Progressive Taxation and Monetary Policy in Australia*

Ekaterina Shabalina

Reserve Bank of Australia

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Abstract

This paper studies how tax progressivity affects monetary policy. Through the lens of a heterogeneous agent model with nominal rigidities it shows that, firstly, higher tax progressivity increases natural rate due to a lower demand for precautionary savings. Secondly, the effect of tax progressivity on the potency of monetary policy is small with a higher progressivity implying a slightly better inflation-output trade-off. Distributional effects of monetary policy, however, are amplified with a higher tax progressivity.

Keywords: *Incomplete Markets, Business cycle Fluctuations, Distributional Effects, Monetary policy.*

JEL classification: *D3, E3, E5, E6, H2, H6, J2.*

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1. Introduction

The degree of income tax progressivity is a classic topic in economics, Feldstein (1973). The classic argument supporting progressive income tax scheme is its insurance role: in the environment with incomplete markets progressive taxation insures households against fluctuations in income. The argument against it is its distortionary nature as it reduces the incentives to work for households at the top of the income distribution. While this question is extensively studied in the long-run, short-run implications of tax progressivity are less explored. This paper contributes to closing this gap by putting forward a heterogeneous agent model with incomplete markets, labour supply decisions and nominal rigidities to study implications of different levels of tax progressivity for the conduct of monetary policy.

The laboratory economy is calibrated to Australia. Since the global financial crisis (GFC) tax progressivity increased in Australia, see Figure 1, where the red line shows the degree of tax progressivity over time measured in terms of the Suits index. This index is similar to the Gini coefficient and reflects how tax burdens are distributed across income levels, with higher values indicating a more progressive tax system. This paper sheds light on how these changes in tax progressivity affected the environment in which the Reserve Bank of Australia (RBA) currently operates. Particularly, it looks at how the natural rate, monetary policy potency and distributional effects of monetary policy change with a change in tax progressivity.

The increase in tax progressivity was not the only change in the fiscal stance since the GFC. The level of government debt also increased, see Figure 2. Campos et al. (2024) shows

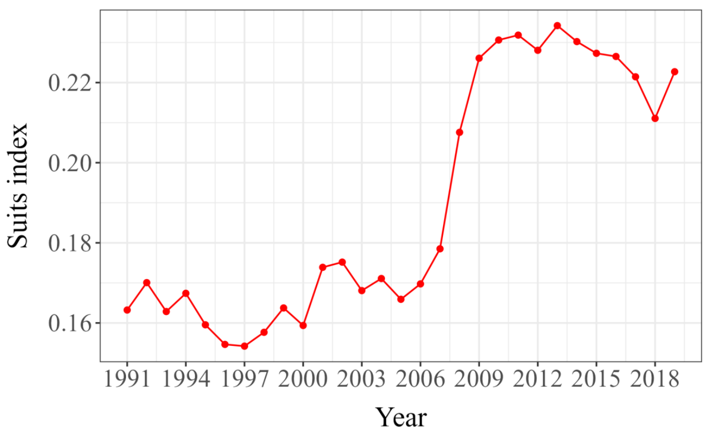

Figure 1: Source: Tran and Zakariyya (2023).

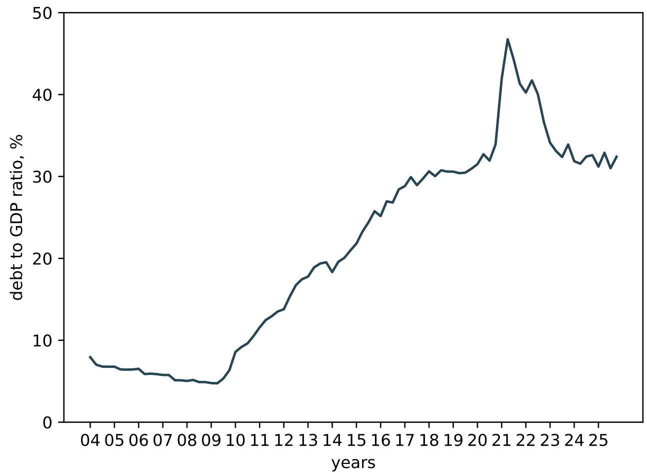

Figure 2: Source: ABS and AOFM.

that debt expansion leads to a higher natural rate as the supply of assets, through which households can insure themselves, expands. Campos et al. (2024) also shows that if a central bank does not incorporate the change in the natural rate into its reaction function, long-term inflation expectations will deviate from central bank's inflation target. Thus, it is important to understand the drivers behind the natural rate.

This paper shows that higher tax progressivity puts an upward pressure on the natural rate. Mainly, the increase in the natural rate is a result of a decrease in demand for precautionary savings: the more insured are fluctuations in disposable income through the taxation system, the lower are the incentives to self-insure. An increase in the progressivity also affects the ability of households to accumulate wealth since it redistriutes income from low marginal propensity to consume (MPC) households to households with higher MPCs, but this mechanism plays a more minor role compared to the insurance one affecting precautionary savings - a result obtained through a decomposition into insurance and wealth effects conducted using the model.

According to the model counterfactuals, the increase in progressivity following the GFC contributed twice as much as debt expansion to the upward pressure on the natural real rate in Australia. Overall, the joint contribution of the two forces led to a somewhat less than 10 basis points upward pressure on the Australian natural rate which, according to Morley and Wong (2025), is equally driven by domestic and international factors.

Regarding the potency of monetary policy, this paper shows that it does not change much with a change in tax progressivity. Inflation-output trade-off turns out to be slightly better with a higher progressivity. This is due to a smaller decrease in participation following contractionary monetary policy, which is due to the lower variability of disposable income when the taxation system is more progressive.

While distributional effects of productivity shocks are smaller with more progressive taxes that work as automatic stabilizers, monetary policy induces larger distributional effects in a system with a higher tax progressivity. Moving to lower marginal tax rates amid worsening of the labour demand particularly benefits households at the top of the wealth and income distributions. Those most productive and wealthy households participate more and cut consumption less in response to monetary tightening the higher the progressivity. For households with lower incomes and wealth, substitution effect on labour supply dominates the income effect in response to monetary policy shocks. Those households faced with higher labour supply and consumption demand from the high-income and wealthy households, consume less in response to contractionary monetary policy shock the higher the progressivity. This leads to amplified distributional effects of monetary policy in the environment with higher progressivity: the beneficiearies of contractionary monetary policy gain more, while those who bear the costs experience greater losses.

The laboratory economy is a heterogeneous-agent model with nominal rigidities. Nominal rigidities allow to study monetary policy. Unlike representative agent models, where natural interest rate depends only on structural parameters such as households' discount factor or productivity growth, market incompleteness allows to study the effects of tax progressivity on the natural rate. Household heterogeneity also allows to look at distributional effects of policies.

The model is calibrated to Australian economy. To reflect Australian environment on the production side a resource sector is introduced and the economy is a small open economy. On the households side progressive income taxes are introduced to study progressive taxation, participation margin of labour supply is essential for the question on progressive taxation. Additionally, offset accounts are introduced to reflect Australian distribution of liquid assets the role of which is discussed below. In both resource and non-resource sectors firms face investment and utilization adjustment costs to improve the business cycle fit. Labour unions set intensive labour margin of adjustment. Fiscal authority sets consumption, profit and labour income tax rates, issues long-term and short-term government debt and conducts government expenditures. Monetary policy follows a Taylor-type rule. There is international trade in liquid and illiquid assets and the foreign economy is modeled through a 3-equation New Keynesian model.

The development of this model is part of a recent uplift within the RBA to enhance the ability to answer questions where heterogeneity across households matters or is of interest. Modeling inequality within a general equilibrium framework allows to account for both direct and indirect transmission channels, with the latter having a substantial contribution to the transmission of monetary policy according to Kaplan et al. (2018) and other following papers.

Related Literature. This paper relates to the literature studying interactions between fiscal and monetary policies in heterogeneous agent models. Campos et al. (2024) study how the supply of government bonds affects the natural interest rate. Relatedly, Bayer et al. (2023) show that higher government debt leads to lower liquidity premium which in turn leads to higher return on government bonds. This paper contributes from the supply of savings side showing that more progressive taxation system decreases the supply of savings. Optimal level of tax progressivity with the progressivity function introduced by Benabou (2002) is studied in Heathcote et al. (2017). For the studies analysing how demographics and income inequality affected natural rate in the US, see Platzer and Peruffo (2022) and Mian et al. (2021).

As this paper, Ferriere and Navarro (2024) studies business cycle implications of tax progressivity, but in relation to its effects on fiscal multipliers showing that they increase with progressivity since higher taxes fall on households with lower marginal propensities to consume. McKay and Reis (2016) study the effects of automatic stabilizers on business cycle dynamics finding small effects on output volatility of the current US tax-and-transfer system. Lavender (2024) studies debt maturity within a tractable HANK model and shows that increase in maturity of government debt leads to a decrease in monetary policy potency.

The interaction between fiscal and monetary policy in relation to optimal policy design is studied in Bilbiie et al. (2024), Acharya et al. (2023), Bhandari et al. (2021), Dávila and Schaab (2023), McKay and Wolf (2022), Le Grand et al. (2021). There is an expanding literature studying monetary policy in HANK models with seminal contributions by Kaplan et al. (2018), Auclert (2019), Bayer et al. (2024a), Auclert et al. (2021a) among many others.

For studies related to Australia, a close paper to this one is Tran and Zakariyya (2023) who study optimal tax progressivity and pension progressivity in an overlapping generations framework. Cho et al. (2024) compare Australian and US tax-and-transfer system empirically and within a life-cycle model. A stylized HANK model with one asset calibrated to Australia is studied in Chipeniuk et al. (2025).

The rest of the paper is structured as follows. Section 2 outlines the model starting with heterogeneous households. Section 3 presents model calibration and solution details. Section 4 discusses results firstly for the steady state, then for the aggregate impulse responses, and finally for the distributional effects. Section 5 concludes.

2. Model Description

The model is an incomplete market small open economy dynamic general equilibrium model, featuring uninsurable risk a' la Bewley (1980)-Aiyagari (1994) and exogenous borrowing constraints. Heterogeneous households to insure against aggregate and idiosyncratic risks save in liquid and illiquid assets. Hours worked are chosen by the labour union who faces wage adjustment costs, while households make labour supply decisions on the extensive margin, since labour supply decisions are an important margin of adjustment for studying income taxes. To reflect Australian environment there are two production sectors in the economy: a resource sector and a non-resource sector. The resource sector is perfectly competitive while the non-resource sector is populated by monopolistically competitive firms who sell their differentiated products to a final goods producer and who face nominal rigidities a' la Rotemberg (1982). Firms in both sectors are subject to investment adjustment costs and capacity utilization costs for a better business cycle fit. Government sets progressive income taxes, consumption taxes and profit taxes to finance government expenditures and return payments on long-term and short-term debt. Fiscal authority chooses average level of income taxes according to a fiscal rule, while government debt balances the budget. Monetary policy operates according to a Taylor-type rule. The economy is a small open economy with the rest of the world represented by a 3-equation New Keynesian model. Time is discrete and in quarters.

2.1. Heterogeneous Households

Progressive income taxes. At the beginning of each period t, households experience an idiosyncratic productivity shock e_t. The shock follows an n_e-state Markov process with a transition matrix $P(e_{t+1}|e_t)$ and a stationary distribution $\pi(e)$. Real after-tax labor income y_t^d of individual at time t is a function of efficiency units, the idiosyncratic productivity state e_t, the real wage, w_t, the labour hours n_t, and the income taxes which follow a progressive scheme as in Benabou (2002): $y_t^d = \xi_t(e_t w_t n_t)^{1-\tau} = \xi_t(y^{pre-tax})^{1-\tau}$, where τ measures the degree of tax progressivity. $\tau = 0$, implies flat taxation scheme, $\tau = 1$ implies fully redistributive system with disposable income, y^d, that is independent from the pre-tax income, $y^{pre-tax}$. The values in between 0 and 1 stand for progressive income taxes. ξ_t is found in the steady state through the budget equation of fiscal authority and follows a fiscal rule in the dynamic responses, see Section 2.4. Note, that in this formulation, it is a tax and transfer system, such that for some households $y^{pre-tax} < y^d$.

Participation. Labour supply is indivisible, and during any period, household can choose whether to participate in the labour market, or receive fixed benefits, u^b. Participation decision is introduced as in Faia et al. (2023) and Ferriere and Navarro (2024) through the comparison of value functions in employment and non-employment states with an addition of amenity shocks, ζ_t^{LF}, that follow Gumbel distribution with the standard deviation σ_ζ.[1]

Two assets. Consumption-savings decisions are as in Kaplan et al. (2018) and Auclert et al. (2021a) where households maximize discounting sum of future utilities and save in liquid and iiliquid assets with liquid assets delivering lower return, r_t^b. Illiquid assets are subject

1 This follows Rust (1987) tradition and is common in dynamic discrete-choice models.

to convex portfolio adjustment costs such that each household forms a portfolio of the two assets. The instantaneous utility takes a standard separable form $u(c,n) = \frac{c^{1-\sigma}}{1-\sigma} - \varphi\frac{n^{1+\nu}}{1+\nu}$, where c_t stands for consumption. The portfolio adjustment costs take the functional form: $\Phi(a_t, a_{t-1}) = \frac{\chi_1}{\chi_2}\left|\frac{a_t-(1-r_t^a)a_{t-1}}{(1+r_t^a)a_{t-1}+\chi_0}\right|^{\chi_2}[(1+r_t^a)a_{t-1}+\chi_0]$, with $\chi_0 > 0$, $\chi_1 > 0$ and $\chi_2 > 1$ and where a_t stands for illiquid asset holdings.[2]

Offset accounts. While holdings of illiquid assets could be only positive, one can borrow in liquid assets with a wedge κ^b between borrowing and lending rates. As is shown in Section 3 in Australia wealthy households hold dis-proportionally large amount of liquid assets (twice as much as in the US) which are concentrated among the rich. Therefore, to account for the distribution of liquid assets, I introduce offset accounts that allow one to earn higher asset return on liquid savings if one pays the offset account fee, o^f, in line with Graham (2024). This gives households additional incentive to save in the form of liquid assets.

Bellman equation. In each period t household chooses consumption, c_t, savings in liquid, b_t, and illiquid, a_t, assets and whether to participate in the labour market, to maximize the following value function:

$$
\begin{aligned}
&V(e_t, b_{t-1}, a_{t-1}) = \max_{c_t, a_t, b_t, \mathbb{1}_{LF}} u(c_t, n_t) + \zeta_t^{LF} + \beta E_t V(e_{t+1}, b_t, a_t) \\
&\text{s.t. } (1+\tau_t^c)c_t + a_t + b_t = \mathbb{1}_{LF}\xi_t(\int_k e_t w_{k,t} n_{k,t} dk)^{1-\tau} + (1-\mathbb{1}_{LF})u^b + \\
&\qquad\qquad + (1+r_t^a)a_{t-1} + (1+r_t^b(b_{t-1}))b_{t-1} - \Phi(a_t, a_{t-1}) - o^f \mathbb{1}_{o^r b_{t-1} - o^f > 0} \\
&\quad a_t \geq 0, \quad b_t \geq \underline{b} \\
&\quad r_t^b(b_{t-1}) = \begin{cases} r_t^b + o^r, & b_{t-1} \geq 0 \quad \text{and} \quad o^r b_{t-1} - o^f > 0 \\ r_t^b, & b_{t-1} \geq 0 \quad \text{and} \quad o^r b_{t-1} - o^f \leq 0 \\ r_t^b + \kappa^b, & b_{t-1} < 0 \end{cases}
\end{aligned} \tag{1}
$$

where E_t denotes the joint expectation operator with respect to the earnings shock, the amenity shock and the aggregate shocks, τ_t^c stands for consumption tax (GST), β is the time discount factor, r_t^a is the return on illiquid assets which is higher in the steady state by the

2 Functional form is taken from Auclert et al. (2021a).

liquidity premium ω than the return on liquid asset and $o^r = \omega$.[3] There are k monopolistic unions who set hours worked and wages, thus the integration over k in employed status. The household chooses to participate in the labour market based on the condition below:

$$\mathbb{1}_{LF} = [V^E(e_t, b_{t-1}, a_{t-1}) \geq V^U(e_t, b_{t-1}, a_{t-1})] \tag{2}$$

where $V^E(e_t, b_{t-1}, a_{t-1})$ and $V^U(e_t, b_{t-1}, a_{t-1})$ are evaluated at the optimal consumption-saving policies. Due to the presence of Gumbel-type amenity shocks, the probability to participate in the labour market has a closed-form solution and is a logit-type probability. For the first-order conditions see Appendix A. **To sum up**, the problem follows closely Auclert et al. (2021a) with an addition of progressive income taxes, consumption taxes, participation margin and offset accounts.

2.2. Labour Unions

There is a continuum of monopolistically competitive unions each of which maximizes welfare of its members subject to wage adjustment costs a' la Rotemberg (1982). Each union hires labour from households and produces union-specific labour with a one-to-one technology. It faces downward sloping demand with the elasticity ε_w from the competitive labour packers that sell final labour bundle with l_t units of efficient labour hours to firms. Additionally, I assume wage indexation that is governed by the parameter χ_w. The problem of each union reads as follows:[4]

$$\begin{aligned} &\max_{w_{k,t}, n_{k,t}} \sum_{s=0}^{\infty} E_t \beta^s \left[\int \left(\frac{c_{t+s}^{1-\sigma}}{1-\sigma} - \varphi \frac{n_{t+s}^{1+\nu}}{1+\nu} \right) \mathbb{1}_{LF} dD_t - \frac{\varepsilon_w}{2\kappa_w} ln \left(\frac{w_{k,t+s}}{(\pi_{t+s-1}^w)^{\chi_w} w_{k,t+s-1}} \right)^2 \right] \\ &\text{s.t.} \int n_{k,t} e_t \mathbb{1}_{LF} dD_t = \left(\frac{w_{k,t}}{w_t} \right)^{-\varepsilon_w} l_t, \quad \int_k n_{k,t} dk = n_t \end{aligned} \tag{3}$$

3 In the dynamics, the valuation effects might occur, see Section 2.5 for details.

4 Where the constraints stand for the labour demand from the labour packers and the supply of labour from households.

Focusing on a symmetric equilibrium where all unions post the same wages $w_{k,t} = w_t \quad \forall k$ delivers a wage Phillips curve with κ_w governing its slope and $\mu_w = \varepsilon_w/(\varepsilon_w - 1)$:

$$ln\left(\frac{w_t}{w_{t-1}}\right) = \beta E_t ln\left(\frac{w_{t+1}}{w_t}\right) - \chi_w \beta ln\left(\frac{w_t}{w_{t-1}}\right) + \chi_w ln\left(\frac{w_{t-1}}{w_{t-2}}\right) + \kappa_w\left[\varphi \int n_t^{1+\nu} \mathbb{1}_{LF} dD_t - \frac{1}{\mu_w}\int c_t^{-\sigma}\xi_t(e_t n_t w_t)^{1-\tau}(1-\tau)\mathbb{1}_{LF} dD_t\right] \tag{4}$$

2.3. Production

Production consists of two sectors: resource and non-resource. The resource sector, as in Gibbs et al. (2018), is perfectly competitive while non-resource sector consists of final good producers that are perfectly competitive and an intermediate good producers who are monopolistically competitive and face quadratic price adjustment costs a' la Rotemberg (1982). Both sectors face investment and utilization adjustment costs, firms' profits are taxed at the same rate τ^f, labour is perfectly mobile between the sectors and firms maximize discounted sum of future profits with the same discount rate r that clears the asset market, see Section 2.6. Production function is Cobb-Douglas with capital and labour in the resource sector and capital, labour and resource inputs in the non-resource one. The problem of the intermediate good producers in the non-resource sector, reads as follows:

$$\begin{aligned}
J_{i,t}(k_{t-1}, p_{i,t-1}) \quad &= \max_{p_{i,t},k_t,I_t,l_t,u_t,y_t^z}\left\{(1-\tau_t^f)\left(\frac{p_{i,t}}{p_{H,t}}\frac{p_{H,t}}{p_t}y_t - w_t l_t^n - I_t - \frac{p_t^z}{p_t}y_t^z - \right.\right.\\
&\left.\left. -\frac{\eta}{2\kappa}\ln\left(\frac{p_{H,t}}{\pi_{H,t-1}^{\chi_p}p_{H,t-1}}\right)^2 Y_t\right) + \frac{E_t J_{i,t+1}(k_t, p_{i,t})}{1+r_{t+1}}\right\}\\
\text{s.t.} \quad & k_t = (1-\delta_t)k_{t-1} + I_t - \frac{\varepsilon_I}{2}\left(log(\frac{I_t}{I_{t-1}})\right)^2; \quad \frac{p_{i,t}}{p_{H,t}} = \left(\frac{Y_t}{y_t}\right)^{\frac{1}{\eta}}\\
& y_t = z_t(k_{t-1}u_t)^{\nu^n}(l_t^n)^{1-\nu^n-\gamma}(y_t^z)^{\gamma}; \quad \delta_t = \delta_0 + \delta_1(u_t - 1) + \frac{\delta_2}{2}(u_t-1)^2
\end{aligned} \tag{5}$$

l_t stands for efficient labour hours, k_t is the level of capital, I_t stands for investments, π_t is inflation rate of the price basket consumed by households, y_t is the output, z_t is the TFP level, u_t is the utilization rate, y^z_t is the resource input, $p_{H,t}$ is the price level of domestically-produced goods and is related to inflation according to inflation definition $\frac{p_{H,t}}{p_{H,t-1}} = (1+\pi_{H,t})$ and χ_p is the price indexation parameter. The problem in the resource sector is as follows:

$$
\begin{aligned}
J^z_{i,t}\left(k^z_{t-1}\right) = \quad & \max_{k^z_t, I^z_t, l^z_t, u^z_t} \left\{ (1-\tau^f_t)\left(\frac{p_{z,t}}{p_t}(y^z_t + y^{z,ex}_t) - w_t l^z_t - I^z_t\right) + \frac{E_t J^z_{i,t+1}(k^z_t)}{1+r_{t+1}} \right\} \\
\text{s.t.} \quad & k^z_t = (1-\delta^z_t)k^z_{t-1} + I^z_t - \frac{\varepsilon^z_I}{2}\left(log(\frac{I^z_t}{I^z_{t-1}})\right)^2 \\
& (y^z_t + y^{z,ex}_t) = z^z_t (k^z_{t-1}u^z_t)^{\nu^z}(l^z_t)^{1-\nu^z} \\
& \delta^z_t = \delta^z_0 + \delta^z_1(u^z_t - 1) + \frac{\delta^z_2}{2}(u^z_t-1)^2
\end{aligned} \tag{6}
$$

l^z_t stands for efficient labour hours, k^z_t is the level of capital, I^z_t stands for investments, y^z_t is the output, z^z_t is the TFP level, p^z_t is the price of resources determined on the international markets. Labour demand from the firms is equal to labour supply from the unions:

$$
l_t = l^z_t + l^n_t \tag{7}
$$

2.4. Fiscal and Monetary Policies

Fiscal policy issues short- and long-term bonds as is the case in Australia, collects labour income, consumption and profit taxes and faces exogenous government expenditures.[5] Thus, the fiscal budget is given by:

$$
\begin{aligned}
\int \left(e_t w_t n_t - \xi_t (e_t w_t n_t)^{1-\tau}\right) \mathbb{1}_{LF} dD_t + \tau^f_t (\frac{p_{H,t}}{p_t} Y_t - w_t l^n_t - I_t - \frac{p^z_t}{p_t} y^z_t - \psi^p_t) + \\
\tau^f_t (\frac{p^z_t}{p_t}(y^z_t + y^{z,ex}_t) - w_t l^z_t - I^z_t) + \int \tau^c_t c_t dD_t + B^{g,ST}_t + q^b_t B^{g,LT}_t = \\
(1 + r_t - \omega_t) B^{g,ST}_{t-1} + (1 + \rho^b q^b_t) B^{g,LT}_{t-1} + G_t
\end{aligned} \tag{8}
$$

5 As in Bayer et al. (2024b), government expenditures could be the one to balance the budget instead of debt, that leads to large GDP responses in line with evidence in Alves et al. (2020). Therefore, the preference was given to adjustment through debt, so that IRFs are closer to empirical evidence presented in Mulqueeney et al. (2025).

where ψ_t^p stands for the price adjustment costs, $B^{g,ST}$ is short-term and $B^{g,LT}$ is long term-debt, and G_t are government expenditures. The price of long-term debt is driven by the no-arbitrage condition with the long-term debt considered as an illiquid asset $E_t(1+r_{t+1})q_t^b = 1 + \rho^b E_t q_{t+1}^b$. Short-term debt is assumed to be liquid. The debt is issued to balance the budget such that debt maturity stays constant. Average labour income taxes are driven by the fiscal rule outside of the steady state. The rule is a simplified version of the rule in Bayer et al. (2024b) and is similar to the one in, for example, Auclert et al. (2020):[6]

$$t_t^{av} = t^{av} + \gamma_{b,\tau}(q^b B_t^{g,LT} + B_t^{g,ST} - q^b B^{g,LT} - B^{g,ST}) + \varepsilon_t^t \tag{9}$$

where $t^{av} = \frac{\int \left(e_t w_t n_t - \xi_t (e_t w_t n_t)^{1-\tau}\right) \mathbb{1}_{LF} dD_t}{w_t n_t}$ and variables without time subscript denote steady state values. Monetary policy follows a Taylor-type rule:[7]

$$i_t = \rho_r i_{t-1} + (1-\rho_r)(r_t^* + \phi_\pi(\pi_t - \bar{\pi}) + \phi_y(Y_t + y_t^{z,ex} - Y - y^{z,ex})) + \varepsilon_t^r \tag{10}$$

2.5. Financial Intermediary

Financial intermediary collects households' illiquid savings and invests them in equities of resource and non-resource firms,[8] and domestic and foreign long-term debt, such that portfolio composition between the assets is homogeneous across households.[9] Intermediary also collects households' liquid savings and invests them in short-term domestic and foreign bonds rebating realized returns on the portfolio back to households. No-arbitrage conditions between all illiquid and between all liquid assets hold delivering Uncovered Interest rate

6 Two rules as in Bayer et al. (2024b) deliver less stable version of the model, especially in the version with participation. As is discussed in, for example, Auclert et al. (2025) and Acharya and Benhabib (2024) HANK models require stricter conditions for determinacy. Although, the only check is with respect to local determinacy, i.e. with a winding number which is a relevant statistic in the sequence space, IRFs for some combination of parameters governing the fiscal rules behave poorly with two rules in periods further out (i.e. 50 quarters ahead), where they should be converging to the steady state.

7 Reaction to output in deviations from the steady state is also to ensure more stability in the model and is left for future work.

8 Resource firms have non-zero profits as they own capital.

9 For the discussion of portfolio composition, see Auclert et al. (2024), where in the application it is shown that for monetary policy shocks endogenous portfolios seem not to matters.

Parity conditions between domestic and foreign bonds with liquidity premium being the wedge between liquid and illiquid returns:

$$\frac{1+\rho^b q^b_{t+1}}{q^b_t} = \frac{E_t Q_{t+1}}{Q_t}\frac{1+\rho^{b^*} q^{b^*}_{t+1}}{q^{b^*}_t} + \psi_t \tag{11}$$

$$1+r_{t+1}-\omega_{t+1} = \frac{E_t Q_{t+1}}{Q_t}(1+r^*_{t+1}-\omega^*) + \psi_t \tag{12}$$

where Q_t is the real exchange rate, ψ_t is the country premium[10] and variables with a * denote corresponding variables in the rest of the world.[11]

2.6. Rest of the World and Capital and Trade Flows

Independently of asset positions households consume the same basket of imports and domestically-produced goods as is the case in Auclert et al. (2021b), non-resource exports are governed by the global demand and relative prices. Price of resources is exogenously driven, with an infinite demand for resource sector output from the rest of the world at the given price. Therefore, perfect competition in the resource sector and the demand for resources from the domestic non-resource sector determine resource export:

$$C_t = \left(\gamma_{hb}^{\frac{1}{\eta^h}} Im_t^{\frac{\eta^h-1}{\eta^h}} + (1-\gamma_{hb})C_{h,t}^{\frac{\eta^h-1}{\eta^h}}\right)^{\frac{\eta^h}{\eta^h-1}} \qquad Ex_t = \gamma^f\left(\frac{p^*_{H,t}}{p^*_t}\right)^{-\eta^f} Y^f_t \tag{13}$$

where γ_{hb} governs home-bias and η is the elasticity of substitution between domestic and foreign goods, Im_t stands for imports and Ex_t stands for non-resource exports. Australian foreign asset position vis-a-vis the rest of the world is driven by net exports and the return

10 The functional form is $\psi(e^{-NFA_t}-1)$.

11 The premium is small and follows Schmitt-Grohé and Uribe (2003) formulation. The trade in two assets is motivated by Australian net foreign asset position that is positive in debt and negative in equities and follows formulation in Shabalina (2023). Additionally, to tame valuation effects from the liquidity premium on fiscal policy budget constraint, it is assumed that the liquidity premium has persistence and only slowly adjusts to dynamics in foreign liquidity premium, the assumption which however does not affect qualitative results.

on the previous period position, $\tilde{r}_t$ that is based on positions in liquid NFA_t^{ST} and illiquid assets NFA_t^{LT} vis-a-vis the rest of the world:

$$NFA_t = (1+\tilde{r}_t)NFA_{t-1} + (Ex_t + \frac{p_t^z}{p_t} y_t^{z,ex} - Im_t) \tag{14}$$

$$NFA_t^{ST} = B_t - B_t^{g,ST} \tag{15}$$

$$NFA_t^{LT} = A_t - v_t - v_t^z - q_t^b B_t^{g,LT} \tag{16}$$

where $A_t + B_t = v_t + v_t^z + q_t^b B_t^{g,LT} + B_t^{g,ST} + NFA_t$ is the asset market clearing condition.

In line with Gali and Monacelli (2005) tradition foreign economy is driven by a 3-equation model. The formulation with habit is taken from Gibbs et al. (2018):

$$(C_t^* - hC_{t-1}^*)^{-1} - h\beta_t^*(C_{t+1}^* - hC_t^*)^{-1} =$$

$$\beta_t^* E_t(1+r_{t+1}^*)\left[(C_{t+1}^* - hC_t^*)^{-1} - h\beta_t^*(C_{t+2}^* - hC_{t+1}^*)^{-1}\right] \tag{17}$$

$$(1+\pi_t^*) = \kappa^*(mc_t^* - \frac{1}{\mu_t^*}) + \beta^* E_t(1+\pi_{t+1}^*) \tag{18}$$

$$i_t^* = \rho_t^{r,*} i_{t-1}^* + (1-\rho_t^{r,*})(r^* + \phi_\pi^* \pi_t^* + \phi_y^*(Y_t^f - Y^f)) + \varepsilon_t^{r*} \tag{19}$$

For the definition of the competitive equilibrium and additional model details see Appendix A.

3. Solution Method and Calibration

The model is calibrated to Australian economy with parameters stated in Table 2. The idiosyncratic earnings process is an AR(1) process in which errors follow a mixture of Normal distributions, see Eq. 21, this delivers a leptokurtic distribution of earnings with negative skewness.[12] The parameters of the process are calibrated to match moments from administrative data on earnings from the Person Level Integrated Data Asset (PLIDA). The calculations are based on a 10% sample of the entire Australian working-age population (ages 18–65). Self-employed individuals are excluded, and the earnings data includes only wages and salaries. For more details, see Nolan and Shabalina (forthcoming). The fitted process,

12 Adding transitory component did not improve the fit with the data moments.

Table 1: Moments of the earnings distribution.

Variable	Data	Model	Variable	Data	Model
Std log earnings	1.05	0.84	Frac. 1-year change $<$ 10%	0.45	0.48
Std (1 year change)	0.66	0.66	Frac. 1-year change $<$ 20%	0.63	0.66
Std (5 year change)	0.92	1.14	Frac. 1-year change $<$ 50%	0.81	0.82
Skewness (1 year change)	-0.31	-0.37	Frac. 5-year change $<$ 10%	0.22	0.22
Skewness (5 year change)	-0.41	-0.04	Frac. 5-year change $<$ 20%	0.40	0.37
Kurtosis (1 year change)	20.43	21.08	Frac. 5-year change $<$ 50%	0.68	0.59
Kurtosis (5 year change)	13.11	8.21			

which is obtained using Generalized Method of Moments, matches the targeted moments well and with a similar precision as in Kaplan et al. (2018), see Table 1. The parameters of the calibrated process are as follows: $\rho = 0.88$, $\sigma_1 = 0.05$, $\sigma_2 = 2.45$, $p_1 = 0.97$, $\mu_1 = 0.02$.

$$y_t = \rho y_{t-1} + \eta_t, \tag{20}$$

$$\eta_t = \begin{cases} N(\mu_1, \sigma_1^2), \text{ with probability } p_1 \\ N(\mu_2, \sigma_2^2), \text{ with probability } (1 - p_1) \end{cases} \tag{21}$$

Wealth targets are calculated using data provided by the Australian Bureau of Statistics (ABS),[13] averaging across all available years (pre-covid). Borrowing penalty is calibrated to match 9% of households with negative liquid assets, the statistic obtained from The Household, Income and Labour Dynamics in Australia (HILDA) Survey averaging across years 2002-2022. Participation rates were taken from PLIDA. Elasticity of intertemporal substitution and Inverse Frisch elasticity are taken from Gibbs et al. (2018). Since higher risk-aversion parameter does not lead to the concentration of liquid assets among the rich in line with the data, a conservative parameter value was chosen and offset accounts were introduced. See Figure 3 for the distribution of liquid assets together with the distribution of illiquid assets, consumption and participation rates and their relation to the respective

13 Table 5204055011 Australian National Accounts: Distribution of Household Income, Consumption and Wealth.

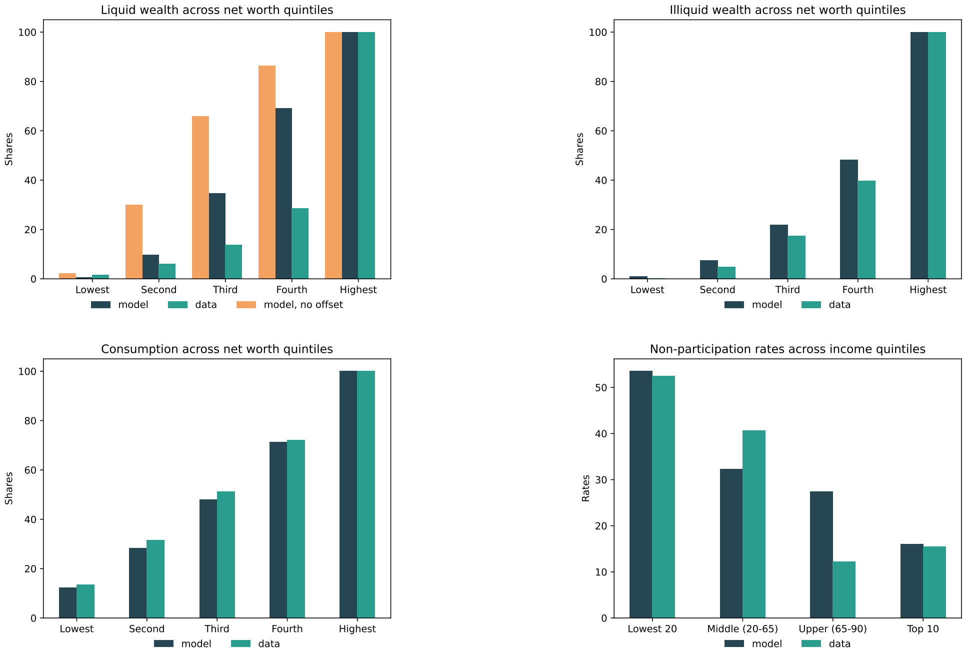

Figure 3: Distributions in the model and data.

distributions in the data. Marginal propensities to consume and participation elasticities are both around 0.2 for a 2-year horizon and slightly less than 0.2 for a one-year horizon.

Tax rates are taken from Tran and Zakariyya (2023). In the empirical estimation, they find lower tax progressivity value for the OLS estimation, but they use 0.2 in the quantitative model which is also in between their OLS estimates and estimates from Cho et al. (2024). Flow value in non-employment is calculated based on the net replacement ratio provided by the OECD and is also equivalent to the unemployment benefits in Nolan and Shabalina (forthcoming).[14] Parameters governing fiscal policy rule are chosen to match fiscal multipliers from an empirical SVAR model under development at Treasury.[15] Government debt to GDP ratios for the short-term and long-term debt and government expenditures are calculated based on outstanding AGS data and final government consumption data provided by the ABS.

Capital to output and depreciation rates are calculated based on mining and non-mining capital and investments data provided by the ABS. Capital share in the non-resource sector

14 Further research can explore a possibility of differential non-employment and unemployment benefits values.

15 Estimated values are not yet publicly available.

is chosen such that in the steady state resource exports are equal to zero.[16] To my knowledge there are no values in the literature for the wage Phillips curve and investment adjustment costs parameters for Australia, so a standard value of 0.1 was chosen for the wage Phillips curve slope and 0.1 was chosen for the investment adjustment cost parameters that deliver investments that are 3 times as volatile as output in line with the empirical estimates for Australian data using Hodrick-Prescott filter.

Foreign economy parameters are mostly taken from Smets and Wouters (2007) except for the Phillips curve parameters which are taken from Bayer et al. (2024a) with CES aggregator of intermediate good producers' outputs instead of Kimball aggregator. Parameter governing duration of foreign long-term debt is taken from US Treasury report to TBAC.[17] For the value of the interest rate Effective Federal Funds Rate was used taken from FRED database augmented with an updated version of the shadow rate estimates from Wu and Xia (2016).[18] Other parameters where possible are taken from Gibbs et al. (2018) and where estimates for Australia are not available - from Bayer et al. (2024a). For the solution method sequence-space jacobian method was used developed in Auclert et al. (2021a).

16 The value is lower than the capital share in the resource sector in Gibbs et al. (2018). Higher values imply negative value of resource export in the steady state.

17 https://home.treasury.gov/system/files/221/TreasuryPresentationToTBACQ32025.pdf, assessed 06.08.2025.

18 Subtracting 2% inflation to get the real rate.

Table 2: Parameter Values, Description and Source.

Parameter	Description	Value and source
	Households	
β	Time discount factor	0.991, target $r = 0.00757$, sample average 1966-2019
σ	EIS	1.0, Gibbs et al. (2018)
ω	Liquidity premium	$0.005 = \omega^*$, Auclert et al. (2021a)
μ_p	Price markup	1.07, target households' wealth $A + B = 20.31Y$, $\mu_p = \eta/(\eta - 1)$, sample average 2004-2020 ABS
χ_0	Portfolio adj. cost pivot	0.25, Auclert et al. (2021a)
χ_1	Portfolio adj. cost scale	4.92, target $B = 3.96Y$, sample average 2004-2020 ABS
χ_2	Portfolio adj. cost curvature	2, Auclert et al. (2021a)
κ^b	borrowing penalty	0.019, target share of households with negative liquid assets 9%, HILDA
$\underline{b}$	borrowing limit	-0.5, average quarterly income, as in Kaplan et al. (2018)
ν	Inverse Frisch elasticity	1.0, Gibbs et al. (2018)
o^f	Offset account fee	0.023, liquid assets distribution
o^r	Additional return on offset account	$0.005 = \omega$
$P(e_{t+1}\|e_t)$	Markov transition matrix for idiosyncratic risk process	see text
σ_ζ	Gumbel distribution std	0.7, target participation rate 67%, PLIDA
	Monetary policy	
ρ_r	Taylor rule interest rate smoothing parameter	0.87, Gibbs et al. (2018)
ϕ_π	Taylor rule inflation coeff.	1.55, Gibbs et al. (2018)
ϕ_y	Taylor rule output gap coeff.	0.21, Gibbs et al. (2018)
p	Aggregate Price level	1, normalization
	Fiscal policy	
ρ^b	Parameter governing duration of long-term debt	0.963, De Graeve and Mazzolini (2023)
$B^{g,LT}$	Outstanding amount of long-term debt	0.0352Y, sample average 2003-2024
$q^b B^{g,LT} + B^{g,ST}$	Outstanding amount of government debt	0.82Y, sample average 2003-2024
G	Government expenditures to output ratio	0.188Y, sample average 1992-2019
τ	Tax progressivity	0.2, Tran and Zakariyya (2023)
τ^c	Consumption tax	0.1, Tran and Zakariyya (2023)
τ^f	Tax on firms' profits	0.11, Tran and Zakariyya (2023)
u^b	Flow value non-employment	0.17, 0.3 of average employment income, OECD
	Production	
δ_0	Capital depreciation in non-resource sector	0.017, sample average 1992-2019
δ_0^z	Capital depreciation in resource sector	0.014, sample average 1992-2019
δ_2	Utilization adj. parameter in non-resource sector	0.009, Bayer et al. (2024a)
δ_2^z	Utilization adj. parameter in resource sector	0.009, Bayer et al. (2024a)
χ_p	Price indexation	0.3, Gibbs et al. (2018)
χ_w	Wage indexation	0.2, Gibbs et al. (2018)
μ_w	Wage markup	1.1, Bayer et al. (2024a)
κ_w	Wage Phillips curve slope	0.1, standard value
κ	Price Phillips curve slope	0.06, Justiniano and Preston (2010)
k	Capital to output ratio in non-resource sector	11.65Y, sample average 1992-2019
k^z	Capital to output ratio in resource sector	1.21Y, sample average 1992-2019
γ	Resource share in non-resource sector	0.05, Gibbs et al. (2018)
ε_I	Investment adj. parameter in non-resource sector	0.1, investment volatility
ε_I^z	Investment adj. parameter in resource sector	0.1, investment volatility
ν^z	Capital share in non-resource sector	0.56, target $y^{z,ex} = 0$
	Open economy and foreign economy parameters	
γ_{hb}	Parameter governing home bias	0.25, Gibbs et al. (2018)
ψ	Country risk premium parameter	0.0001, Schmitt-Grohé and Uribe (2003)
η^h	Elasticity of substitution between foreign- and domestically produced goods	0.8, Gibbs et al. (2018)
η^f	Elasticity of substitution between foreign- and domestically produced goods in foreign economy	0.8, Gibbs et al. (2018)
μ^*	Foreign price markup	1.1, Bayer et al. (2024a)
φ^*	Dis-utility parameter in foreign economy	1.0, Smets and Wouters (2007)
α^*	Capital share in foreign economy	0.19, Smets and Wouters (2007)
ϕ_π^*	Taylor rule inflation coeff. in foreign economy	2.0, Smets and Wouters (2007)
$\rho^{r,*}$	Taylor rule interest rate smoothing parameter in foreign economy	0.8, Smets and Wouters (2007)
ϕ_y^*	Taylor rule output gap coeff. in foreign economy	0.08, Smets and Wouters (2007)
h	Habit parameter in foreign economy	0.7, Smets and Wouters (2007)
ν^*	Inverse Frisch parameter in foreign economy	1.83, Smets and Wouters (2007)
κ^*	Price Phillips curve slope in foreign economy	0.1, Bayer et al. (2024a)
ρ^{b^*}	Parameter governing duration of foreign long-term debt	0.969, US Treasury report

4. Quantitative Results

In this section firstly the steady state results are presented which are focused on the dependence of natural rate on tax progressivity and government debt level. Then, the impulse-responses to a monetary policy shock are shown to assess the dependence of the potency of monetary policy on tax progressivity. And lastly the distributional effects of monetary policy are discussed.

4.1. Steady state results

Figure 4 shows the natural real rate[19] given different levels of tax progressivity (left graph) and different levels of government debt (right graph) in the steady state where there are no aggregate shocks, but with idiosyncratic shocks at the household level. The values $\tau = 0.2$ and the total supply of government bonds of 0.2 stand for the baseline values. Tax progressivity is varied from the flat taxation system ($\tau = 0$) to a taxation system in which $\tau = 0.5$, government debt is varied from the economy with no government debt to a level of government debt that is a bit lower than annual GDP.[20] The natural rate rises with the value of tax progressivity and with the level of government debt. The higher the progressivity of taxes, the more insured are households against idiosyncratic income shocks as progressive taxes work as automatic stabilizers. Thus, precautionary savings decrease which decreases overall amount of savings in the economy and leads to a higher real natural rate. If government supplies more bonds, that increases the amount of assets through which households can insure themselves, thus real natural rate also rises, although the extent of the increase is smaller than shown in Campos et al. (2024) where bonds are the only asset available to households and which shows the results for the US in the closed economy setting. The increase in tax progressivity since the GFC led to an upward pressure on the real natural rate by about 5 b.p. according to these elasticities and the debt expansion from almost 0 to 0.2 contributed only half of that increase. Those two forces are not the only drivers of the Australian natural rate. For the estimation of domestic vs. foreign drivers of Australian

19 Natural rate is the riskless return that equates the demand and supply of savings in the long-run equilibrium - long-run r

20 Debt maturity is kept constant in this exercise.

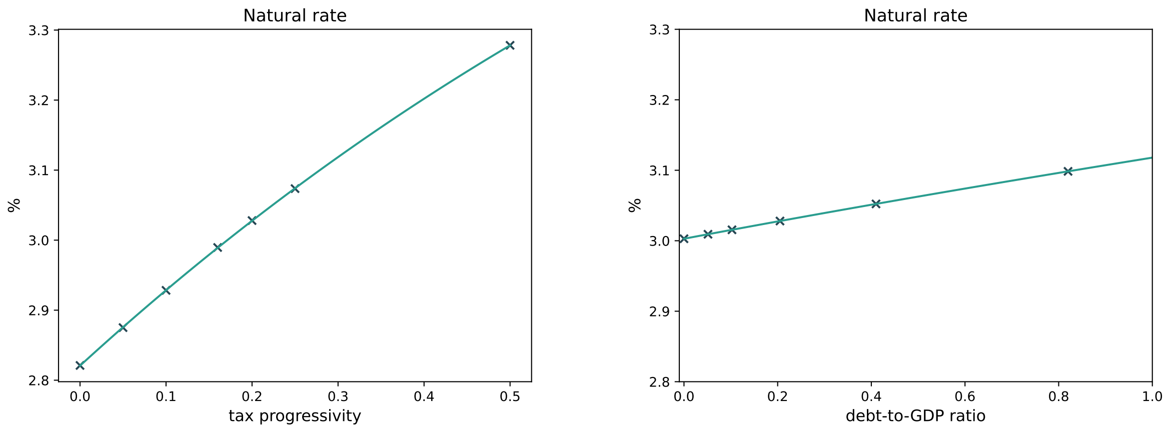

Figure 4: Natural rate as a function of tax progressivity and government debt level.

natural rate, see Morley and Wong (2025) where half of the dynamics driving Australian natural rate is attributed to domestic factors.

Figure 5 shows a decomposition of the increase in tax progressivity from $\tau = 0.16$ to $\tau = 0.2$ into contributions of different model features. The first bar shows the increase in the real natural rate normalized to 1 between the two progressivity levels. The next four light green bars show how each model element changes this difference when added to the model. Their sum is equal to the first dark green bar. Firstly, roughly the same difference in the natural rate is observed in a model with one asset in which households face idiosyncratic risk and exogenous borrowing constraint (see Appendix A.5 for the description of households' problem in this case). The next bar titled "housing wealth" shows how the change in the natural rate is affected by the introduction of the second asset into the model. The contribution of the second asset is small and negative. Illiquidity of the second asset slightly decreases incentives of households to cut on precautionary savings with an increase in tax progressivity. Offset accounts, on the other hand, contribute positively and have an offsetting effect to the housing wealth. Participation margin of adjustment plays a substantial role and since higher progressivity stimulates higher participation rates through insurance of labour earnings, it leads to a decrease in the change in natural rates as households accumulate more savings. A minor contribution of wealth to the change in the natural rate can be also seen from the second decomposition shown by the yellow bars.

The last two yellow bars show the role of wealth accumulation and insurance that higher

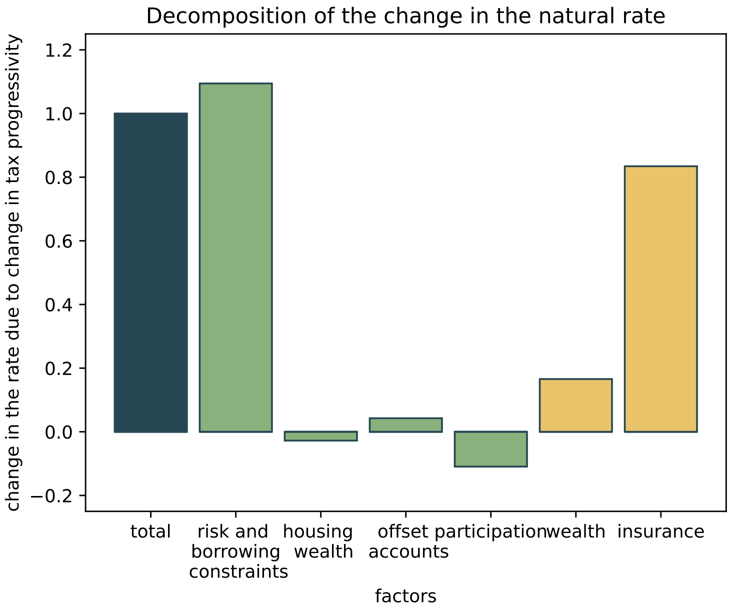

Figure 5: Model features affecting the change in the natural rate between two levels of tax progressivity.

tax progressivity provides: 1) with a higher tax progressivity, households are less able to accumulate wealth since income is redistributed to households with higher marginal propensities to consume leading to lower amount of savings 2) with higher tax progressivity households are more insured and thus accumulate less precautionary savings. The sum of the two yellow bars yields the dark green bar titled "total". According to the decomposition obtained through the counterfactual in which households accumulate same levels of wealth in economies with different tax progressivities,[21] almost all the decrease in savings is driven by a decreased incentive to accumulate precautionary savings.

4.2. Impulse response analysis

Firstly, Figure 6 presents the results of the tax progressivity shock itself. The shock is of 0.04 size with a 0.8 persistence such that the shock decreases by half after one year. For the case of a permanent shock and the transition path of inflation between the two steady states see Figure 13 in the Appendix. All variables except for inflation and the cash rate (nominal central bank's rate) are shown in percentage deviations from the steady state; inflation and the cash rate are shown in deviations from the steady state. The shock acts as a demand

21 In this case markups are adjusted to keep the wealth levels the same.

shock and is inflationary (first row, first and second panels). This is because an increase in tax progressivity leads to a redistribution of income to lower income households that have higher marginal propensities to consume. Therefore, it leads to an increase in consumption and GDP (second row, second panel, first row first panel). It also incentivises households to participate more since their disposable income's variability decreases (second row, first panel). Since the shock disincentivises households with high productivity to participate in the labour market, in the subsequent periods the shock leads to a decrease in tax revenues from labour income taxes (second row, third panel) and a decrease in GDP. As a result of inflationary pressures, monetary policy tightens (first row, third panel). Figure 13 in the Appendix shows a transition between two steady states (i.e. if the shock is permanent) which is also inflationary.

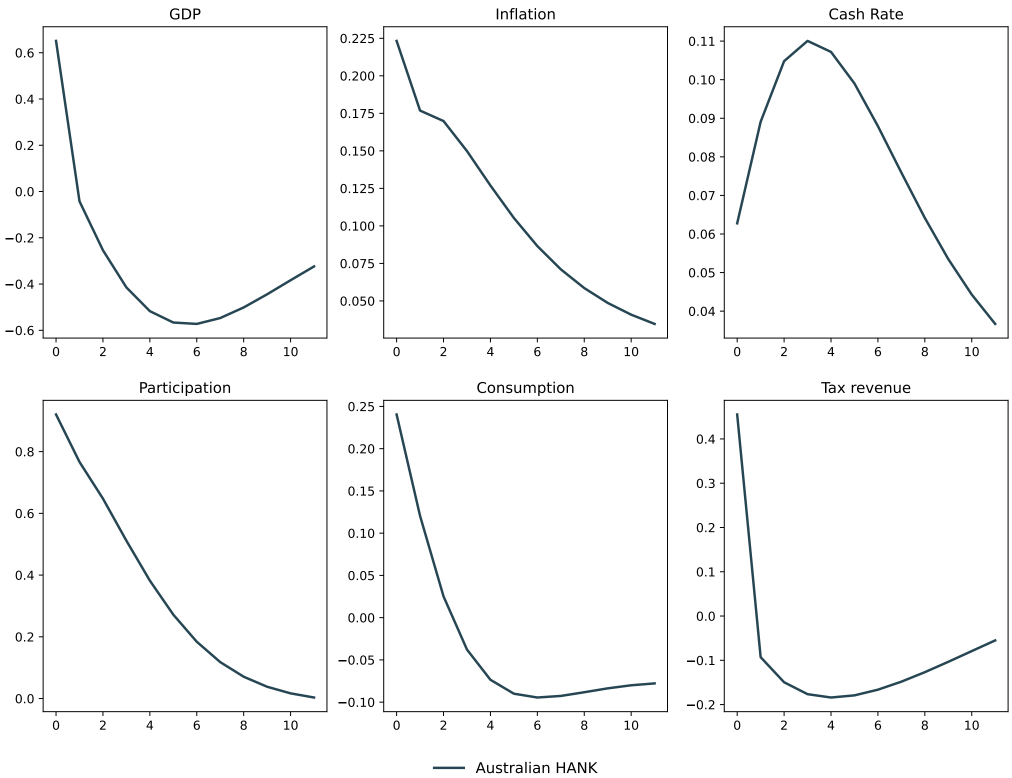

Figure 6: Impulse responses to a positive shock to tax progressivity.

Figure 7 shows impulse responses of selected macroeconomic variables to a contractionary 25 b.p. monetary policy shock. All variables except for inflation and the cash rate are shown in percentage deviations from the steady state; inflation and the cash rate are shown in deviations from the steady state. The dark green lines show responses in the model with higher tax progressivity, baseline value $\tau = 0.2$, and the light green lines show the responses in the model with lower tax progressivity, $\tau = 0.16$. In both cases, the monetary tightening induces a decrease in consumption and investments leading to a decrease in GDP and a decrease in inflation. Participation slightly decreases because of a decrease in labour demand that induces a fall in labour earnings. Across the tax progressivity levels, the responses are similar with a slightly better sacrifice ratio/monetary policy trade-off in the case of a higher tax progressivity. With a higher tax progressivity households' decrease in participation is less since the automatic stabilizer insures them against large drops in disposable labour income.

Most of the difference between responses, like for the steady state results, is coming from the insurance role of taxation rather than its effect on wealth accumulation. Figure 14 in the Appendix shows impulse responses to a monetary policy shock in the models with the same levels of wealth, but different tax progressivity levels which are very similar to the responses shown in the main text. Figure 12 shows the responses given different levels of government debt that implies also a slightly better trade-off with a higher debt levels.

4.3. Distributional effects

As multiple papers in the literature pointed out, Kaplan et al. (2018), Auclert (2019), Acharya et al. (2023), etc., monetary policy lifts not all boats equally. Figure 8 shows how average welfare in consumption equivalent units changes for each wealth quartile following contractionary monetary policy shock.[22] The dark green bars stand for the model with the baseline tax progressivity, $\tau = 0.2$, and the light bars stand for the model with a lower tax progressivity, $\tau = 0.16$. Note, that these are the changes in welfare in response to monetary policy shocks given different levels of tax progressivity. For the steady state values of welfare given different levels of tax progressivity, see Appendix B.4 where the values show improvement in welfare of low-income households with higher tax progressivity. Interestingly, with a higher tax progressivity distributional effects of monetary policy are more amplified: the lowest quartile looses in terms of welfare more with higher progressivity,

22 For the changes in the distribution after monetary policy shock and for a joint welfare change that incorporates changes in the distribution, see Figures 17 and 16 in the Appendix.

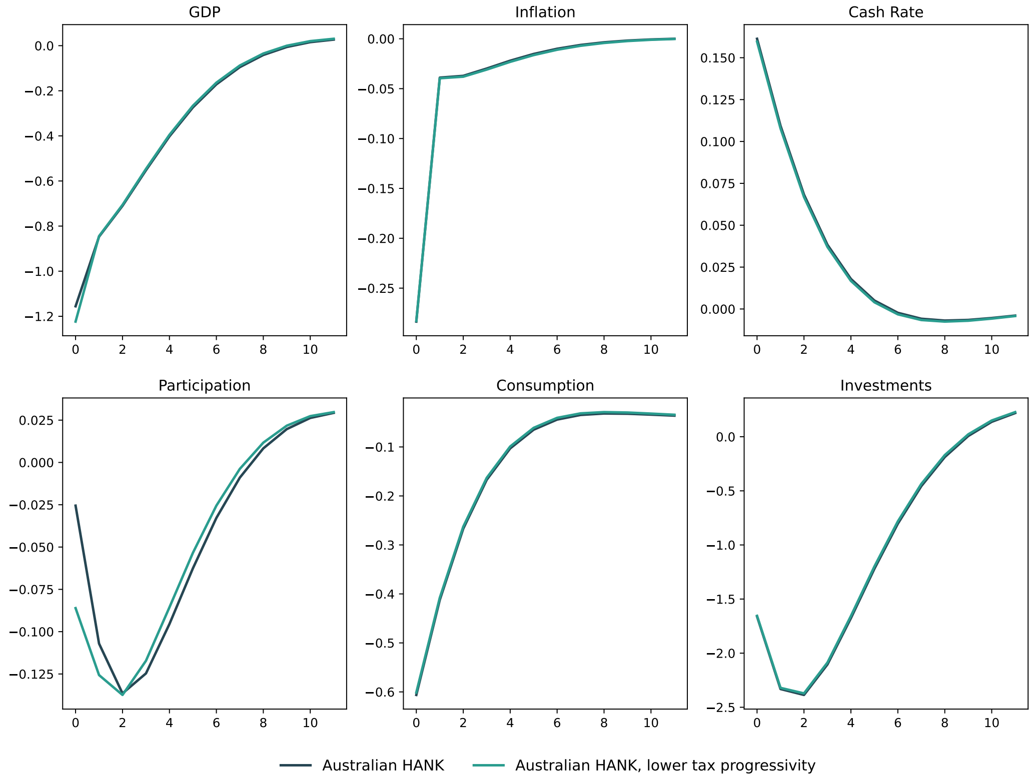

Figure 7: Impulse responses to a contractionary monetary policy shock.

and the highest quartile benefits more. The effects are driven mainly by the changes in labour earnings across the wealth distribution rather than the asset channel as shown in Figure 9 where each of the bars (welfare changes) from Figure 8 is decomposed into labour and asset channels. As a result of tax progressivity acting as an automatic stabilizer, higher income and wealthy households end up benefitting more from lower tax rates to which they move after contractionary monetary policy shock compared to low-wealth households among which participation rate is lower.[23]

The welfare dynamics are driven by both, consumption and participation responses, as is the case in Ferriere and Navarro (2024), see Figure 10 with consumption responses shown on the left panel and participation responses shown on the right panel. At the top of the wealth

23 This is, however, the case for monetary policy shocks as opposed to total factor productivity shocks, which have dampened distributional consequences the more progressive the taxation system is, see Figure 21 in the Appendix. Figure 18 and Figure 19 show distributional effects of larger government debt and both larger government debt and higher tax progressivity with distributional effects being amplified at the bottom of the distribution with both higher debt and higher progressivity akin the results of tax progressivity alone. For the results of higher profit tax or non-employment benefits with a baseline fiscal rule, see Figure 20.

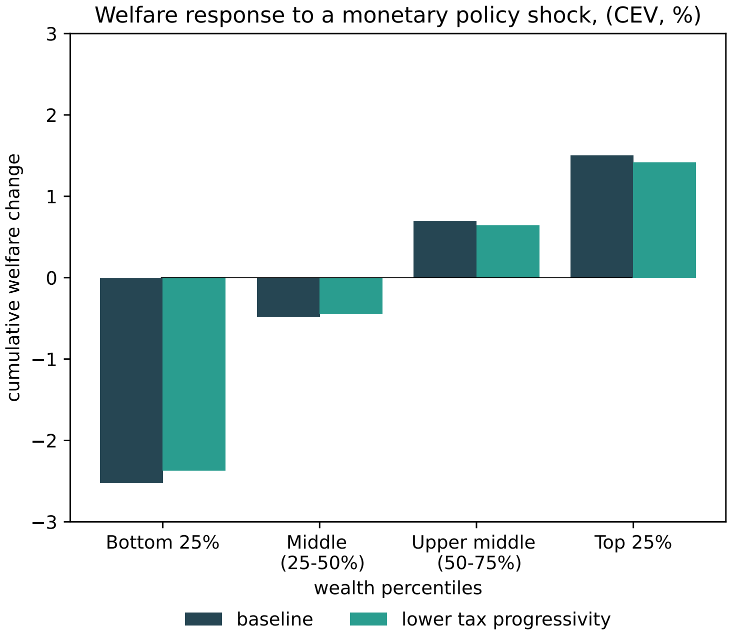

Figure 8: Distributional effects of monetary policy: welfare across wealth distribution.

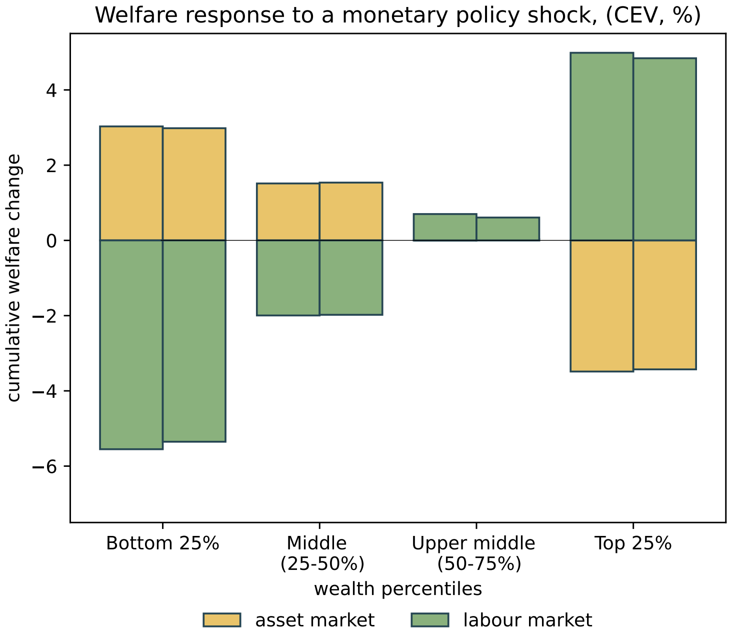

Figure 9: Distributional effects of monetary policy: decomposition into asset and labour channels.

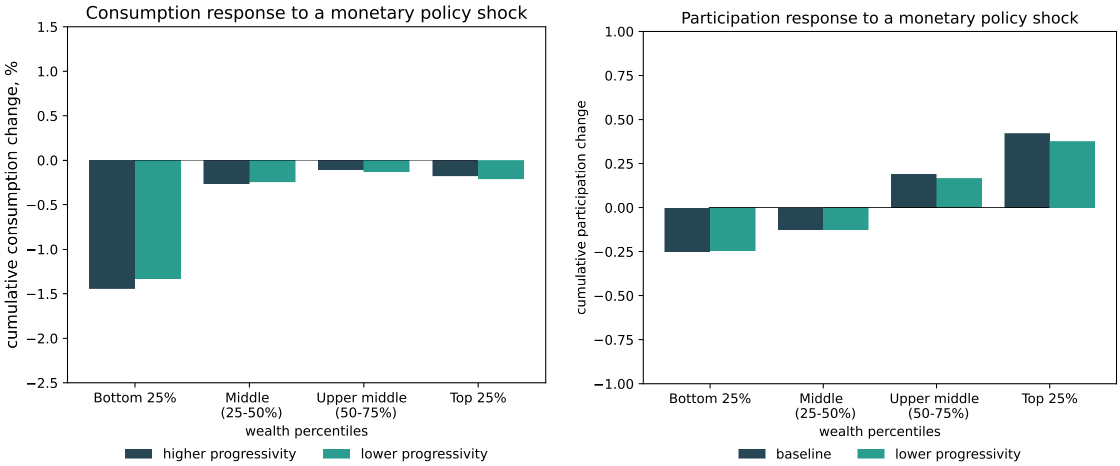

Figure 10: Distributional effects of monetary policy: consumption and participation across wealth distribution.

distribution, households participate more in response to contractionary monetary policy shocks the higher is the tax progressivity because they face lower marginal tax rates. This results in higher consumption following tightening policy among the wealthy households the higher the progressivity. For wealth-poor households the substitution effect on labour supply dominates the income effect in response to monetary policy shocks. Those households faced with higher labour supply and higher consumption demand from the wealth-rich households, cut on consumption by more and participate less the higher the tax progressivity.

Across income distribution the distributional effects are even more pronounced, see Figure 11. The distributional effects are generally U-shaped with households in the middle loosing the most after a contractionary monetary policy shock. Again, the most productive households at the top of the income distribution participate more and consume more with more progressive taxation. Amid lower labour demand from firms lower income households or less productive households participate less and cut on consumption more the higher the tax progressivity. At the bottom of the income distribution, households have highest MPCs and loose the most in terms of welfare from cutting consumption, so they use participation margin to smooth their consumption and participate more the more insurance tax progressivity provides. This helps them sustain their levels of consumption. Therefore, across income, both consumption and participation responses follow a U-shape pattern.

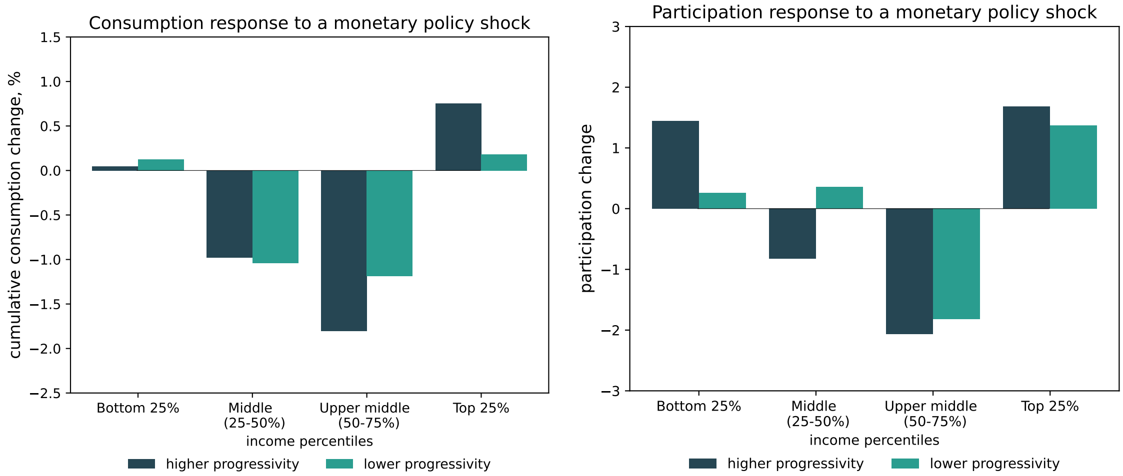

Figure 11: Distributional effects of monetary policy: consumption and participation across income distribution.

The distributional effects depend on the reaction of fiscal authority to the increase in the interest rate. For the discussion of these results, see Appendix B.3.

5. Conclusion

This paper introduces a heterogeneous-agent model with nominal rigidities calibrated to Australia. Household heterogeneity opens the door to analyze the drivers of the natural rate, which is determined by households' discount factor or productivity growth in representative agent models. Instead, in incomplete market models, the natural rate is determined through the market equilibrium of the supply of assets (for example, government bonds) and demand for assets, i.e. households' savings. Through the lens of the model, featuring two assets, participation margin and offset accounts prevalent among Australians, it finds that an increase in tax progressivity leads to a higher natural rate.

At the business cycle frequency, it finds that an increase in tax progressivity leads to a slightly better inflation-output trade-off that monetary authority faces. On the other hand, distributional effects of monetary policy are more amplified with higher levels of tax progressivity.

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A. Additional Model Details

A.1. Households first-order conditions

Let us define a function $\overline{V}_j(e_t, a_{t-1}, b_{t-1})$:

$$\overline{V}_j(e_t, a_{t-1}, b_{t-1}) = log[\sum_{LF} exp(\max_{a_t^{LF}, b_t^{LF}} u((\xi_{j,t}^{LF} + (1+r_t^a)a_{t-1} + (1+r_t^b(b_{t-1}))b_{t-1} - \Phi(a_t^{LF}, a_{t-1}) - o^f \mathbb{1}_{o^r b_{t-1} - o^f > 0} - a_t^{LF} - b_t^{LF}) + \lambda_t(b_t^{LF} - \underline{b}) + \mu_t a_t^{LF} + \beta E_{e_{t+1}} \overline{V}_j(e_t, a_t^{LF}, b_t^{LF}) \frac{1}{1+\tau_t^c}))] \tag{22}$$

where $\xi_{j,t}^{LF} = u^b$ if in non-employment status and $\xi_{j,t}^{LF} = \xi(e_t w_t n_t)^{1-\tau}$ if employed. $\overline{V}_j(e_t, a_{t-1}, b_{t-1}) = E_\zeta V_j(e_t, a_{t-1}, b_{t-1}, \boldsymbol{\zeta}_t)$. Using the above, the F.O.C.s with respect to liquid and illiquid assets are as following:

$$u_{c_t,LF} \frac{1}{1+\tau_t^c} = \lambda_t + \beta E_e \partial_b \overline{V}_j(e_{t+1}, a_t^{LF}, b^{LF} o_t) \tag{23}$$

$$u_{c_t,LF} \frac{1+\Phi_1(a_t, a_{t-1})}{1+\tau_t^c} = \mu_t + \beta E_e \partial_a \overline{V}_j(e_{t+1}, a_t^{LF}, b_t^{LF}) \tag{24}$$

where $u_{c_t,LF}$ is the marginal utility of consumption in the specified labour force status. Envelope conditions:

$$\partial_b \overline{V}_t(e_t, a_{t-1}, b_{t-1}) = \frac{\sum_{LF_t} exp(\tilde{V}_t^{LF}(e_t, b_{t-1}, a_{t-1})) u_{c_t^*,LF} \frac{1+r_t^b(b_{t-1})}{1+\tau_t^c}}{exp(\overline{V}_t(e_t, a_{t-1}, b_{t-1}))} \tag{25}$$

$$\partial_a \overline{V}_t(e_t, a_{t-1}, b_{t-1}) = \frac{\sum_{LF_t} exp(\tilde{V}_t^{LF}(e_t, b_{t-1}, a_{t-1})) u_{c_t^*, LF} \frac{1+r_t^a - \Phi_2(a_t^*, a_{t-1})}{1+\tau_t^c}}{exp(\overline{V}_t(e_t, a_{t-1}, b_{t-1}))} \tag{26}$$

Condition determining the usage of an offset account:

$$o^r b_{t-1} > o^f \tag{27}$$

which can only be satisfied for households who are not borrowing-constrained in liquid assets and results in an additional step in the solution algorithm involving element-wise solution for $b^*(e_t, b_{t-1}, a_{t-1})$ and $a^*(e_t, b_{t-1}, a_{t-1})$ on the b grid.

A.2. Firms first-order conditions

In the non-resource sector intermediate goods firms choose labour, resource input, capital, investments, utilization and prices:

$$mc_t y_t (1 - \nu - \gamma) = w_t l_t^n (1 - \tau_t^f) \tag{28}$$

$$y_t^z (1 - \tau_t^f) \frac{p_{z,t}}{p_t} = mc_t y_t \gamma \tag{29}$$

$$(1 - \tau_t^f) = Q_t^n \left(1 - \varepsilon_I \ln\left(\frac{I_t}{I_{t-1}}\right) \frac{1}{I_t}\right) + \frac{E_t Q_{t+1}^n}{1 + r_{t+1}} \varepsilon_I \ln\left(\frac{I_{t+1}}{I_t}\right) \frac{1}{I_t} \tag{30}$$

$$Q_t^n = E_t Q_{t+1}^n \frac{1 - \delta_{t+1}}{1 + r_{t+1}} + \frac{E_t mc_{t+1}}{1 + r_{t+1}} \nu z_{t+1} (k_t u_{t+1})^\nu (l_{t+1}^n)^{1-\nu-\gamma} (y_{t+1}^z)^\gamma \frac{1}{k_t} \tag{31}$$

$$Q_t^n k_{t-1} (\delta_1 + \delta_2 (u_t - 1)) u_t = mc_t \nu z_t (k_{t-1} u_t)^\nu (l_t^n)^{1-\nu-\gamma} (y_t^z)^\gamma \tag{32}$$

$$\ln(1 + \pi_{H,t}) - \chi_p \ln(1 + \pi_{H,t-1}) = \kappa \left(\frac{mc_t}{1 - \tau_t^f} - \frac{1}{\mu_p} \frac{p_{H,t}}{p_t}\right) + E_t \frac{Y_{t+1}}{Y_t} \frac{1 - \tau_{t+1}^f}{(1 - \tau_t^f)(1 + r_{t+1})} \left(\ln(1 + \pi_{H,t+1}) - \chi_p \ln(1 + \pi_{H,t})\right) \tag{33}$$

In the resource sector perfectly competitive firms choose labour, capital, investments and utilization:

$$w_t = \frac{p_{z,t}}{p_t} z^z_t (u^z_t k^z_{t-1})^{\nu^z} (l^z_t)^{-\nu^z} (1-\nu_z) \tag{34}$$

$$(1-\tau^f_t) = Q^z_t \left(1 - \varepsilon^z_I \ln\left(\frac{I^z_t}{I^z_{t-1}}\right)\frac{1}{I^z_t}\right) + \frac{E_t Q^z_{t+1}}{1+r_{t+1}} \varepsilon^z_I \ln\left(\frac{I^z_{t+1}}{I^z_t}\right)\frac{1}{I^z_t} \tag{35}$$

$$Q^z_t = E_t Q^z_{t+1} \frac{1-\delta^z_{t+1}}{1+r_{t+1}} + E_t \frac{p_{z,t+1}}{p_{t+1}} \frac{1-\tau^f_{t+1}}{1+r_{t+1}} \nu^z \frac{y^z_{t+1} + y^{z,ex}_{t+1}}{k^z_t} \tag{36}$$

$$Q^z_t k^z_{t-1}(\delta^z_1 + \delta^z_2(u^z_t - 1))u^z_t = \frac{p_{z,t}}{p_t}(1-\tau^f_t)\nu^z(y^z_t + y^{z,ex}_t) \tag{37}$$

A.3. Rates, Prices and International Flows

Consumption of domestically and foreign produced goods:

$$C_{h,t} = (1-\gamma_{hb})\left(\frac{p_{H,t}}{p_t}\right)^{-\eta^h} C_t \tag{38}$$

$$Im_t = \gamma_{hb}\left(\frac{p_{F,t}}{p_t}\right)^{-\eta^h} C_t \tag{39}$$

$$p_t = \left(\gamma_{hb} p^{1-\eta^h}_{F,t} + (1-\gamma_{hb}) p^{1-\eta^h}_{H,t}\right)^{\frac{1}{1-\eta^h}} \tag{40}$$

Prices follow the Law of One Price:

$$\frac{p_{F,t}}{p_t} = Q_t \equiv \frac{\mathcal{E}_t p^*_t}{p_t} \tag{41}$$

$$\tag{42}$$

where $\mathcal{E}_t$ is the nominal exchange rate. No-arbitrage conditions across illiquid assets hold:

$$v_t = \frac{E_t(d_{t+1} + v_{t+1})}{1+r_{t+1}} \qquad v^z_t = \frac{E_t(d^z_{t+1} + v^z_{t+1})}{1+r_{t+1}} \tag{43}$$

$$q^b_t = \frac{E_t(1+\rho^b q^b_{t+1)}}{1+r_{t+1}} \qquad q^{b^*}_t = \frac{E_t(1+\rho^{b^*} q^{b^*}_{t+1})}{1+r^*_{t+1}} \tag{44}$$

where d_t and d_t^z are dividends of non-resource and resource firms. Returns rebated to households by financial intermediary read as follows:

$$1 + r_t^b = \frac{NFA_{t-1}^{ST}}{B_{t-1}} \frac{Q_t}{Q_{t-1}} (1 + r_t^* - \omega_t^*) + (1 - \frac{NFA_{t-1}^{ST}}{B_{t-1}})(1 + r_t - \omega_t) \tag{45}$$

$$\begin{aligned} 1 + r_t^a = & \frac{v_{t-1}}{A_{t-1}} \frac{d_t + v_t}{v_{t-1}} + \frac{v_{t-1}^z}{A_{t-1}} \frac{d_t^z + v_t^z}{v_{t-1}^z} + \frac{q_{t-1}^b B_{t-1}^{g,LT}}{A_{t-1}} \frac{1 + \rho^b q_t^b}{q_{t-1}^b} + \frac{NFA_{t-1}^{LT}}{A_{t-1}} \frac{Q_t}{Q_{t-1}} \frac{1 + \rho^{b^*} q_t^{b^*}}{q_{t-1}^{b^*}} \\ & + (1 - \frac{v_{t-1} + v_{t-1}^z + q_{t-1}^b B_{t-1}^{g,LT} + NFA_{t-1}^{LT}}{A_{t-1}})(1 + r_t) \end{aligned} \tag{46}$$

$$1 + \tilde{r}_t = \frac{NFA_{t-1}^{LT}}{NFA_{t-1}} \frac{Q_t}{Q_{t-1}} \frac{1 + \rho^{b^*} q_t^{b^*}}{q_{t-1}^{b^*}} + \frac{NFA_{t-1}^{ST}}{NFA_{t-1}} \frac{Q_t}{Q_{t-1}} (1 + r_t^* - \omega_t^*) \tag{47}$$

$$1 + i_{t-1} = (1 + r_t)(1 + \pi_t) \tag{48}$$

with the last equation standing for the Fischer equation and $\tilde{r}$ being the return on the net foreign asset position.

A.4. Equilibrium Definition

Definition 1: Competitive Equilibrium. A Competitive Equilibrium of the economy satisfies the following definition: the sequence $[c_t, a_t, b_t, \mathbb{1}_{LF}]_{t=0}^{\infty}$ solves households' consumption-saving and participation decisions in 1 and 2, given the distribution of idiosyncratic shocks, $P(e_{t+1}|e_t)$ and the sequence of prices r_t^a, r_t^b, r_t, w_t. The policy functions resulting from the consumption-saving and the participation decisions are solved through fixed point iteration. Aggregate assets holdings and consumption of the households are equal to the product of the individual optimal policy functions and the distribution of households across participation, income and assets states. Firms in each sector choose labour demand, l_t^n and l_t^z, and capital inputs,k_t and k_t^z (and resource inputs for the firms in the non-resource sector) to solve discounted profit optimization, given in 5 and 6. Labour unions choose wages and hours worked to maximize the welfare of their members given in 3, the supply of labour from the households and the demand for labour from the firms. Monetary policy follows a Taylor-type rule, 10, and fiscal policy follows a fiscal rule, 9, and balances the budget through debt issuance. Capital and trade flows mirror each other and are governed by 13 and 14. Domestic economy is small relative to the rest of the world, which prices, interest rates and outputs evolve according to 17, 19, 18. Asset, labour and goods market clearing conditions are satisfied.

A.5. One asset model

$$
\begin{aligned}
&V(e_t, b_{t-1}) = \max_{c_t, b_t} u(c_t, n_t) + \beta E_t V(e_{t+1}, b_t) \\
&\text{s.t. } (1+\tau_t^c)c_t + b_t = \xi_t\Big(\int_k e_t w_{k,t} n_{k,t} dk\Big)^{1-\tau} + (1 + r_t^b(b_{t-1}))b_{t-1} \\
&\qquad b_t \geq \underline{b} \\
&\qquad r_t^b(b_{t-1}) = \begin{cases} r_t^b, & b_{t-1} \geq 0 \\ r_t^b + \kappa^b, & b_{t-1} < 0 \end{cases}
\end{aligned}
\tag{49}
$$

B. Additional Model Results

B.1. Impulse-responses

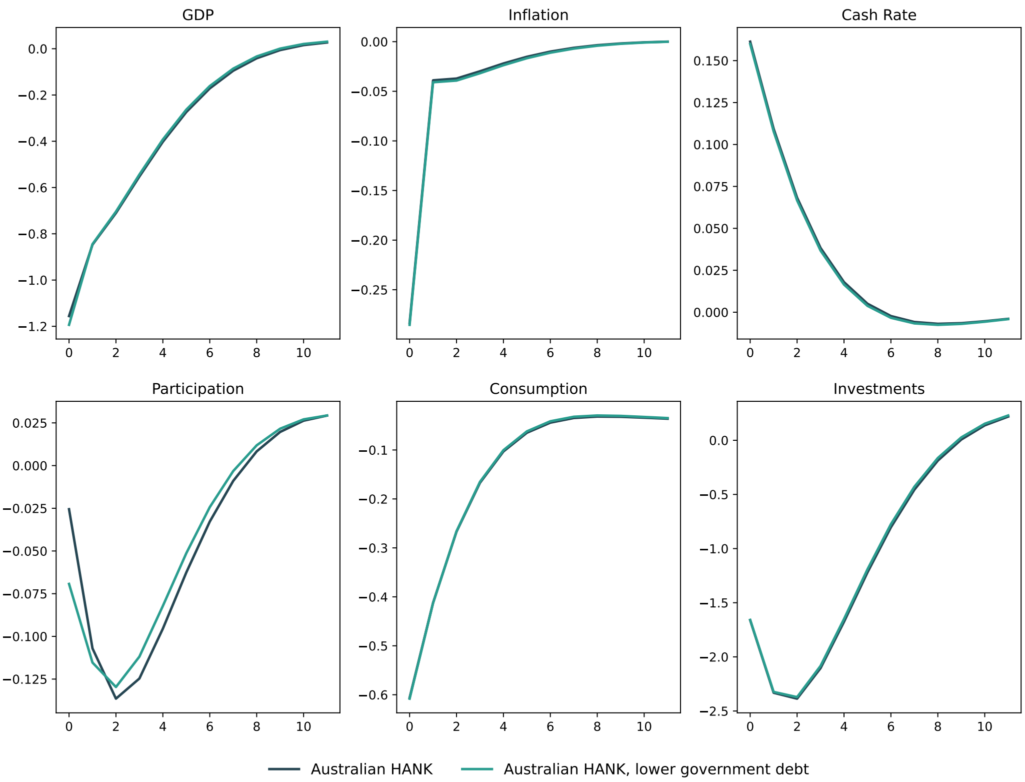

Figure 12: Impulse responses to a contractionary monetary policy shock, different levels of government debt.

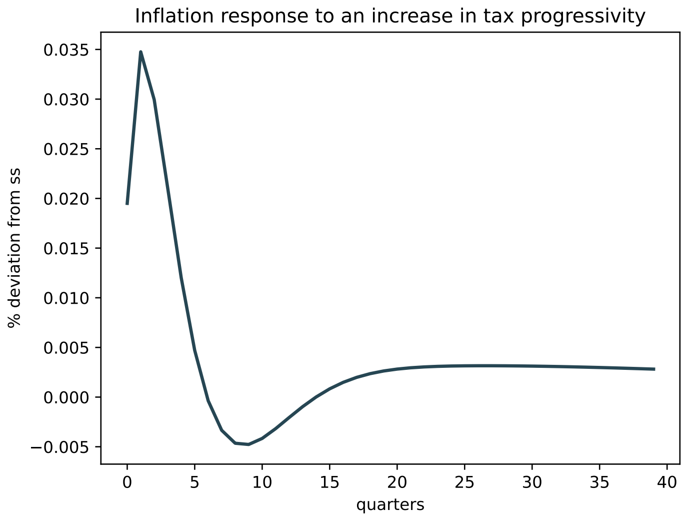

Figure 13: Inflation dynamics on the transition path between two steady states with different levels of tax progressivity. Since it is harder to get convergence with non-linear solution, this result is shown in the one asset model.

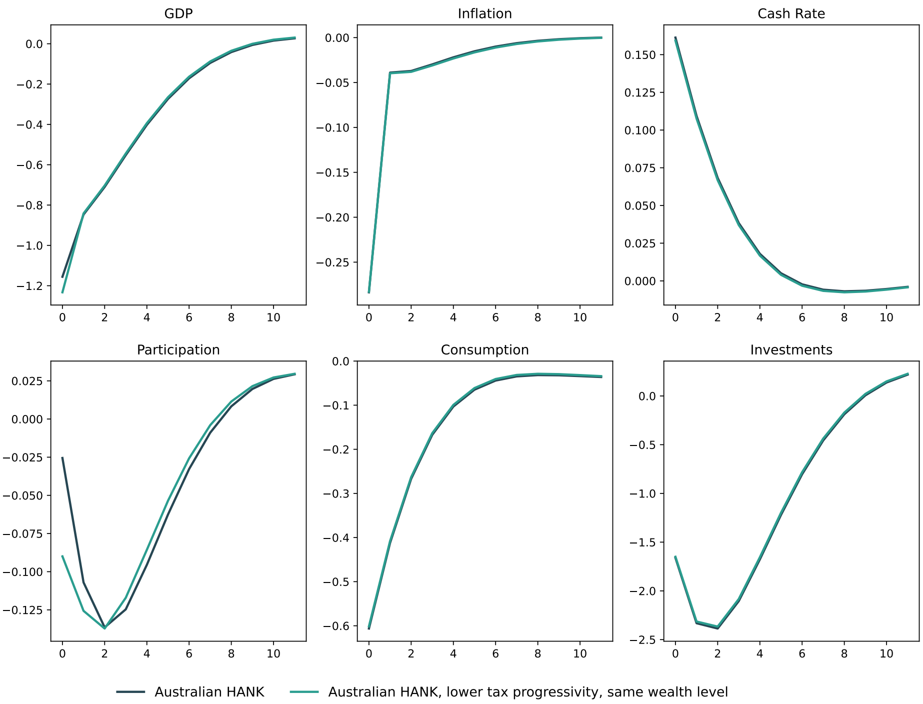

Figure 14: Impulse responses to a contractionary monetary policy shock, same levels of wealth and different tax progressivity.

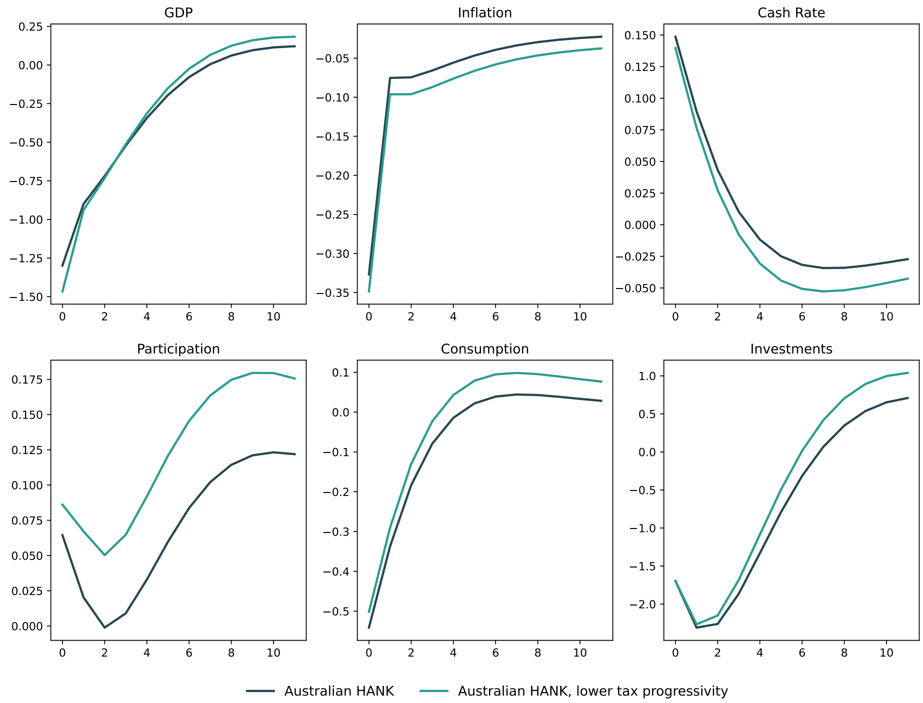

Figure 15: Impulse responses to contractionary monetary policy shock, different fiscal rule coefficient.

B.2. Distributional effects

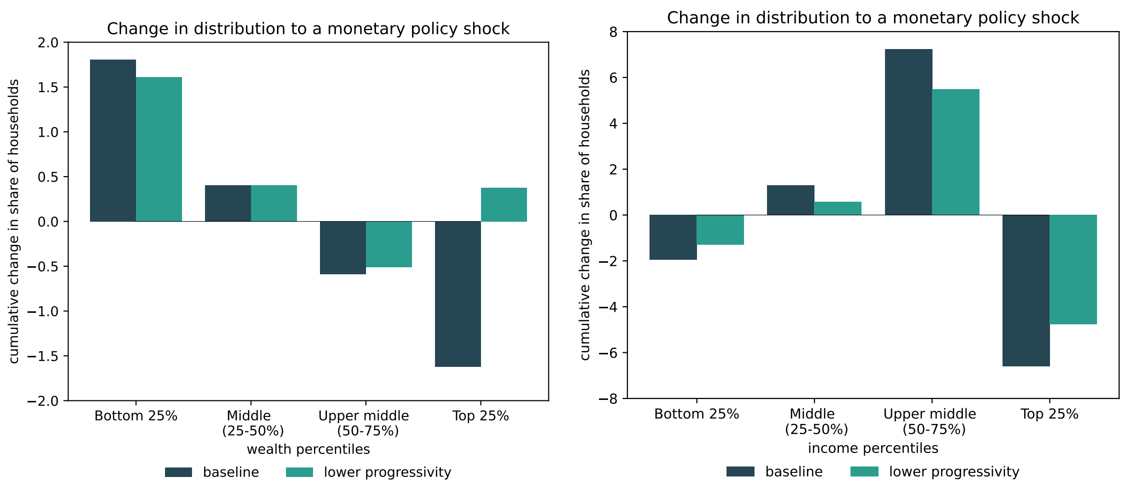

Figure 16: Changes in shares of households across wealth and income distributions.

B.3. Policy analysis

The results in the previous section show distributional effects with the baseline fiscal rule, see Eq. 9 which is also stated below for convenience. The rule results in a decrease in

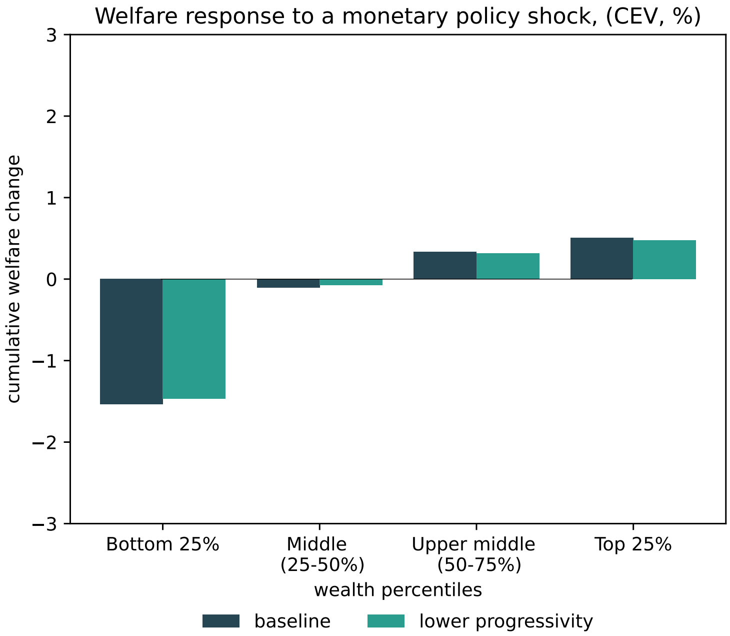

Figure 17: Distributional effects accounting for the change in shares across percentiles, i.e. showing a drop in welfare accounting for the change in average welfare and the change in the number of households in each quartile.

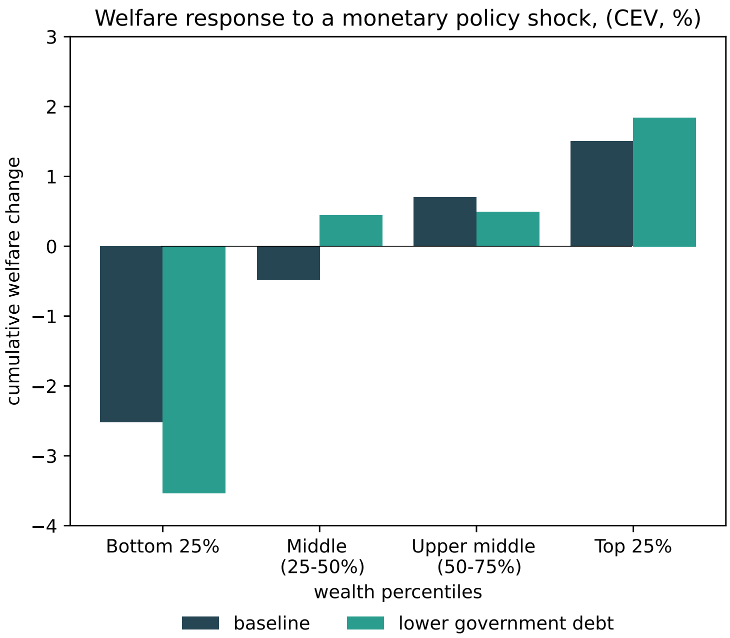

Figure 18: Distributional effects with different levels of government debt.

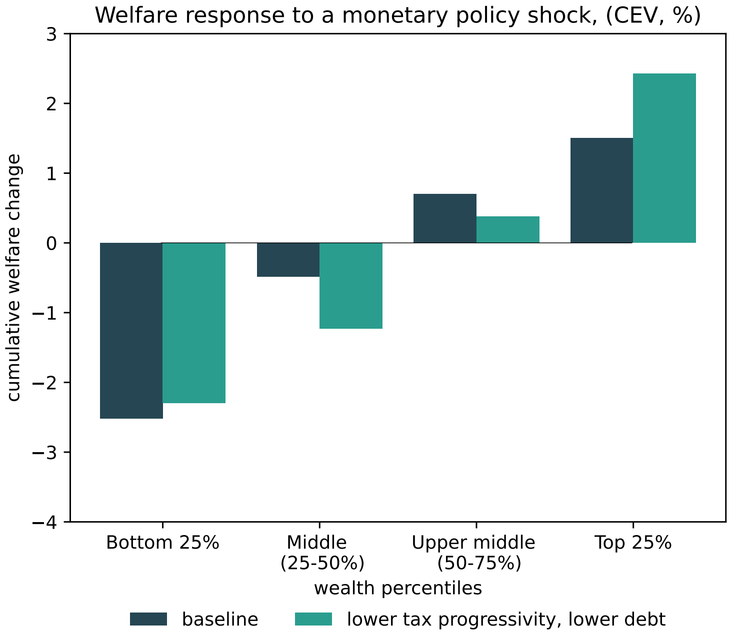

Figure 19: Distributional effects with different levels of government debt and tax progressivity.

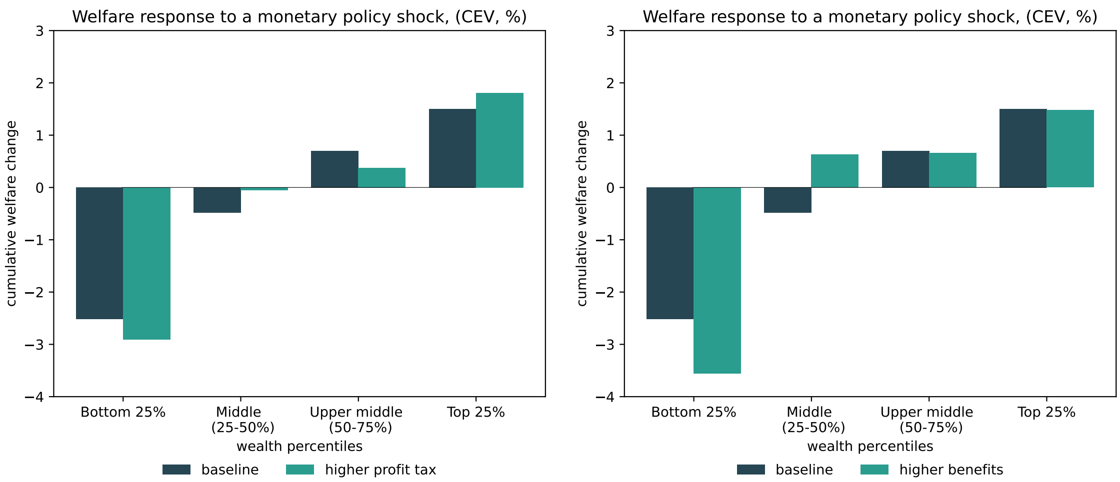

Figure 20: Distributional effects with different profit tax rates and non-employment benefits.

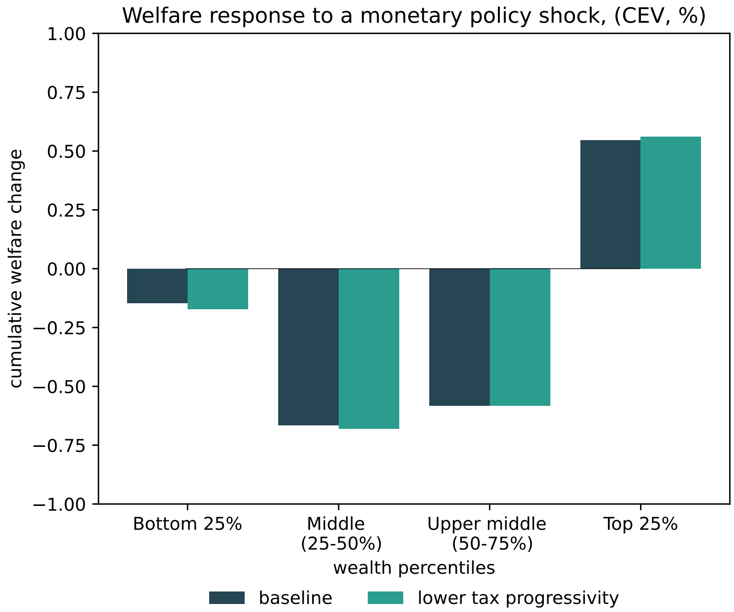

Figure 21: Distributional effects of total factor productivity shock.

the average tax rate in response to a contractionary monetary policy shock. Below are presented distributional effects across wealth, or a similar figure to Figure 8, in the case with a coefficient $\gamma_{b,\tau}$ of the opposite sign such that the average tax rate increases in response to a contractionary monetary policy shock.[24] See the distributional effects in Figure 22 for this case. Opposite to the baseline case, welfare decreases the most at the top of the wealth distribution and the distributional effects are smaller with a higher tax progressivity.[25] This highlights the role of fiscal-monetary interactions in shaping distributional effects of policies.

$$t_t^{av} = t^{av} + \gamma_{b,\tau}(q^b B_t^{g,LT} + B_t^{g,ST} - q^b B^{g,LT} - B^{g,ST}) + \varepsilon_t^t \tag{50}$$

24 In the case when $\gamma_{b,\tau} = 0$ results are qualitatively as in Figure 8.

25 For the impulse responses of aggregate variables with the modified fiscal rule, see Figure 15.

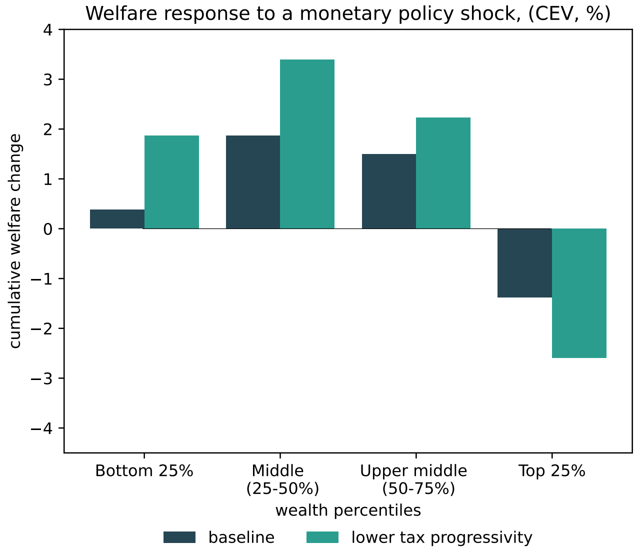

Figure 22: Distributional effects of monetary policy: different fiscal rule coefficient.

B.4. Steady state levels of utility

Table 3: Steady State Levels of Utility Across Income and Wealth.

income quartile	higher progressivity	lower progressivity
bottom 25%	-0.367	-0.385
middle 25-50%	-0.218	-0.211
upper 50-75%	-0.071	-0.067
top 25%	-0.124	-0.122
wealth quartile	**higher progressivity**	**lower progressivity**
bottom 25%	-0.314	-0.321
middle 25-50%	-0.217	-0.218
upper 50-75%	-0.156	-0.155
top 25%	-0.094	-0.091

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