Household Liquidity Policy*

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Abstract

We assess 'household liquidity policy', a novel approach to stimulus that relies on relaxed regulation instead of conventional fiscal tools. We develop a model to analyse the aggregate and distributional effects of liquidity policy relative to conventional fiscal stimulus, focusing on an increasingly common form: early access to retirement saving accounts. We find that both policies generate similar aggregate stimulus but with distributional and welfare trade-offs due to their funding sources. Liquidity policy benefits wealthier workers and retirees, who enjoy lower taxes and flexibility. Liquidity policy is regressive, shifting the burden onto poorer households who suffer reduced consumption in retirement.

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1 Introduction

Suppose the government wants to stimulate aggregate demand. The conventional approach, fiscal stimulus through government transfers or spending, works primarily because liquidity-constrained households have high marginal propensities to consume and spend meaningfully when they receive additional income (Kaplan and Violante, 2014; Auclert et al., 2024; Aguiar et al., 2024). This mechanism works by alleviating liquidity constraints, not by providing households with greater lifetime resources.

The above observation suggests an alternative approach to stimulus that has become increasingly prevalent in the real world: using regulatory changes rather than fiscal expenditures to temporarily enhance household liquidity. One prominent example of this approach is to grant households early access to otherwise illiquid retirement savings during periods of aggregate distress.[1] Such interventions have become increasingly popular, with over thirty countries implementing temporary relief from retirement saving regulations during recent economic downturns (OECD, 2021). As we document, these policies have released liquidity in magnitudes comparable to conventional fiscal stimulus (Figure 2). We designate this regulatory approach to stimulus, which operates outside the government budget, as 'household liquidity policy.'

In this paper, we compare household liquidity policy with conventional fiscal stimulus. Focusing on liquidity policies that relax retirement regulations, our paper makes three main sets of contributions. First, we develop a heterogeneous-agent model that micro-founds the presence of an illiquid retirement account through explicit government policy, rather than imposing it as an exogenous technological constraint. This approach allows us to analyse temporary regulatory changes as a stimulus tool, something not possible in standard models where illiquidity is imposed rather than derived.

Second, we trace the mechanisms and funding of each policy — fiscal stimulus draws on future taxes, while liquidity policy draws on households' retirement wealth — and identify the tradeoffs that each approach entails. In our model, fiscal stimulus creates distortions through future taxation and redistributes resources away from retirees and future generations. By contrast, liquidity policy reduces tax distortions but undermines retirement adequacy for present-biased households. Overall, we find that the two approaches differ fundamentally in who bears the cost of stimulus, not in their immediate effectiveness.

Third, we evaluate the aggregate, distributional and welfare consequences of household liquidity policy compared to conventional fiscal stimulus. We show that both policies can de-

[1] Many other forms exist and have been used during recent crises, e.g. temporary mortgage payment holidays, student loan forbearance, rent deferrals, and tax payment deferrals.

liver similar aggregate stimulus, but with very different distributional results. Fiscal stimulus spreads repayment broadly, while liquidity policy effectively privatises the cost of aggregate demand management, concentrating it on those who withdraw and spend — disproportionately poorer and more present-biased households. As a result, when we turn towards welfare, we find that liquidity policy is favoured by workers in the top half of the wealth distribution, as well as retirees and future generations, who avoid higher taxes and benefit from portfolio rebalancing. These groups constitute a majority, so liquidity policy is popular in our model. But we find that it is also the more regressive option: it concentrates the costs of aggregate demand management on the subset of the population least equipped to bear it.

To analyse the above policies, we develop a heterogeneous agent model with explicit retirement policy. We begin with the standard framework for analysing fiscal policy: households facing uninsured idiosyncratic risks with access to two accounts, one liquid and one illiquid, and a fiscal authority constrained by a fiscal rule (as in Kaplan and Violante, 2014; Auclert et al., 2024; Bayer et al., 2023). We build upon these papers by providing an explicit micro–foundation for government–mandated illiquidity, described below, which then feeds into the standard two–asset model of consumption behaviour.[2]

We add three main features that capture the tradeoffs between fiscal policy and household liquidity policy. First, we include an overlapping–generations life–cycle with work and retirement phases (Blanchard, 1985; Yaari, 1965). This creates a need to provide for retirement, in addition to the standard precautionary saving motive. Second, a portion of the population is subject to naive present–bias, leading to over–consumption (and under–saving) in the present (Laibson, 1997; Maxted et al., 2024; Maxted, 2025). As a result, our model captures one of the principal rationales for government intervention in retirement saving — the view that many individuals are myopic and lack the ability to save for retirement if left entirely to their own devices (Feldstein, 1985). Third, we add realistic retirement policy, which consists of multiple pillars: first, a tax–funded state pension that goes to all retirees, and second, defined–contribution individual retirement accounts with realistic tax subsidies, restrictions on early withdrawal, and contribution requirements, depending on the calibration. This retirement account micro–founds the illiquid asset that is standard in two–asset heterogeneous–agent models; here, illiquidity is due to regulations to address myopia, and differences in return are due to tax concessions.

We calibrate the model with a two-step approach, where we fix many of the standard parameters, then internally calibrate three key parameters: the share of present-biased house-

[2] Throughout this paper, we use the term ‘liquidity’ or ‘liquid resources’ to refer to resources that can be used close–to immediately for consumption. This includes cash, bank and saving deposits, consumer credit, and investments in securities that can be sold at will.

holds, the regulations governing mandatory retirement contributions, and the tax subsidy on the illiquid account. The degree of present bias is selected to match empirical estimates of the aggregate MPC in stationary equilibrium. The retirement regulations are set in an optimal policy exercise that is able to rationalise the contribution rates and tax concessions we observe in many retirement systems around the world.

In the stimulus experiment, we shock the model with deficit-funded transfers (fiscal policy) and unanticipated early access to retirement savings (liquidity policy), both calibrated to boost spending by the same amount over one quarter. Matching the short–term stimulus from the two approaches allows us to compare their long–run implications. There are three main differences. First, the tax changes driven by the fiscal rule distort inter–temporal consumption smoothing, and this distortion is much greater under fiscal than liquidity policy. Second the tax changes also cause redistribution, with lower future consumption by retirees and future generations, who subsidise the transfers received by workers. And third, liquidity policy undermines retirement adequacy for present–biased workers, reducing their consumption upon retirement, and more so for the individuals who were initially less wealthy.

After characterising the mechanisms through which the two policies operate, we then use our model to quantify their relative importance for household well-being, both in aggregate and across the distribution. We show that household liquidity policy is better for wealthy workers, retirees, and future generations. The economic intuition behind this result is that such individuals do not benefit much from conventional fiscal stimulus, but are still liable for higher taxes under fiscal policy. Further, wealthy workers value the ability to rebalance their portfolio more than their less wealthy counterparts. By contrast, fiscal policy is preferred by working households with low wealth, a group disproportionately comprised of present–biased households. Aggregating across this heterogeneity, we find that roughly 70 percent of households prefer liquidity policy over conventional fiscal stimulus in our baseline calibration. In short, liquidity policy may be politically popular despite its regressivity, as it concentrates the costs of stimulus on a relatively small subset of society, namely the present–biased and low–wealth workers.[3]

Related literature This paper brings together two large strands of literature. On one hand, the influential heterogeneous agent macro literature explains fiscal and monetary policy transmission based on liquidity constraints and the distinction between liquid and illiquid assets (see e.g. Kaplan and Violante, 2014; Kaplan et al., 2018; Bayer et al., 2019; Auclert

[3] We also evaluate how cross-country heterogeneity in retirement policy and fiscal rules affect our results. We find that liquidity policy is marginally better for society the stricter is retirement policy, and the more aggressively the fiscal rule retires government debt, as households benefit from portfolio re-balancing and delayed debt-repayment.

et al., 2024). Empirically, retirement savings make up a substantial portion of the illiquid assets in household portfolios, a fact often observed but not modelled in this literature. On the other hand, there is a growing public economics literature that evaluates retirement policy and the optimal degree of illiquidity in retirement saving systems (see e.g. Amador et al., 2006; Moser and Olea de Souza e Silva, 2019; Beshears et al., 2025; Andersen et al., 2024; Beshears et al., 2020). While these papers assume that the level of illiquidity in retirement systems is a social choice, they are largely silent on macroeconomic considerations related to fiscal stimulus. To the best of our knowledge, our paper is the first to offer a positive and normative evaluation of household liquidity policy relative to conventional fiscal stimulus.

A growing empirical literature analyses past episodes of household liquidity policies (Argento et al., 2015; Kreiner et al., 2019; Andersen, 2020; Hamilton et al., 2024; Preston, 2022; Schneider and Moran, 2025; Shapiro and Slemrod, 1995). We bring these stimulus packages together under the banner of household liquidity policy and analyse them theoretically in a modeling environment that allows for direct comparison with conventional fiscal policy. This allows for positive and normative comparisons of the two approaches, which may help to design future stimulus packages.

Our work complements Hamilton et al. (2024), which analyses Australia's early withdrawal program during Covid–19, using detailed micro data to identify who withdraws and what they do with the money. The authors show empirically that around one in six working age people withdrew, the modal withdrawal was all of the \$20,000 allowed, and these households on average spent 40% of the funds within eight weeks. They argue that this is evidence of present–bias, which they estimate in a structural model. Our paper makes a different but complementary contribution. While the above authors identify the MPC and the strength of present-bias, we take present-bias as given, and instead develop a model that captures the key trade-offs between household liquidity policy and conventional fiscal policy. This allows us to perform the first positive, normative, and distributional comparison of these two different approaches to stimulus.

Our model is informed by empirical evidence from Schneider and Moran (2025) who show that self-control heterogeneity plays an important role in predicting early withdrawal following the release of retirement savings in Australia. Overall, individuals in the top quintile of self-control issues are 60% more likely to withdraw than those in the bottom. Motivated by these results, we incorporate heterogeneity in present-bias into our model and examine how liquidity policy affects individuals with and without present-bias.

Some papers use quantitative models to explore the role of retirement accounts in stimulating the economy, but none compare liquidity policy to conventional fiscal policy. Love (2017) proposes a policy to stimulate the economy using counter–cyclical matching to retirement contributions, which he evaluates in a life-cycle model. Graves (2025) develops a HANK model to analyze the flight–to–liquidity that occurs following an increase in unemployment. He conducts one counterfactual exercise showing the effect of lower withdrawal penalties on aggregate consumption during Covid–19. Finally, Kaplan et al. (2020b) explore the tradeoff between health outcomes and economic impacts of policy choices during Covid–19 in the USA. They combine a HANK model with an SIR module of disease transmission, and use it to assess the impact of the various economic and health policies used in the USA. A part of the CARES Act that they model is the USA's removal of the withdrawal penalties from individual retirement accounts, as in Graves (2025), but this is not the focus of their analysis. Our paper differs from the above by (1) characterising the different channels through which household liquidity policy differs from conventional fiscal policy, (2) evaluating the distributional implications of the two policies, and (3) conducting a welfare analysis of the two policies, something that no previous paper has attempted.

We build upon the broader heterogeneous–agent macro literature by providing a new micro foundation for the illiquid accounts commonly featured in two-asset macro models (Kaplan and Violante, 2014; Kaplan et al., 2018; Bayer et al., 2019; Auclert et al., 2024). This illiquidity is generally modelled as an exogenous feature of the world, when in reality it is usually a result of government policy. Empirically, household budgets are made up of only two types of genuinely illiquid asset: housing and retirement savings (Fagereng et al., 2019). In both cases, much of the illiquidity is due to regulation, e.g. restrictions or penalties on withdrawals from retirement accounts, and limits to home equity withdrawal. Modelling it as such opens the option for liquidity policy in our environment. Our modelling approach also builds upon Attanasio et al. (2024) and Maxted et al. (2024) who show the importance of present–bias for hand-to-mouth behaviour and fiscal policy, but do not consider household liquidity policy.

Finally, we connect to a large literature on retirement system design. A common thread in this literature is that imposed illiquidity is justified to help households overcome biases in their decision–making. The government has a role in mandating some form of retirement saving, and faces a problem of how to balance the need for commitment against the need for flexibility and self-insurance, and also to balance the welfare of the behaviourally biased against those who are not (Beshears et al., 2025; Moser and Olea de Souza e Silva, 2019; Amador et al., 2006). Building upon the insights of this literature, we incorporate these trade-offs into our calibrated model. We build upon the above literature by taking these models into the domain of macroeconomics, allowing us to evaluate the aggregate and distributional effects of household liquidity policy compared to conventional fiscal stimulus.

Road map The paper proceeds as follows. Section 2 documents how early access to retirement accounts represent a new tool for stimulus. Section 3 details the model and Section 4 describes its calibration. We then turn to the stimulus policy experiments in Section 5, showing the two approaches are similar in aggregate, but have different distributional implications. We evaluate their differences with a welfare analysis in Section 6.

2 A New Tool: Retirement Accounts as Stimulus Funds

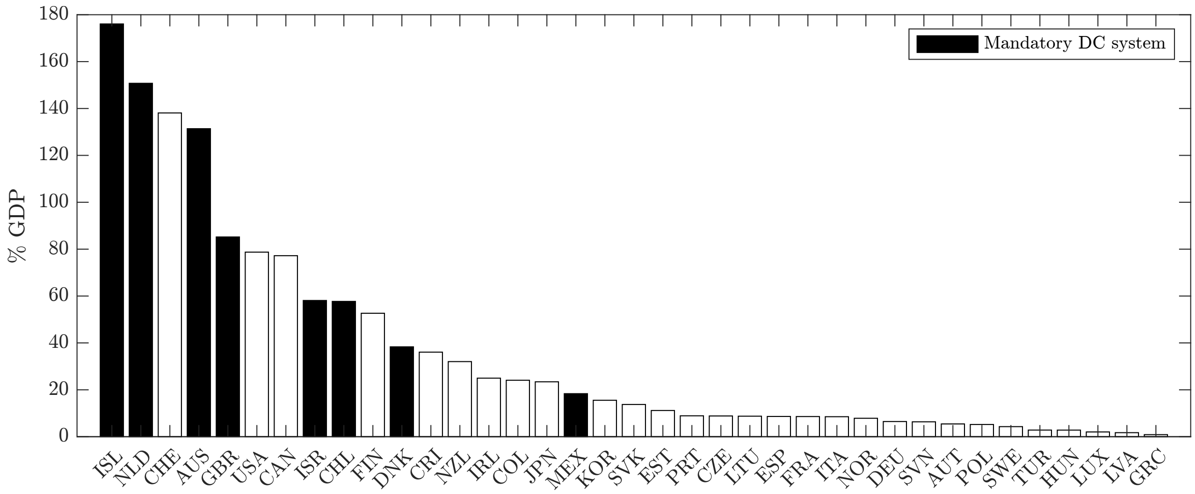
Individual defined-contribution (DC) retirement accounts have become an important pillar of retirement policy across both advanced and emerging economies, constituting an increasingly significant pool of household wealth.[4] These accounts allow individuals to accumulate wealth during working years, with governments often incentivising or mandating participation to ensure adequate retirement provision. Such accounts can build up substantial resources, as illustrated in Figure 1, which plots total retirement assets across OECD countries, distinguishing between countries with voluntary contributions (in white) and mandatory contributions (in black). In the United States, retirement wealth reaches roughly 80% of GDP, while in Australia, such wealth reaches approximately 125%. Countries with mandatory contributions naturally have more assets in the private pension system than those with strictly voluntary contributions, which dominate the right tail of Figure 1. As such, liquidity policy is more feasible in countries with mandatory contributions, and this setting is the focus of our study as a result.

Illiquidity during work life. A defining characteristic of DC retirement accounts is their regulated illiquidity during working years. Government restrictions, which take the form of early withdrawal penalties or prohibitions, are often motivated by the presumption that some individuals are myopic and lack the self-control to adequately save for retirement on their own Diamond (1977); Feldstein (1985); Laibson (1997).

The exact form of liquidity restriction varies considerably across jurisdictions (OECD, 2019, Table 3.4). In countries like Australia, contributions from labour income are mandatory for all employees and withdrawals are prohibited except under extreme circumstances such as terminal illness, rendering these accounts effectively illiquid. Other systems permit early

[4]Defined contribution accounts are common, and increasingly being adopted as countries attempt to reduce the fiscal burden of state–only systems facing ageing populations (OECD, 2018). Among OECD countries, 20 have some form of individual DC account and around half of these have mandatory contributions. Examples include Australia, Chile, Denmark, Iceland, Israel, Mexico, and the Netherlands (OECD, 2023). Outside the OECD, mandatory contributions have been implemented in numerous countries across Europe, Asia, and Latin America (Kritzer, 2005).

Figure 1: Retirement system assets



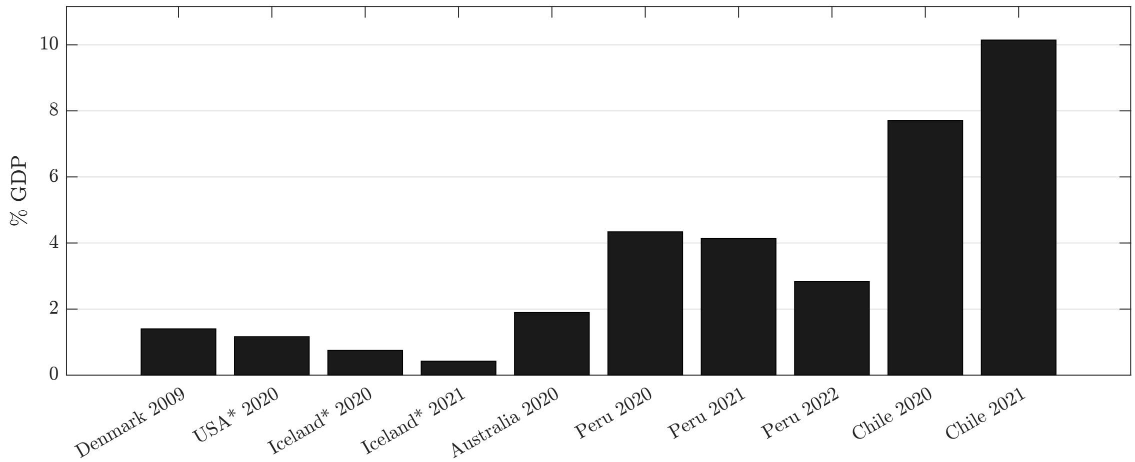
Source: values from OECD 2022 Total Pension Funds' Assets, % of GDP; classification as mandatory DC system from (OECD, 2023, Table 4.2)

withdrawals, but with a meaningful tax penalty attached (e.g. 10% in the U.S.), creating disincentives against accessing retirement savings prematurely. The key is that illiquidity in these accounts is a *regulatory* feature rather than an inherent characteristic of the underlying assets, and thus one that governments can adjust.

Early access as stimulus. Governments do make such adjustments. In response to recent economic crises, a growing number of countries have provided temporary early access to wealth held in otherwise illiquid retirement accounts, mobilising people's own savings to support household well-being and stimulate aggregate demand. Denmark was one of the first to introduce such measures, allowing early withdrawals in 2009 during the Global Financial Crisis. The results were dramatic: Danish households withdrew retirement assets equal to roughly 1.4 percent of GDP (Kreiner et al., 2019). This approach became more widespread during the Covid-19 pandemic, with more than 30 countries altering their retirement policies to support consumers and stimulate demand (OECD, 2021). Countries took three main approaches: allowing early withdrawals when they were previously banned, as in Australia, Chile, and Peru (OECD, 2021; Madeira, 2022; Hamilton et al., 2024); reducing or removing early withdrawal penalties, as in the United States (Derby et al., 2024); and reducing contribution rates, as in Malaysia and Brunei (IMF, 2021a,b).

These policies led to early withdrawals that injected liquidity equivalent to, and sometimes much larger than, conventional stimulus programs. Figure 2 shows the magnitude of these early withdrawals, per annum, as a share of GDP. Australia's program released an equivalent of 2% of pre-Covid GDP and Iceland's under 1% of GDP over two years. And

Figure 2: Early pension withdrawals in select countries, by year



Sources: Authors' calculations. Reference GDP is 2019 for Covid era policies and 2009 for Denmark's. Current price GDP from IMF WEO statistics. Danish figures from Kreiner et al. (2019); USA from Derby et al. (2024); Iceland from IMF (2023); Australia from ATO 'COVID-19 Early release of super' statistics (2023); Peru from Olivera (2023); Chile from Pienknagura and Evans (2021) Table 2. * indicates withdrawals from a system with voluntary contributions only.

in the United States, working-age households withdrew $250 billion from their retirement accounts in 2020 (Derby et al., 2024), equivalent to roughly 1.2% of GDP. For comparison, the CARES Act authorised a first-round of stimulus checks of roughly $300 billion in March 2020. Finally, the largest liquidity injections were in Peru and Chile, where withdrawals totalled 4–10% of GDP for multiple years in a row. The magnitude of these withdrawals placed them on par with some of the most expansive stimulus programs of recent decades.

Modelling stimulus through early access to retirement wealth. In this paper, we develop a model that allows us to analyse the aggregate and distributional effects of household liquidity policy relative to conventional fiscal stimulus by embedding a realistic defined contribution retirement system into our model. Although details vary, DC retirement systems across the world are characterised by (a) restrictions on access during working life, (b) voluntary or mandatory contribution rules, and (c) tax concessions, and they are usually complemented by a state pension.[5] Our model has all these features as well. This not only gives us the ability to analyse liquidity policy in the appropriate environment, but also gives life to the illiquid asset commonly featured in two–asset heterogeneous agent models (e.g. Kaplan et al., 2018). In our setting, the illiquidity is due to regulations designed to encourage accumulation during working life, and any difference in asset returns comes from preferen-

[5]The design of individual retirement accounts differs meaningfully across countries, and our model nests many countries' systems as special cases. We discuss the design of these retirement systems, and variation across countries, in more depth in Supplemental Appendix A.

tial tax treatment. And because illiquidity is an imposition by the government, temporary changes to regulations are a new lever that can stimulate demand.

3 A model of household liquidity policy as stimulus

We develop a continuous-time heterogeneous agent model to analyse the trade-offs inherent in different types of stimulus policies. The foundation of our framework is a two-asset incomplete markets model with a life-cycle component, which we extend by explicitly modeling retirement accounts as regulated savings vehicles. This model allows us to study both conventional fiscal stimulus and household liquidity policies in a unified framework.

The model features three essential elements that distinguish it from standard heterogeneous agent models. First, households experience a life-cycle with two distinct phases (working life and retirement) creating a natural need for retirement planning. Second, a fraction of households exhibit present-bias, causing them to systematically under-save for retirement, which generates a welfare-improving role for government intervention. Third, the government implements retirement policies through both a state pension and the regulation of individual retirement accounts, which are generally illiquid, but can be temporarily adjusted during economic downturns.

Our environment consists of a continuum of households, a fiscal authority, and a regulatory framework governing retirement accounts. Prices (the interest rate and wage) are fixed, and the stationary equilibrium between households and fiscal authority is characterised by a tax rate that balances the government budget. This partial equilibrium approach allows us to isolate the direct effects of policy interventions on household behaviour without the confounding effects of price adjustments.

3.1 Households

Households are differentiated by their stage of life (working or retired) and four time–varying state variables: their idiosyncratic productivity z and employment state, the balance in their liquid account b, their illiquid account balance a, and their present–bias type β. We collect these states into the vector $x = (b, a, s, \beta)$, where s captures life–stage, workforce status and employed productivity.

3.1.1 Life–cycle transitions

Households live through working–life and then retirement (Yaari, 1965; Blanchard, 1985), transitioning out of each phase with fixed Poisson intensities (δ_R, δ). When young, they work, and make consumption and asset allocation decisions. In retirement, they make the same decisions but can no longer receive the market wage. This creates a need for income that is met personally by any assets they retire with, and collectively by the distribution of a fixed state–pension w_R. With these resources, retirees solve a cake–eating problem until they die, and are replaced by workers with no assets.

3.1.2 Idiosyncratic risk

Working–age households are subject to two types of idiosyncratic risk to their income. First, they jump in and out of employment with Poisson finding and separation intensities (λ_f, λ_s). Second, whilst employed, their log–labour productivity is a diffusion that follows an Ornstein–Uhlenbeck process

$$d \ln z_t = -\theta_z(\ln z_t - \ln \bar{z})dt + \sigma_z dW_t \tag{1}$$

Where θ_z captures its persistence, $\bar{z}$ is the stationary mean, normalised to 1, W_t is a Wiener process, and σ_z is the weight on this noise. Newborn workers are employed, and draw their productivity from the stationary distribution of z. Retired workers are not subject to any idiosyncratic risk beyond the chance of death.

3.1.3 Budget constraints

All households have access to two accounts for storing wealth—a liquid and an illiquid account. At any point in time, households have two choice variables—consumption $c > 0$, funded from their liquid account, and voluntary transfers between the two accounts $d \in \mathbb{R}$.

Liquid account The law of motion for the liquid account is

$$\dot{b} = r_b(b) \cdot b + (1 - \xi(x)) \cdot y(x) - d - \chi(d, a) - (1 + \tau_c) \cdot c + T(x) - \tau_b(x) \tag{2}$$

Drift in liquid assets comes from various sources. First, asset returns, where $r_b(b)$ is the balance–dependent rate of return on the liquid account. We assume positive balances attract a return of r_b, and that borrowing, whilst allowed, comes with an extortionate penalty $\omega >> 0$ so that $r_b(b < 0) = r_b + \omega$.[6] This assumption creates a soft–borrowing constraint, which will be important later. $y(x)$ is idiosyncratic income, assumed to be wz when working, w_U when

[6]This setup reflects the empirical reality that few households are actually borrowing constrained (Lee and Maxted, 2023), as in the wealthy hand–to–mouth literature (Kaplan and Violante, 2014). Instead, many hover close to zero liquid assets, rotate credit card balances (but not at their limit), and rarely exhaust *all* avenues for borrowing, which come with ever more onerous terms (pay–day loans, pawn shops, loan sharks).

unemployed, and w_R when retired. $T(x)$ captures fiscal transfers, c is consumption, which attracts a tax τ_c, and $\tau_b(x)$ is a state–contingent income tax function, discussed in full in Section 3.2.

Working households may be required to contribute a proportion of their income $\xi(x)$ into their illiquid account (equal to zero in unemployed and retired states). As we will discuss in Section 3.2, this is one of the levers of regulation the government uses in retirement policy. As well as this, households may make voluntary transfers into (and out of) the illiquid account (d). These transfers are subject to a constraint $d \geq \gamma$ which is another lever of the government retirement policy, discussed in Section 3.2. Any voluntary transfers are subject to adjustment costs $\chi(d, a)$ which, following Kaplan et al. (2018), have the structure

$$\chi(d, a) = \chi_0(d)|d| + \frac{\chi_1}{2}\frac{d^2}{a} \tag{3}$$

The convex nature of this function puts a handbrake on the voluntary transfer policy, necessary to avoid jumps in continuous time, and its structure leads to analytical solutions for d. The linear cost $\chi_0(d)$ may differ for withdrawals and deposits.[7]

Illiquid account The law of motion for the illiquid account is

$$\dot{a} = r_a \cdot a + \xi(x) \cdot wz + d - \tau_a(x) \tag{4}$$

Where r_a is the rate of return on the illiquid asset, and $\tau_a(x)$ is a state–contingent tax function, defined in Section 3.2. Borrowing is not allowed in the illiquid account, $a \geq 0$.

3.1.4 Present–biased preferences

A portion of the population $\eta \in [0, 1]$ is subject to present–bias, the rest are standard exponential discounters. The present–biased households have 'instantaneous gratification' (IG) preferences, the continuous–time analogue to quasi–hyperbolic discounting (Harris and Laibson, 2013; Laibson and Maxted, 2023; Maxted, 2025). We discuss these preferences and their relation to exponential discounters in Supplemental Appendix B. In short, they use a biased discount function the places discretely less weight $\beta \leq 1$ on all moments beyond the present.

$$D(s-t) = \begin{cases} 1 & \text{if } s-t=0 \\ \beta \cdot e^{-\rho(s-t)} & \text{if } s-t>0 \end{cases}$$

[7] For example to replicate the USA's 10% tax penalty on withdrawals.

Inter–temporal choices weighing present and future are therefore distorted by the lower weight placed on the future perceived value. Furthermore, we assume households are completely naive about their bias, making decisions assuming their future selves will be rational.[8]

3.1.5 Household problem and solution

During each stage of life, households choose consumption and voluntary transfers to maximise perceived value.

Exponential household Suppose we have substituted the drift in labour productivity with an N–state discrete process, and that this process, and jumps in and out of unemployment, are governed by Poisson intensities $\lambda^{z\to z'}$. During working life, the Hamilton–Jacobi–Bellman equation (HJB) is

$$\begin{aligned}\rho v(x) - \partial_t v(x) = \max_{c,d} &\left\{ u(c) + \partial_b v(x) \cdot \dot{b}(c,d,x) + \partial_a v(x) \cdot \dot{a}(d,x) \right\} \\ &+ \sum_{z'} \lambda^{z\to z'} \left[v(x') - v(x) \right] + \delta_R \left[v_R(x) - v(x) \right] \end{aligned} \tag{5}$$

Where $\dot{b}(c,d,x)$ and $\dot{a}(d,x)$ are defined by Equations 2 and 4. This problem's FOC define the policy functions

$$u'(c(x)) = (1+\tau_c)\partial_b v(x) \tag{6}$$

$$\partial_a v(x) = \partial_b v(x)(1 + \chi_d(d(x), a)) - \kappa(x) \tag{7}$$

Where $\kappa(x)$ is the Lagrange multiplier on the withdrawal constraint. There is an equivalent HJB and set of FOCs defining the solution to the retired household's problem.

$$(v_R(x), c_R(x), d_R(x)) \tag{8}$$

Present–biased household The biased households' perceived value and policies are recovered directly from the exponential household results.

Lemma 3.1 (Present–biased solution (Maxted, 2025))**.** Assuming (1) CRRA utility with risk–aversion σ, and (2) never–binding soft–borrowing constraint, the naive IG consumer's

[8] This is an innocuous assumption. Maxted (2025) shows that under two assumptions—(1) CRRA utility and (2) soft–borrowing constraint—a problem with any degree of sophistication is isomorphic to a fully naive agent with a lesser degree of present–bias. This assumption simplifies the analysis because the solution can be reached in two steps: (1) solve the exponential discounter's problem to find $v(x)$ and use the solution as the IG consumer's continuation value to (2) solve the IG consumer's problem for each type.

value and policies are scale transformations of the exponential discounter's equivalents

$$c^{\beta}(x) = \beta^{-\frac{1}{\sigma}} \cdot c(x) \quad \text{and} \quad v^{\beta}(x) = \beta \cdot v(x) \quad \text{and} \quad d^{\beta}(x) = d(x) \tag{9}$$

Proof. Derivation following Maxted (2025) in Supplemental Appendix B. □

The intuition behind this result, from Maxted (2025), is that an exponential discounter sets consumption so that marginal utility equals the marginal continuation value of liquid resources in future. The present–biased household does the same, but they perceive their marginal continuation value to be lower by β, and so consume more. Note that the present–bias only comes into play in decisions that trade between the present and future. The voluntary transfer choice is about balancing marginal values in the future, and as such is unaffected by present–bias.

State distribution The policy functions defined above determine the drift in the endogenous state variables i.e. the balances in the liquid and illiquid accounts. All other state transitions—–between productivity and employment status within working life, and transitions between life stages—–are exogenous. Together, these state–transition rules define how the distribution of households across the state-space moves around over time and therefore define the Kolmogorov Forward Equation (KFE). We represent these transition processes with the infinitesimal generator $\mathcal{A}$ such that the KFE is defined by the below, where $\mathcal{A}^*$ is the adjoint of the generator.

$$\partial_t h(x) = \mathcal{A}^* \left[h\right](x) \tag{10}$$

3.2 Retirement policy

Having described household behaviour, we now turn to the government's role in shaping it. Present–biased households over–consume and arrive at retirement with inadequate savings, a pattern they would prefer to avoid if they could commit in advance. These mistakes create a rationale for government intervention: by constraining household choices, the government can provide commitment on behalf of households.[9] And the tools the government uses to mandate and support saving in turn become the lever for household–liquidity policy.

In our model, the government sets retirement policy through an unconditional state pension w_R and regulations governing individual retirement accounts (IRAs). The underlying

[9] There are other rationales for government intervention in retirement savings e.g. moral hazard or redistribution. We focus on this particular motive because there is ample evidence that people do suffer from present–focused choices, and this evidence is often raised in policy documents relating to retirement systems.

asset in the retirement account is the same as that in the liquid account, with equal gross rates of return:[10]

$$r_b = r_a = r$$

The account's illiquidity stems from regulation rather than inherent asset characteristics. The degree of illiquidity is determined by four regulatory parameters. The government can impose penalties on early withdrawals ($\chi_0(d < 0) = \chi_0$), and may also restrict early withdrawals directly through the constraint $d \geq \gamma$. In line with our discussion of DC schemes in Section 2, the government may also mandate that a proportion $\xi \in [0, 1)$ of labour income be contributed to the retirement account and may also offer a tax deduction $\varphi \in [0, 1]$ that reduces the tax burden on contributions and returns.

The mandatory contribution rate and tax concession affect the tax functions introduced in Equations 2 and 4 as follows:

$$\tau_b(x) = \tau \left[rb \cdot (b > 0) + (1 - \varphi\xi)wz \right] \tag{11}$$

$$\tau_a(x) = \tau(1 - \varphi)ra \tag{12}$$

The variable φ reduces tax liability for mandatory contributions and asset returns, and leaves withdrawals tax–free.[11] When $\varphi = 1$, contributions come from pre–tax income and returns are tax–exempt. We assume that voluntary contributions are made from post–tax income and withdrawals are not taxed. Further, we assume that retirees face no withdrawal restrictions, continue to receive tax concessions, but cannot make deposits.

In standard two–asset heterogeneous–agent models, illiquidity is imposed as a technological feature (Kaplan et al., 2018). Here, it arises endogenously from regulation, providing a micro–foundation for the illiquid account in those models and aligning with real–world pension design. This framework nests many countries' systems as special cases and, crucially, allows us to analyse the impact of temporary regulatory changes (i.e. liquidity policy) within a consistent macroeconomic model.

[10] In developed countries, participation in DC plans doesn't substantially change the span of available assets. Retail consumers may not access alternatives like hedge funds directly, but these comprise a small portion of DC retirement funds, which primarily hold market securities or real assets accessible through market equivalents.

[11] This implements a concessional 'TTE' system, where the first two flows (contributions and returns) are taxed, albeit at reduced rates, leaving the withdrawals (the final flow) exempt. We discuss different tax designs for DC systems in Supplemental Appendix A.

3.3 Fiscal authority

The fiscal authority pays benefits to the retired (w_R) and unemployed (w_U), services debt (rB), makes government purchases of the consumption good G, and makes discretionary transfers to households $T(x)$. It takes in taxes on consumption, capital and labour income. Deficits are funded by changes in government debt $\dot{B}$, defined below.

$$\dot{B} = \underbrace{G + w_U\pi_U + w_R\pi_R + rB + \int T(x)h(x)dx}_{\text{Spending}} - \underbrace{\int \left(\tau_c c(x) + \tau_b(x) + \tau_a(x)\right) h(x)dx}_{\text{Revenues}} \tag{13}$$

Where π_U and π_R represent the measures of unemployed and retired people, and z_U and z_R represent those states (e.g. $\pi_U = \int h(b, a, z = z_U, \beta)dx$). Borrowing is restricted by an exponential fiscal rule (Auclert et al., 2023; Galí, 2020; Angeletos et al., 2023):

$$\dot{B} = -\mu \left(B - \bar{B}\right) \tag{14}$$

This rule sets an exponential decay of the government debt gap around some ideal level $\bar{B}$, where $\mu \geq 0$ (if zero, always hold debt constant; as $\mu \to \infty$, return to $\bar{B}$ immediately).[12] We assume that government debt is fixed at the target in the stationary solution, and that the fiscal authority uses the consumption tax rate as the marginal tool to meet the fiscal rule in both the stationary and dynamic solutions. We assume that this rule is suspended while any stimulus is active (whether fiscal or liquidity policy), and reactivated immediately after.

3.4 Stationary equilibrium

For fixed prices (w, r) and given retirement policy settings $(w_R, \chi_0, \gamma, \xi, \varphi)$, a stationary equilibrium is the set of working–life and retirement value functions $(v(x), v_R(x))$ and policy functions $(c(x), c_R(x), d(x), d_R(x))$, the measure over household states $h(x)$, and the consumption tax rate τ_c such that

– The values and policies solve the household problem (Equations 5 to 9)

– $h(x)$ is stationary (i.e. $\partial_t h(x) = 0$ in Equation 10)

– τ_c balances the budget (Equation 13)

Details of the computational solution are provided in Supplemental Appendix D.

[12]Under this fiscal rule, debt must follow the path $B_{t+s} - \bar{B} = \left(B_t - \bar{B}\right) e^{-\mu s}$ yielding a half–life of $\ln 2/\mu$ in units of model frequency.

Stimulus policy This model allows us to analyse the two approaches to stimulus policy we're interested in. Stimulus is taken to mean policy interventions that increase aggregate consumption above its stationary level in the short–run. And the two methods available to the policy–maker are (a) fiscal transfers ΔT_t, funded by deficits and repaid via future tax changes that meet the fiscal rule, or (b) household liquidity policies i.e. regulatory changes to either restrictions on retirement account withdrawals $\Delta\gamma_t$, or mandatory retirement contribution rates $\Delta\xi_t$; we focus on the former in this paper.

4 Calibration

We calibrate the model to match an economy with illiquid individual retirement accounts. We employ a two-step calibration routine. First, we externally calibrate many of the institutional and preference parameters based on empirical evidence and the existing literature. Second, we internally calibrate (i) the share of households with present-bias, which is set to target the average MPC and (ii) two key parameters that govern retirement policy, which are set in an optimal policy exercise that maximises the welfare of prospective newborns, subject to various constraints.

Our calibration achieves two goals that set the scene for our policy experiments. First, by assuming that retirement policy is ex-ante constrained optimal, we ensure a fair comparison between fiscal and liquidity policy. If retirement policy were too restrictive, liquidity policy would be unambiguously welfare improving; if too loose, there would not be enough firepower for liquidity policy to be a viable substitute for fiscal stimulus. This approach delivers, in our baseline calibration, a retirement system that roughly approximates what we observe in many of the countries that have implemented the largest and most economically meaningful versions of household liquidity policy, as discussed in Section 2.

Second, our calibrated model generates behaviour consistent with empirical evidence, with appropriate ratios of wealth to income, savings rate, and the drop in consumption on retirement. Most importantly, the aggregate MPC is empirically realistic. This is necessary to ensure in our stimulus experiments that the consumption boost from fiscal (the desired policy outcome) is matched by an appropriate increase in government debt (which sets the longer–run policy impact). This goal is achieved by calibrating the present–biased share η internally to match the aggregate MPC to empirical estimates.

4.1 Externally calibrated parameters

The full set of parameters is reported in Table 1.[13] Most of the externally calibrated parameters are standard, and the details—covering idiosyncratic risk, preferences, prices and steady–state fiscal policy—are provided in Supplemental Appendix C. Below, we focus on the novel elements in our model: the households' lifecycle structure and preference heterogeneity, and the government's fiscal rule and retirement policy.

Table 1: Calibrated parameters

Parameter	**Symbol**	**Baseline calibration**	**Source**
Retirement intensity	δ_R	1/160	40 year av. work–life
Death intensity	δ	1/80	OECD (2023)
Sep. & find. intensity	(λ_s, λ_f)	(0.0587,1.2)	Shimer (2005) & BLS
Log–income process	(θ_z, σ_z)	AR1(0.9136,0.0426)	Floden and Lindé (2001)
Risk aversion	σ	2	Standard
Discount rate	ρ	0.0025	Carroll et al. (2017)
Present–bias	(β_L, β_H)	(0.5,1)	Ganong and Noel (2020)
Present–bias share	η	0.5	Target MPC $\in [0.15, 0.25]$
Risk–free real rate	r	0.0051	$\sim$ 2% p.a.
Borrowing penalty	ω	0.4024	500% p.a.
Wage	w	0.25	Numeraire
Unemployment benefit	w_U	0.1	Shimer (2005)
Income tax	τ	25%	OECD average
Consumption tax	τ_c	12%	Budget balance
Government spending	G	0.0238	G/GDP = 15%
Steady state debt	$\bar{B}$	0.1589	Debt/GDP = 25%
Fiscal rule	μ	0.0128	Galí (2020)
Adjustment costs	(χ_0, χ_1)	$(0, 0.001)$	Trivial

Life–cycle Working lives and retirement last an average of 40 and 20 years, respectively. This assumes a working life spanning 25–65, and matches the OECD average expected life–years after retirement (OECD, 2023, p. 192). After death, retirees are replaced by newborns with zero assets and initial productivity drawn from its stationary distribution.[14]

Preference heterogeneity The population is split into two types of households: present–biased and exponential. The present–biased households have $\beta = 0.5$, similar to Ganong and Noel (2020) and Laibson et al. (2024), and the exponential have $\beta = 1$. The share of biased households is calibrated internally and discussed below.

[13] Time is continuous, with a base frequency of one quarter.

[14] We also impose two rules on retirement to keep the solution stable: forced retirement above a (very high) asset threshold, and bankruptcy upon retirement for households retiring with the minimum asset balances. The rationale and details for these are discussed in Supplemental Appendix C.

Fiscal rule The exponential parameter on the fiscal rule is set to $\mu = 0.0128$, such that debt gaps are closed with a half–life of 13.5 years, following Galí (2020).

Retirement policy In our baseline calibration, we focus on individual retirement accounts where withdrawals are not allowed during working life, $\gamma = 0$, and the withdrawal penalty is set to zero $\chi_0(d < 0) = 0$. We focus on fully illiquid accounts because they are common, generally result in large asset stocks, and have experienced some of the most substantial withdrawals when liquidity policies have been implemented (see e.g. Hamilton et al., 2024).[15] The state pension is set to $w_R = 0.075$, a replacement rate of 30% average worker income, which is the average replacement rate across OECD countries with a mix of state and private pension schemes.[16]

4.2 Internally calibrated parameters

We jointly calibrate three remaining parameters: the share of present–biased households (η), the mandatory contribution rate (ξ), and the tax benefits on retirement accounts (φ). We do this in two stages. In the first, the social planner chooses the mandatory contribution rate and tax benefits to maximise the welfare of prospective newborns, subject to a participation constraint, and conditional on the share of present-biased consumers (η). The social planner's optimal choice balances the needs of both rational and biased consumers, which generates a standard trade-off between flexibility and commitment (see Appendix A for details). This gives us $(\xi^*(\eta), \varphi^*(\eta))$. In the second stage, we condition on the social planner behaving optimally, and set η^* such that the aggregate worker MPC in stationary equilibrium is close to 0.2, the mid–point of empirical estimates (Kaplan and Violante, 2022). The resulting parameters are $(\xi^*, \varphi^*, \eta^*) = (0.08, 0.37, 0.5)$.

Retirement policy. The calibrated contribution rate of 8% and tax benefit of 37% closely match real-world DC systems with mandatory contributions. The social planner chooses mandatory contributions anticipating that present-biased agents would not save adequately for retirement if left entirely to their own devices. Mandatory contributions increase everyone's saving rate relative to a model without forced saving, but much more so for the biased workers (see Appendix A). Interestingly, the planner does not find the tax subsidy to be a

[15] This is the norm across many countries with DC accounts in Europe, Asia, and Latin America. In contrast, the U.S. penalty of 10% for early withdrawals is low by international standards. Indeed, Beshears et al. (2015) state that "The United States stands alone in the high degree of liquidity in its DC system."

[16] This is the average replacement rate provided by the 'mandatory public' state pension, weighted across OECD states that combine state and private components in their pension schemes (OECD, 2023).

useful tool for increasing savings; its presence serves a political purpose of building buy–in into the system, rather than incentivising saving.

We focus on a retirement system with mandatory contributions not only because it is constrained-optimal, but also because it is incredibly common. While the US system has voluntary contributions, the majority of DC systems in Europe, Asia, and Latin America have mandatory contributions.[17] Further, the above retirement system closely approximates many of the countries that have implemented the largest and most economically meaningful versions of household liquidity policy, such as Australia, Chile, Peru, and Denmark.[18] We assess the sensitivity of our results to looser retirement policy in Section 6.2.

Present–bias. Our baseline calibration yields a present-bias share of $\eta = 0.5$. Given that present-biased consumers have $\beta = 0.5$ while standard consumers have $\beta = 1$, this delivers an average β of 0.75, within the range of previous estimates in consumption-saving models (Laibson et al., 2024; Hamilton et al., 2024). We explore the sensitivity of our results to this parameter in Appendix A.5.

4.3 Model validation

Table 2 compares aggregate moments among workers in the stationary solution to the model to equivalents in the USA. The model produces an average quarterly MPC of 0.22 among workers (0.24 for the whole population), within the range of recent empirical estimates for non–durable consumption (Ganong et al., 2023; Jappelli and Pistaferri, 2014; Sahm et al., 2010, 2012; Fagereng et al., 2021; Kueng, 2018; Kaplan and Violante, 2022). Our model generates a reasonable MPC due to the presence of hand-to-mouth consumers, with roughly 40% of workers being hand–to–mouth, in line with standard estimates from the literature (e.g. Aguiar et al., 2024; Kaplan et al., 2020a; Kaplan and Violante, 2022).[19]

The model comes close to aggregate wealth–to–income ratios: recording total financial wealth of 6.4 times labour income, compared to 4.1 in the US data; and liquid wealth measuring one year's worth of labour income, compared to 0.6 in the data. Having greater total wealth is natural, given that our baseline calibration features a mandatory DC retirement system, which is different than the US system, but similar to many other countries. The average household saving rate is 7% in our model, higher than the US, but in the range of OECD rates.

[17]For examples within the OECD, see Footnote 4.

[18]See Supplemental Appendix A for details on design features of DC retirement systems across the world.

[19]Hand–to–mouth status is defined by having liquid assets less than half of monthly labour income (Kaplan and Violante, 2022).

Table 2: Aggregate moments for workers

Moment	Model	Data	Source
Quarterly MPC	0.22	$[0.15, 0.25]$	Kaplan and Violante (2022)
% HTM	40	41	”
Liquid wealth / labour income	1.0	0.6*	”
Fin. wealth / labour income	6.4	4.1*	”
Personal saving rate	7%	$[0, 10]$%	OECD range
Median Δc on retirement	-1%	-3.5%	Aguila et al. (2011)

*From the bottom 95% of the empirical wealth distribution.

In addition, our model generates an empirically realistic change in spending at the time of retirement. In our model, the median change in spending upon retirement is -1%. For comparison, Aguila et al. (2011) estimate a median change of -3.5%. Further, our model generates realistic heterogeneity in the response, with a positive relationship between Δc and wealth at retirement, similar to Aguila et al. (2011) and Moran et al. (2021).

Across the distribution Figure 3a plots the distributions of liquid and retirement assets. Few households have any liquid assets at all, a result of their present–bias leading them to under–save. The distribution of retirement assets is approximately exponential, because it reflects the age distribution—in the baseline calibration no–one makes voluntary contributions, and so balances in the retirement account are built of 8% contributions from labour income, and asset returns, accumulated over time.

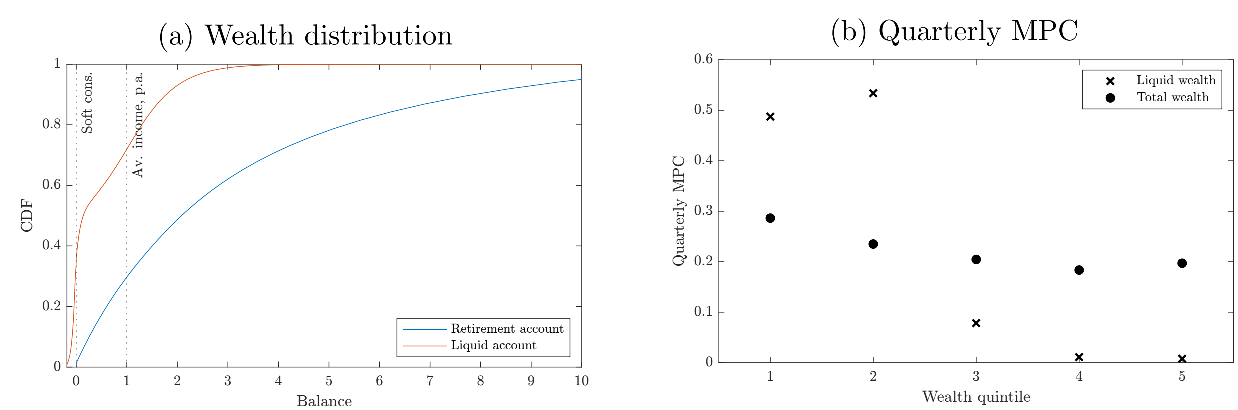


Figure 3b plots the household MPC across the quintiles of liquid and total wealth. The MPC is high in the first two quintiles of the liquid account distribution, which are closest to the soft–borrowing constraint, and declining rapidly after that. The MPC is roughly flat with total wealth. This mirrors reality well, as various studies have shown that the MPC is sharply declining in liquid wealth, but much less so with total wealth (e.g. Fagereng et al., 2021; Ganong et al., 2023).

5 Stimulus policy

We now characterise the mechanisms through which the two policies operate, then evaluate their aggregate and distributional effects on consumer spending and other outcomes. We first establish that liquidity policy indeed works similarly to fiscal stimulus in aggregate: opening a window during which people can withdraw from their retirement accounts leads to such withdrawals, and the greater liquidity boosts consumption in much the same way as a fiscal transfer. At the aggregate level, the two approaches are similar—they increase liquidity in the present by incurring debt, but they differ in where this debt sits (on the government's books, representing an implicit liability for households in the form of future taxes, or against workers' retirement accounts), and the process through which it is repaid.

Having established that both approaches 'work' as stimulus in aggregate, we then explore the other implications that each stimulus approach has. These include distortions to inter–temporal choices from changing tax rates, inter–generational distributional effects, and reduced retirement adequacy for workers.

5.1 Defining the stimulus policy experiments

We assume that the planner wishes to induce a specific stimulus to aggregate household consumption over a set period of time, and it is deciding which intervention to use. In the baseline experiment we set the desired stimulus to be 5% of stationary average household consumption over a period of one quarter (i.e. $\Delta = 1$). To frame the results it is useful to define a policy–dependent aggregate that accumulates average household consumption over a period Δ

$$C(T, \gamma) = \int_0^{\Delta} \left(\int c_{t+s}(x; T, \gamma) \cdot h_{t+s}(x; T, \gamma) dx \right) ds$$

The stationary aggregate, for example, is $\bar{C} = C(0, 0)$; and the target for a given policy mix (T, γ) is therefore

$$C(T, \gamma) = 1.05 \times \bar{C}$$

Both interventions are modeled as MIT shocks to the policy instrument that last for a duration of one–quarter.[20] The baseline fiscal intervention is a shock to T, paid to workers, that solves: $C(T^*, 0) = 1.05 \times \bar{C}$.[21] And the baseline liquidity policy intervention is similarly a shock to γ that lasts for one quarter such that $C(0, \gamma^*) = 1.05 \times \bar{C}$. In both cases, taxes

[20] Unanticipated before time–0 but known thereafter.

[21] We choose to target workers in the baseline fiscal exercise so its magnitude can be compared to the alternative liquidity policy, which is only effective for the working–age. We explore an alternative where the whole population receives the transfer in Section 6.2.

adjust endogenously to meet the fiscal rule defined in Section 3.3. All other variables, like wages and the interest rate, are held fixed to isolate the direct effects of the policies.

5.2 Common aggregate stimulus

The first thing to establish is that liquidity policy works as stimulus in the model. The amounts needed to achieve a 5% consumption boost are below.

Result 5.1 (Stimulus equivalence)**.** Both interventions can implement the desired stimulus, with scales that are close in magnitude at $T^* = 0.0706$ and $\gamma^* = -0.0723$.

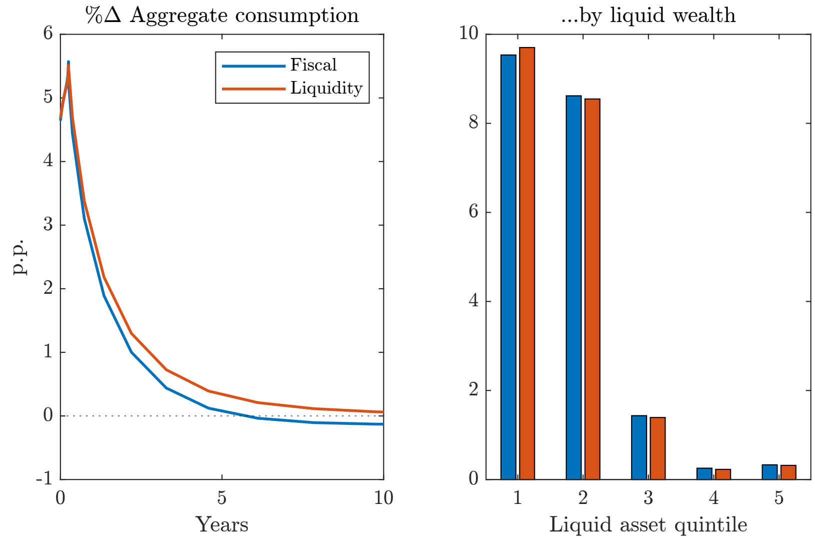
The calibrated stimulus policies transfer the equivalent of 7.06% average annual income to working households under fiscal policy, or allow them to withdraw an amount equivalent to 7.23% of average annual income over a quarter under liquidity policy. In the US, this is equivalent to nearly $5,500 in each case. The calibrated policy counterfactual is therefore large for a fiscal stimulus (e.g. the US CARES Act transferred $1,200 per person and an extra $500 per child), but small for a liquidity policy (e.g. in Australia people were allowed to withdraw up to $AU20,000 from their superannuation accounts). The fact that the calibrated numbers are so close suggests policymakers should see them as having an equivalent impact on aggregate demand.

Figure 4 shows the impulse responses of aggregate consumption under the two different stimulus policies. Liquidity policy clearly has a stimulative effect on consumption, just as fiscal does, prompting a 5% increase in the aggregate consumption rate over the stationary equivalent ($\bar{C}$), as they were calibrated to do. After the immediate stimulus, liquidity policy produce less drag on consumption in the medium term (left panel). The two paths for consumption diverge within a few years, with the one under fiscal policy going negative as the stimulative effects wear off and the repayment plan kicks in. Under both policies this stimulus is mainly driven by workers who started off with less liquidity (right panel), as expected because these people tend to have higher MPCs (see Figure 3b).

5.3 Difference in funding

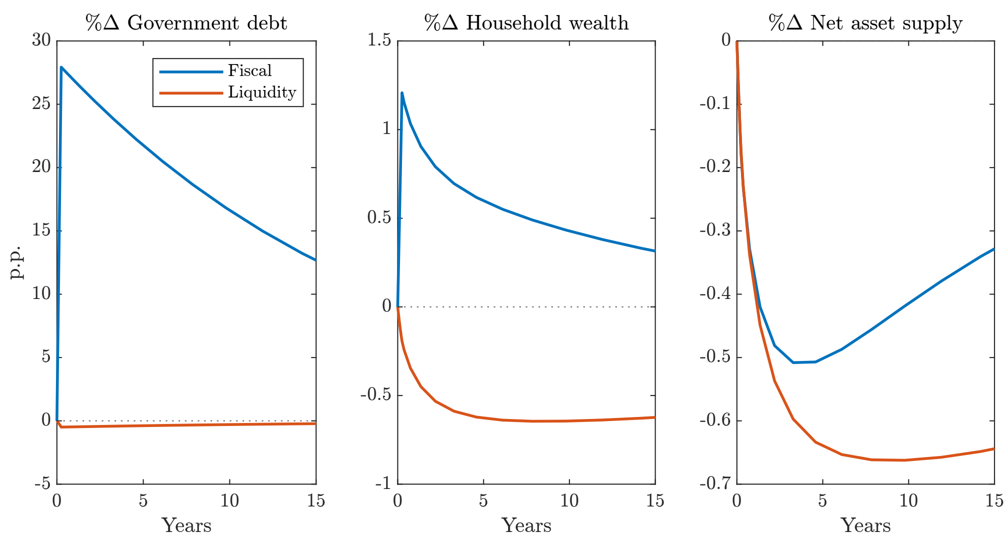
The difference in funding mechanism is apparent by comparing the responses of government debt and household wealth under the two policies. In Figure 5, government debt jumps under fiscal policy as the transfers drive deficits, and then glides down as the debt is repaid with higher taxes. This increased government debt funds a concurrent increase in household wealth (visible in the middle panel) under fiscal policy, which reduces as households spend the extra liquidity on consumption and higher taxes. By contrast, there is no immediate

Figure 4: Consumption response to different policies



impact on household wealth from liquidity policy (which only alters asset allocation), but a similar gradual decline as households (a) consume the extra liquid resources, and (b) retire with fewer illiquid resources.

Figure 5: Funding channels



The government debt accumulated under fiscal policy represents an implicit liability for households: the present value of their increased future tax bill, not recognised in their balance sheets. To show the consolidated household financial position, the right panel of Figure 5 plots their net asset supply—the difference between households' wealth (the sum of liquid and illiquid assets) and government debt. This plot shows two things. First, the path of this aggregate is quite similar under the two policies for the first few years, and only starts to deviate in later years. The effects of both policies last a long time. Second, the duration of fiscal policy's impact clearly depends on the fiscal rule, but liquidity policy's effects necessarily span generations. They only wash out of the system after all affected workers retire, and die, which will be many decades after the stimulus occurred.

From the perspective of the aggregate economy, both policies do the same thing in qualitative terms. They increase liquidity for workers, driving short–term consumption, and they fund this with decreased illiquid wealth, whether in retirement accounts or greater future taxes. The difference between the two is where decreased illiquid wealth is situated, who repays it, and when. Under fiscal policy it sits as a debt on the government's balance sheet, and it is repaid with the (broad–based) consumption tax in a process determined by the fiscal rule. Under liquidity policy it sits like a debt on households' balance sheets (as a negative entry in their retirement accounts), and it is 'repaid' in lump sums by workers as they retire, in a process determined by the retirement rate. The primary reason the aggregate asset supply curves diverge in the right panel of Figure 5 is that the fiscal rule 'retires' debt at a faster rate than workers retire.[22]

Although the two approaches are qualitatively similar at the aggregate level, they have potentially different distributional and normative implications because of the difference in the size of the repayment tax base, and the redistribution and distortions caused by the repayment mechanism. The taxes used to repay increased government debt have a broad base, applying to workers and retirees regardless of their status when the fiscal policy was implemented. By contrast liquidity policy is repaid from a narrower base—only the workers that extracted liquidity are forced to 'repay' by having lower future–value retirement savings—and it is not at all redistributive. One other difference between these repayment mechanisms at the aggregate level is whether they cause inter–temporal distortions.

5.4 Inter–temporal distortion

The two approaches have different implications for the path of tax rates, and the inter–temporal distortions these cause. Knowing the tax rate is growing (declining), households will shift consumption into the present (future)—a distortion away from the optimal smoothing path.

Lemma 5.2 (Euler distortions)**.** Assuming the borrowing constraint is non–binding, the

[22] We explore an alternative fiscal rule that equalises these rates in Section 6.2.

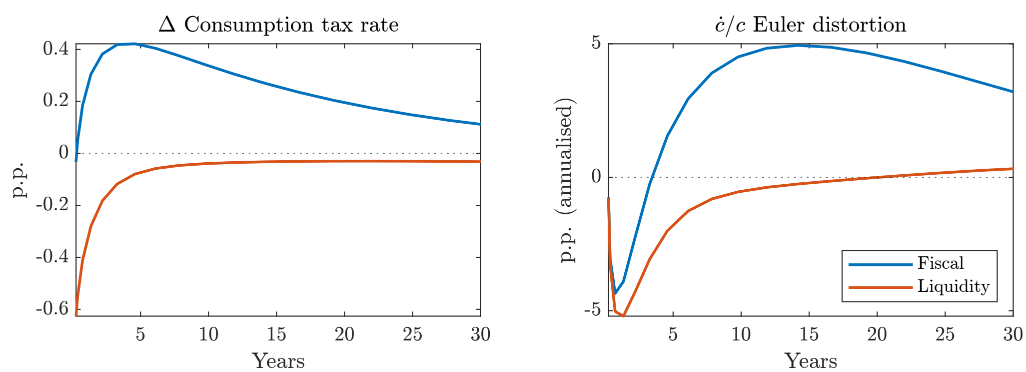
changing consumption tax rate distorts the Euler equation

$$\mathbb{E}\left[\frac{\dot{c}(x)}{c(x)}\right] = \frac{1}{\sigma}[r_b(b)\cdot b + r(b)) - \rho] - \underbrace{(1+\tau_t)(1-\beta^{1/\sigma})\partial_b \hat{c}_t(x)}_{\text{Bias distortion}} - \underbrace{\frac{1}{\sigma}\left[\frac{\dot{\tau}}{1+\tau_t}\right]}_{\text{Tax distortion}}$$

Proof. Derived in Supplemental Appendix B. □

Figure 6 plots the consumption tax over time under the two policies (left panel), as well as the distortions to the optimal expected consumption growth path they imply (right panel). Under fiscal policy, consumption taxes climb steadily, peaking 0.4 p.p. higher than the stationary level about five years after the stimulus, and they glide down slowly over following decades. By contrast under liquidity policy the consumption tax drops with the stimulus. This is because the stimulus increases the tax base and the fiscal authority needs to keep the budget balanced.[23] It climbs back again slowly over following decades as aggregate consumption returns to normal.

Figure 6: Euler distortions



Both policies imply short–term distortions to consumption growth because they both imply climbing tax rates over the first few years. These distortions effectively disappear under liquidity policy after the first few years, as the consumption tax rate stabilises close to the stationary level. But the distortions persist under fiscal policy for decades, with a maximal impact of causing expected annual consumption growth to be more than 4 percentage points higher than in the stationary solution.

We have established that both policies stimulate consumption in much the same way, but they differ in their funding mechanisms, and the inter–temporal distortions these imply. These results are all at the aggregate level, but the different approaches to stimulus distribute their impacts quite differently across households states, and we explore this in the next section.

[23] We explore an alternative scenario with an asymmetric fiscal rule in Section 6.2

5.5 Distributional implications

5.5.1 Conflicting generational interests

Questions about the long–run implications of government policies are often framed as generational conflicts. It's useful to define three distinct groups within the population because they are affected by the policies differently. These are workers and retirees, those who are working whilst the stimulus occurs, and retired at time–0, respectively, and the future generations, those whose working lives begin after the stimulus ends.

Figure 7: Generational consumption

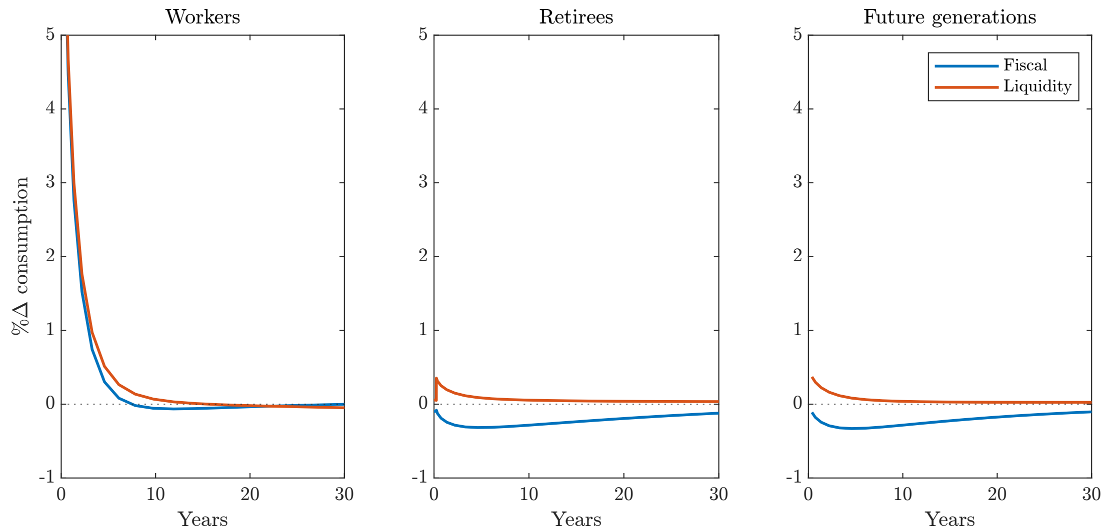


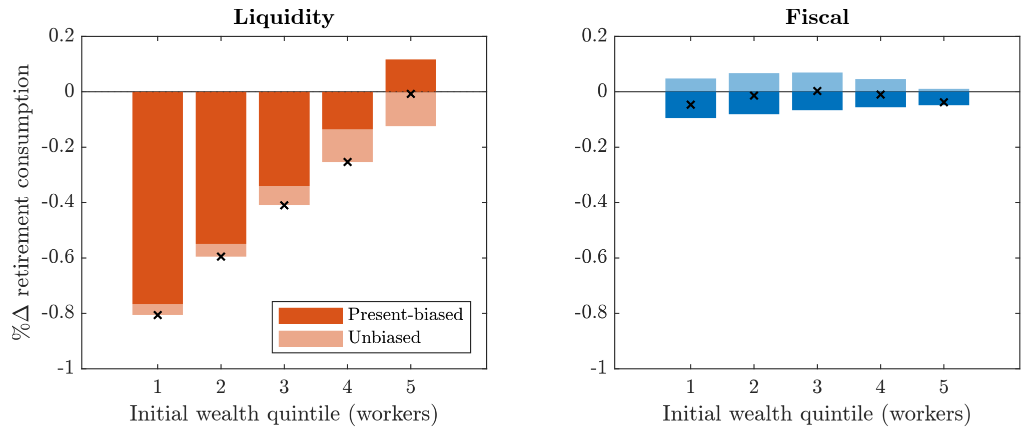
Figure 7 shows the average consumption path, relative to the stationary solution, for these distinct groups under each stimulus policy. Workers' consumption is boosted the most, by design, and there is little drag in the later years as the repayment plans for each policy kicks in. By contrast, retirees and future generations both experience a drag on their consumption under fiscal policy—they must pay higher taxes and didn't receive any stimulus—and a boost under liquidity policy—caused by the tax distortions discussed in Section 5.4.

5.5.2 Retirement (in)adequacy

Reduced retirement adequacy—fewer resources on retirement for affected households—is the main negative implication of liquidity policy, and it only affects the workers who withdrew from their accounts and spent the money. To measure retirement adequacy, we compare the consumption rate that the cohort of workers at time–0 can expect the moment they retire under the different stimulus policies, relative to the equivalent in the stationary solution.

Figure 8 plots this change for the section of this cohort that retires 20 years after the stimulus, and breaks down contributions by wealth quintile and present–bias types.[24] The figure shows that liquidity policy has a much more severe impact on retirement adequacy than fiscal, which has almost no effect on adequacy. This impact is stronger the less wealthy workers are, and mainly driven by the behaviour of biased households at all points in the wealth distribution.

Figure 8: Relative outcomes at retirement, by wealth and present–bias type



There are three forms of non–Ricardian behaviour at play in our model. First is the standard inability to smooth due to incomplete markets, second is the excess discounting caused by the OLG structure, and third is the over–consumption brought on by present–bias (Attanasio et al., 2024; Maxted et al., 2024). All stimulus relies on there being some non–Ricardian households. These results for retirement adequacy show that liquidity policy concentrates the duty of payment for stimulus mainly on the shoulders of the biased households. That is, exactly the group for whom the illiquidity in the retirement system is designed.

6 Welfare

We have established that both approaches work to stimulate household consumption, but that they come with various contrasting implications in different dimensions. To weigh these distinct implications appropriately, we use a welfare analysis to quantify the degree of households' preference for liquidity policy over fiscal stimulus. We show that liquidity policy is better for the retired, richer and unbiased workers, and future generations i.e. those who will (a) not gain much from the stimulus benefits of either policy, but will (b) pay more in taxes under fiscal, and are (c) more likely to be over–invested in their retirement accounts.

[24]Results are qualitatively the same for any retirement date.

We conclude by exploring the sensitivity of the welfare analysis to various dimensions of the problem—the strictness of retirement policy, the nature of the fiscal rule, and the size and targeting of the fiscal stimulus.

To do this analysis we use a money–metric compensating variation (CV). At time–0, for each point in the state–space, we find the change in liquid assets that would be required to make the household indifferent to liquidity policy instead of the baseline fiscal intervention

$$\hat{v}(b + CV(x), a, z, \beta; 0, \gamma) = \hat{v}(x; T, 0)$$

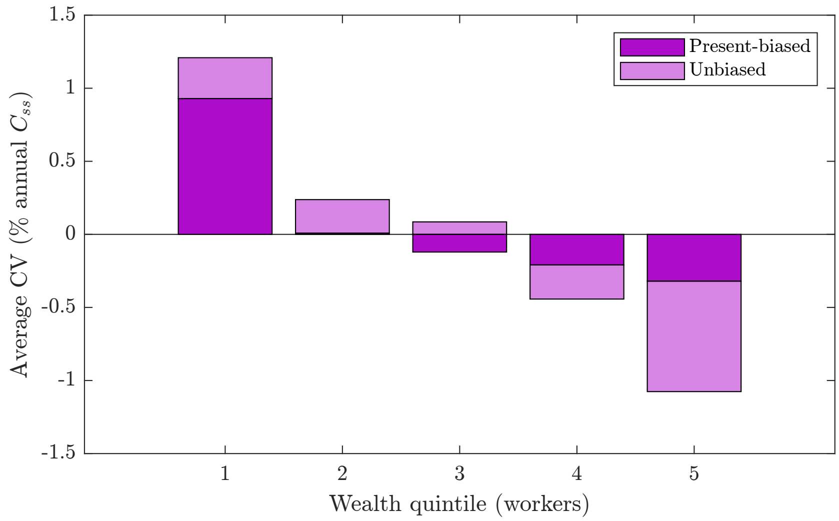
We find this compensating variation from two perspectives: (a) the near–sighted evaluation finds the CV based on households' perceived value functions i.e. accepting any naivete they have, and (b) the long–run evaluation finds the CV based on a correct anticipation of how they will behave (O'Donoghue and Rabin, 2006; Bernheim and Taubinsky, 2018; Naik and Reck, 2024), defined in Equation 16. This compensating variation shows the intensity of a preference for fiscal policy—positive numbers indicate the need to compensate for using liquidity policy instead, and negative numbers indicate a willingness to *pay* for liquidity policy to be used.

6.1 Winners and losers from liquidity vs fiscal policy

Who benefits from liquidity policy over fiscal? Wealthy workers and retirees. Retirees don't stand to gain anything from the stimulus, but they must subsidise the stimulus to workers, and their consumption is further distorted by the changing taxes, as we saw in Figure 7. To highlight the importance of wealth for workers' preferences, Figure 9 plots the average compensating variation across wealth quintiles showing that enthusiasm for fiscal policy is declining in wealth.

Wealthy workers are more likely to be Ricardian, more likely over–invested in their retirement account, and (like retirees) also expect to pay greater taxes under fiscal. Hence their preference for liquidity policy, which allows them to escape taxes and grants more flexibility in portfolio decisions that they can ignore if they wish. Figure 9 also disaggregates by type, showing that the majority of the benefit of fiscal over liquidity policy is accruing to biased households in the bottom quintile of the wealth distribution. Biased households are over–respresented in this quintile because their bias leads them into debt, and because of this they stand to lose the most from having lower retirement assets. This result confirms the intuition that many opponents to liquidity policy voiced—that it places the cost of support on the shoulders of the least well off, and the most in need of help to save for retirement.

Figure 9: Worker preference for fiscal policy, by wealth & type



Aggregate welfare results The best approach to stimulus depends on the welfare criterion. Liquidity policy is popular—it is preferred by an overwhelming majority, whether evaluated by households' near–sighted or long–run preferences (69% and 72%). Moreover, the average compensating variation is negative—for the long–run evaluation, the average CV is -1.6% of average annual stationary consumption—meaning there is surplus to compensate the losers because the average household would pay to switch from fiscal to liquidity policy.

A Utilitarian planner, however, would choose fiscal policy, which yields greater average utility. The difference arises because the losers under liquidity policy have a much higher marginal utility of consumption than the winners. Liquidity policy wins in a vote because this group is a minority, and in average money–metric terms because they can be compensated cheaply. But these criteria both favour the well–off, as they don't weight individual preferences by their marginal utility of consumption. In pure utility terms, the heavy losses to the high marginal utility group dominate, and so fiscal policy is the better choice.

6.2 Robustness to alternative assumptions

In this section we see how sensitive the baseline results are to different fiscal rules, targeting and magnitudes of the stimulus, and ex–ante retirement policy. In aggregate, liquidity policy is preferred to fiscal across all of our robustness checks around the baseline calibration for the retirement policy. It wins a majority vote in each case, and also costs a *negative* average compensating variation. This popularity is not due to naivete—the results in this section are all based on long–run evaluations, in which the evaluator correctly anticipates naive present–biased behaviour. In fact naive evaluations would be even more strongly in favour of liquidity policy. So the liquidity policy's widespread appeal is robust to these different assumptions. It is, however, quite regressive, with present–biased and less wealthy workers benefiting much more from fiscal stimulus. By contrast, if retirement policy were looser, then it is less binding on working–age people and this leads to reduced benefits from liquidity policy, tipping the balance back in favour of fiscal as the better approach to stimulus, both in aggregate and out of a concern for distributional impacts.

Fiscal rule symmetry The baseline results came from a symmetric fiscal rule—governments set tax rates to get debt back to target whether it is below or above this target. One of the implications of such a rule is that liquidity policy is accompanied by a persistent tax cut, to balance the government's books as the consumption tax's base is expanded. The populations we found to prefer liquidity policy may feel this way mainly because they like the tax cut. Although temporary tax cuts are often part of stimulus packages, we may also expect governments to apply fiscal rules asymmetrically, with the actual allowable debt level anywhere between zero and $\bar{B}$. In this case the fiscal rule would only activate when debt was above the upper bound, and otherwise taxes would stay fixed and deficits or surpluses allowed.

Table 3 shows that using an asymmetric fiscal rule reverses the average worker preference for liquidity policy. Workers on average now all prefer fiscal policy; the previous preference for liquidity policy among the unbiased workers was apparently driven by the tax cuts attached. Similarly, the retirees are still in favour of liquidity policy, but their enthusiasm is dampened (though not by enough to tip the scales to fiscal policy in aggregate).

Table 3: CV to prefer liquidity policy (% annual C_{ss})

	Baseline	Asymmetric	Consolidating	Accommodating
Total	-1.6	-0.1	-2.1	-0.8
Workers	-0.1	1.6	-0.5	0.8
Biased	*0.6*	*1.9*	*0.2*	*1.3*
Unbiased	*-0.8*	*1.3*	*-1.1*	*0.2*
Retired	-4.2	-3	-4.8	-3.5

Fiscal rule severity The timing of the fiscal rule may also matter. In the baseline results, the fiscal rule is set to mirror the EU's fiscal compact, following Galí (2020), which sets a target half–life for debt gaps of 13.5 years ($\mu = 0.0128$). Here we consider two alternative rules—the 'consolidating' one sets a stricter repayment schedule, with $\mu = 0.0256$ so the half–life is halved, and the 'accommodating' one sets a more lax schedule, with $\mu = 0.0063$. The accommodating rule is set so that government debt is 'retired' at the same rate as the working population. This is an interesting special case because it means the timing under liquidity and fiscal policy are essentially identical.

Figure 10: Aggregate impact of fiscal rule severity

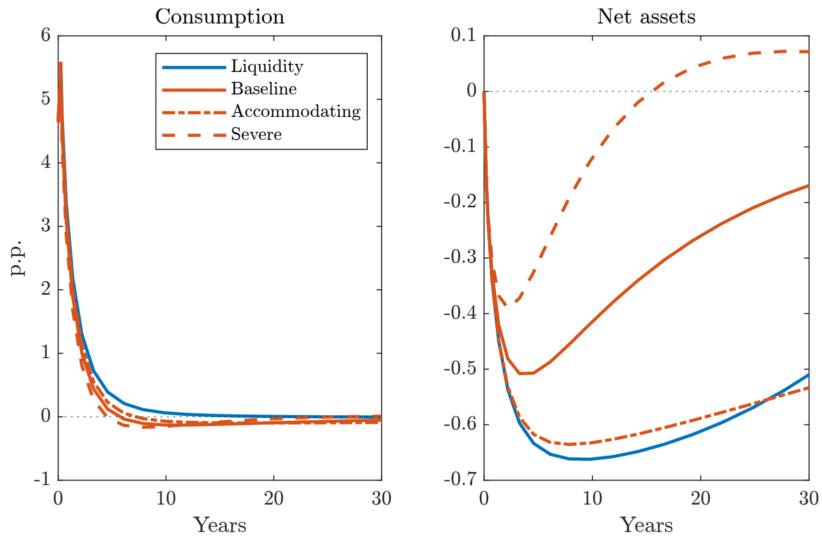


Figure 10 shows the aggregate consumption and net wealth plots under each alternative fiscal rule. They show what you'd expect—the drag on consumption is greater the stricter the rule, as net assets return to their stationary level quicker. Table 3 shows that the preference for liquidity policy diminishes with the intensity of the fiscal rule—it is greatest for the consolidating rule, followed by the baseline, and then the accommodating rule. As the fiscal rule relaxes, the taxes required to repay it are pushed further into the future and so they feel less onerous to the present generations, increasing the relative appeal of fiscal policy.

Targeting The baseline policy counterfactuals pitted liquidity policy against a fiscal transfer targeted at workers. This was designed to make the recipient group match, so they were more comparable. Here we explore how the main results differ when everyone receives the transfer.

If everyone receives the transfer then the total transfer per person needs to be smaller to achieve the same consumption stimulus. Specifically, to match the liquidity intervention we now need a transfer of $T^* = 0.0403$ for one quarter (versus 0.0706 when targeting workers), a total outlay for the government of around 10% less than when just targeting workers (retirees have a greater MPC than the average worker).

Table 4 shows that in this scenario, the overall long–run preference for liquidity policy is stronger. This is driven by a reversal of preferences for retirees, who now prefer to receive the fiscal transfer, and biased workers, who prefer to withdraw from their retirement accounts than receive a 40% smaller fiscal transfer. Unbiased workers are also much more in favour of the liquidity policy in this scenario. This result indicates how much the preference for, or against, redistribution was driving attitudes to fiscal policy.

Magnitude Table 4 shows long–run CVs under different magnitudes for the stimulus—50% and 150% the size of the baseline exercise—and their equivalent liquidity interventions. It shows a close–to linear relationship: liquidity is preferred overall in each case, with everyone's preference scaling up, or down, with the impulse magnitude.

Table 4: CV to prefer liquidity policy (% annual C_{ss})

	Baseline	Un–targeted	2.5% impulse	7.5% impulse	Lower ex–ante ξ
Total	-1.6	-2.1	-0.8	-2.6	1.4
Workers	-0.1	-4.9	-0.1	-0.1	4.1
Biased	*0.6*	*-3.9*	*0.2*	*0.8*	*5.9*
Unbiased	*-0.8*	*-5.9*	*-0.4*	*-1.0*	*2.3*
Retired	-4.2	2.8	-2.0	-7.0	-3.4

Looser retirement policy The baseline results all work in an environment with retirement policy set optimally in the exercise in Section A. This policy is designed with the needs of newborns in mind, and one of its side–effects is to leave older workers generally over–invested in their retirement accounts, particularly if they are not present–biased. If we suppose instead that the government set retirement policy with the whole population in mind, but with the same participation constraint as the buy–in equilibrium, then the optimal policy sets contribution rates to about half what they are in the baseline, and with much smaller tax concessions as well: $(\hat{\xi}, \hat{\varphi}) = (0.04, 0.12)$.

We redo the stimulus policy experiments with this calibration of the model's stationary solution. Fiscal and liquidity policy both now need to release more money to achieve the same stimulus $\hat{T} = 0.0816$ and $-\hat{\gamma} = 0.0875$ because the aggregate worker MPC is reduced to 0.2.

Table 4 shows that, with this starting retirement policy, fiscal is the better stimulus option for the average person. The average worker prefers it, with biased workers having the stronger (long–run) preference, whilst the average retiree still prefers liquidity policy because it means they avoid future taxes. Two forces drive the result for workers. With looser ex–ante retirement policy, there are both fewer wealthy workers who are over–invested in their retirement accounts, and more poorer workers who will suffer from the reduced retirement adequacy. Liquidity policy is thus an even more regressive stimulus option in settings where retirement contributions are low, or even not mandatory, as in the United States.

7 Conclusion

This paper introduces household liquidity policy, a distinct class of demand management tools that operate through relaxed regulation rather than the usual fiscal and monetary levers. Focusing on the most prominent example (early access to private retirement savings), we compare this tool to conventional fiscal stimulus. Using a heterogeneous agent model designed to capture the core tradeoffs inherent in both fiscal and liquidity policy, we show that both are capable of delivering the same short–term stimulus, but they have very different long–run implications. Liquidity policy is likely to be popular but it is a much more regressive option. By effectively privatising the cost of stimulus, it shifts the long–term burden of repayment onto the shoulders of the poorer and more present–biased workers who spend the money in the short–term.

A Optimal retirement policy

In this section the retirement policy parameters are set to implement the optimal mandatory DC scheme. Within the constraints of the policy framework, the government chooses the optimal mandatory contribution rate (ξ) and tax concession (φ).

A.1 The government's problem

The government's problem is similar to that in the literature on paternalistic savings policies in that they must balance two tradeoffs. First, following Amador et al. (2006), there is both a need to provide households with commitment (to overcome present bias) and flexibility (to insure against idiosyncratic risk). This prompts government intervention to help the present–biased save, but puts a limit on how much mandatory saving is appropriate. Second, present–bias is heterogeneous but unobserved by the government. This introduces a need for the government to balance the interests of the biased against the unbiased, potentially prompting screening or compensation (Moser and Olea de Souza e Silva, 2019; Beshears et al., 2025). Our setting differs from the extant literature by limiting the government's options to a DC system with uniform settings across the working–age population.

We evaluate welfare of these policy settings as follows.

Definition A.1 (Social welfare criterion)**.** Social welfare in the stationary solution is defined as the expected long–run value for a prospective newborn.

$$W(\xi, \varphi) = \mathbb{E}_{(z,\beta)}[\hat{v}(0, 0, z, \beta; \xi, \varphi)] \tag{15}$$

$$\hat{v}(x; \xi, \varphi) = \mathbb{E} \int e^{-\rho s} u\left(c(x_s; \xi, \varphi)\right) ds \tag{16}$$

This is found in two steps. First we find the value of actual (rather than anticipated) behaviour[25] in Equation 16, referred to as the 'long–run value' (O'Donoghue and Rabin, 2006; Bernheim and Taubinsky, 2018; Naik and Reck, 2024). Using this value means the government anticipates but does not adopt the bias of its subjects when evaluating policy choices. Second we restrict attention to newborns (zero assets) and find their expected long–run value, based on the stationary distribution over (z, β) in Equation 15. Defining the criterion like this means comparisons of welfare under different policy regimes pose the question: 'which society would you prefer to be born into, anticipating potential present–bias?'.

[25] Both $w(x)$ and $v(x)$ are based on the incorrect assumption that the policy rules are $\check{c}(x)$.

Having defined a welfare criterion, we consider two approaches to the problem that differ in how powerful the government is. These lead to two distinct equilibria, defined below.[26]

Definition A.2 (Social equilibrium)**.** The social equilibrium is a stationary equilibrium with retirement policy settings $(\tilde{\xi}, \tilde{\varphi})$ that maximise steady state social welfare.

$$(\tilde{\xi}, \tilde{\varphi}) = \arg\max_{\xi,\varphi} W(\xi, \varphi)$$

The social equilibrium is the outcome of an all–powerful government's problem, in the sense that they can guarantee compliance with the policy settings they choose. As we will show in the next section, the optimal tax concession is zero in the social equilibrium. To rationalise the ubiquity of these tax concessions, we suppose the government is subject to an extra participation constraint, optimisation under which leads to the 'buy–in' equilibrium.

Definition A.3 (Buy–in equilibrium)**.** The buy–in equilibrium is a stationary equilibrium with retirement policy settings (ξ^*, φ^*) that maximise social welfare subject to a participation constraint: no newborn chooses to opt out of the system by setting their own personal retirement parameters to $(\xi_i, \varphi_i) = (0, 0)$.

$$(\xi^*, \varphi^*) = \arg\max_{\xi,\varphi} W(\xi, \varphi) \;\text{ s.t. }\; \hat{v}(0, 0, z, \beta; \xi^*, \varphi^*, \tau_c) \geq \hat{v}(0, 0, z, \beta; 0, 0, \tau_c) \; \forall \, z, \beta$$

The buy–in equilibrium is the outcome when we imagine each household has the option at the start of their careers to opt out of the system[27]. In this case the government must cajole compliance for the system to be stable. The government wants to implement a pooling equilibrium where no–one opts out because (i) their policy tools don't allow for screening as in Moser and Olea de Souza e Silva (2019), and (ii) a separating equilibrium where only the present–biased opt in is not possible anyway, due to naivete. Note that this amounts to ensuring the rational agents opt in: assuming naivete, everyone thinks themselves rational.

A.2 The social equilibrium

Figure 11 plots the social welfare under different combinations of retirement policy settings, with warmer colours representing greater welfare. The social equilibrium is labelled, and picks the highest welfare point in the area plotted.

Result A.4 (Social equilibrium)**.** The social equilibrium is $(\tilde{\xi}, \tilde{\varphi}) = (0.09, 0)$

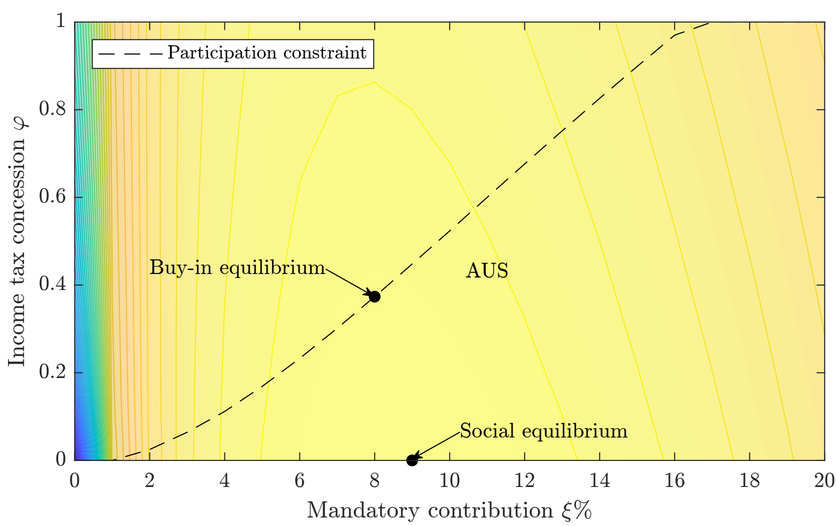
[26]We don't mean that there are multiple equilibria, but that the government will select different equilibria under these different constraints.
[27]Call this the 'Dubai option'.

This contribution rate is toward the lower end of the mandatory contribution rates in countries with compulsory DC schemes.[28]

Note that the social equilibrium involves no tax concession. The plotted results are for a population with $\eta = 0.5$, but the optimality of zero tax concession in social equilibrium holds no matter how small or large a share of the population are biased—it is never necessary to compensate people for a policy that helps them, and tensions between biased and unbiased workers are better resolved by adjusting the contribution rate than with tax concessions.

This result reflects a finding in the empirical public literature that a majority of people are not responsive to incentives to save for retirement, and those that are tend to save more in retirement accounts by reducing savings elsewhere (Chetty et al., 2014; Choukhmane and Palmer, 2024). The use of tax concessions to encourage retirement savings is therefore likely to incur a fiscal cost with little welfare benefit. In our setting, greater tax concessions also necessitate higher tax rates on consumption to make up for the eroded base. The result here tells us the marginal welfare benefit from the concessions is less than the welfare cost of their fiscal side–effect.

Figure 11: Social welfare under policy settings



A.3 The buy–in equilibrium

Despite their apparent suboptimality, tax concessions are ubiquitous in actually–existing DC schemes, as discussed in Section 2. To rationalise them, we explore a political dimension to the government's problem—the need to implement a pooling equilibrium where agents opt–in to the retirement system at the beginning of their careers. The black dashed line in Figure

[28]See Supplemental Appendix A for an overview of institutional settings across countries.

11 traces out the limited menu facing a government that has to deal with a participation constraint. In this setting, the tax concession ensures participation. Each contribution rate ξ has a minimum concession $\varphi(\xi)$ necessary to implement a pooling equilibrium, and this minimum is increasing in the contribution rate $\varphi'(\xi) > 0$. The government selects among these $(\xi, \varphi(\xi))$ to maximise welfare. The result is the buy–in equilibrium, with an optimal contribution rate lower than in the social equilibrium, and more tax concessions.

Result A.5 (Buy–in equilibrium)**.** The Buy–in equilibrium is $(\xi^*, \varphi^*) = (0.08, 0.37)$

This result is in line with what's observed in the real world—substantial tax concessions coupled with mandatory contributions close to the OECD examples in Supplemental Appendix A—and this is our preferred calibration as a result. The tax treatment in the model is a 'TTE' system, with concessions for the taxes on entry and returns. Direct comparison to other countries is difficult because most countries use an EET system, where only withdrawals are taxed. The one country that is comparable is Australia, identified on Figure 11, which taxes mandatory contributions from pre–tax income and Superannuation returns at 15%, a $\varphi = 0.4$ discount on the standard 25% rate for an average worker.[29] With a mandatory contribution rate currently at 11%, this is remarkably close to the buy–in equilibrium in our model.

A.4 The impact of retirement policy for working–age people

Retirement policy substantially raises working households' saving rates and retirement adequacy, and this effect is stronger for the present–biased households. Table 5 shows the impact of retirement policy for workers, by type. To see behaviour without mandatory savings first we set $\xi = 0$ and re–solve the model. In this scenario, working households' saving rate is 10% of earnings, with a large difference between present–biased and unbiased households (4% and 16% respectively). With mandatory savings, the average saving rate is higher (23%), with little difference between the two types of household.

Table 5: Effect of mandatory saving on workers, by type

	Average saving rate (% earnings)		**Median %ΔC at retirement**	
	Present–biased	Unbiased	Present–biased	Unbiased
Without mandatory saving	4	16	−27	−13
With mandatory saving	22	24	16	−12

[29]Specifically this is the average personal income tax rate on labour income for a single person with no children on the average wage, from the OECD's 'Labour taxation - average and marginal tax wedge decompositions' series in 2023.

Similarly, retirement adequacy, which we measure as the median expected change in consumption from working to the first year of retirement, is much improved by the policy (see Table 5).[30] Without mandatory saving, unbiased people's consumption drops by a median of 13% upon retirement, and more than double this for present–biased households. With mandatory saving, the unbiased household's consumption drop barely changes, whereas biased households now see an increase in their consumption of 16%, as they move from being working–poor to having resources to spend.

A.5 Sensitivity to present–biased share

Table 6 shows how the government's solutions change with the present–biased population share.[31] The optimal mandatory contribution rate is increasing in the present–biased population share, reflecting the increasing level of need in society. The tax concession necessary in the buy–in equilibrium is increasing as well, to ensure early–career opt–in to the system.[32] The aggregate worker MPC in the buy–in equilibrium is also increasing in η, both due to the combination of a greater share of present–biased households, and the greater mandatory contribution rate.

Table 6: government solutions with different population mixes

Present–biased share η	10%	20%	30%	40%	**50%**	60%	70%	80%	90%
Buy–in Equilibrium									
ξ^*	0.04	0.06	0.06	0.07	**0.08**	0.08	0.08	0.09	0.09
φ^*	0.11	0.23	0.23	0.30	**0.37**	0.37	0.37	0.45	0.45
Worker MPC	0.05	0.10	0.14	0.18	**0.22**	0.26	0.30	0.34	0.38
Social Equilibrium									
$\tilde{\xi}$	0.05	0.06	0.07	0.08	**0.09**	0.09	0.09	0.10	0.10

[30] Specifically, we find the difference between the workers' consumption policy and the average expected consumption rate over the first year of retirement, using the employed worker's state distribution to identify moments.

[31] The grid–search is restricted to whole percentage–points in ξ.

[32] The optimal tax concession is zero in the social equilibrium across all levels of the present–biased population.

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