Quantitative Easing with Heterogeneous Portfolios

Pengyue Zhu

May 21, 2025

Abstract

Quantitative Easing (QE) has been extensively employed as an unconventional monetary policy tool to stabilize financial markets and stimulate economic activity. Notably, quantitative easing re-emerged as a key policy tool during the COVID-19 pandemic. However, its effectiveness and distributional consequences hinge critically on the heterogeneity of household portfolios. This paper develops a macroeconomic model in which households differ in their asset holdings. By incorporating these differences, the analysis examines how wealth redistribution may amplify or dampen QE-induced asset price movements, and how such redistribution influences aggregate consumption and investment.

1 Introduction

Quantitative Easing (QE) has become a central tool of unconventional monetary policy, especially during periods when nominal interest rates approach the zero lower bound. By purchasing long-term government bonds and mortgage-backed securities in large quantities, central banks aim to lower long-term interest rates and stimulate aggregate demand. This policy was notably deployed during the 2008 financial crisis, the COVID-19 recession, and has been used extensively by the Bank of Japan and the European Central Bank.

While a growing body of literature has examined the macroeconomic effects of QE, most models abstract from household-level heterogeneity in asset holdings. In practice, households hold very different portfolios, shaped by preferences, transaction costs, age, liquidity needs, and financial constraints. For instance, younger households or those with high liquidity tend to hold more short-term assets, while older or wealthier households often accumulate long-term bonds and retirement funds.

This chapter studies how such portfolio heterogeneity influences the transmission of QE. Specifically, I ask: How does household heterogeneity in short- and long-term asset holdings affect the redistribution of wealth and the macroeconomic impact of QE? Using a simple dynamic model with heterogeneous households and government bonds of varying maturities, I find that:

- In the short run, QE redistributes wealth from short-term bond holders (e.g., money market funds) to long-term bond holders (e.g., pension funds), amplifying QE's effects.
- In the long run, the redistribution reverses: long-term bond holders ultimately bear capital losses due to persistent price changes, dampening the long-run effects of QE.

The model is calibrated using data from the 2022 Survey of Consumer Finances (SCF), where I document heterogeneity in asset portfolios across households. I also explore empirical moments such as the ratio of short- to long-term asset holdings and marginal propensities to save in different asset classes.

Overall, this paper highlights the importance of considering household-level portfolio heterogeneity when evaluating the transmission and effectiveness of QE. Redistribution effects, when coupled with heterogeneous marginal propensities to save, play a critical role in amplifying or attenuating QE's macroeconomic consequences.

2 Analytical Insights in a Two-period Environment

In this section, I present a simple two-period framework in which each household holds fixed portfolio shares of short- and long-term assets, to provide analytical insights into the role of portfolio heterogeneity. In particular, I show that, compared to a benchmark with homogeneous portfolio allocations, the effect of QE on the long-term interest rate differs and depends on the dispersion in household portfolios as well as the price difference between long- and short-term assets.

A unit measure of HHs indexed by $i \in [0,1]$ make consumption/saving decisions:

$$\max_{c_0(i),a_0(i)} \quad u(c_0(i)) + \beta u(c_1(i))$$
$$s.t.\ c_0(i) + q_0^l b_0^l(i) + q_0^s b_0^s(i) = y_0(i) + q_0^l b_{-1}^l(i) + q_0^s b_{-1}^s(i)$$
$$c_1(i) = y_1(i) + b_0^l(i) + b_0^s(i)$$

Each HH has a **fixed portfolio** captured by s_L^i which is the share of long-term holding:

$$b_t^l(i) = s_L^i a_t(i),\ b_t^s(i) = (1-s_L^i)a_t(i).$$

We can rewrite HH i's problem:

$$\max_{c_0(i),a_0(i)} \quad u(c_0(i)) + \beta u(c_1(i))$$
$$s.t.\ c_0(i) + q_0(i)a_0(i) = y_0(i) + q_0(i)a_{-1}(i)$$
$$c_1(i) = y_1(i) + a_0(i),$$

where

$$q_0^l b_{-1}^l(i) = s_L^i \cdot q_0(i)a_{-1}(i),\ q_0^s b_{-1}^s(i) = (1-s_L^i)\cdot q_0(i)a_{-1}(i),$$
$$q_0^l b_0^l(i) = s_L^i \cdot q_0(i)a_0(i),\ q_0^s b_0^s(i) = (1-s_L^i)\cdot q_0(i)a_0(i).$$

Therefore, the aggregate asset price is:

$$q_0(i) = s_L^i q_0^l + (1-s_L^i)q_0^s.$$

Assuming log utility and solving HH i's problem, we have

$$a_0(i) = \frac{\beta}{1+\beta}\left(\frac{y_0(i)}{q_0(i)} + a_{-1}(i)\right) - \frac{y_1(i)}{1+\beta}.$$

Aggregating long-term holding amount across all HHs, we obtain the aggregate long-term demand:

$$\begin{aligned} B_0^{Ld} = \int_i a_0(i)\cdot s_L^i di &= \int_i \left[\frac{\beta}{1+\beta}\left(\frac{y_0(i)}{q_0(i)} + a_{-1}(i)\right) - \frac{y_1(i)}{1+\beta}\right] s_L^i di \\ &= \frac{\beta}{1+\beta} y_0 \int_i \frac{s_L^i}{q_0(i)} di + \frac{\beta}{1+\beta}\int_i b_{-1}^l(i) di - \frac{y_1}{1+\beta}\int_i s_L^i di \\ &= \frac{\beta}{1+\beta} y_0 \int_i \frac{s_L^i}{q_0(i)} di + \frac{\beta}{1+\beta} B_{-1}^{Ld} - \frac{y_1}{1+\beta}\int_i s_L^i di \end{aligned}$$

Equating aggregate long-term demand and the long-term supply:

$$\frac{\beta}{1+\beta} y_0 \int_i \frac{s_L^i}{s_L^i q_0^l + (1-s_L^i) q_0^s} di + \frac{\beta}{1+\beta} B_{-1}^{Ld} - \frac{y_1}{1+\beta} \int_i s_L^i di = B_0^{Ls}.$$

Taking total derivative:

$$\left[-\frac{\beta}{1+\beta} y_0 \int_i \frac{(s_L^i)^2}{\left(s_L^i q_0^l + (1-s_L^i) q_0^s\right)^2} di \right] dq_0^l = dB_0^{Ls}.$$

The aggregate effect of QE, i.e. $dB_0^{Ls} < 0$, is that the long-term price increases, i.e. $dq_0^l > 0$.

Consider the special case where there are only two households with heterogeneous portfolio shares, s_L^1 and s_L^2:

$$-\frac{\beta}{1+\beta} y_0 \left(\frac{(s_L^1)^2}{\left(s_L^1 q_0^l + (1-s_L^1) q_0^s\right)^2} + \frac{(s_L^2)^2}{\left(s_L^2 q_0^l + (1-s_L^2) q_0^s\right)^2} \right) dq_0^l = dB_0^{Ls}$$

Comparing to the homogeneous case where each HH holds exactly the same portfolio, i.e. $s_L^1 = s_L^2 = \bar{s}_L$ and $\bar{s}_L = \frac{s_L^1 + s_L^2}{2}$:

$$-\frac{\beta}{1+\beta} y_0 \left(\frac{2(\bar{s}_L)^2}{\left(\bar{s}_L q_0^l + (1-\bar{s}_L) q_0^s\right)^2} \right) dq_0^l = dB_0^{Ls}.$$

Given the same QE shock dB_0^{Ls}, the difference in the price effect dq_0^l between the homogeneous case and the heterogeneous case is not determined. It depends on the spread of the households' portfolio and the difference between the long-term price and the short-term price:

$$\frac{(s_L^1)^2}{\left(s_L^1 q_0^l + (1-s_L^1) q_0^s\right)^2} + \frac{(s_L^2)^2}{\left(s_L^2 q_0^l + (1-s_L^2) q_0^s\right)^2} \quad v.s. \quad \frac{2(\bar{s}_L)^2}{\left(\bar{s}_L q_0^l + (1-\bar{s}_L) q_0^s\right)^2}$$

If the price effect dq_0^l is larger under heterogeneous portfolios, then heterogeneity amplifies the impact of QE; otherwise, it dampens it. In either case, the analysis makes clear that portfolio heterogeneity plays an important role in shaping the aggregate price response to QE.

3 Infinite-horizon Model

This section extends the two-period model to an infinite-horizon setting and endogenizes households' portfolio choices by introducing a utility component, $v^i(B_t^s(i), q_t^l B_t^l(i))$, which captures heterogeneous preferences over short- and long-term asset holdings. The use of a "value-in-utility" term, placing asset holdings directly into the utility function, is a well-established modeling device in macroeconomics and finance. This formulation captures a form of preferred-habitat behavior, where agents derive utility not only from consumption and leisure, but also from holding particular types of financial assets. By incorporating bond holdings into the utility function, the model allows for imperfect substitutability between assets of different maturities, even in the absence of frictions like transaction costs or asymmetric information. This approach has been widely used in the context of analyzing the effects of quantitative easing (QE) and term structure dynamics. For instance, Andrés, López-Salido, and Nelson (2004) introduce imperfect asset substitution through a utility-based preference for bonds of different maturities in a

DSGE framework. Similarly, Chen, Cúrdia, and Ferrero (2012) embed a VIU term to model household preferences over long-term bonds, capturing the macroeconomic effects of large-scale asset purchases. Li and Wei (2013) adopt a similar mechanism to explain changes in the term structure resulting from shifts in bond supply under QE. These formulations are consistent with the theoretical foundation laid by Vayanos and Vila (2021), who develop a preferred-habitat model of the term structure in which investors have exogenous demand for specific maturities. Overall, the VIU approach offers a tractable way to model segmentation in bond markets and helps explain why changes in the maturity composition of government debt, such as those induced by QE, can have real economic effects.

3.1 Household preferences and constraints

A unit measure of HHs indexed by $i \in [0,1]$ have preferences over consumption and asset holdings:

$$\sum_{t=0}^{\infty} \beta^t \left[u(C_t(i)) + v^i(B_t^s(i), q_t^l B_t^l(i)) \right] \tag{1}$$

In addition to consumption, the HH chooses its position in long-term bonds $q_t^l B_t^l(i)$ and short-term bonds $B_t^s(i)$ subject to the budget constraint and borrowing constraints:

$$C_t(i) + q_t^l B_t^l(i) + B_t^s(i) = Y_t(i) + \left[q_t^l(1-\delta) + x \right] B_{t-1}^l(i) + R_{t-1} B_{t-1}^s(i) - T_t(i) \tag{2}$$

$$B_t^s \geq -\underline{B}^s, \; B_t^l \geq -\underline{B}^l \tag{3}$$

HH i's FOCs are

$$u'(C_t(i)) = v_t^S(i) + \beta R_t u'(C_{t+1}(i))$$

$$u'(C_t(i)) = v_t^L(i) + \beta \frac{q_{t+1}^l(1-\delta) + x}{q_t^l} u'(C_{t+1}(i))$$

where $v_t^S(i) \equiv \partial_S v^i(B_t^s(i), q_t^l B_t^l(i)) = \frac{\partial v^i(B_t^s(i), q_t^l B_t^l(i))}{\partial B_t^s(i)}$, and $v_t^L(i) \equiv \partial_L v^i(B_t^s(i), q_t^l B_t^l(i)) = \frac{\partial v^i(B_t^s(i), q_t^l B_t^l(i))}{\partial (q_t^l B_t^l(i))}$, which implies

$$\beta \mathbf{E}_t \left[\left(\frac{q_{t+1}^l(1-\delta) + x}{q_t^l} - R_{t+1} \right) u'(C_{t+1}(i)) \right] = v_t^S(i) - v_t^L(i)$$

3.2 Government

Government issues both types of bonds. Let $B_t^{s,g}$ and $B_t^{l,g}$ denote the government's holdings of short-term bonds and long-term bonds. The government sets the path of $\{B_t^{s,g}, B_t^{l,g}, T_t\}$ subject to the following budget constraint:

$$B_t^{s,g} + q_t^l B_t^{l,g} = R_{t-1} B_{t-1}^{s,g} + \left[q_t^l(1-\delta) + x \right] B_{t-1}^{l,g} + T_t \tag{4}$$

3.3 Market Clearing

Goods market clearing:

$$\int_i C_t(i) di = \int_i Y_t(i) di \tag{5}$$

Bond market clearing:

$$\int_i B_t^s(i)di + B_t^{s,g} = 0 \tag{6}$$

$$\int_i B_t^l(i)di + B_t^{l,g} = 0 \tag{7}$$

3.4 Equilibrium

Given endowment $\{Y_t(i)\}$ and the government's balance sheet policies $\{B_t^{s,g}, B_t^{l,g}\}$, an equilibrium is a set of prices $\{q_t^l, R_t\}$ and quantities $\{C_t(i), B_t^s(i), B_t^l(i), T_t(i)\}$ such that: (i) each HH chooses $\{C_t(i), B_t^s(i), B_t^l(i)\}$ to maximize (1) subject to (2) and (3); (ii) the government chooses $\{T_t\}$ such that the budget constraint (4); (iii) the goods market clearing condition (5) holds; (iii) the short-term and long-term bond markets clearing conditions (6) and (7) hold.

4 Estimation of the model

In this section, I choose the model's parameters over multiple steps. I start by fixing a few parameters, relating to time preferences and discounting, based on external information or common choices from related papers. Then, I calibrate some macro variables to match US data. Finally I estimate key parameters using the Simulated Method of Moments (SMM). The HHs' utility from consumption is assumed to be log: $u(C) = \ln C$. Utility from assets is parameterized as a nested CES:

$$v^i(B^s(i), q^l B^l(i)) = \bar{v}\left(\alpha(i)(B^s(i))^{\frac{\eta-1}{\eta}} + (1-\alpha(i))(q^l B^l(i))^{\frac{\eta-1}{\eta}}\right)^{\frac{\eta}{\eta-1}\omega}$$

Therefore, HHs have heterogeneous preferences over asset holdings, v^i. In particular, the assets' relative weight $\alpha(i)$ is different among HHs. A higher $\alpha(i)$ means the HH has more weight on short-term assets. η governs how easily the household substitutes between short-term and long-term bonds. A igher η implies the household is more willing to substitute between B^s and B^l, while a lower η implies stronger complementarity. $\bar{v}$ is the scaling parameter or utility weight which normalizes the utility or value function v^i. It could reflect the marginal utility weight on financial assets, or be used for unit consistency. ω is the curvature parameter (capturing risk aversion or portfolio preference). It introduces additional curvature to the CES aggregator, modifying the effective elasticity or risk sensitivity.

4.1 Calibration

The fixed or calibrated the parameters are listed in the following table 1:

4.2 SMM Estimation

Next, I will estimate the remaining parameters: $\alpha(1)$, $\alpha(2)$, $\bar{v}$, η, ω. $\alpha(1)$ and $\alpha(2)$ are households' preference weight toward short-term assets. $\bar{v}$ is the scaling parameter that governs the overall strength of utility from asset holdings. η is the elasticity of substitution between the two asset types. ω is the curvature parameter controlling diminishing marginal utility.

To estimate these parameters, I use the Simulated Method of Moment Approach (SMM) with the following moments: (i) short-preferring households' average short-term

Table 1: Fixed or Calibrated Parameters

Parameter	Values	Description
β	0.94	Subjective discount factor
δ	0.1	Depreciation rate of long-term bonds
x	0.12	Coupon payment or interest return on the long bond
Y_1	1.0	Total income of HH type 1
Y_2	0.72	Total income of HH type 2
B^g	-1.72	Total government holdings of bonds
s_{share}	0.25	Government's initial portfolio share in short-term bonds

assets holding share; (ii) long-term preferring households' average long-term assets holding share; (iii) short-preferring households' total asset share; (iv) HHs' marginal propensity to save (MPS) in short-term assets; (v) HHs' marginal propensity to save (MPS) in long-term assets.

I use the Survey of Consumer Finances (SCF) year 2022 data to obtain the first three targeted moments. Then, I refer to Fagereng et al. (2021) to obtain the approximated values of MPS in short-term assets and long-term assets. The following table 2 reports the empirical (middle column) and model (right column) values of the targeted moments for the SMM estimation.

Table 2: Targeted Moments for the SMM Estimation

Moment	Data/Literature	Model
$\frac{B^s(1)}{B^s(1)+q^l \cdot B^l(1)}$	0.957948	0.90627
$\frac{q^l \cdot B^l(2)}{B^s(2)+q^l \cdot B^l(2)}$	0.884845	0.870115
$\frac{B^s(1)+q^l \cdot B^l(1)}{(B^s(1)+q^l \cdot B^l(1))+(B^s(2)+q^l \cdot B^l(2))}$	0.2489	0.232627
MPS_s	0.35	0.30963
MPS_L	0.13	0.13977

The SMM procedure is exactly identified, and the empirical data perfectly match each moment with the model. The table below reports point estimates for each of the parameters estimated via SMM.

Table 3: Fixed or Calibrated Parameters

Parameter	Values	Description
$\alpha(1)$	0.9687312	HH 1 weight in short-term
$\alpha(2)$	0.3	HH 2 weight in short-term
$\bar{v}$	0.08905207	Scaling parameter
η	1.1	Elasticity of substitution
ω	0.83075414	Curvature parameter

5 Quantitative Analysis

This section presents a quantitative analysis based on the estimation results from the previous section. To examine how wealth redistribution operates during quantitative easing (QE), I first conduct a counterfactual analysis comparing scenarios with and without redistribution among households. Then, to better understand the underlying mechanisms and quantify the impact of redistribution, I decompose the impulse responses of each household type's consumption and asset holdings.

First, Figure shows that as government buying more long-term assets, long-term rate decreases and short-term rate increases, which is consistent with conventional idea.

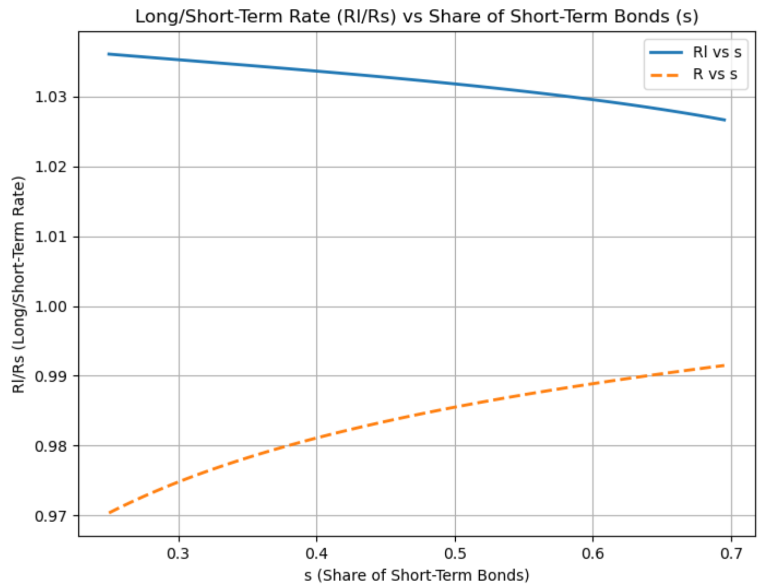

Figure 1: Short-/Long-term rate as Government increases long-term holdings

5.1 Steady-state Counterfactual Analysis

This section presents steady-state counterfactual experiments to isolate the effects of wealth redistribution within the model. By comparing alternative steady states under different compositions of government short- and long-term debt, we assess how interest rates respond and how the wealth distribution across households changes, thereby identifying the direction and magnitude of redistribution in the steady state.

Figure 2 shows that, as the government increases its holdings of short-term debt, short-preferring households gain wealth share in the steady state, while long-preferring households lose wealth share. This indicates that, in the long run, wealth is redistributed from long-preferring to short-preferring households.

To isolate the effect of long-run wealth redistribution, I shut down redistribution by offsetting it with lump-sum taxes across households. Figure 3 shows that as the government increases its long-term bond holdings (by exchanging short-term bonds for long-term ones), the long-term interest rate falls, i.e., the price of long-term bonds rises. However, this price effect is attenuated in the presence of wealth redistribution. The

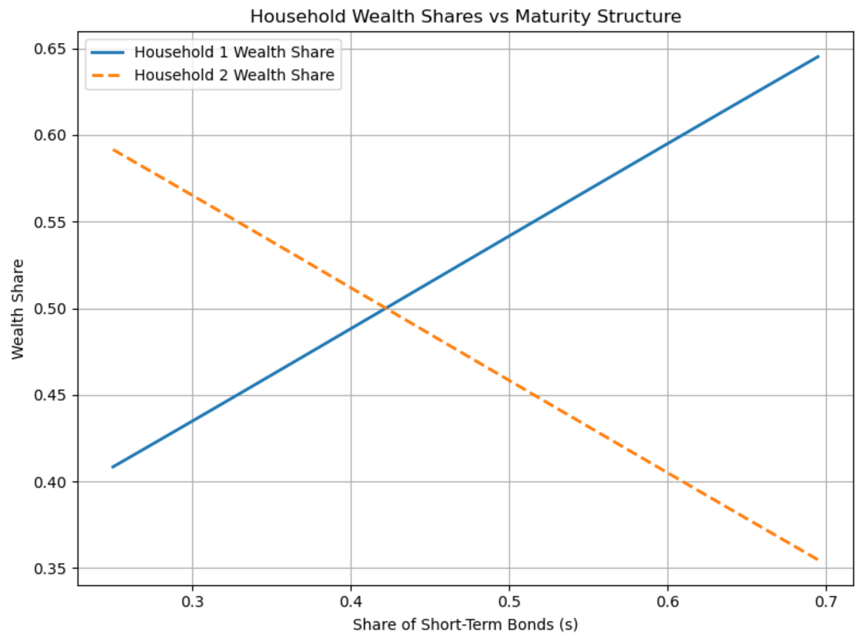

Figure 2: Short-/Long-preferring HH wealth share at steady state

intuition is that, as long-preferring households lose wealth in the long run, their reduced demand for long-term bonds dampens the price response.

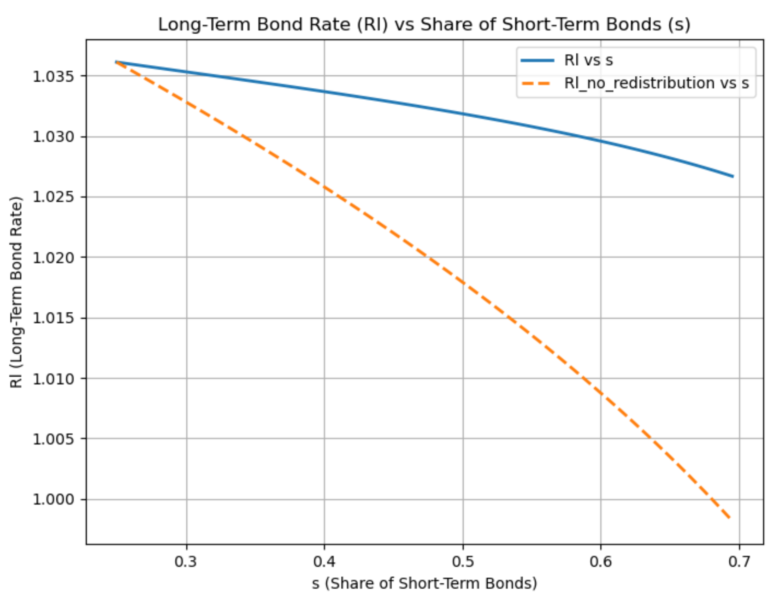

Figure 3: Weakened long-run effect of QE on long-term rate

5.2 Dynamics Counterfactual Analysis

Having examined the long-run steady states, I now turn to the short-run dynamics. While we previously saw that wealth is ultimately redistributed from long-preferring to short-preferring households, the short-run response reveals the opposite pattern. Figure 4 presents the transitional dynamics of household wealth shares following a QE shock. Immediately after the shock, the wealth share of long-preferring households increases, while that of short-preferring households declines. Over time, however, the redistribution gradually aligns with the long-run outcome. This highlights that the direction of wealth redistribution can be reversed in the short run. Intuitively, the immediate wealth redistribution arises because long-preferring households experience larger capital gains from holding long-term assets.

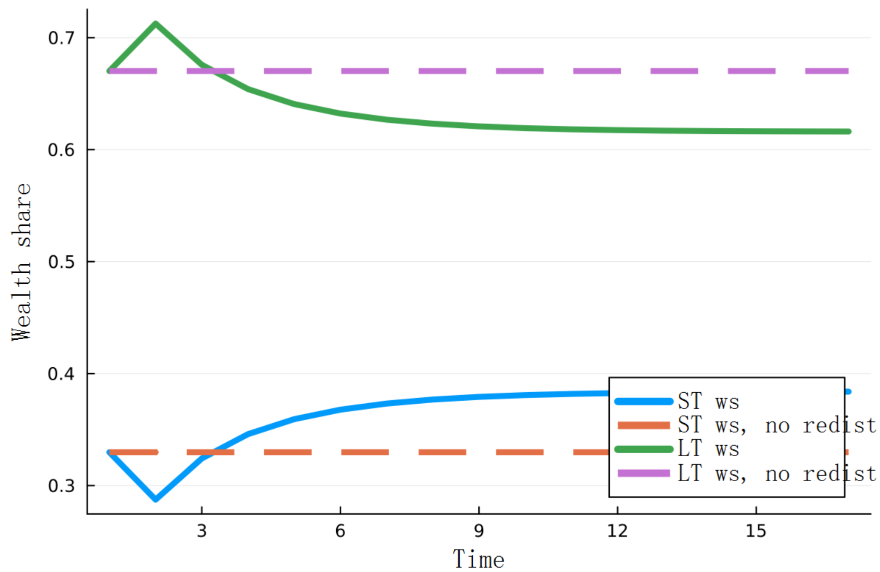

Figure 4: Wealth share impulse response

Next, I present the transitional dynamics of long- and short-term interest rate responses to QE in Figure 5. Specifically, I compare the baseline case with wealth redistribution to a counterfactual where redistribution is shut down. Interestingly, in the short run, long-preferring households experience capital gains, which raises their demand for long-term bonds and amplifies the QE effect on long-term rate. At the same time, short-preferring households lose wealth and reduce their demand for short-term bonds, further amplifying the short-term rate response in that market as well. As a result, the magnitude of the price effects differs across time due to the opposite directions of wealth redistribution in the short run versus the long run.

5.3 Impulse Response Decomposition

To better understand the underlying mechanism, I decompose the impulse responses of households' consumption and asset holdings, both short- and long-term, following a QE shock into two components: the price effect and the redistribution effect. Figure 6 presents this decomposition for short-preferring households, showing the responses of their wealth, consumption, and bond holdings. In the bottom-left panel, which displays short-term bond holdings, we observe that the redistribution effect initially dampens the

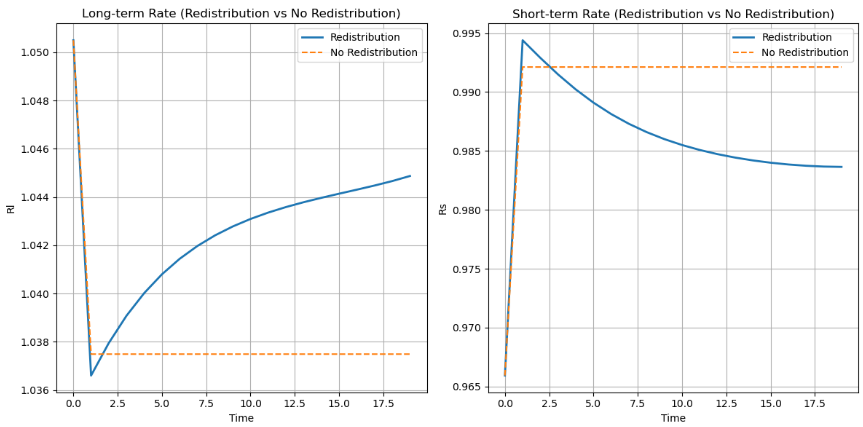

Figure 5: Short-/Long-term rate Transitional Dynamics

price effect in the short run, but later amplifies it in the long run. This dynamic leads to a stronger short-run aggregate impact on the short-term rate and a weaker effect in the long run.

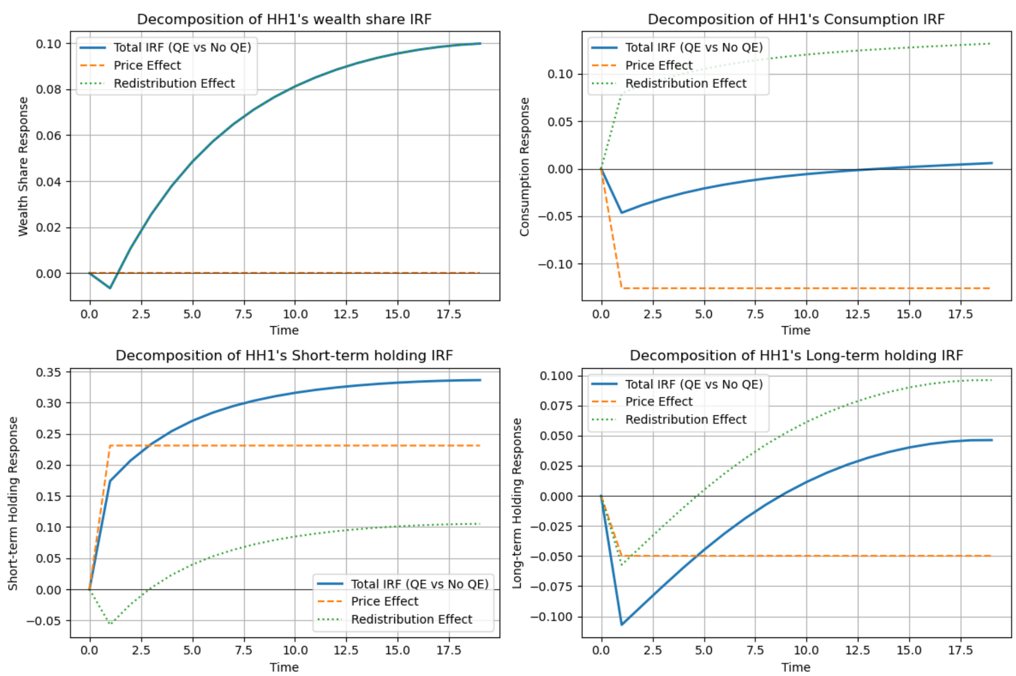

Figure 6: Decomposition of HH 1 impulse response

Figure 7 presents the decomposition for long-preferring households, with the bottom-right panel showing their long-term bond holdings. Although the government's supply of long-term bonds decreases following the QE shock, leading to a decline in total long-term holdings, the redistribution effect initially increases the long-term holdings of these households. This amplifies the short-run rise in long-term bond prices. However, in the long run, the redistribution effect turns negative, reducing long-term bond demand among long-preferring households and dampening the long-run price response.

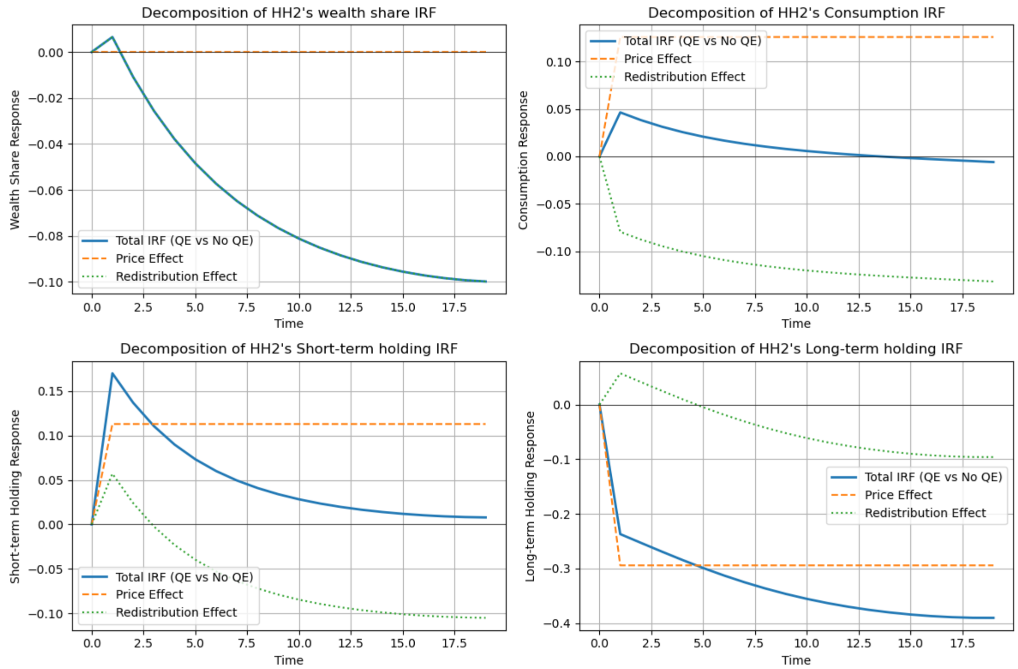

Figure 7: Decomposition of HH 2 impulse response

6 Conclusion

This paper develops and analyzes a dynamic, infinite-horizon model with heterogeneous households and two types of government bonds, short-term and long-term, to study the redistributive and macroeconomic effects of Quantitative Easing (QE). By incorporating differences in household portfolio preferences and asset holdings, the model captures important channels through which QE impacts the economy beyond the traditional interest rate mechanism.

The analysis reveals a key insight: the direction and magnitude of wealth redistribution depend critically on the time horizon. In the short run, QE disproportionately benefits long-preferring households through capital gains on long-term bonds, while short-preferring households lose wealth. This dynamic amplifies the short-run price effects of QE. In contrast, over the long run, as the government's bond portfolio shifts, wealth is gradually redistributed from long-preferring to short-preferring households, dampening the price response and attenuating QE's long-run impact.

Counterfactual experiments further show that shutting down redistribution significantly alters the transmission of QE. Decomposing the impulse responses of household consumption and asset holdings highlights the dual role of asset prices and wealth redistribution in shaping macroeconomic outcomes. These findings underscore the importance of accounting for portfolio heterogeneity and distributional effects when evaluating the effectiveness and consequences of unconventional monetary policy.

Overall, this research contributes to the growing literature on the heterogeneous-agent transmission of monetary policy and provides a foundation for future work examining optimal QE design, welfare implications, and the interaction between redistribution and financial markets.

From a policy perspective, these results suggest that the design of QE programs should account for distributional consequences alongside aggregate outcomes. Ignoring portfolio heterogeneity may lead to over- or underestimation of the true effects of QE on bond prices, consumption, and welfare. Moreover, since redistribution can amplify or dampen QE's impact depending on the horizon, policymakers should be cautious when relying on short-run responses to guide long-term decisions. That said, the model abstracts from certain real-world complexities, such as labor market frictions, endogenous asset supply, and financial intermediaries, which may further influence the dynamics of redistribution. Future work could extend this framework to incorporate these features and assess the robustness of the key insights under more realistic settings.