^\star}{\mathrm{d}\theta_t(\zeta_t)}$ can still be positive or negative. Intuitively, when a household is willing to buy more life insurance when it becomes richer, then this household will also buy more life insurance if it has a stronger bequest motive intensive. Meanwhile, when the household is willing to buy more life insurance when it becomes poor, an increase in the bequest motive intensity may motivate the household to buy more insurance if the insurance channel dominates, or it may lead to a lower demand of the insurance policy at the intensive margin if the self-insurance channel dominates.

Extensive margin. Recall the marginal index at the uninsured optimizer $C_t = C_t^{0\star}(W_t; \theta_t(\zeta_t))$ and $B_t = 0$,

$$\mathcal{M}_t(W_t) \;=\; \beta\Big\{-\phi_{t+1}\,p_t\,\mathbb{E}_t\big[V'_{t+1}\big(W_{t+1}\big)\,R_{t+1}\big] + (1-\phi_{t+1})\,\theta_t(\zeta_t)\,\mathbb{E}_t\big[u'(W_{t+1})\,\big(1-p_tR_{t+1}\big)\big]\Big\},$$

where $W_{t+1} = [\,W_t - C_t^{0\star}(W_t;\theta_t(\zeta_t))\,]R_{t+1}$. Since the uninsured optimal consumption choice $C_t^{0\star}(W_t;\theta_t(\zeta_t))$ generally depends on $\theta_t(\zeta_t)$, the relevant object is the total derivative:

$$\frac{\mathrm{d}\mathcal{M}_t(W_t)}{\mathrm{d}\theta_t(\zeta_t)} \;=\; \frac{\mathrm{d}}{\mathrm{d}\theta_t(\zeta_t)}\beta\Big\{-\phi_{t+1}\,p_t\,\mathbb{E}_t\big[V'_{t+1}\big(W_{t+1}\big)\,R_{t+1}\big] + (1-\phi_{t+1})\,\theta_t(\zeta_t)\,\mathbb{E}_t\big[u'(W_{t+1})\,\big(1-p_tR_{t+1}\big)\big]\Big\}.$$

Expanding this derivative yields

$$\begin{aligned}\frac{\mathrm{d}\mathcal{M}_t(W_t)}{\mathrm{d}\theta_t(\zeta_t)} \;=\; -\; & \underbrace{\beta\phi_{t+1}p_t\,\frac{\mathrm{d}}{\mathrm{d}\theta_t(\zeta_t)}\mathbb{E}_t\big[V'_{t+1}(W_{t+1})R_{t+1}\big]}_{<0} \\ & +\; \underbrace{\beta(1-\phi_{t+1})\,\mathbb{E}_t\big[u'(W_{t+1})(1-p_tR_{t+1})\big]}_{>0} \\ & +\; \underbrace{\beta(1-\phi_{t+1})\,\theta_t(\zeta_t)\,\frac{\mathrm{d}}{\mathrm{d}\theta_t(\zeta_t)}\mathbb{E}_t\big[u'(W_{t+1})(1-p_tR_{t+1})\big]}_{<0},\end{aligned}$$

which is overall ambiguous in sign. It follows that the effect of the bequest motive intensity $\theta_t(\zeta_t)$ on insurance adoption at the extensive margin is not necessarily monotone.

A.5. Comparative Statics in Mortality Risk across both Intensive and Extensive Margins

Intensive margin. Recall the household problem is

$$\max_{(C_t,B_t)\in\mathcal{F}_t(W_t)}\;\mathcal{J}_t(C_t,B_t;\phi_{t+1}) \;=\; u(C_t)+\beta\Big\{\phi_{t+1}\,\mathbb{E}_t\big[V_{t+1}(W_{t+1})\big]+(1-\phi_{t+1})\,\theta_t(\zeta_t)\,\mathbb{E}_t\big[u(X_{t+1})\big]\Big\},$$

with $W_{t+1}=[\,W_t-C_t-p_tB_t\,]R_{t+1}$ and $X_{t+1}=W_{t+1}+B_t$. The first order conditions at an interior optimum $(C_t^\star,B_t^\star)$ are

$$\begin{aligned}\mathcal{J}_B &= \beta\Big\{-\,\phi_{t+1}\,p_t\,\mathbb{E}_t\big[V'_{t+1}(W_{t+1})\,R_{t+1}\big]+(1-\phi_{t+1})\,\theta_t(\zeta_t)\,\mathbb{E}_t\big[u'(X_{t+1})\,(1-p_tR_{t+1})\big]\Big\}=0,\\ \mathcal{J}_C &= u'(C_t)-\beta\,\mathbb{E}_t\Big[\big(\phi_{t+1}\,V'_{t+1}(W_{t+1})+(1-\phi_{t+1})\,\theta_t(\zeta_t)\,u'(X_{t+1})\big)R_{t+1}\Big]=0.\end{aligned}$$

Differentiating the FOCs with respect to ϕ_{t+1} and applying the IFT yields

$$\begin{bmatrix}\mathcal{J}_{BB} & \mathcal{J}_{BC}\\ \mathcal{J}_{CB} & \mathcal{J}_{CC}\end{bmatrix}\begin{bmatrix}\dfrac{\mathrm{d}B_t^\star}{\mathrm{d}\phi_{t+1}}\\[2ex] \dfrac{\mathrm{d}C_t^\star}{\mathrm{d}\phi_{t+1}}\end{bmatrix}=-\begin{bmatrix}\mathcal{J}_{B\phi}\\ \mathcal{J}_{C\phi}\end{bmatrix},\qquad \frac{\mathrm{d}B_t^\star}{\mathrm{d}\phi_{t+1}}=-\,\frac{\mathcal{J}_{B\phi}\,\mathcal{J}_{CC}-\mathcal{J}_{BC}\,\mathcal{J}_{C\phi}}{\mathcal{J}_{BB}\,\mathcal{J}_{CC}-\mathcal{J}_{BC}^2}.$$

Here the mixed partials with respect to ϕ_{t+1} are

$$\begin{aligned}\mathcal{J}_{B\phi} &= \beta\Big\{-\,p_t\,\mathbb{E}_t\big[V'_{t+1}(W_{t+1})R_{t+1}\big]-\theta_t(\zeta_t)\,\mathbb{E}_t\big[u'(X_{t+1})(1-p_tR_{t+1})\big]\Big\}<0,\\ \mathcal{J}_{C\phi} &= -\,\beta\,\mathbb{E}_t\Big[\big(V'_{t+1}(W_{t+1})-\theta_t(\zeta_t)\,u'(X_{t+1})\big)R_{t+1}\Big].\end{aligned}$$

Strict concavity of $\mathcal{J}_t$ in (C_t, B_t) implies $\mathcal{J}_{BB} < 0$, $\mathcal{J}_{CC} < 0$, and $\mathcal{J}_{BB}\mathcal{J}_{CC} - \mathcal{J}_{BC}^2 > 0$, so the denominator is strictly positive. Moreover, since $\mathcal{J}_{B\phi} < 0$ and $\mathcal{J}_{CC} < 0$, the first term in the numerator is positive, while the second term is not signed in general because both $\mathcal{J}_{BC}$ and $\mathcal{J}_{C\phi}$ are ambiguous. Therefore, the sign of $\frac{\mathrm{d}B_t^\star}{\mathrm{d}\phi_{t+1}}$ is generally ambiguous.

Extensive margin. Recall the marginal index at the uninsured optimizer $C_t = C_t^{0\star}(W_t; \phi_{t+1})$ and $B_t = 0$,

$$\mathcal{M}_t(W_t) \;=\; \beta\Big\{-\phi_{t+1}\, p_t\, \mathbb{E}_t\big[V'_{t+1}(W_{t+1})\, R_{t+1}\big] + (1-\phi_{t+1})\, \theta_t(\zeta_t)\, \mathbb{E}_t\big[u'(W_{t+1})\, \big(1-p_t R_{t+1}\big)\big]\Big\},$$

where $W_{t+1} = [\, W_t - C_t^{0\star}(W_t; \phi_{t+1})\,]R_{t+1}$. Since the uninsured optimal consumption choice $C_t^{0\star}(W_t; \phi_{t+1})$ depends on ϕ_{t+1}, the relevant object is the total derivative

$$\frac{d\mathcal{M}_t(W_t)}{d\phi_{t+1}} \;=\; \frac{d}{d\phi_{t+1}}\beta\Big\{-\phi_{t+1}\, p_t\, \mathbb{E}_t\big[V'_{t+1}(W_{t+1})\, R_{t+1}\big] + (1-\phi_{t+1})\, \theta_t(\zeta_t)\, \mathbb{E}_t\big[u'(W_{t+1})\, \big(1-p_t R_{t+1}\big)\big]\Big\}.$$

Expanding this derivative yields

$$\begin{aligned}
\frac{\mathrm{d}\mathcal{M}_t(W_t)}{\mathrm{d}\phi_{t+1}} \;=\; &-\; \beta p_t\, \mathbb{E}_t\big[V'_{t+1}(W_{t+1})R_{t+1}\big] \\
&-\; \beta\phi_{t+1}p_t\, \frac{\mathrm{d}}{\mathrm{d}\phi_{t+1}}\mathbb{E}_t\big[V'_{t+1}(W_{t+1})R_{t+1}\big] \\
&-\; \beta\theta_t(\zeta_t)\, \mathbb{E}_t\big[u'(W_{t+1})(1-p_t R_{t+1})\big] \\
&+\; \beta(1-\phi_{t+1})\, \theta_t(\zeta_t)\, \frac{\mathrm{d}}{\mathrm{d}\phi_{t+1}}\mathbb{E}_t\big[u'(W_{t+1})(1-p_t R_{t+1})\big].
\end{aligned}$$

The first and third terms are negative, while the second and fourth terms depend on how the uninsured optimal consumption rule $C_t^{0\star}(W_t; \phi_{t+1})$ responds to ϕ_{t+1} through W_{t+1}, and are therefore not signed in general. Hence, $\frac{\mathrm{d}\mathcal{M}_t(W_t)}{\mathrm{d}\phi_{t+1}}$ is also generally ambiguous in sign. It follows that the effect of mortality risk ϕ_{t+1} on insurance adoption at the extensive margin is not necessarily monotone.

II. Appendix B

A. *Technical Details of Heckman Maximum Likelihood Estimation*

Following the two-stage model defined in the main text, the selection equation is given by:

$$Z'_{i,t}\eta + \varepsilon_{1,i,t} > 0 \tag{18}$$

where the error terms $\varepsilon_{1,i,t}$ (selection) and $\varepsilon_{2,i,t}$ (outcome) are assumed to be drawn from a bivariate normal distribution:

$$\varepsilon_{1,i,t} \sim N(0,1) \tag{19}$$

$$\varepsilon_{2,i,t} \sim N(0,\sigma^2) \tag{20}$$

$$\text{corr}(\varepsilon_{1,i,t}, \varepsilon_{2,i,t}) = \rho \tag{21}$$

For a given observation (i,t), the log-likelihood function $l_{i,t}$ depends on whether the outcome $Y_{i,t}$ is observed ($D_{i,t} = 1$) or unobserved ($D_{i,t} = 0$). The log-likelihood is constructed as follows:

$$l_{i,t} = \begin{cases} \ln \Phi\left(\frac{Z'_{i,t}\eta + (Y_{i,t} - X'_{i,t}\beta)\rho/\sigma}{\sqrt{1-\rho^2}}\right) - \frac{1}{2}\left(\frac{Y_{i,t} - X'_{i,t}\beta}{\sigma}\right)^2 - \ln(\sqrt{2\pi}\sigma) & \text{if } Y_{i,t} \text{ is observed} \\ \ln \Phi(-Z'_{i,t}\eta) & \text{if } Y_{i,t} \text{ is not observed} \end{cases} \tag{22}$$

where $\Phi(\cdot)$ represents the standard normal cumulative distribution function.

In the maximum likelihood estimation process, the parameters σ and ρ are not estimated directly to ensure they remain within their valid mathematical bounds ($\sigma > 0$ and $-1 < \rho < 1$). Instead, the model directly estimates $\ln \sigma$ and the inverse hyperbolic tangent of ρ ($\text{atanh}\, \rho$):

$$\text{atanh}\, \rho = \frac{1}{2} \ln\left(\frac{1+\rho}{1-\rho}\right) \tag{23}$$

Finally, the coefficient for the inverse Mills ratio, defined as $\lambda = \rho\sigma$, captures the magnitude and direction of the sample selection bias. The standard error for λ is approx-

imated using the delta method (propagation of error). Specifically:

$$\mathrm{Var}(\lambda) \approx \mathbf{D}\mathrm{Var}(\{\operatorname{atanh}\rho, \ln\sigma\})\mathbf{D}' \tag{24}$$

where $\mathbf{D}$ is the Jacobian matrix of λ with respect to the directly estimated parameters $\operatorname{atanh}\rho$ and $\ln\sigma$.