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Leonardo Becchetti

becchetti@economia.uniroma2.it

University of Rome Tor Vergata

Demetrio Bova

University of Warsaw

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Leonardo Becchetti, Department of Economics and Finance, University of Rome Tor Vergata, Rome, Italy

Demetrio Bova, Department of Political Economy, Faculty of Economic Sciences, University of Warsaw, Warsaw, Poland

Corresponding author: Leonardo Becchetti, Department of Economics and Finance, University of Rome Tor Vergata, Via Columbia 2, 00133 Rome, Italy. Email: becchetti@economia.uniroma2.it

Abstract

Under what conditions is compulsory social insurance for long-term care justified, and how should it be designed and financed? We develop a theoretical framework integrating household choices between formal and informal care, incomplete private insurance, care externalities, benefit design, demographic change, public financing, and professional-care supply. Voluntary risk pooling may be undermined by adverse selection, while the case for compulsory coverage strengthens when insurance-market frictions, liquidity constraints, redistribution and external benefits of adequate care interact. Optimal benefits increase with dependency severity under specified conditions; a combination of care-linked services and unrestricted cash may outperform either instrument alone by balancing verifiable care provision against household flexibility. We derive a fiscal-feasibility frontier incorporating dependency ratios, benefit costs, healthcare savings, employment-related fiscal offsets and the financing base. Fiscal solvency, however, does not ensure effective coverage: when professional-care supply is inelastic, higher care-linked reimbursement is capitalised into prices rather than additional care and can reduce welfare when public funds are costly. Predictable ageing can also justify partial prefunding. The framework identifies the economic rationale, design choices and real-resource constraints governing compulsory long-term care insurance.

JEL codes: I13, I18, J14, H51, D82.

Keywords: Long-term care insurance; care dependency; social insurance; informal caregiving; care externalities; long-term care financing.

1. Introduction

Population ageing is making care dependency an increasingly important social risk, distinct from ordinary retirement-income risk. In the European Union the population aged 65 and over exceeded 21 percent in 2023 and is projected to approach 30 percent by 2050 (OECD and European Commission, 2024); public long-term-care expenditure is also projected to rise substantially (Blavet, Lorenzoni and Rapp, 2026). Individuals face uncertainty about whether, when and how severely they will become dependent, as well as about care duration and available family support. The central policy question is therefore not simply how to finance longer lives, but under what conditions compulsory insurance improves on voluntary arrangements, how entitlements should be structured, and whether the promised services can be supplied.

Care improves recipients' wellbeing and autonomy while also affecting household production and relatives' capacity to work. Much care remains unpaid, disproportionately supplied within families, yet it consumes time

and can reduce current earnings and future pensions (England, 2005; Van Houtven, Coe and Skira, 2013; Korfhage and Fischer-Weckemann, 2024). Adequate care may also avert acute hospital use. These effects have different welfare status. The forgone earnings of an informal caregiver are a real private cost even without a financial transaction; a reduction in publicly financed hospital spending is a possible fiscal offset; uncompensated benefits to third parties are genuine externalities. Neither unpaid provision nor low care wages alone proves market failure: the relevant question is whether decision-makers internalise the full marginal social value and cost of care.

We distinguish three linked sets of conditions. First, voluntary private insurance may be incomplete because of adverse selection, loading costs, liquidity constraints and limited foresight (Finkelstein and McGarry, 2006; Brown and Finkelstein, 2007; Hendren, 2013); care externalities and redistributive objectives offer additional reasons for collective coverage. Second, even when compulsory insurance is warranted, benefits require a choice of severity-related generosity, copayments and a mix of unrestricted cash and accredited services. Third, fiscal feasibility depends on dependency incidence, benefit costs, funding bases and demonstrable offsets, whereas real feasibility depends on professional-care capacity. A financially solvent scheme may otherwise raise provider prices with little change in delivered care. These conditions address different market failures and cannot be replaced by a single general claim of public-sector superiority.

Our contribution is to connect these mechanisms within one tractable framework rather than claim that each is novel. Starting from formal and informal care choice, we derive the social wedge from uncompensated benefits and the fragility of voluntary pooling, then characterise compulsory benefits and the cash-versus-services margin. The fiscal-feasibility frontier incorporates net budget requirements, while an equilibrium welfare benchmark makes explicit provider price pass-through, the marginal cost of funds and care-supply elasticity. Intertemporal finance is considered as a supplementary design choice. Throughout, we distinguish household opportunity costs, external welfare effects and cash-flow offsets to avoid double counting. The propositions identify conditions strengthening the case for compulsory pooling; they do not purport to prove that it dominates every well-functioning private insurance regime.

2. Related Literature and Contribution

The economics of care establishes that paid and unpaid caregiving sustain human capabilities beyond market output (England, 2005; Folbre, 2024; Addati et al., 2018). Informal assistance may substitute for low-intensity home help yet complement professional nursing in more severe states (Bonsang, 2009). It can also impose persistent costs through labour-force withdrawal, wages and pension accumulation (Van Houtven, Coe and Skira, 2013; Korfhage and Fischer-Weckemann, 2024). Our modelling contribution is to include these opportunity costs directly in household care production instead of treating all unpaid care as an uncompensated social benefit. This prevents a common but incorrect inference that the absence of a market wage itself establishes underprovision.

Demand for private long-term-care insurance is constrained by multidimensional private information and contractual limits. Individuals may know their own dependency risk or possess unusually strong insurance preferences, complicating standard adverse-selection tests (Finkelstein and McGarry, 2006). Market contracts can be expensive and incomplete (Brown and Finkelstein, 2007); under some information structures, profitable trade may fail entirely (Hendren, 2013). Public insurance is not without costs: it can crowd out private contracts (Brown and Finkelstein, 2008), and mandatory funding can distort labour or consumption decisions. Following the broader welfare approach of Chetty and Finkelstein (2013), our model compares these mechanisms conditionally rather than interpreting low private take-up as sufficient proof of a public-insurance gain.

Family structure and insurance incentives interact. The availability of children willing to provide care can reduce insurance demand (Mommaerts, 2025), while stated willingness to provide additional unpaid hours falls as their time burden rises (de Jong et al., 2023). Germany and Japan illustrate different compulsory-insurance

designs: public coverage can be combined with private choice, cash, or service-centred entitlements (Campbell and Ikegami, 2000; Campbell, Ikegami and Gibson, 2010; Rothgang, 2010). The effects of cash benefits are not uniform. Comparative evidence links them to informal-care substitution and different responses in formal service use across European settings (Courbage, Montoliu-Montes and Wagner, 2020; Szenkurök, 2026). This motivates treating the division between fungible transfers and verifiable care as an endogenous welfare problem, not a binary ideological choice.

Recent quantitative studies evaluate the optimal structure of long-term-care provision with heterogeneous needs, risk and service preferences (Clavet, Michaud and Navaux, 2026). Our analytical approach is complementary: it seeks transparent sufficient statistics for the insurance, financing and supply margins rather than jurisdiction-specific simulations. The sustainability literature shows why projected care expenditure cannot be read from demographic ratios alone. Older populations face staff shortages alongside expenditure growth (OECD and European Commission, 2024); nursing scarcity can affect occupancy and skill mix (Heger et al., 2025); and slow productivity growth in labour-intensive care can raise relative costs (Hartwig, 2008; Celebi, Hartwig and Sandqvist, 2025). These findings support treating an insurance fund's solvency and the economy's capacity to deliver care as separate restrictions.

The paper adds three linked insights. First, it states when insurance-market frictions and uncompensated care benefits strengthen the case for compulsory pooling, while retaining a competitive-private benchmark. Second, it combines severity-related coverage, potentially positive copayments and a formal cash-versus-care condition in the same household model. Third, it connects a fiscal-feasibility frontier to a provider-incidence calculation that identifies when more reimbursement purchases actual care and when it largely finances higher prices. The distinctive contribution is the interaction among these conditions; the study deliberately leaves a full heterogeneous-agent calibrated welfare comparison to future research.

3. The Model

3.1 Dependency risk and timing

Consider a continuum of individuals of unit mass. In the initial period individuals are autonomous and economically active. Individual i has income $y_i > 0$. In the following period she becomes care-dependent with probability $\pi_i \in (0,1)$.

Conditional on dependency, severity is represented by $0 < d \leq d_{\max}$, with cumulative distribution $F(d)$. Higher d represents a greater loss of autonomy and a larger potential need for long-term care.

An individual who does not become dependent receives utility $u(m_i)$, where m_i denotes disposable resources in the later period. If dependency occurs, the individual receives long-term care.

3.2 Formal and informal care

Let $x \geq 0$ denote professional formal care and $z \geq 0$ informal care provided by relatives. Effective care is

$$q = x + \eta z, \qquad 0 < \eta \leq 1 \tag{1}$$

where η converts an hour of informal care into units comparable with formal care. It need not equal one because different forms of care require different skills.

Formal care has price $p > 0$. The potential family caregiver earns market wage $w > 0$, so an hour devoted to caregiving entails forgone earnings w. Informal care may additionally generate psychological, health and organisational costs. Let $\chi(z)$, with $\chi'(z) \geq 0$ and $\chi''(z) > 0$, denote their monetary equivalent.

The minimum private resource cost of producing q units of effective care is therefore

$$K(q;p,w) = \min_{x,z\geq 0}\{px + wz + \chi(z)\,;\; x + \eta z \geq q\} \tag{2}$$

Unpaid care therefore has a potentially substantial private opportunity cost (de Jong et al., 2023), even when no market payment is observed.

Proposition 1 (Formal versus informal care). *Suppose both formal and informal care are used at an interior optimum. Then*

$$w + \chi'(z) = \eta p \tag{3}$$

and, holding the required effective-care level q fixed,

$$\frac{\partial z^{opt}}{\partial w} = -\frac{1}{\chi''(z^{opt})} < 0, \qquad \frac{\partial z^{opt}}{\partial p} = \frac{\eta}{\chi''(z^{opt})} > 0 \tag{4}$$

Hence a higher opportunity cost of family time reduces informal caregiving, whereas a higher formal-care price increases it, as long as the interior solution remains valid.

Proof. At an interior optimum the technological constraint in (2) binds, so $x = q - \eta z$. Substitution into (2) gives $pq + z(w - \eta p) + \chi(z)$. The first-order condition is (3). Differentiating it with respect to w and p yields (4). ▫

4. Private Care Provision and the Care Externality

Let utility in the dependency state be

$$U^P(q;M,d) = u\big(M - K(q)\big) + v(q,d) \tag{5}$$

where M denotes resources available after dependency. Here, $K(q) \equiv K(q;p,w)$, defined in (2), is the minimum private resource cost of producing q units of effective care, including the opportunity cost of informal caregiving. The term $u[M - K(q)]$ captures utility from resources net of care costs, while $v(q,d)$ represents the direct utility derived from care, conditional on care quantity and dependency severity. Assume $u' > 0, u'' \leq 0, v_q > 0, v_{qq} < 0$, and $v_{qd} \geq 0$. The last condition means that the marginal value of care weakly increases with dependency severity.

At an interior solution, the privately optimal amount of care q^P satisfies

$$v_q(q^P,d) = u'\big(M - K(q^P)\big)K_q(q^P) \tag{6}$$

The right-hand side is the utility cost of the resources required to finance an additional unit of care.

Care may also yield benefits not internalised by the dependent household. Write these as E(q,d), with E_q ≥ 0 and E_qq ≤ 0: examples include genuine third-party spillovers and health-system savings. Because K(q;p,w) already includes the caregiver's forgone earnings, that opportunity cost cannot be counted again as an externality. Programme-specific evidence of lower hospital use after coordinated care suggests possible fiscal offsets, not a universal effect (Brühmann et al., 2023).

We keep resource and fiscal accounts separate: K contains private care and caregiving costs; E contains uncompensated effects on third parties; and avoided public healthcare costs or additional tax receipts enter the fiscal budget only insofar as they are causal offsets. Their underlying welfare effects must not be counted twice.

The social value of care is therefore

$$U^S(q; M, d) = u\big(M - K(q)\big) + v(q, d) + E(q, d) \tag{7}$$

Proposition 2 (Underprovision of care). *If $E_q(q^P, d) > 0$ and the social objective in (7) is strictly concave in q, then*

$$q^S > q^P \tag{8}$$

Proof. At the private optimum, the derivative of the first two terms in (7) is zero by (6). Hence $\partial U^S / \partial q|_{q=q^P} = E_q(q^P, d) > 0$. Strict concavity then implies that the social optimum lies to the right of the private optimum. ▫

Care is underprovided not because a low market wage is itself evidence of market failure, but because part of its social return is not appropriated by those financing it. If $E_q = 0$ and insurance and credit markets are complete, this particular rationale for public subsidisation disappears.

5. Dependency Risk and Incomplete Private Insurance

Define the indirect private value of resources in the dependency state as

$$V(M, d) = \max_{q \geq 0}\big\{u\big(M - K(q)\big) + v(q, d)\big\} \tag{9}$$

Consider a private insurance contract paying state-contingent benefit $b(d)$ in the event of dependency and charging premium P beforehand. Ex ante utility of individual i is

$$\mathcal{W}_i(P, b) = u_0(y_i - P) + \beta\big[(1 - \pi_i)u_1(m_i) + \pi_i \int V(m_i + b(d), d)\, dF(d)\big] \tag{10}$$

Risk aversion can make such state-contingent transfers valuable, but adverse selection may obstruct voluntary pooling.

The difficulty is that long-term care risk may not be perfectly insurable privately. To represent selection transparently, suppose there are two risk classes, $\pi_H > \pi_L$, while the severity distribution $F(d)$ is common across types and individual risk type is not perfectly observable by insurers.

Let $\Omega_i[b]$ denote the maximum premium type i is willing to pay for benefit schedule b. If a set S of individuals purchases insurance, the pooled premium required to finance the contract is

$$P(S) = (1 + \ell)\, \bar{\pi}(S)\, \bar{b}, \qquad \bar{b} = \int b(d)\, dF(d) \tag{11}$$

where $\ell \geq 0$ is an insurance loading and $\bar{\pi}(S)$ is the average dependency probability among purchasers.

Proposition 3 (Fragility of voluntary pooling). *Consider a candidate pooling equilibrium containing both high- and low-risk individuals. If*

$$\Omega_L[b] < (1 + \ell)\bar{\pi}\, \bar{b} \tag{12}$$

where $\bar{\pi}$ is the population-average dependency probability, universal voluntary pooling cannot be sustained. Exit of low-risk individuals raises the average risk of the remaining pool and therefore weakly increases the premium required to finance the same benefit schedule.

Proof. Condition (12) implies that low-risk individuals strictly prefer remaining uninsured to purchasing the pooled contract. Their exit increases $\bar{\pi}(S)$ because $\pi_L < \pi_H$. Equation (11) then implies a weakly higher actuarially required premium for the remaining participants. ▫

The mechanism is a selection feedback, not merely a high insurance premium. A low-risk individual compares the common pooled premium with her own willingness to pay and exits when the former exceeds the latter. The remaining pool has higher average dependency probability, so the actuarially required premium rises for unchanged benefits. This can induce further exit by relatively low-risk purchasers. Proposition 3 establishes why universal voluntary participation fails under (12); it does not claim that every market must unravel completely or that a mandate alone resolves all coverage imperfections.

Compulsory public insurance is not invariably welfare-superior. In a competitive market where insurers accurately observe or classify relevant dependency risks, contracts cover severity and duration without major exclusions, loading costs are low, and households anticipate future needs and can finance premiums, private contracts can transfer consumption across states effectively. Risk-rated premiums reduce selection pressure, although they may create affordability problems for high-risk individuals. When redistribution is not a public objective and care externalities are absent, there may be no strong efficiency case for compulsory coverage. The model therefore distinguishes the efficiency of voluntary pooling from a social preference for protection independent of individual insurability.

Compulsion becomes more attractive as this benchmark fails. Unobservable risk generates the adverse-selection mechanism; limited foresight weakens early demand for distant protection; illiquidity prevents insurance purchase despite positive willingness to pay; and caps or exclusions leave catastrophic losses uninsured. Need-based redistribution can provide protection where actuarially fair individual premiums would be prohibitive. Positive external benefits from adequate care supply another reason for intervention even when insurers successfully pool expenditure risk. These frictions do not all need to operate simultaneously, nor does mandatory participation automatically correct moral hazard, inferior quality or unequal access to professional workers.

Universal risk pooling can secure participation and support need-based entitlements financed by contributive capacity. It can coexist with regulated supplementary private or mutual insurance, including open enrolment, limits on exclusions and risk adjustment. The gains from compulsory coverage must nevertheless be weighed against administrative costs, distorted financing, induced service demand and supply constraints. The paper models these margins separately rather than asserting unconditional superiority of national insurance.

6. National Social Insurance for Care Dependency

We now introduce a compulsory national insurance. Individuals contribute according to

$$T(y), \qquad T'(y) \geq 0 \tag{13}$$

while entitlement depends on dependency status and severity rather than the individual's contribution history:

$$b = b(d) \tag{14}$$

This separates financing according to contributive capacity from entitlement according to dependency need.

Let G denote general-tax financing and Γ administrative expenditure. Ex ante budget balance requires

$$\int T(y_i)\, d\mu(i) + G = \int \pi_i \left[\int b(d)\, dF(d)\right] d\mu(i) + \Gamma \tag{15}$$

6.1 Optimal benefit generosity

Let an additional euro of insurance benefit increase available resources from M to $M + b$. Let $q_b = \partial q^P / \partial b \geq 0$ denote the care-demand response. For a representative insured individual, define the marginal social value of one additional euro of benefit in dependency state d as

$$\mathcal{B}(d, b) = \omega V_M(M + b, d) + E_q(q, d)q_b \tag{16}$$

where $\omega > 0$ is the social welfare weight assigned to the recipient. The first term is the insurance and consumption-smoothing value of the transfer. The second is the additional social value generated if the benefit causes more care to be consumed.

Let $\lambda > 0$ be the shadow social cost of public funds. An interior optimal benefit satisfies

$$\mathcal{B}(d, b^{\text{opt}}) = \lambda \tag{17}$$

Proposition 4 (Severity-related benefits*).* *Suppose $\mathcal{B}_d \geq 0$ and $\mathcal{B}_b < 0$. Then the optimal insurance benefit is weakly increasing in dependency severity:*

$$\frac{db^{opt}(d)}{dd} = -\frac{\mathcal{B}_d}{\mathcal{B}_b} \geq 0 \tag{18}$$

Proof. Differentiate (17) with respect to d. Since $\mathcal{B}_b < 0$ and $\mathcal{B}_d \geq 0$, the resulting expression in (18) is weakly positive. ▫

This motivates benefits graded by dependency severity rather than a uniform entitlement.

Sufficient conditions are non-decreasing marginal utility from care and marginal external care benefits as severity rises, without an offsetting deterioration in the benefit-induced care response. Together with decreasing marginal social value of benefits, these imply the stated comparative static; severity alone is insufficient.

6.2 Why neither zero nor unlimited copayment is generally optimal

Full reimbursement need not be optimal. Suppose greater coverage generates additional induced public cost $\mathcal{M}(b, d)$, with $\mathcal{M}_b \geq 0$. This term can represent unnecessary utilisation, weak quality control or other benefit-induced costs beyond the direct euro of coverage.

The optimality condition becomes

$$\mathcal{B}(d, b^{\text{opt}}) = \lambda[1 + \mathcal{M}_b(b^{\text{opt}}, d)] \tag{19}$$

Positive copayments can be efficient when additional coverage induces costly utilisation. Liquidity constraints and high marginal utility of consumption instead support lower copayments; compulsory insurance does not entail unlimited reimbursement.

7. Cash Benefits versus Care-Linked Benefits

A particularly relevant design question is whether insurance should provide unrestricted cash or finance actual care services. Let a denote unrestricted cash and s a care-linked benefit, with total public expenditure $B = a + s$. Let private indirect utility in the dependency state be $V(a, s, d)$, and let effective care be $q(a, s, d)$.

Define

$$q_a = \frac{\partial q}{\partial a}, \qquad q_s = \frac{\partial q}{\partial s}, \qquad q_s > q_a \tag{20}$$

where the final inequality captures the idea that a euro earmarked for care typically produces more actual care than an unrestricted euro.

Consider a marginal reallocation of one euro from cash to care-linked support, holding total public expenditure fixed. Social welfare changes by

$$\frac{dW}{d\varepsilon} = V_s - V_a + E_q(q_s - q_a) \tag{21}$$

The first term captures the private welfare cost or benefit of restricting fungibility. The second captures the additional external benefit generated by the change in actual care.

Care-linked support is preferred at the margin when

$$E_q(q_s - q_a) > V_a - V_s \tag{22}$$

Condition (22) compares the gain in external care benefits with the recipient's foregone freedom to spend a euro on the highest-valued need. It motivates, but does not by itself prove the optimality of, a mixed personal care budget containing both accredited services and cash.

Earmarking gives the public insurer greater assurance that financed resources are converted into verifiable care, which matters when care quality or external social returns are high. Cash remains valuable precisely because households face heterogeneous expenses—transport, adaptations, respite and informal-care support—that a standardised service list may miss. If a cash euro is used for these purposes, its contribution to effective care need not be negligible. The welfare comparison is therefore not between 'care' and 'no care'; it is between the additional external gain from earmarked provision and the private loss from restrictions on fungibility, evaluated at the household's actual responses.

The relative merits of the instruments change as care expands. Early units may prevent serious health deterioration and generate large social gains, whereas the external return to further services tends to decline under concavity. Cash flexibility may then become more valuable than additional earmarking. Equality in (22) is the interior first-order condition; a positive margin for services at low provision and a negative one at high provision are additionally needed to exclude corner solutions.

Formally, let s in [0,B] denote spending tied to care and B-s unrestricted cash, with W(s)=V(B-s,s)+E[q(B-s,s),d]. If W is continuous, twice differentiable and strictly concave over the feasible range, and W'(0)>0 while W'(B)<0, there is a unique interior allocation. The inequalities have economic content: initially, a service euro must generate enough additional effective care to outweigh the loss of fungibility; when nearly all spending is earmarked, household flexibility must be more valuable at the margin. Without these assumptions, (22) is merely necessary and either instrument can be optimal alone.

Cash can indirectly finance family respite, transport or partial compensation for foregone caregiving earnings; for specialised nursing or compliance with minimum standards, accredited services retain a verification advantage. The amount of effective care obtained from either transfer must therefore be estimated rather than imposed. European evidence finds heterogeneous responses of formal and informal care to cash support (Courbage et al., 2020; Szenkurök, 2026).

A practical implication is a two-layer package: a basic entitlement to professionally verified services where standards and external effects justify it, together with discretionary cash for expenses that vary across dependent households. This mix addresses incomplete planner information without abandoning accountability. It is not an unconditional prescription: when formal-care supply is fixed, extra service-linked support may

increase prices rather than the quantity of care. Section 10 examines the required market-equilibrium adjustment.

8. Fiscal Feasibility of National Care Insurance

We now move from individual optimisation to the aggregate financing problem. Let D_t be the number of care-dependent beneficiaries at date t, N_t the number of contributors, and Y_t^B the aggregate contribution base. Let $\bar{b}_t$ denote average benefit expenditure per dependent individual.

Care provision may also generate budgetary offsets. Let H_t denote public healthcare expenditure avoided through adequate care, and R_t additional public revenue associated with effects such as greater caregiver employment and formalisation of care work. Let G_t be general-tax financing and Γ_t administrative cost.

Fiscal savings and revenue offsets must be evaluated against a counterfactual. Only causally attributable healthcare savings enter Ht and only induced public receipts enter Rt. These are budget entries, not independent additions to the welfare externality E; caregiver earnings already captured in the household cost function cannot be double-counted.

If a proportional contribution τ_t finances the residual requirement, contemporaneous budget balance requires

$$\tau_t Y_t^B + G_t + H_t + R_t = D_t \bar{b}_t + \Gamma_t \tag{23}$$

The minimum contribution rate is therefore

$$\tau_t^{\min} = \frac{D_t \bar{b}_t + \Gamma_t - G_t - H_t - R_t}{Y_t^B} \tag{24}$$

Equation (24) identifies the financing requirement net of causally attributable fiscal offsets rather than gross benefit expenditure. A reduction in hospital use or an increase in taxable caregiver employment can make a given entitlement less expensive to the public budget. Neither effect should be assumed for every intervention: programme-specific evidence of lower medical costs illustrates plausibility but does not identify a general saving per care euro (Brühmann et al., 2023).

Suppose initially that the contribution base consists only of employees, so that $Y_t^B = N_t \bar{y}_t$, where $\bar{y}_t$ is average taxable labour income. Define the care-dependency ratio

$$\rho_t = \frac{D_t}{N_t} \tag{25}$$

Then

$$\tau_t^{\min} = \rho_t \frac{\bar{b}_t}{\bar{y}_t} + \frac{\Gamma_t - G_t - H_t - R_t}{N_t \bar{y}_t} \tag{26}$$

Proposition 5 (Fiscal feasibility frontier). *Let $\bar{\tau}$ denote the maximum contribution rate considered economically or politically sustainable. National care insurance is contemporaneously fiscally feasible if and only if*

$$D_t \bar{b}_t + \Gamma_t \leq \bar{\tau} Y_t^B + G_t + H_t + R_t \tag{27}$$

Under payroll-only financing, this is equivalent to

$$\rho_t \leq \rho_t^{max} = \frac{\bar{\tau}\bar{y}_t}{\bar{b}_t} + \frac{G_t + H_t + R_t - \Gamma_t}{N_t \bar{b}_t} \tag{28}$$

A broader contribution base and credible budget offsets relax the fiscal constraint; higher dependency ratios and benefit costs tighten it.

Proof. Rearranging (23) gives (24). Imposing $\tau_t^{\min} \leq \bar{\tau}$ gives (27). Under $Y_t^B = N_t \bar{y}_t$ and $D_t = \rho_t N_t$, division by $N_t \bar{b}_t$ yields (28). ▫

9. Demographic Change and Years Lived in Dependency

The number of dependent people should not simply be treated as an arbitrary trend. Let A_t denote the autonomous older population, α_t the probability of entering dependency, and ξ_t the probability that a dependent person exits the dependent state through recovery or death.

The stock of dependent individuals evolves according to

$$D_{t+1} = (1 - \xi_t) D_t + \alpha_t A_t \tag{29}$$

When transition probabilities are approximately stationary, expected duration in dependency is increasing in $1/\xi$. Longevity improvements can therefore raise the financing burden even if the probability of entering dependency does not increase, whenever survival after entering poor-health states increases sufficiently.

The fiscal burden depends on person-years lived in dependency, not life expectancy alone. A higher incidence of dependency and longer survival after entry both raise the stock of beneficiaries, unless offset by recovery. Informal-care cost projections likewise depend on these demographic and health transitions (Hu et al., 2024). Improved prevention and healthy ageing could shift those transitions (OECD, 2025), although the baseline treats them as exogenous.

10. Financial Resources Are Not Enough: The Care-Capacity Constraint

Let aggregate desired formal care be $X^D(p, b)$, with $X_p^D < 0$ and $X_b^D > 0$. Care-sector supply is $X^S(p)$, with $X_p^S \geq 0$. Market equilibrium satisfies

$$X^D(p, b) = X^S(p) \tag{30}$$

Differentiating with respect to insurance generosity b gives

$$\frac{dp}{db} = \frac{X_b^D}{X_p^S - X_p^D} > 0 \tag{31}$$

The increase in the equilibrium quantity of formal care is

$$\frac{dX}{db} = \frac{X_p^S X_b^D}{X_p^S - X_p^D} \geq 0 \tag{32}$$

Proposition 6 (Care-capacity constraint and price capitalisation). *An expansion of insurance generosity raises the equilibrium formal-care price. It raises the quantity of formal care when supply is upward sloping, and if short-run supply is perfectly inelastic the quantity response is zero:*

$$\left.\frac{dX}{db}\right|_{X_p^S=0} = 0 \tag{33}$$

Proof. Equations (31) and (32) follow by total differentiation of (30). Since $X_b^D > 0$, $X_p^D < 0$ and $X_p^S \geq 0$, the denominator in (31) is positive. Setting $X_p^S = 0$ in (32) gives (33). ▫

Fiscal solvency does not guarantee the availability of nurses, facilities or territorial services. Documented nursing shortages reinforce the relevance of this separate real-resource constraint (Heger et al., 2025).

In the limiting case of fixed capacity $\bar{X}_t = a_t L_t^C$, where L_t^C is care-sector employment and a_t care productivity, the system additionally requires

$$X_t^D \leq a_t L_t^C \tag{34}$$

Financing alone cannot overcome a binding labour-capacity constraint.

10.1 Connecting care capacity to optimal insurance design

The care benefit derived in Section 6 uses the response of effective care to greater coverage. In market equilibrium the relevant formal-care response is instead dX/db in (32), incorporating both quantity and price adjustment.

Proposition 6A (Capacity-adjusted marginal care benefit). *With E_X>0, the care-mediated external gain from care-linked generosity is E_X(dX/db). This term is non-negative under the demand and supply signs in (30) and approaches zero as short-run formal-care supply becomes perfectly inelastic.*

Proof. Multiply the equilibrium quantity response (32) by E_X and take X^S_p to zero, with X^D_p<0.

Even when this care-mediated gain vanishes, cash insurance or redistribution may retain value. Proposition 6A alone does not establish the welfare effect of provider price transfers; the following benchmark makes their incidence explicit.

10.2 Welfare-optimal care-linked reimbursement, price pass-through and fiscal cost

To account for price transfers, consider a specific policy rather than a generic cash benefit: a public per-unit reimbursement s ≥ 0 for accredited professional care. Hold informal care, quality, risk pooling and the professional supply schedule fixed, with competitive pricing and no queues or rationing. Let v(X) denote money-metric private benefits of formal care and C(X) its real resource cost, where v"(X)<0 and C"(X)>0. Recipients pay the net price p-s and providers receive p. Equilibrium therefore satisfies v'(X)=p-s and C'(X)=p. Put β=-v"(X)>0 and κ=C"(X)>0. Differentiation yields:

$$\chi \equiv \frac{dX}{ds} = \frac{1}{\beta + \kappa}, \qquad \rho \equiv \frac{dp}{ds} = \frac{\kappa}{\beta + \kappa} \tag{34a}$$

Here ρ is the share of reimbursement capitalised into provider prices, and χ is the additional care quantity per unit reimbursed. Higher inverse-supply slope κ increases ρ and reduces χ.

Let U(r)=max_X{v(X)-rX} denote recipient surplus at the net price r=p-s, and Π(p)=max_X{pX-C(X)} providers' maximised profits. A weight ω≥1 captures distributive priority given to dependent households relative to providers, while λ≥1 is the marginal social cost of public funds in the same money-metric units. Separate $E^N(X)$, genuine non-fiscal spillovers to third parties, from H(X), public healthcare expenditures

causally avoided by the intervention; the latter enters the government budget rather than being added again to E^N. Hold other fiscal and general-equilibrium channels fixed. The social objective for this instrument is:

$$\mathcal{W}(s) = \omega U(p(s) - s) + \Pi\big(p(s)\big) + E^N\big(X(s)\big) - \lambda\big[sX(s) - H\big(X(s)\big)\big] \tag{34b}$$

The term $\lambda[sX\text{-}H(X)]$ counts net public cost once. The envelope identities $U_r=-X$ and $\Pi_p=X$, combined with (34a), imply:

$$\frac{d\mathcal{W}}{ds} = [\omega(1-\rho) + \rho - \lambda]X + [E_X^N + \lambda H_X - \lambda s]\chi \tag{34c}$$

Proposition 6B (Optimal reimbursement with limited care capacity). *Assume $\omega\geq 1$, $\lambda\geq 1$, $X>0$, $E^N_x\geq 0$ and $H_x\geq 0$. (i) At $s=0$, a positive reimbursement increases welfare exactly when (34c) is positive. (ii) If care supply is perfectly inelastic and $\lambda>1$, marginal reimbursement reduces welfare under the maintained fixed-quality benchmark. (iii) With linear inverse demand and supply around a common unsubsidised equilibrium (X_0,p_0), constant β and κ, and constant external and fiscal marginal returns $e=E^N_x\geq 0$ and $h=H_x\geq 0$, condition (34e) yields the unique non-negative optimum (34f). Holding baseline quantities and all other primitives fixed, optimal reimbursement is weakly higher when supply is more elastic (κ lower).*

Proof. The first claim follows from the derivative in (34c). For the second, a fixed quantity implies $\chi=0$ and full price pass-through $\rho=1$; consequently:

$$\lim_{\kappa\to\infty} \frac{d\mathcal{W}}{ds} = (1-\lambda)X_0 < 0 \qquad (\lambda > 1) \tag{34d}$$

If formal-care supply is completely fixed, increasing reimbursement raises the producer price one-for-one, leaves the patient's net price unchanged, and produces no more care. The public outlay is then a transfer to providers financed at social cost λ; it is welfare-neutral at $\lambda=1$ and strictly harmful at $\lambda>1$ in this benchmark. Under linear schedules, market clearing yields $X(s)=X_0+s/(\beta+\kappa)$, $\rho=\kappa/(\beta+\kappa)$, and $\chi=1/(\beta+\kappa)$. To solve the remaining interior problem, define the weighted-incidence index:

$$\mu_\kappa = \frac{\omega\beta + \kappa}{\beta + \kappa}, \qquad 2\lambda > \mu_\kappa \tag{34e}$$

Substitution in (34c) gives a strictly decreasing marginal-welfare schedule in s when (34e) holds. The constrained optimum is therefore:

$$s_{\text{opt}}(\kappa) = \max\left\{0, \frac{e + \lambda h + \big((\omega-\lambda)\beta + (1-\lambda)\kappa\big)X_0}{2\lambda - \mu_\kappa}\right\} \tag{34f}$$

For the comparative static in (34f), let $N(\kappa)$ and $D(\kappa)>0$ be its numerator and denominator. At an interior optimum, $N'(\kappa)=(1-\lambda)X_0\leq 0$ and $D'(\kappa)=-\mu'(\kappa)\geq 0$, since $\mu'(\kappa)=(1-\omega)\beta/(\beta+\kappa)^2\leq 0$. Hence N/D, and its positive part, weakly decrease with κ.

This threshold concerns the per-unit care-linked instrument, not compulsory risk pooling as a whole. Even with fixed formal-care supply, a state-contingent cash benefit may improve consumption smoothing or redistribution; conversely, a larger care workforce can increase the payoff to reimbursement by delivering new units rather than higher prices. The comparative static assumes a common unsubsidised baseline, linear demand and supply around it, competitive providers, fixed quality and no rationing. Provider market power, queues, endogenous quality or financing responses could alter both incidence and welfare. It would therefore be inappropriate to interpret a low estimated supply elasticity alone as proof that social insurance should be abandoned.

For a comparison with unrestricted cash at an initially zero voucher, let m_a be the gross marginal social value of a cash euro, holding care demand fixed. Since a unit increase in s costs X_0 gross euros, the voucher is preferable per gross euro when:

$$\omega(1-\rho_0) + \rho_0 + \frac{(E_X^N + \lambda H_X)\chi_0}{X_0} > m_a \tag{34g}$$

In (34g), the first two terms represent how an extra voucher euro is divided between beneficiaries and providers, and the third represents external and fiscal returns from induced care. The common financing charge cancels only in the comparison of equal gross public spending, while the marginal cost of public funds still determines the value of avoided public expenditure. If cash itself changes formal or informal care use, both sides require general-equilibrium evaluation; the condition is not an unconditional dominance result.

A further implication of (34f) is a threshold on the inverse supply slope κ. For λ>1, a positive initial reimbursement gain requires:

$$\kappa_{\text{crit}} \equiv \frac{e + \lambda h + (\omega - \lambda)\beta X_0}{(\lambda - 1)X_0} \quad (\lambda > 1) \tag{34h}$$

Under the concavity condition (34e), an interior positive reimbursement exists only when κ lies below the critical inverse-supply slope in (34h). If the critical value is positive, this is equivalent to a minimum competitive supply elasticity at the baseline, $\varepsilon_s = p_0/(\kappa X_0)$. Greater non-fiscal care externalities and verified healthcare savings make reimbursement more worthwhile; a larger excess social cost of public funds makes it less attractive. The threshold depends on the assumed common baseline and linear schedules. In applications it should be estimated jointly with demand responses, provider incidence and the shadow cost of financing, rather than treated as a portable empirical constant.

If reimbursement is capped at the care price, (34f) must also satisfy $s \leq p(s)$; the policy optimum is restricted to that admissible interval.

11. The Care Cost Disease

Let the wage of care workers be w_t^C and their productivity a_t. The unit labour cost of professional care is approximately

$$p_t^C = \frac{w_t^C}{a_t} \tag{35}$$

Its proportional growth rate is

$$\frac{\dot{p}_t^C}{p_t^C} = \frac{\dot{w}_t^C}{w_t^C} - \frac{\dot{a}_t}{a_t} \tag{36}$$

If care-sector wages must broadly follow economy-wide wages while labour productivity in personal care grows more slowly, $g_w > g_a$, then

$$g_{p^C} > 0 \tag{37}$$

Thus financing faces both more person-years of dependency and potentially rising real unit costs of labour-intensive care.

12. PAYG versus Partial Prefunding

A national insurance scheme need not be purely pay-as-you-go. Let F_t denote reserves at the beginning of period t. With end-of-period contributions and benefits, define net care obligations before contribution revenue as

$$C_t = D_t \bar{b}_t + \Gamma_t - G_t - H_t - R_t \tag{38}$$

and let reserves evolve according to

$$F_{t+1} = (1 + r_t)F_t + \tau_t Y_t^B - C_t \tag{39}$$

For constant r and a non-negative terminal reserve, intertemporal solvency over horizon T requires

$$F_0 + \sum_{t=0}^{T} \frac{\tau_t Y_t^B}{(1+r)^{t+1}} \geq \sum_{t=0}^{T} \frac{C_t}{(1+r)^{t+1}} \tag{40}$$

Solvency is intertemporal: early surpluses can finance later deficits, but a balanced annual budget need not ensure long-run feasibility.

Suppose distortionary financing costs are convex:

$$\mathcal{D}(\tau_t) = \frac{\gamma}{2}\tau_t^2 Y_t^B, \qquad \gamma > 0 \tag{41}$$

The government chooses the contribution path to minimise

$$\sum_{t=0}^{T} \beta^t \mathcal{D}(\tau_t) \tag{42}$$

subject to (40).

Proposition 7 (Contribution smoothing and prefunding). *Suppose $\beta = (1+r)^{-1}$, the contribution base is exogenous, there are no constraints on reserve accumulation, and the solution is interior. Then*

$$\tau_t = \tau^{opt} \qquad \forall t \tag{43}$$

If net obligations grow relative to the contribution base and the smoothed path generates early surpluses, partial prefunding follows; rising aggregate obligations alone do not suffice.

Proof. Let λ_F be the multiplier on the present-value solvency constraint. The first-order condition is $\beta^t \gamma \tau_t Y_t^B = \lambda_F Y_t^B/(1+r)^{t+1}$. Since $\beta = (1+r)^{-1}$, cancellation of Y_t^B implies $\tau_t = \lambda_F/[\gamma(1+r)]$ for all t. ▫

This is a tax-smoothing argument for partial, not necessarily full, funding; its validity depends on returns, uncertainty and feasible reserve accumulation.

The relevant benchmark is obligations per unit of financing base, adjusted for discounting and returns. If the base grows faster than obligations or reserve constraints bind, early accumulation need not occur.

13. Why the Financing Base Matters

Universal insurance need not be financed only through employee payroll. Let

$$Y_t^B = Y_t^L + \kappa Y_t^O, \qquad \kappa \geq 0 \tag{44}$$

where Y_t^L is labour income and Y_t^O represents other taxable income sources brought into the financing base.

From (24), whenever the scheme requires positive net contributions,

$$\frac{\partial \tau_t^{\min}}{\partial Y_t^B} = -\frac{D_t \bar{b}_t + \Gamma_t - G_t - H_t - R_t}{(Y_t^B)^2} < 0 \tag{45}$$

Broadening the contribution base lowers the rate needed on any one base for a given positive net funding requirement.

Mixed financing can therefore reduce reliance on employee payroll contributions as the contributor-to-beneficiary ratio declines.

14. Discussion and Limitations

The model distinguishes three conditions that must be considered jointly: an efficiency or equity rationale for broad risk pooling, the efficient design of benefits and contributions, and the ability of the public budget and the care sector to honour entitlement. Mandatory participation can prevent exit-driven selection and redistribute across risk types, but it does not in itself ensure quality, eliminate induced utilisation or train nurses. A public programme can therefore be justified at the insurance margin while still requiring modification at the benefit-design or capacity margin.

Policy design requires graded benefits rather than unlimited reimbursement. A mixed cash/services package is justified where the external gain from verified care offsets the welfare cost of reduced household discretion; cash may also support informal care, so full earmarking is not generically optimal. Public-health savings and additional tax receipts can ease the contribution burden, but must be estimated causally and reconciled with the real-resource accounting. The broad financing base reduces reliance on payroll taxation and becomes more important as demographic dependency increases.

Policy sequencing matters. Insurance expansion without workforce training, retention and productivity improvements can bid up prices without producing care, whereas supply expansion alone leaves households exposed to catastrophic expenses. The price-pass-through model identifies the role of elasticities, provider incidence, distributive weights and the marginal cost of public funds in this trade-off. A credible national reform would evaluate both the financing frontier and the capacity frontier, with explicit attention to changes in the professional workforce and unmet need.

The framework remains stylised. Severity is one-dimensional, caregiver and recipient are not separate strategic agents, care quality and queues are fixed in the reimbursement benchmark, and transitions into dependency, aggregate labour supply and the contribution base are largely exogenous. Budget offsets are reduced-form effects rather than outputs of a structural health-production model. These simplifications make conditions tractable but preclude a complete welfare ranking between public and private arrangements in economies with heterogeneous households, endogenous prevention, or provider market power.

A quantitative test needs dependency entry and duration, substitution between informal and professional care, demand and supply elasticities, causal healthcare offsets, caregiver employment and taxable earnings, administrative costs and financing distortions. The estimates would locate a country relative to its fiscal and real feasibility frontiers and permit simulations of benefit generosity, cash-service composition and partial prefunding. Priority extensions are endogenous prevention and workforce investment; their joint modelling would show whether the next public euro has greater value when used for an additional benefit or for future capacity.

15. Conclusions

Compulsory social insurance for long-term care has a conditional economic rationale, not an automatic one. Competitive private insurance may provide adequate protection under observable risk, complete contracts and affordable premiums. Adverse selection, liquidity constraints, incomplete coverage, genuinely external care benefits and a preference for redistribution, however, strengthen the case for compulsory pooling. The model clarifies the mechanisms behind that assessment without claiming to derive an all-purpose dominance theorem.

Once insurance is adopted, universal entitlement should not mean unlimited reimbursement. Benefit generosity can rise with dependency severity under explicit monotonicity assumptions, while cost sharing and the balance between cash and accredited services depend on incentives, family knowledge and the marginal value of additional care. Fiscal feasibility reflects the dependency ratio, administrative costs, the contribution base and causally verified offsets—not gross expenditure alone.

The decisive additional boundary is real capacity. When professional-care supply is inelastic, reimbursement may primarily raise provider prices and can lower welfare if public funds are costly. Viable reforms must therefore combine sound risk pooling and redistribution with financing instruments and investments capable of increasing the quantity and quality of care supplied. This link between the justification for compulsory insurance, its design and its deliverability is the paper's unifying result.

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