

# LIFE-CYCLE MODELS FOR LONG-TERM CARE, HEALTH CARE AND PENSIONS: A REVIEW

Miguel León-Ledesma, Katsuyuki Shibayama, Yasmine Talbi

Report

2026



# Life-Cycle Models for Long-Term Care, Health Care and Pensions. A Review\*

Miguel León-Ledesma, University of Exeter and CEPR

Katsuyuki Shibayama, University of Kent

Yasmine Talbi, University of Kent

January 26, 2026

## Abstract

We survey the use of life-cycle models in the analysis of pensions, health care, and long-term care in ageing societies. It reviews how life-cycle frameworks with heterogeneous agents have been extended to incorporate demographic change, health and care risks, family interactions, and public insurance design. The discussion emphasizes key modelling choices, common mechanisms, and trade-offs that shape quantitative results, including the roles of incomplete markets, means-tested programs, and informal care provision. By comparing different strands of the literature, the paper clarifies what existing models can and cannot say about long-run fiscal sustainability, saving behavior, and policy design, and highlights important gaps for future research.

---

\*This research has been funded by the Nuffield Foundation Grant “Connect: Developing a Holistic Approach to Old Age Support Systems in the UK” (WEL/FR-000023799).

## 1. Introduction

Life-cycle and Overlapping Generations (OLG) models are the natural candidate to analyse quantitatively the effects of policy reforms in models where demographic structure and intergenerational links are explicitly needed. This note reviews the literature on three key policy elements of LC models. Namely, pensions, health shocks, and long term care (LTC). Because we want to understand the potential distributional effects of shocks and policies, our emphasis will be on models that contain the following elements:

- A life-cycle / overlapping generations (OLG) model
- Heterogeneous agents
- Long-term care (LTC), pension and/or health insurance

Pensions modelling is by now very well established. They are easy to incorporate in larger scale OLG models and, in some cases, they improve the model properties in terms of determinacy and multiplicity of steady states. There is also an established literature on health shocks and health insurance. Much of it focuses on explaining the observed lack of wealth decumulation expected in later life stages. LTC literature, however, is newer and less well established, although rapidly expanding given the challenges of long-term dependency in ageing populations. Hence, we devote more thought to how can LTC be incorporated in models with pensions, health insurance, or both. The first and second sections focus on the life-cycle models for pensions and health insurance. The third section reviews LTC within life-cycle frameworks. The final section offers some thoughts on the integration of these three strands.

Our focus in this review is on theoretical models of LTC with pensions and health insurance, rather than stylized theoretical frameworks, empirical reduced-form analyses, or general policy overviews. There are by now many papers that survey the literature on heterogeneous agent models, including LC models. See, for instance, Heathcote et al (2009), Guvenen (2011), and Krueger et al (2016) among others. There is also a large literature on health shocks in LC models (see De Nardi, 2024) and a very large literature on pensions in LC-OLG models since Auerbach and Kotlikoff (1987). Many of existing papers focus on the US case given its importance and the availability of data to calibrate medium to large-scale models. UK LTC arrangements are discussed at length in Banks et al (2023) which focuses on England.

## 2. Life Cycle Models for Policy Analysis

Quantitative LC models describe an economy populated by multiple cohorts of agents who make consumption, labor supply, and saving decisions over the life cycle. Agents face age-dependent earnings profiles, idiosyncratic risk, survival uncertainty, and borrowing constraints, and interact through markets and government policy. Equilibrium prices and fiscal variables are determined

endogenously, allowing researchers to compare steady states and to trace long transition paths following reforms.

A large part of the modern quantitative LC literature builds on heterogeneous-agent, incomplete-markets models that aim to match observed earnings and wealth distributions. Classic benchmarks include Huggett (1996), which demonstrates how idiosyncratic earnings risk and life-cycle structure can generate empirically plausible wealth distributions, and the applied general-equilibrium OLG policy tradition associated with Auerbach and Kotlikoff (1987). These foundations are useful reference points for understanding why later LC-OLG applications place heavy emphasis on distributional outcomes and on transition dynamics.

Most applications in this review build on incomplete-markets life-cycle models in which households self-insure through saving and public programs provide partial insurance. In these environments, reforms generate both efficiency effects (through tax distortions and general equilibrium prices) and insurance/redistribution effects, so welfare comparisons are inherently cohort-specific.

### **3. Pensions in Life-Cycle Models**

Public pension systems were among the earliest institutions analyzed using LC-OLG models. Their life-cycle structure makes them particularly well suited to study intergenerational redistribution, demographic change, and the long-run fiscal consequences of pension design. This section highlights modelling choices—benefit formulas, payroll taxation, endogenous labor supply and retirement, and longevity heterogeneity and their quantitative implications.

The overlapping-generations (OLG) framework has become the standard vehicle for analyzing public pension systems. In its canonical two-period form, individuals work and save when young and retire when old. A pay-as-you-go (PAYG) scheme is typically modeled as a payroll tax on workers that finances contemporaneous transfers to retirees, whereas a funded system obliges saving in an account that pays benefits out of accumulated, risk-adjusted returns. This framework traces back to Samuelson’s (1958) seminal consumption–loan model and Diamond’s (1965) growth OLG model, which together established how intergenerational transfers interact with capital accumulation and efficiency. Aaron (1966) formalized the internal rate of return on PAYG systems as equal to the growth rate of the wage bill, providing the canonical comparison between the market interest rate and the sum of demographic and productivity growth rates.

A major quantitative branch studies reform in economies with heterogeneity and incomplete markets, where PAYG pensions provide insurance as well as redistribution. In this setting, political support for reform and the welfare incidence of transition paths can differ sharply from representative-agent benchmarks; Conesa and Krueger (1999) is a canonical contribution. Another strand emphasizes that pension reform is not purely a closed-economy question: capital mobility and global demographic change affect equilibrium factor prices and the burden of reform across cohorts, as illustrated by

Attanasio, Kitao, and Violante (2007). Several papers also study policy levers beyond payroll tax and replacement rates, including retirement-age reforms and benefit claiming incentives in richer quantitative models with health and survival risk (e.g. Imrohoroglu and Kitao (2012); Kitao (2014)).

### **3.1. PAYG Systems**

In the Diamond (1965) framework, an unfunded transfer crowds out private saving. If the economy is dynamically inefficient—i.e. the interest rate is below the growth rate of the wage bill—PAYG can raise welfare; otherwise it depresses capital accumulation and output. Subsequent work has emphasized that PAYG pensions also provide insurance. With idiosyncratic earnings or longevity risk, PAYG redistributes both within and across cohorts. Quantitative LC models with incomplete markets (e.g. Imrohoroglu, Imrohoroglu, and Joines 1999) find that such insurance can be valuable even in the presence of capital crowding-out. Moreover, when aggregate risk is imperfectly shared through private markets, unfunded systems linked to wages can provide intergenerational risk-sharing, sometimes yielding Pareto improvements (Krueger and Kübler 2006).

### **3.2. Funded Systems**

Funded systems are modeled as mandatory savings vehicles invested in financial assets. Their attraction lies in higher expected returns, though these returns are risky and must be evaluated in welfare-equivalent, risk-adjusted terms. Without genuine pre-funding – and given legacy liabilities – the apparent return advantage of funding disappears (Geanakoplos, Mitchell and Zeldes, 1998; 2000). A critical feature is the transition: cohorts alive during a reform bear a “double burden,” financing both the incumbent retirees and their own future pensions. OLG simulations and analytic work stress that in present value terms, the transition does not constitute a free lunch (Sinn, 2000).

### **3.3. Mixed Designs, Redistribution, and Politics**

Distributional studies in heterogeneous-agent LC settings demonstrate that reforms create winners and losers across skill, wealth, and age groups. For instance, Huggett and Ventura (1999) show how two-tier reforms shift welfare by type, while Conesa and Krueger (1999) highlight the insurance role of PAYG in voting models. These insights underpin the political durability of PAYG schemes, despite their potential inefficiency in representative-agent settings. Broader policy frameworks, such as those synthesized in Barr and Diamond (2008) and the World Bank’s multi-pillar reports, integrate these findings into a system-design perspective.

A further set of contributions enriches the pension analysis by adding reform margins that matter empirically such as benefit claiming, extensive-margin labor force participation, and the fiscal arithmetic of sustainability under demographic change. In a life-cycle general equilibrium model with endogenous participation and benefit claiming, Imrohoroglu and Kitao (2012) quantify how

alternative combinations of payroll tax changes, replacement-rate adjustments, and retirement-age reforms affect labor supply, claiming behavior, and long-run system balance. Related quantitative exercises compare sustainability “packages” that achieve the same solvency objective but differ sharply in their incidence and efficiency costs (e.g., raising the normal retirement age versus means-testing benefits) and therefore in their welfare rankings across cohorts.

Another strand emphasizes that pensions provide insurance against labor-market risk and aggregate uncertainty, creating a risk-sharing versus distortion trade-off that is naturally studied in settings with incomplete markets. Storesletten, Telmer, and Yaron (1999) analyze alternative social security arrangements through this lens. Finally, quantitative assessments of partial privatization highlight how conclusions can reverse once one accounts for incomplete markets and missing insurance; Nishiyama and Smetters (2007) is a leading example in this tradition.

### **3.4. Modeling Choices**

Outcomes in LC models hinge on demographic assumptions, the treatment of survival risk, the availability of insurance markets, benefit formulas (defined benefit versus defined contribution, progressivity), openness to international capital flows, and fiscal closure rules. Survey contributions such as Weil (2008) summarize how these dimensions alter the relative merits of PAYG and funded arrangements.

### **3.5. Summary**

Collectively, the literature highlights four broad conclusions. First, when the economy is dynamically inefficient, PAYG transfers can improve efficiency; otherwise they typically reduce capital and output. Second, with incomplete markets and heterogeneity, the insurance and redistribution roles of PAYG may justify its presence despite lower capital accumulation. Third, funded pillars promise higher expected returns but carry risk and impose legacy costs; only with genuine pre-funding are their return advantages sustainable. Fourth, optimal pension design often combines pillars, balancing efficiency, insurance, and redistribution in ways that depend sensitively on demographic, institutional, and market environments.

## **4. Health Shocks and Health Insurance**

Health care expenditures are a major source of late-life economic risk. Spending is highly skewed, persistent, and only partially insured, motivating extensions of LC models that incorporate health dynamics, medical expenditures, and public insurance programs. This section reviews the main modelling approaches and explains how insurance design and means testing shape saving incentives and distributional outcomes.

A complementary line of work brings institutional detail from health insurance into quantitative OLG models. Jeske and Kitao (2009) study how the tax treatment of employer-provided health insurance shapes coverage and welfare in a general-equilibrium life-cycle setting. At the micro–macro interface, French and Jones (2011) estimate a structural retirement model with saving and uncertain medical expenses to quantify how Medicare and employer-provided health insurance affect retirement behavior. Finally, work on selection in health insurance markets provide empirical discipline for modelling insurance demand: Fang, Keane, and Silverman (2008) document advantageous selection in Medigap and identify preference-based channels that can coexist with risk-based selection.

These micro-founded estimates and empirical selection patterns are useful inputs for macro life-cycle modelling. Retirement models with medical expense risk help discipline the joint calibration of health transitions, out-of-pocket expenditure processes, and the value of public insurance at older ages. Evidence of advantageous selection underscores that observed insurance take-up cannot be interpreted purely through risk type: preference heterogeneity (risk aversion, planning horizons, cognition) can be first-order. In practice, many quantitative applications incorporate these insights in reduced form—via heterogeneous insurance tastes or participation costs—because modelling competitive insurance pricing with multidimensional private information inside a general equilibrium OLG model remains computationally demanding.

Health shocks and health insurance have become central features in quantitative LC models, reflecting their importance for savings behavior, inequality, and the evaluation of public policy. Building on the representative-agent OLG tradition, heterogeneous-agent models introduce idiosyncratic health risk, medical expenditures, and institutional insurance schemes in order to replicate empirically observed savings patterns, particularly at older ages.

#### **4.1. Modeling Health Shocks**

The starting point is the recognition that medical expenses are large, highly skewed, and strongly correlated with age and health status. In LC models, health shocks are typically modeled as stochastic processes governing out-of-pocket medical expenditures (Hubbard, Skinner and Zeldes, 1995; Palumbo, 1999). De Nardi, French and Jones (2010) refine this approach by estimating health-expenditure dynamics from micro data and embedding them in life-cycle models with realistic demographics. These models show that precautionary motives against catastrophic health shocks are crucial in explaining the high wealth holdings of the elderly. Kopecky and Koreshkova (2014) highlight the importance of long-term care and nursing home expenditures, showing that these shocks are a key driver of late-life saving.

## 4.2. Insurance Arrangements

Quantitative studies incorporate multiple layers of insurance. Means-tested social insurance (e.g. Medicaid in the United States) is represented as government transfers conditional on low income or high medical expenses (Hubbard et al., 1995). Medicare or public health insurance for the elderly is modeled as an age-based, partly subsidized program, reducing but not eliminating out-of-pocket risk (De Nardi, French and Jones, 2016). Private health insurance and employer-provided coverage are sometimes added as additional states or choice variables. Jeske and Kitao (2009) integrate employer-sponsored health insurance and show how tax policy distorts coverage and saving incentives. These institutional features are essential for matching observed heterogeneity in medical spending and asset decumulation at older ages.

## 4.3. Distributional and Policy Insights

Three broad insights emerge from this literature. First, incomplete insurance markets leave individuals exposed to substantial health expenditure risk, generating strong precautionary saving. Second, public health insurance programs, by reducing out-of-pocket risk, alter both savings and redistribution, with effects that differ strongly across the income distribution. Hubbard et al. (1995) show that means-tested Medicaid reduces saving among low-income households but provides valuable insurance. De Nardi, French and Jones (2010) demonstrate that health risk explains much of the persistence of late-life wealth inequality, while De Nardi, French and Jones (2016) quantify the redistributive and insurance roles of Medicare. Kopecky and Koreshkova (2014) further stress that nursing home costs interact with Medicaid design, shaping both savings and welfare. Finally, extensions with general equilibrium OLG structures (Conesa and Krueger, 1999; Jung and Tran, 2016) highlight fiscal trade-offs, intergenerational transfers, and the long-run effects of health-policy reforms.

## 4.4. Modeling Choices

Results depend on how health shocks are parameterized, the treatment of survival risk, and the extent of insurance availability. High-order Markov processes estimated from panel data (De Nardi et al., 2010; 2016) capture persistence and heterogeneity in medical costs. Longevity risk interacts with health expenditure risk, reinforcing precautionary behavior. Market incompleteness is typically modeled as limited access to private annuities or actuarially fair insurance, enhancing the welfare role of public programs. Calibration to micro data is crucial, with models often matching distributional facts on medical expenditures and wealth. Studies of wealth adequacy such as Scholz, Seshadri and Khitatrakun (2006) underscore that incorporating realistic medical expense risk is essential for understanding whether households save “optimally” over the life cycle.

## 4.5. Summary

Health-augmented LC-OLG models show that medical expenditure risk is central to understanding savings behavior, late-life wealth inequality, and the welfare consequences of insurance policy. Public programs such as Medicaid and Medicare in the US reduce risk exposure but reshape saving incentives and redistribute resources across both income groups and generations. The consensus is that well-calibrated health shocks and insurance arrangements are indispensable components of modern quantitative frameworks.

## 5. Long-Term Care

The LTC literature is rapidly expanding. The questions the different contributions to this literature try to address differ, and there is no modelling consensus so far. This reflects the complexity of LTC arrangements within families and how they interact with public sector provision.

From a modelling perspective, long-term care differs from other late-life risks along several dimensions. LTC needs are typically persistent, arise late in life, and are closely tied to functional limitations rather than transitory health shocks. These features imply that LTC risk interacts strongly with household saving decisions, family structure, and public insurance design, making it particularly challenging to incorporate into standard life-cycle or OLG frameworks.

A seminal contribution is by Barczyk and Kredler (2018), who model intra-family bargaining over informal care provision under imperfect altruism. The interaction between caregiver and care recipient is captured within a dynamic, non-cooperative framework calibrated to U.S. data. Related work includes Barczyk and Kredler (2014a, 2014b), both of which are more theory oriented models in continuous time. Lise and Yamada (2019) present evidence of bargaining between couples and show that bargaining power is not constant and changes if a shock hits only one of the members of the couple.

These contributions are central to the LTC literature because they move beyond reduced-form representations of family support and explicitly model care-giving as the outcome of strategic interaction within families. Informal care is not treated as an exogenous transfer, but as the equilibrium outcome of bargaining under imperfect altruism and limited commitment. This approach highlights how family-provided care can respond endogenously to policy incentives, an insight that is difficult to capture in unitary-family models.

Regarding saving behavior, public support for LTC risks has heterogeneous effects across different household types. Several studies, such as Bueren (2023), examine the impact of LTC risks on household saving decisions using simulated theoretical models. Ameriks et al. (2020) account for the slower asset decumulation observed in the data, relative to predictions from standard models, by explicitly incorporating LTC into considerations. With the same motivation, Kopecky and

Koreshkova (2014) calibrate their model to U.S. data, explicitly factoring in the role of Medicaid.

A common finding across this strand of the literature is that LTC risk can generate strong incentives to retain assets late in life, even in the presence of public insurance. Importantly, however, models differ in the channels through which this operates. In some frameworks, assets are held primarily as self-insurance against potentially long and costly care episodes, while in others bequest motives or strategic considerations within families play a central role. As a result, the literature does not support a simple or universal “spend-down” narrative.

In models with means-tested public support, such as Medicaid in the U.S., saving incentives are highly nonlinear. Households close to eligibility thresholds may face reduced marginal returns to saving, while wealthier households optimally self-insure to avoid reliance on public care. Quantitative results depend sensitively on assumptions about eligibility rules, benefit generosity, and the interaction with bequest motives, suggesting caution in extrapolating simple policy implications.

The implications of LTC extend beyond its impact on saving behavior. Koreshkova and Lee (2020) offer a complementary perspective by introducing a two-sided optimization framework involving nursing homes and care recipients. Their model emphasizes equilibrium responses within the care supply market. Borsenberger et al. (2022) study the design of optimal insurance schemes - private and/or social for formal home care and nursery home care.

These contributions highlight that LTC policies can affect not only household behavior but also the organization and pricing of care provision. By modelling nursing homes or care providers as optimizing agents, this literature captures supply-side responses that are absent from models focusing exclusively on household decision-making.

Regarding the policy design, Braun, Kopecky, and Koreshkova (2017, 2019) examine the design and implications of Medicaid in the U.S. using a dynamic principal-agent structure under asymmetric information. Their analysis explains the limited participation in private LTC insurance markets, despite substantial aging-related health risks.

A related empirical and theoretical literature asks why private LTC insurance coverage remains limited despite sizeable risk exposure. A key insight is that one-dimensional adverse selection predictions may fail when individuals differ both in risk and in preferences for insurance: Finkelstein and McGarry (2006) document “multiple dimensions of private information” in the U.S. LTC insurance market. This evidence motivates structural models that jointly accommodate risk heterogeneity, preference heterogeneity, and the interaction of private insurance with means-tested public programs. Recent work also extends family-based LTC frameworks to richer family networks and care-giver heterogeneity; for example, Bakota et al. (2024) develop a “designated-child” extension building on the Barczyk–Kredler approach.

A complementary quantitative literature seeks to “explain the market” by modelling both demand-side interactions with public insurance and supply-side frictions in private LTC insurance. In

particular, Braun, Kopecky, and Koreshkova (2017) develop an equilibrium contracting framework in which Medicaid affects demand and adverse selection, market power, and administrative costs affect supply. Their results rationalize low take-up and the observed pattern of underwriting rejections across wealth and health types, and they clarify that the relative importance of public insurance versus private-market frictions differs across the income distribution.

These papers emphasize informational frictions and contract design as key determinants of insurance market outcomes. Rather than attributing low private insurance coverage solely to crowding-out by public programs, they show how adverse selection and moral hazard interact with means-tested public insurance to shape equilibrium participation.

Methodologically, there has been progress in parameter inference. Unlike reduced-form linear estimations, some studies directly estimate structural parameters based on theoretical model simulations. Ko (2022) addresses adverse selection in LTC insurance markets by incorporating the optimization behavior of adult children. Mommaert (2025) also examines informal care giving decisions and their influence on insurance demand. Both studies employ the Method of Simulated Moments (MSM) to calibrate structural parameters, aligning model outcomes with empirical distributions. Although his primary focus is on bequest behavior, Lockwood (2018) also incorporates LTC into his model. His study is the first to apply the Method of Simulated Moments (MSM) in this context.

The use of structural estimation methods represents an important step forward for the LTC literature. By tying model parameters directly to observed behavior, these approaches help discipline quantitative predictions and facilitate counterfactual policy analysis. At the same time, they highlight the data requirements and identification challenges inherent in modelling informal care, family interactions, and insurance demand jointly.

Focused on the case of Japan, where population ageing started earlier than in the UK, Mikoshiba (2025) deploys a rich OLG model with two-sided altruism to quantify the welfare effects of a public LTC insurance system. Fukai et al. (2021) build and calibrate a simple partial equilibrium life-cycle model to analyse individuals' medical expenditure risks over the life-cycle and the roles of the national health insurance system. Imrohorglu and Zhao (2018) focus on China, a country undergoing rapid population aging.

These country-specific studies illustrate how institutional context matters for LTC outcomes. Differences in family structure, labor market institutions, and public insurance design imply that quantitative results may not generalize across settings. OLG models calibrated to different countries therefore provide valuable insights into the interaction between demographic change and policy design.

On the empirical front, there are some papers that are helpful to calibrate the health status dynamics in our model. For instance, Hosseini et al. (2025) use a dynamic panel to study the relationship between health shocks and earnings. Also, Banks et al. (2019) run repeated cross-sectional surveys

to document significantly steeper declines in nondurable expenditures at older ages in the UK compared to the US, despite similar income paths.

These empirical contributions provide key inputs for quantitative modelling by documenting health transitions, expenditure patterns, and cross-country differences at older ages. While not focused exclusively on LTC, they inform the calibration of health dynamics and consumption behavior that underpin many structural models of long-term care risk.

## 6. Synthesis and Open Questions

A recurring lesson across the three domains is that program interactions can be quantitatively important even when each program is “well understood” in isolation. For example, pension income affects eligibility for means-tested health and LTC benefits; medical and care risks shape optimal retirement timing and therefore lifetime contributions; and family structure mediates the incidence of public LTC reforms through informal care and transfers. Because these linkages operate over long horizons and differ systematically by cohort and household type, LC models remain one of the few frameworks capable of evaluating them consistently.

Methodologically, an important open area is combining richer micro evidence (structural estimates of retirement/insurance demand, empirical health transitions, and care-giving behavior) with the discipline of LC models. Doing so would help narrow the gap between “policy counterfactual” models that are tightly calibrated but stylized, and structural models that fit micro moments but abstract from economy-wide feedbacks. A second open issue is uncertainty about future policy and cost growth (particularly for health and LTC), which is often taken as deterministic in quantitative exercises but is central for long-run fiscal risk.

The literature reviewed above makes clear that pensions, health care, and long-term care interact through common life-cycle mechanisms: saving and decumulation under incomplete markets, risks that concentrate late in life, and public insurance programs that provide insurance while also creating incentive distortions. A key modelling frontier is to integrate these domains without losing tractability, while remaining disciplined about what is identified and what is assumed.

As highlighted above, the existing literature predominantly targets the U.S. context and centers on private LTC insurance and Medicaid. Notably, all of the above are published in the last ten years, implying this is an expanding area. Also, most studies appear in top-tier journals, underscoring the importance of methodologically sound quantitative analyses of LTC.

The UK LTC system differs substantially from its U.S. counterpart in terms of financing structure, public provision, and institutional incentives. As such, existing models cannot be directly transferred without careful and significant consideration of tax and policy incentives. Nonetheless, the approach in papers such as Ko (2022) and Mommaert (2025) provides a good starting point to tailor our model to the UK LTC system.

Incorporating pensions LTC models is relatively simple as it has an element of pay-as-you-go tax and transfer (State Pension) and private savings (part of which is occupational pensions). In the Japan context, Mikoshiba (2025) incorporate a PAYG public pension system along with public health insurance and public LTC insurance within the study of the welfare effects of LTC insurance system in Japan. However, the public health insurance system considered is very simple and does not consider the production of health services. Fukai et al. (2021) incorporate public pension (as well as public health insurance and public LTC insurance programs) with the study of medical expenditure risks and the roles of national health insurance system in Japan. Meanwhile, in the US context, Ameriks et al. (2020), Braun et al. (2019), Ko (2022), Kopecky and Koreshkova (2014) all include pensions in the income flow. Barczyk and Kredler (2018) allocate an age-invariant pension flow to the parent. The paper then continues to empirically analyse care arrangements and informal care by the children depending on pension quintiles. Bueren (2023) develops and estimates a model of retired single individuals, incorporating pension benefits and annuities in the individual's permanent income.

Hence pensions are incorporated in this previous literature in LTC. But it appears that a fully fledged pension system is featured only in the Japan context such as Mikoshiba (2025). A fully fledged pensions, health system, and LTC framework in an integrated model is, so far, absent from the literature.

Health shocks can also be incorporated following existing literature. However, the incorporation of the three systems tailored to the UK within a single model can prove computationally complex and require very costly parameterisations. If, furthermore, this is done within a general equilibrium model that aims to incorporate capital and labor market interactions between the three systems, such model could become excessively complex and difficult to solve quantitatively. It would also be difficult to identify clear channels where the systems interact and how they affect intergenerational distributive effects. For these reasons, we believe a better approach is to incorporate systems according to the question at hand rather than building models that span all systems. This is also a necessary step before attempting to build and calibrate large-scale models for policymakers and practitioners. Given the methodological challenges of LTC, we conclude that it would be best to make LTC the feature that should be present in these models, with health and pensions systems added according to the policy question at hand. We also favor starting from partial equilibrium LC models before moving onto computationally challenging general equilibrium models.

## References

- Aaron, H.J., 1966. The social insurance paradox. *Canadian Journal of Economics and Political Science*, 32(3), pp.371-374.
- Ameriks, J., Briggs, J., Caplin, A., Shapiro, M.D. and Tonetti, C., 2020. Long-term-care utility and late-in-life saving. *Journal of Political Economy*, 128(6), pp.2375-2451.

- Attanasio, O., Kitao, S. and Violante, G.L., 2007. Global demographic trends and social security reform. *Journal of Monetary Economics*, 54(1), pp.144–198.
- Auerbach, A.J. and Kotlikoff, L.J., 1987. *Dynamic Fiscal Policy*. Cambridge: Cambridge University Press.
- Bakota, I., Barczyk, D., Kredler, M. and Yang, F., 2024. The designated-child model of long-term care provision. Working paper.
- Banks, James, Richard Blundell, Peter Levell, and James P. Smith. 2019. Life-Cycle Consumption Patterns at Older Ages in the United States and the United Kingdom: Can Medical Expenditures Explain the Difference? *American Economic Journal: Economic Policy* 11 (3): 27–54.
- Banks, J, French, E. and McCauley, J., 2023, Long-term Care in England, National Bureau of Economic Research, Number 31826, Nov.Barczyk, D. and Kredler, M., 2018. Evaluating long-term-care policy options, taking the family seriously. *The Review of Economic Studies*, 85(2), pp.766-809.
- Barczyk, D. and Kredler, M., 2014a. Altruistically motivated transfers under uncertainty. *Quantitative Economics*, 5(3), pp.705-749.
- Barczyk, D. and Kredler, M., 2014b. A dynamic model of altruistically-motivated transfers. *Review of Economic Dynamics*, 17(2), pp.303-328.
- Barr, N. and Diamond, P., 2008. *Reforming Pensions: Principles and Policy Choices*. Oxford: Oxford University Press.
- Borsenberger, Claire & Cremer, Helmut & Joram, Denis & Lozachmeur, Jean-Marie & Malavolti, Estelle, 2024. The design of insurance contracts for home versus nursing home Long-Term Care, TSE Working Papers 24-1528, Toulouse School of Economics (TSE).
- Braun, R.A., Kopecky, K.A. and Koreshkova, T., 2017. Old, frail, and uninsured: Accounting for puzzles in the U.S. long-term care insurance market. Federal Reserve Bank of Atlanta Working Paper 2017-3 (revised 2020).
- Braun, R.A., Kopecky, K.A. and Koreshkova, T., 2019. Old, frail, and uninsured: Accounting for features of the US long-term care insurance market. *Econometrica*, 87(3), pp.981-1019.
- Braun, R.A., Kopecky, K.A. and Koreshkova, T., 2017. Old, sick, alone, and poor: A welfare analysis of old-age social insurance programmes. *The Review of Economic Studies*, 84(2), pp.580-612.
- Brown, J.R. and Finkelstein, A., 2008. The interaction of public and private insurance: Medicaid and the long-term care insurance market. *American Economic Review*, 98(3), pp.1083–1102.
- Bueren, J., 2023. Long-term care needs and savings in retirement. *Review of Economic Dynamics*, 49, pp.201-224.
- Conesa, J.C. and Krueger, D., 1999. Social security reform with heterogeneous agents. *Review of*

Economic Dynamics, 2(4), pp.757-795.

De Nardi, M. 2024. Health Inequality and Health Types, Sargan Lecture, Royal Economic Society, Belfast, UK, 2024.

De Nardi, M., French, E. and Jones, J.B., 2010. Why do the elderly save? The role of medical expenses. *Journal of Political Economy*, 118(1), pp.39–75.

De Nardi, M., French, E. and Jones, J.B., 2016. Medicaid insurance in old age. *American Economic Review*, 106(11), pp.3480–3520.

De Nardi, M., French, E. and Jones, J.B., 2016. Savings after retirement: A survey. *Annual Review of Economics*, 8, pp.177–204.

De Nardi, M., French, E., Jones, J.B. and McGee, R., 2021. Medicaid insurance in old age. *American Economic Review*, 111(11), pp.3480–3520.

Diamond, P.A., 1965. National debt in a neoclassical growth model. *American Economic Review*, 55(5), pp.1126-1150.

Fang, H., Keane, M.P. and Silverman, D., 2008. Sources of advantageous selection: Evidence from the Medigap insurance market. *Journal of Political Economy*, 116(2), pp.303–350.

Fehr, H., Jokisch, S. and Kotlikoff, L.J., 2008. Dynamic globalization and its potentially alarming prospects for low-wage workers. *Journal of Monetary Economics*, 55(3), pp.491–518.

Feldstein, M., 1974. Social security and private saving: Reply. *Journal of Political Economy*, 82(5), pp.905-914.

Finkelstein, A. and McGarry, K., 2006. Multiple dimensions of private information: Evidence from the long-term care insurance market. *American Economic Review*, 96(4), pp.938–958.

French, E. and Jones, J.B., 2011. The effects of health insurance and self-insurance on retirement behavior. *Econometrica*, 79(3), pp.693–732.

Fukai, T., Ichimura, H. Kitao, S., and Mikoshiba, M., 2021. Medical Expenditures over the Life Cycle: Persistent Risks and Insurance, Discussion papers 21073, Research Institute of Economy, Trade and Industry (RIETI).

Geanakoplos, J., Mitchell, O.S. and Zeldes, S.P., 1998. Would a privatized social security system really pay a higher rate of return? NBER Working Paper No. 6713.

Geanakoplos, J., Mitchell, O.S. and Zeldes, S.P., 2000. Would a privatized social security system really pay a higher rate of return? In: J. Campbell and M. Feldstein (eds.), *Risk Aspects of Investment-Based Social Security Reform*. Chicago: University of Chicago Press, pp.137-200.

Guvenen, F., 2011. Macroeconomics with Heterogeneity: A Practical Guide. *Economic Quarterly-Federal Reserve Bank of Richmond*, 97(3), p.255.

- Heathcote, J., Storesletten, K. and Violante, G.L., 2009. Quantitative macroeconomics with heterogeneous households. *Annual Review of Economics*, 1(1), pp.319-354.
- Hosseini, R. Kopecky, K., Zhao, K., 2025. How Important Is Health Inequality for Lifetime Earnings Inequality?, *The Review of Economic Studies*, forthcoming.
- Hubbard, R.G., Skinner, J. and Zeldes, S.P., 1995. Precautionary saving and social insurance. *Journal of Political Economy*, 103(2), pp.360–399.
- Huggett, M., 1996. Wealth distribution in life-cycle economies. *Journal of Monetary Economics*, 38(3), pp.469–494.
- Huggett, M. and Ventura, G., 1999. On the distributional effects of social security reform. *Review of Economic Dynamics*, 2(3), pp.498-531.
- Imrohoroglu, A., Imrohoroglu, S. and Joines, D.H., 1995. A life cycle analysis of Social Security. *Economic Theory*, 6(1), pp.83–114.
- Imrohoroglu, A., Imrohoroglu, S. and Joines, D.H., 1999. Social security in an OLG economy with land. *Review of Economic Dynamics*, 2(3), pp.638-665.
- Imrohoroglu, S. and Kitao, S., 2012. Social security reforms: Benefit claiming, labor force participation, and long-run sustainability. *American Economic Journal: Macroeconomics*, 4(3), pp.96–127.
- Imrohoroglu, A. and Zhao, K., 2018. The Chinese saving rate: Long-term care risks, family insurance, and demographics. *Journal of Monetary Economics*, 96, pp.33-52.
- Jeske, K. and Kitao, S., 2009. U.S. tax policy and health insurance demand. *American Economic Journal: Macroeconomics*, 1(1), pp.157–188.
- Jung, J. and Tran, C., 2016. Market inefficiency, insurance mandates and cross-subsidies in the U.S. health insurance market. *Journal of Economic Dynamics and Control*, 64, pp.33–47.
- Ko, A., 2022. An equilibrium analysis of the long-term care insurance market. *The Review of Economic Studies*, 89(4), pp.1993-2025.
- Krueger, D. and Kübler, F., 2006. Pareto-improving social security reform when financial markets are incomplete? *American Economic Review*, 96(3), pp.737-755.
- Krueger, D., Mitman, K. and Perri, F., 2016. Macroeconomics and heterogeneity, including inequality. *Handbook of Macroeconomics*.
- Kopecky, K.A. and Koreshkova, T., 2014. The impact of medical and nursing home expenses on savings. *American Economic Journal: Macroeconomics*, 6(3), pp.29-72.
- Koreshkova, T. and Lee, M., 2020. Nursing homes in equilibrium: Implications for long-term care policies. Available at SSRN 3885803.
- Kotlikoff, L.J., Smetters, K. and Walliser, J., 1999. Privatizing Social Security in the United States.

Review of Economic Dynamics, 2(3), pp.532–574.

Lise, J. and Ken Yamada, 2019. Household Sharing and Commitment: Evidence from Panel Data on Individual Expenditures and Time Use. *The Review of Economic Studies*, vol. 86(5), pages 2184-2219.

Lockwood, L.M., 2018. Incidental bequests and the choice to self-insure late-life risks. *American Economic Review*, 108(9), pp.2513-2550.

Mikoshiba, M., 2025. Universal Insurance with In-kind Transfers: The welfare effects of long-term care insurance in Japan, Discussion papers 25030, Research Institute of Economy, Trade and Industry (RIETI).

Mommaerts, C., 2025. Long-term care insurance and the family. *Journal of Political Economy*, 133(1), pp.1-52.

Nishiyama, S. and Smetters, K., 2005. Consumption taxes and economic efficiency with idiosyncratic wage shocks. *Journal of Political Economy*, 113(5), pp.1088–1115.

Palumbo, M.G., 1999. Uncertain medical expenses and precautionary saving near the end of the life cycle. *Review of Economic Studies*, 66(2), pp.395–421.

Rust, J., and Phelan, C., 1997. How Social Security and Medicare affect retirement behavior. *Econometrica*, 65(4), pp.781–831.

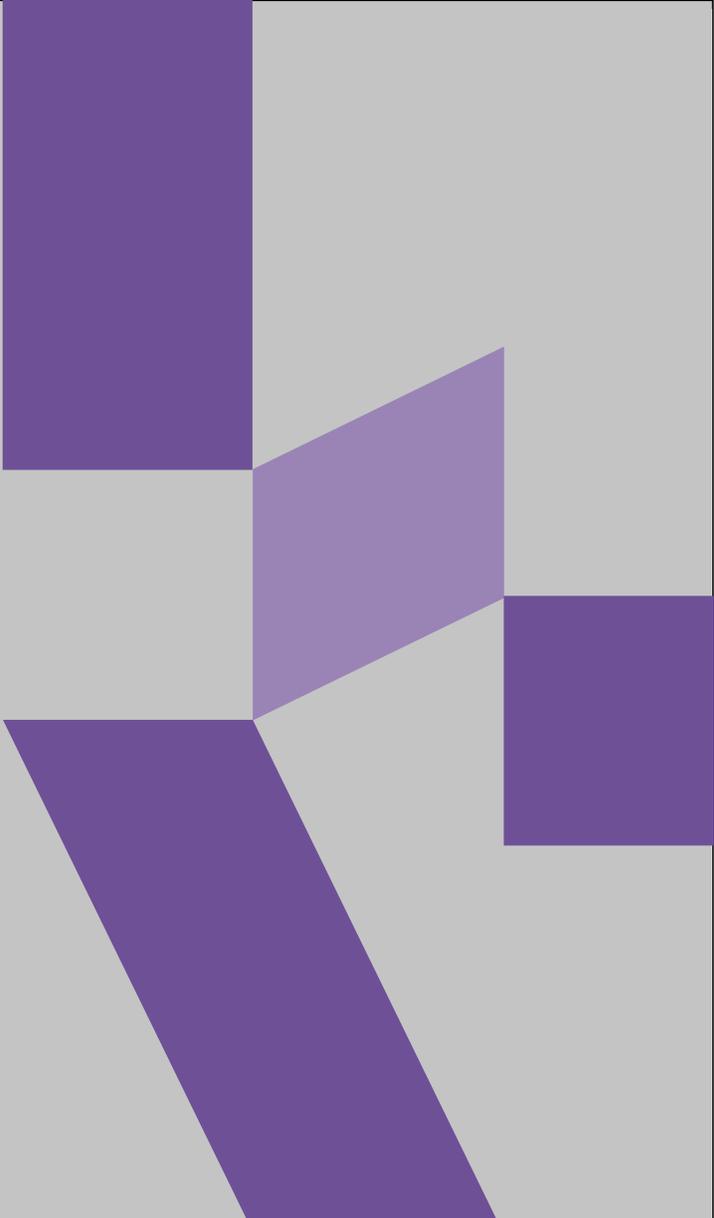
Samuelson, P.A., 1958. An exact consumption-loan model of interest with or without the social contrivance of money. *Journal of Political Economy*, 66(6), pp.467-482.

Scholz, J.K., Seshadri, A. and Khitatrakun, S., 2006. Are Americans saving ‘optimally’ for retirement? *Journal of Political Economy*, 114(4), pp.607–643.

Sinn, H.W., 2000. Why a funded pension system is needed and why it is not needed. *International Tax and Public Finance*, 7(4-5), pp.389-410.

Weil, P., 2008. Overlapping generations: The first jubilee. *Journal of Economic Perspectives*, 22(4), pp.115-134.

World Bank, 1994. *Averting the Old Age Crisis: Policies to Protect the Old and Promote Growth*. Washington, DC: World Bank.



Care Research and Outcomes Centre, Cornwallis Central,  
University of Kent, Canterbury, Kent CT2 7NF

[kent.ac.uk](http://kent.ac.uk)

University of  
**Kent**