Distributional Effects of Monetary Policy*

Matthias Doepke
Northwestern

Martin Schneider
Stanford

Veronika Selezneva
Northwestern

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Abstract

We assess the distributional consequences of monetary policy in the current economic environment in the United States. Through its effect on inflation, monetary policy affects the real value of nominal assets and liabilities, and therefore redistributes wealth between borrowers and lenders in the economy. In addition, unconventional policies such as "quantitative easing" affect real interest rates and the availability of credit, once again leading to redistributional effects. We first document the potential exposure to redistribution effects on the U.S. economy using recent data from the Flow of Funds accounts and the Survey of Consumer Finance. We then quantify the redistribution effects of monetary policy using a rich life-cycle model with idiosyncratic risk, financial constraints, a housing sector, and nominal borrowing and lending. We also discuss the extent to which the recent financial crisis, which has lowered net worth of many households and tightened financial constraints, has changed the nature of distributional consequences of monetary policy.

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1 Introduction

This paper assesses the distributional consequences of monetary policy in the current economic environment in the United States. The focus of the analysis is on redistribution effects that originate from the heterogeneity in exposure to nominal assets in the economy. Both conventional and unconventional monetary policy works (at least in part) by affecting interest rates. Changes in interest rates have heterogeneous effects on borrowers and lenders in the economy. Moreover, how a given household or firm is affected depends not just on the overall amount of borrowing or lending, but also on the specific assets or liabilities that are being held (short versus long maturity, government-issued bonds versus corporate bonds versus asset-backed securities etc.). An important part of the analysis is therefore a documentation of the exposure of different sectors and groups of households in the economy to different asset classes.

The first step of our analysis is to construct an up-to-date balance sheet of exposure to nominal risk for the U.S. economy, broken down by sector and different groups of households. This work based on the methodology of Doepke and Schneider (2006b) with a number of extensions. The second step is to employ a rich macro-economic model featuring income and wealth heterogeneity, life-cycle savings, and financial constraints to assess the macro and welfare consequences of changes in monetary policy. Various policies are considered, ranging from temporary to sustained rises in inflation, an overall rise or fall in interest rates, and also unconventional monetary policy measures such as "quantitative easing" that affect the structure of interest rates in more specific ways.

The quantitative analysis also includes two extensions that are novel in this literature and that are motivated by recent macroeconomic research on the effect of the Great Recession. First, there has been a lot of interest in characterizing the impact on consumption and savings of sudden changes in income (such as those brought about by fiscal stimulus). In standard life-cycle models without financial constraints, consumption responses are often small, because the impact of income changes is smoothed over many periods. However, recent empirical work shows sizeable consumption responses for many households. We introduce idiosyncratic income risk and preference heterogeneity in way that allows us to match quantitative measures of the marginal propensity to consume for different types of households distinguished by income, home ownership, and exposure to financial constraints.

Second, current monetary policy takes place in the context of a recovery from a recession where the economy may still be well below its long-run growth path. As a consequence, we will analyze how the distributional impact of monetary policy differs between an economy that starts out in its balanced growth path compared to one that is in the middle of a recovery from a major downturn.

In the next section, we outline the accounting framework used for the empirical component of the project. Section 3 describes the quantitative modeling framework. Section 4 summarizes the quantitative experiments that will be carried out using the theoretical framework as well as inputs from the empirical documentation part.

2 Accounting Framework

We document postwar nominal asset and liability positions in the U.S. economy for various groups of households as well as the government and foreign sectors. We combine data from the Flow of Funds Accounts of the United States (FFA) and the Survey of Consumer Finances (SCF, both published by the Federal Reserve Board). We consider not only directly held nominal assets and liabilities, but also indirect nominal positions, which are due to shares in investment intermediaries and claims on the ownership of firms.

For most securities, the data consist of book values that are hard to interpret and compare. We therefore construct the stream of future nominal payments associated with every major class of security, and then restate all positions at market value. With this approach, we can also estimate the duration of agents' positions (or their average maturity), which allows us to gauge the effects of partially anticipated inflation.

With a matrix of credit market position in hand, we can perform thought experiments: how would the value of positions change in response to change in inflation or interest rates? One concrete example is reported in Figure 2 for the household sector: Suppose that, for 10 years after a given benchmark year, inflation is 5 percentage points per year higher than expected at the end of the benchmark year.

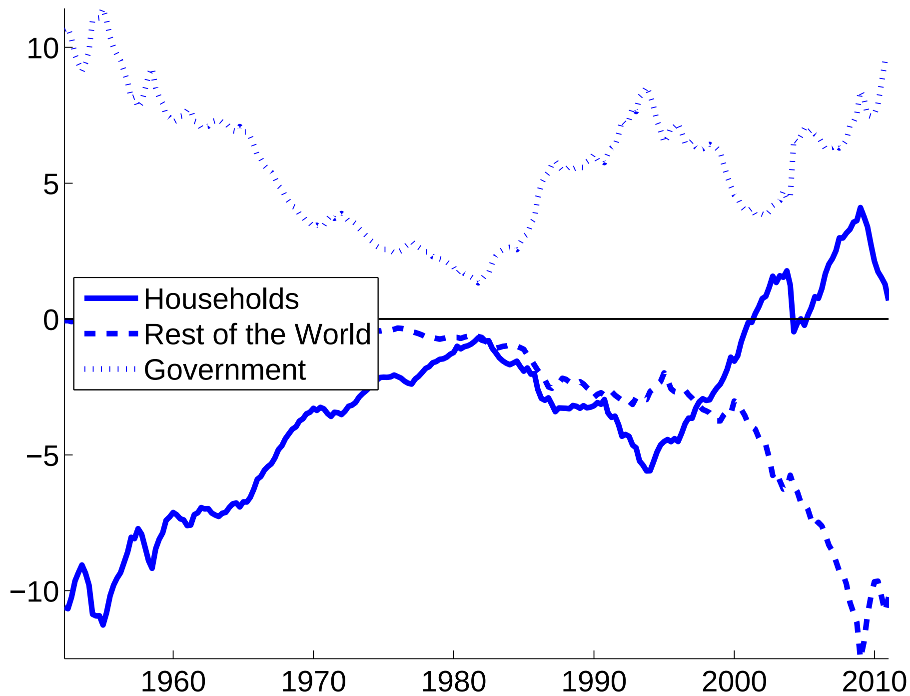

Figure 1: Net Nominal Positions Across Sectors in the United States

Figure 1 consolidates all businesses with the balance sheets of their owners. This creates three sectors: households, government and the rest of the world; redistribution sums to zero across these sectors. The horizontal axis is time starting in 1952.Sectoral positions are measured as per cent of GDP. The vertical axis has government at the top as the winner and households at the bottom as the loser. When there was a lot of debt outstanding after the war, the main redistribution effect of this type of inflation episode is away from households towards government. In the 1970s, when a lot of this debt had been retired, this effect was much smaller. Thus the inter-sectoral redistribution effects in the 1970s were not very important.

As we move forward in time, i.e go in a rightward direction in the figure, where magnitudes become larger again after 1980, there is another important difference.

There is a new group of losers, the rest of the world. The rest of the world's position has become very important recently. In this more recent period, if you had this announcement of five per cent inflation over ten years, both the government and the household sector would be net winners in the US, and the foreigners would pay the bill.

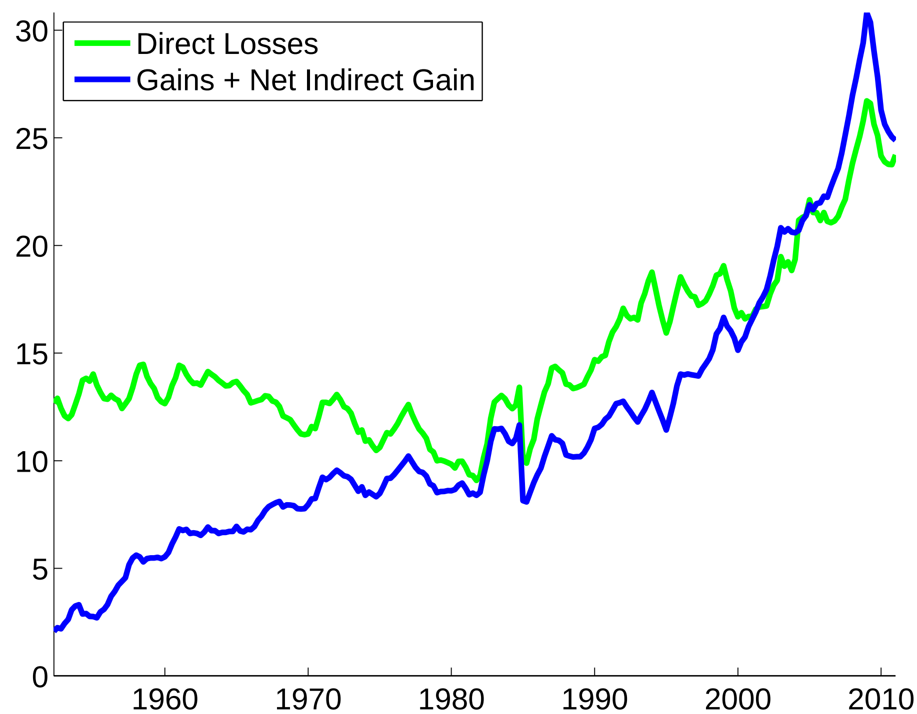

Figure 2: Effect of Inflation Announcement on HH sector, % GDP

Looking at net positions at the sectoral level masks the fact that within the household sector as well as within the firm sector there is heterogeneity. One way to see their magnitude is to examine all the household gross, positive and negative positions, and to run the experiment for those. See Figure 2 "Effect of Inflation Announcement on HH sector, % GDP." In Figure 2 one can observe the direct losses for households (in green) and then the gains that households make through revaluation of their own debt and revaluation of the businesses that they own (in blue). The difference between these two lines is the net household gain or loss. The key point is that the gross gains and losses are much bigger.

To measure other source of changes in credit market positions beyond this example, we plan to further decompose changes in credit market positions into (i) an expected return, (ii) a net trade in the bond market (iii) a gain or loss due to surprise inflation and (iv) a gain or loss due to interest rate surprises. The key ingredient in this decomposition is a measure of interest rate and inflation expectations (and the associated measure of surprise).

We can obtain measures of expectations by estimating a multifactor linear term structure model that jointly describes the dynamics of interest rates and inflation. We will consider two versions of the term structure model. One is rather standard and imposes rational expectations; it is estimated using only actual data. The second uses both survey data and actual data to measure expectations and their dynamics. The resulting innovations will deliver additional thought experiments that result from other types of shocks.

3 Quantitative Macro Framework

The accounting framework described so far allows us to estimate the direct distributional impact of monetary policy changes in terms of wealth changes of various sectors and groups of households in the economy. The next component of the proposed research consists of a quantitative macroeconomic model that allows us to gauge how the economy adjusts to the policy-induced redistribution shock. This includes the possibility of additional redistribution effects through changes in prices, changes in the severity of financial constraints, and so on. The framework is related to earlier work in Doepke and Schneider (2006c) and Doepke and Schneider (2006a), but contains a number of important extensions. Most importantly, we allow for idiosyncratic shocks to income and preferences in order to closely match marginal propensities to save and consume for different types of consumers. In addition, we include a segmented housing sector where different types of households live in different types of houses. For most U.S. households, home equity is the largest component of their net worth; hence, modeling the feedback from monetary policy to house prices for different groups of households is a key challenge for assessing redistribution effects. Here we describe key features of our framework.

3.1 Preferences and Demographics

We consider an overlapping-generations economy in which consumers live for T periods. In every period, a new cohort of size one is born. People derive utility from consumption goods, housing services, as well as leisure. We formulate the decision problem recursively. The state variables for a household are age a, financial assets k, house ownership h, productivity z, and time preferences β. A special feature is that there is is a finite set of types of houses that can be bought, indexed from 1 to N. We have $h \in \{0, 1, \ldots, N\}$, where $h = 0$ denotes that the household does not own a house, and $h > 0$ denotes that the household owns a particular type of house. As the notation already implies, at most one house can be owned at any given time (although the financial asset may include housing assets, as explained below). A household that does not own a house can rent. The renting decision is denoted by $r \in \{0, 1, \ldots, N\}$ The service flow that a given type of house yields is denoted by s(h), with $s(0) = 0$. For a given type of house, renting reduces the service flow by factor $\mu < 1$.

There are different types of households, indexed by j, that can differ in terms of preferences, income processes, the bequest motive and so on. With these preliminaries, the Bellman equation for a generic pre-retirement household is given by:

$$v_j(a, k, h, z, \beta, \Omega) = \max_{c,r,s,n,k',h'} \left\{ u_j(c, s, n) + \beta \sum \pi_j(z', \beta' | z, \beta) v_i(a + 1, k', h', z', \beta', \Omega') \right\}$$

subject to:

$$\begin{aligned} (1 + \tau_c)\, p_c\, c + p_r(r) + p_h(h') + k' = p_h(h) + (1 + (1 - \tau_k)i)\, k + (1 - \tau_n)\, w_j(a)\, z\, n, \\ s = s(h) + \mu s(r), \\ k' \geq -\psi p_h(h') \end{aligned}$$

and subject to the constraint that $r = 0$ if $h > 0$. Here τ_c etc. are tax rates, p_r are rental prices for housing, p_h are house prices, i is the interest rate, and $w_j(a)$ is the type- and age-specific profile for average labor productivity. The first constrains is the budget constraint, the second constraint links the service flow from housing to housing owned and rented, and the third constraint is the borrowing constraint. The aggregate state vector is given by Ω. Prices and tax rates depend on Ω, but this notation is suppressed for simplicity. People know the aggregate law of motion $\Omega' = F(\Omega)$. In a steady state/balanced growth path, Ω is constant and can be omitted from the value functions, but we introduce the notation here to allow the analysis of transition paths.

In the period in which the bequest $\tilde{b}_i$ (which is type-specific) is received, the budget constraint changes to:

$$(1+\tau_c)\, p_c\, c + p_r(r) + p_h(h') + k' = p_h(h) + (1+(1-\tau_k)i)\, k + (1-\tau_n)\, w_j(a)\, z\, n + \tilde{b}_i.$$

After retirement, the decision problem changes to:

$$v_j(a,k,h,\beta,\Omega) = \max_{c,r,s,k',h'} \left\{ u_j(c,s) + \beta \sum \pi_j(\beta'|\beta) v_i(a+1,k',h',\beta',\Omega') \right\}$$

subject to:

$$\begin{aligned}(1+\tau_c)\, p_c\, c + p_r(r) + p_h(h') + k' &= p_h(h) + (1+(1-\tau_k)i)\, k + tr_j(a),\\ s &= s(h) + \mu s(r),\\ k' &\geq -\psi p_h(h')\end{aligned}$$

That is, the social security transfer replaces labor income, and z no longer appears as a state variable. In the final period of life the decision problem is:

$$v_j(T,k,h,\Omega) = \max_{c,r,s,b} \{u_j(c,s,b).\}$$

subject to:

$$\begin{aligned}(1+\tau_c)\, p_c\, c + p_r(r) + b &= p_h(h) + (1+(1-\tau_k)i)\, k + tr_j(a),\\ s &= s(h) + \mu s(r),\end{aligned}$$

where b is the bequest left to the offspring. The decision problem in the period before retirement and the penultimate period also need to be adjusted to account for the change in state variables taken into the next period. In the first period, people start out without assets and without houses.

We choose the following period utility functions (for now):

$$u_j(c,s,n) = \frac{\left((c)^{1-\eta-\sigma_i}\,(s_t)^{\eta}\,(1-n)^{\sigma_i}\right)^{1-\gamma}}{1-\gamma},$$

and the utility in the last period is:

$$u_j(c,s,b) = +\frac{\left((c)^{1-\eta-\sigma_i}\,(s_t)^{\eta}\right)^{1-\gamma}}{1-\gamma} + \xi_i \frac{b^{1-\epsilon_i}}{1-\epsilon_i}.$$

3.2 The supply of houses

The aggregate supply of each type of house is fixed at $H(h)$ for $h \in \{1, 2, \ldots, N\}$. Let $G_j(a,k,h,\beta|\Omega)$ be the measure of type-j agents with a given individual state at aggregate state Ω, and let $r(a,k,0,z,\beta,\Omega)$ be the policy function for renting. The housing market clearing constraint for house type h is:

$$\sum_j \int_{a,k,z,\beta} dG_j(a,k,h,z,\beta|\Omega) \\ + \sum_j \int_{a,k,z,\beta} I(r(a,k,0,z,\beta,\Omega) = h)\; dG_j(a,k,0,z,\beta|\Omega) = H(h), \quad (1)$$

that is, the total supply of houses of type h has to be equal to the mass of people owning such a house plus the mass of people renting one.

3.3 Determination of the rental rate

Rental houses are held by real estate investment funds that are part of the diversified capital stock that households invest in. Hence, the rental rate in equilibrium has to be such that rental investment in each type of house yields the world return on capital i. Notice that there is no aggregate uncertainty in this economy, so this is a safe rate of return. The rental rate for a given type of house h given state Ω today and state Ω' tomorrow therefore satisfies:

$$\frac{p_h(h)(\Omega') + p_r(h)(\Omega')}{p_h(h)(\Omega)} = 1 + i(\Omega').$$

or:

$$p_r(h)(\Omega') = (1 + i(\Omega'))\, p_h(h)(\Omega) - p_h(h)(\Omega').$$

In a steady state/BGP this is simply:

$$p_r(h) = i\, p_h(h). \tag{2}$$

3.4 Housing equilibrium

Assume (for now) that all goods are traded, so that the world interest rate also pins down wages. Then we can think of the interest rate, the wage rate (by type and age, they may supply different efficiency units), and the goods price as given. Consider the steady state equilibrium assuming the aggregate state is fixed (i.e., prices and taxes don't change and can be treated as parameters).

Then a recursive equilibrium consists of the following objects:

- Value functions $v_j(a, k, h, z, \beta)$ for each type j (and also the same for retired and last period agents).
- Policy functions $c_j(a, k, h, z, \beta)$, $r_j(a, k, h, z, \beta)$, $s_j(a, k, h, z, \beta)$, $n_j(a, k, h, z, \beta)$, $k'_j(a, k, h, z, \beta)$, $h'_j(a, k, h, z, \beta)$ and $b_j(k, h)$.
- Rental rates $p_r(h)$ and prices $p_h(h)$ for each housing type h.

The equilibrium conditions are:

- Value functions and policy functions solve the respective Bellman equations.
- Rental rates $p_r(h)$ satisfy (2).
- Rental rates $p_r(h)$ and prices $p_h(h)$ for each housing type h.
- The market-clearing condition (1) is satisfied for each type of house.

3.5 Additional model elements

The description so far includes the main features of the household sector and equilibrium conditions in the small-open-economy setting. The full model will allow for additional general-equilibrium components, in particular to allow for a feedback from wealth shocks to the labor market. In addition to standard wealth effects, we will allow for the possibilities of nominal rigidities and a frictional labor market to explore alternative of sources of feedback from redistribution shocks to the labor market and aggregate economic activity.

A further important model element is the government sector. The government in our model economy taxes income and consumption and issues new government debt B_{t+1} to finance social security transfers, general government expenditures G_t, and interest on existing debt B_t. Allowing for government debt is essential given the important role that government debt plays for the redistribution effects of inflation. We will explore alternative scenarios for the fiscal policy response to monetary policy changes.

In addition to the domestic consumers, we also allow for the possibility that foreigners are investing in the domestic market, which again is an important feature of the data. We will consider alternative scenarios how international capital flows react to monetary policy shocks.

4 Computational Experiments

Combining the accounting framework and the modeling framework, we are able to carry out a set of experiments to gauge the redistribute effects of various monetary policy measures. The experiments take the following form:

- **Pure inflation shock:** The simplest type of experiment is a sudden inflation shock, i.e., a sudden rise in the price level *without* changes in expected future inflation. While this is not the most empirically plausible type of shock, it is useful to provide intuition on the overall exposure to nominal price changes in the economy. Given the accounting framework, we can compute the wealth change for each sector and group of households that would be generated by such a shock. With the quantitative (and calibrated) modeling framework, we can feed the redistribution shock into the model as a shock that displaces the economy from its balanced growth path, and then assess the macroeconomic and welfare consequences of this change over time, for each group and sector and for the economy as a whole.

- **Inflation expectations shock:** In the same way, we can assess the consequences of a shock to future inflation expectations. Holding the real term structure fixed, an inflation expectation shock shifts the nominal term structure in a deterministic way, and given the streams-of-payment representation of assets in the accounting framework we can revalue each group's portfolio to compute redistribution effects, which then become inputs in the quantitative analysis.

- **Shocks during economic recovery:** For each type of shock, we will redo the analysis for various scenarios of an economy recovering from a large economic shock, such as recent recession. Doing this is important because the reaction to a redistribution shock crucially depends on whether (and to which degree) financial constraints are binding. If a real shock to the economy leads to binding financial constraints throughout the economy, the reaction to a redistribution shock will be substantially different compared to normal times.

- **Real interest rate shocks and quantitative easing:** We can also use the accounting and modeling framework to assess the effects of shocks that involve changes in real interest rates (as opposed to changes in the nominal term structure for a fixed real term structure), which were also highly affected by the recent crisis. A particular application of this is an analysis of quantitative easing, one effect of which is a twist in the real term structure in terms of long and short real rates.

5 Calibration and Computational Experiments

[TO BE COMPLETED]

6 Conclusions

[TO BE WRITTEN]

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