Bank-Dependent Households and The Unequal Costs of Inflation

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Abstract

Inflation reduces the real return on liquid assets for U.S. households and impairs their precautionary savings capacity. This mechanism is motivated by two facts I document in the data. First, I show that historically around 60% of U.S. households keep all their liquid assets in bank deposits. Second, bank deposits are low and insensitive to market rates. Then, inflation pushes down the return on assets for deposit holders even in periods of high market returns. I study the magnitude of this channel in a heterogeneous agents model that incorporates a portfolio choice and non-competitive banking sector. In the model, the wealth distribution and the level of inflation shape the optimal choice of banks' interest rates. I show that the model is able to reproduce the portfolio distribution and interest rates observed in the data both at the steady state and after short-lived shocks. In the model, I study the consequences of a rise in trend inflation as well as a short-term shock that pushes inflation up. The costs of high inflation for households depend on their position in the wealth distribution. Poor households' saving ability is negatively affected by the decision of banks to keep deposit returns low, generating sizable welfare costs. As a side effect, inflation increases wealth concentration. The paper also studies the implications of a non-competitive banking sector for the ability of the central bank to control inflationary shocks.

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1 Introduction

How costly is inflation is both an old and elusive question in the economics discipline. The economic literature has pointed to two main channels on why inflation is costly. One branch of the literature argues that inflation is a tax on an asset useful for transaction purposes (Friedman (1969), Lucas (2000), Lagos and Wright (2005)) whereas the business cycle literature has argued that high inflation generates production misallocation (Clarida, Gali, and Gertler (1999), Woodford (2003)). Yet the estimated magnitude of these channels is in opposite contrast to the general public opinion that panic in times of inflation.

In this paper, I explore the cost of inflation through a previously overlooked channel. I argue that anticipated inflation impairs households' precautionary savings capacity. In other words, future inflation reduces households' ability to smooth consumption. The logic is simple: expected inflation lowers real returns for households' savings because their nominal rates do not adjust with inflation. This mechanism rests in two facts I document in the data. First, most U.S. households hold all their liquid assets in bank deposits. Second, deposit returns are low and insensitive to market returns. Therefore, inflation acts as a tax on households' savings and reduces households' saving incentives. This channel, however, does not spread equally across households; it impacts mainly households at the low end of the wealth distribution.

I study the cost of inflation through this channel using a tractable general equilibrium heterogeneous agent model. The cost of inflation in the model depends on the ability of households to substitute between asset types and the passthrough of inflation to the returns on those assets. The model incorporates a portfolio choice into the household problem and a non-competitive banking sector which together allow the model to capture the evidence on the joint distribution of asset choices and the dynamics of different interest rates. I use the model to study a rise in trend inflation as well as a short-run surprise in future inflation. The model delivers a sizable cost of inflation, concentrated at the low end of the wealth distribution, coming from a reduction in the ability of households to smooth consumption.

The paper begins by providing empirical evidence on the impact of future inflation on the real return on households' liquid assets. First, using the Survey of Consumer Finances, I show that approximately 60% of U.S. households accumulate all their liquid assets in the form of bank deposits or currency. I label these households as *Bank-Dependent*. Surprisingly, this share has remained stable even in periods of high inflation and high market returns, like the 70s and the 80s. Moreover, Bank-Dependent households are not poor nor hand-to-mouth households and, in fact, a large share of households with several months of income in liquid assets follow into this category. Secondly, using data on Call Reports, and similarly to Drechsler, Savov, and Schnabl (2017), I document that banks keep their nominal return on deposits low relative to similar market instruments. Otherwise stated, there exists a spread between market returns and deposit returns. Furthermore, these spreads become larger in periods of high nominal rates, that is, the size of the spread between market and deposit returns depends on the level of the market interest rate. This evidence motivates my mechanism: when inflation is high, the real return on assets for Bank-Dependent households falls. Interestingly, the real return on deposits decreases even if the central bank lifts its policy return because commercial banks will keep their nominal return on deposits low.

In the second part of the paper, I develop a tractable heterogeneous agents model in line with Kaplan, Moll, and Violante (2018b) and Auclert, Rognlie, and Straub (2018) with government debt but no capital. Savings in the model are crucial for households to self-insure against idiosyncratic income shocks that arise in the form of labor productivity. To account for the market segmentation documented in the data I incorporate into the households' problem a portfolio decision between three types of assets: checking deposits, savings deposits, or government bonds. All assets are equally liquid, mature in one period, and differ only in their rate of return. I assume that the portfolio decision is periodically done in a discrete way: each household stores all funds in one type of asset each period. This assumption also allows the model to isolate the role of assets as a saving device from other roles played in the literature like for transaction services.

Households also periodically receive a random idiosyncratic fixed nonpecuniary trading cost that determines their ability to access high-return assets during that period. There are two types of households in the model: Unsophisticated households and Investors. These two groups of households differ only in the distribution from which they draw their trading costs. Unsophisticated households can save using checking accounts at no cost but need to pay the trading cost they draw if they want to store funds in the savings account that period. Unsophisticated households find it prohibitively costly to invest in government bonds. Investors, however, can park their assets at no cost in savings accounts but need to pay the nonpecuniary cost each period to save in the form of government bonds. Once the portfolio decision is taken, households decide on their consumption-saving choice subject to borrowing constraints. The fixed nature of the shock allows the model to capture the increasing probability of saving in high-return assets for wealthy households, as in the data. The randomness of the shock helps the model account for the nonnegligible share of wealthy households that keep all their savings in very low-return accounts.

A novel feature of this model is that the wealth distribution shapes the aggregate elasticity of deposits, a crucial component for the optimal markdown of deposit returns by banks. Specifically, aggregate deposit elasticities can be decomposed as individual elasticities weighted by the relative importance of each household in the deposit market. In the model, deposits controlled by wealthier households are more elastic. The reason is that the opportunity cost of saving in the form of deposit scales with households' wealth. Then, movements in interest rates of deposits generate larger fluctuations in the opportunity cost for wealthier households. Given the fixed nature of the trading cost, this induces a larger share of wealthy households moving the funds in and out of the deposit market. Scenarios of high inflation or nominal bond returns alter the joint distribution of wealth and asset choices, altering the aggregate elasticity and banks' optimal deposit spreads.

Banks' market power in deposit supply has recently been argued in the literature as the reason for the imperfect passthrough from market rates to deposit rates (Drechsler et al. (2017)). Following this literature, the financial sector in the model is composed of monopolistic banks. I restrict banks' market to small islands populated by a new random sample of households each period. Banks are multi-product firms: they issue checking and savings deposits and post returns on both assets subject to a zero lower bound. Banks internalize their influence on the consumption-saving decisions of their customers when choosing optimal rates. Banks' optimal choice of deposit interest rates will shape the consequence of inflation: keeping deposit returns high will isolate deposit holders, whereas insensitive nominal returns will hinder them.

In the calibrated economy, banks face a very inelastic demand for checking deposits coming from Unsophisticated households and optimally choose to set the nominal return on checking to the zero lower bound, as in the data. In other words, banks find it optimal to squeeze their inelastic checking account customers as much as possible. The optimal interest spread between savings deposits and bonds can be decomposed into two components. The first piece is the inverse elasticity of savings funds. The higher the elasticity of the funds in the savings deposit market, the smaller the spread. Additionally, banks have the incentive to keep Unsophisticated households in the checking account and prevent them from parking their funds into savings deposits. This provides the banks extra incentives to lower the return on savings and increase the spread.

Interestingly, the elasticity of savings funds and the incentives to keep Unsophisticated households in the checking account depend on the level of inflation and bond returns. The model response of deposit returns after a shock that pushes inflation and the nominal return on bonds resembles the one observed in the data. In particular, in response to the shock, banks optimally keep the nominal return of checking at zero and only imperfectly passthrough the change in the bond return to deposit holders. The reason is that the higher bond return allows banks to increase the profits per dollar from their inelastic customers in the checking account. This gives incentives to keep the return on savings low in order to prevent Unsophisticated households from abandoning the checking deposit and switching to savings. However, if the bank does not lift the savings return, it triggers a migration of Investors' funds into the bond market. In equilibrium, banks choose to mimic only imperfectly the changes in the bond return with the savings return which allows them to partially retain Investors' funds but also prevent a larger migration of Unsophisticated households into savings.

I calibrate the model to capture the opportunity cost of holding deposits as well as the joint distribution of wealth and asset choices, to the extent possible. The model does a reasonable job at matching the steady state moments on the calibration. I validate my model by studying the response of deposit returns to a shock that pushes inflation and the nominal return on bonds. The response of the model resembles the one observed in the data both in interest rates and quantities fluctuations.

I use the model to study a rise in trend inflation and also a temporary shock that pushes up inflation in the short run. In the long run, the new steady state with higher inflation features a lower real return on checking accounts but, surprisingly, a higher real return on savings deposits. The real bond rate, however, stays constant in the new equilibrium. In the high inflation environment, banks exploit the higher nominal return on bonds and still find it optimal to charge the largest spread possible to inelastic households in the checking account. As a consequence of the lower return on checking, Unsophisticated households' incentives to accumulate decrease, and wealth redistributes to wealthy Investors. This wealth redistribution towards wealthy elastic investors pushes up the aggregate elasticity of savings funds and increases the equilibrium real return on savings. As a consequence, the cost of inflation is concentrated in poor Unsophisticated households that now find it harder to self-insure. Investors, however, benefit from the increase in inflation since now the return on their assets is higher.

In the short run, I use the model to study an unexpected shock that pushes up inflation under the assumption that the central bank follows a Taylor rule. When the shock hits, inflation rises and the government lifts the real return on bonds. This increase in returns, however, is not shared by all households since deposit returns only imperfectly reproduce bond movements. As a result, mid-wealth households drain their assets from banks which increases the volatility of their marginal utility, a consequence of a decrease in self-insurance ability. I compare this economy with a counterfactual in which all interest rates move in the same way to show that the fall in self-insurance ability is driven by the heterogenous response in the interest rates.

Section 2 presents the evidence on households portfolio and deposit interest rates dynamics. Section 3 develops the model, explores the optimal rate setting by banks, calibrates, and shows the short-run dynamics of the model. Section 4 studies the cost and consequences of a rise in inflation in the long and short term. Finally, Section 5 presents additional results on monetary policy and inequality.

Related Literature

This paper contributes to several strands of the literature.

First, several papers studied the cost of inflation. The most classical view argues that inflation is costly because it acts as a tax on an asset we would like to hold for non-pecuniary benefits, usually to conduct transactions. The work of Friedman (1969), Lucas (2000), and Lagos and Wright (2005) among many others lie in this group. Kurlat (2019) extends the analysis of inflation as a cost on transaction assets using a model that features banks and entry into the banking sector. The business cycle literature, for example Clarida, Gali, and Gertler (1999) or Woodford (2003), argues that inflation is costly because it generates production misallocation. Finally, papers have argued that inflation surprises can be costly for lenders in presence of nominal contracts, like in the work of Doepke and Schneider (2006). The contribution of my paper is to study in isolation the role of inflation as a tax on precautionary saving decisions through changes in real returns, an overlooked channel by the main part of the literature.

This paper is not the first to claim that inflation impairs households' savings capacity. A seminal work İmrohoroğlu (1992) studies the welfare cost of inflation in an economy with imperfect insurance. In her model, cash is the only asset used for self-insurance and inflation translates negatively one to one to the return on money. In her model, the cost of inflation is several times larger than the one studied previously in the transaction cost literature. Contrarily, Erosa and Ventura (2002) uses a model in which all agents have access to a second asset apart from money that pays a higher return to argue that the cost of inflation coming from distortions in the savings market is minimum. My paper fills the gap between these two papers by arguing that a large share of households use near cash assets (deposits) as their savings vehicle, and do not have access to liquid instruments that pay the market return. In periods of high inflation, and given that banks do not lift the return on deposits, their savings capacity is impacted and inflation is very costly for them.

Additionally, a recent saga of papers has studied the role of banks' market power on deposits for the aggregate. Beginning from the work of Drechsler, Savov, and Schnabl (2017) and later followed by Polo (2021) and Wang (2020). These papers focus on how banks' market power on deposits shapes the transmission of monetary policy through bank lending. My contribution to this literature is to study the implications of a noncompetitive banking sector on the household side, in particular for inflation as a distortion to saving decisions.

More broadly, this paper is the first to combine the recent wave of heterogenous agents general equilibrium models in line with the work of Kaplan, Moll, and Violante (2018b) or Auclert, Rognlie, and Straub (2018) with a model of non-competitive banking sector like Monti (1972) and Klein (1971). The presence of heterogeneous agents delivers a state-dependent elasticity that shapes the optimal spreads in the banking sector after shocks. Additionally, I explore how monetary policy transmission is affected by the imperfect response of deposit rates.

Optimal MP? Contributes by pointing to a relevant channel usually neglected by this literature

XAVIER SIM paper!!!

2 Data and Motivating Facts

In this section, I describe the datasets used and document facts that motivate my modeling choices and inform the quantitative analysis. The empirical section has two main parts. First, on the side of the households, I document that historically most U.S. households have used bank deposits as their only source of liquid assets, especially those households at the lower end of the wealth distribution. Second, I show that banks have kept deposit rates historically low and insensitive to market returns.

2.1 Data Sources

For households' portfolio data I use the Survey of Consumer Finances (SCF), a survey sponsored by the Federal Reserve Board. The survey is a repeated cross-sectional survey of U.S. families that includes information on household balance sheets, income, and demographic characteristics. Post-1983 data of the SCF is available on the website of the Board of Governors of the Federal Reserve System, and pre-1983 has been linked to the new waves by Kuhn, Schularick, and Steins (2020). In the modern version of the survey around 6500 families are interviewed every three years with particular attention to capturing top wealthy families in the US. I keep the entire sample of households in the SCF without any demographic or income restrictions. Additional results on households portfolio in Appendix A are computed using Survey of Income and Program Participation (SIPP).

For bank interest rates I use the Consolidated Report of Condition and Income -generally referred to as Call reports-. Specifically, banks needs to file a Call report every quarter reporting its balance sheet and cash flow to the regulators. I use data on average holdings of deposits and expenses to implicitly compute the interest rate on deposits. Appendix A explains the sample used and details the computation.

2.2 Bank-Dependent Households and Deposits Returns

I restrict my attention to documenting households' choice of liquid assets. *Liquid assets* in this section consist of the entire universe of financial assets in the SCF[1] excluding certificates of deposits, pension funds, life insurance, and other managed and miscellaneous assets. I restrict my attention to liquid assets because they have been identified in the literature as the determinant class of assets to understand households' ability to smooth consumption after changes in income.[2] Pension funds, life insurance, CDs, and misc assets are therefore excluded from the sample because these funds are not available on the spot at no cost, and are therefore not convenient for consumption smoothing[3].

I split the data between two types of households: those who have all their liquid assets in the form of bank deposits and those who have some money invested in the market. I label the first class of households as *Bank-Dependent*. That is, a household is Bank-Dependent if all its financial assets are in bank deposits.[4] The rest of the section documents the number of households in this group and its characteristics.

Figure 16 shows that historically around 60% of U.S. households hold all their liquid assets in the form of bank deposits. This share is stable even though market rates fluctuated largely during U.S. history. That is, households do not seem to abandon the state of bank dependency even when the market return on similar assets was high.

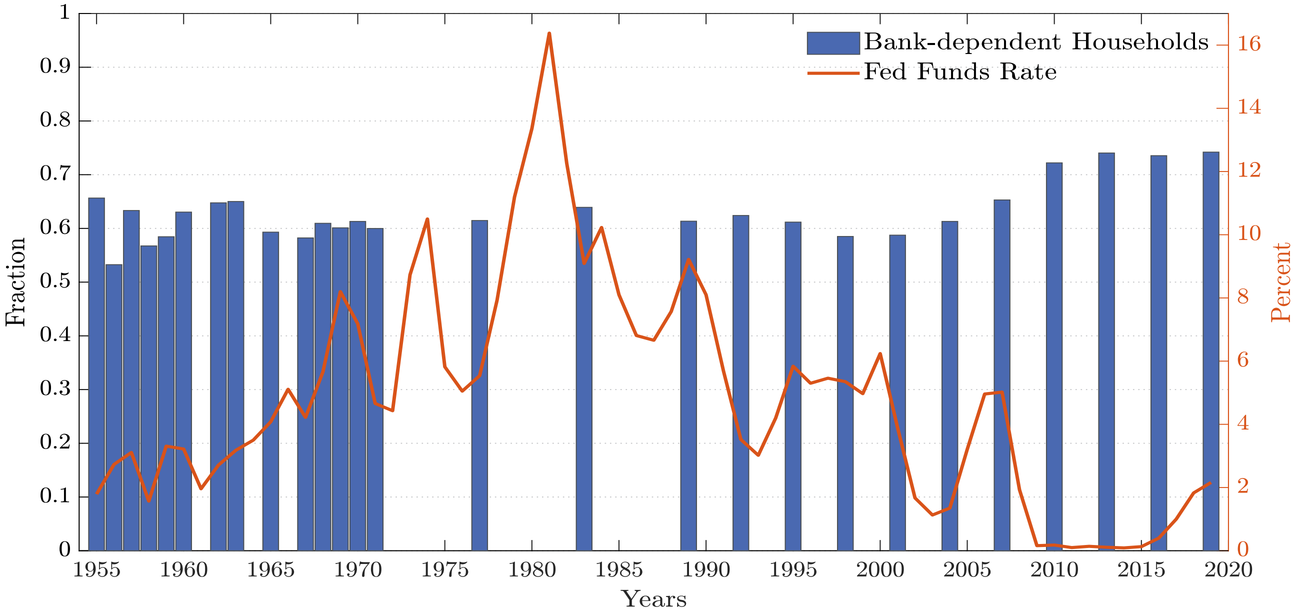
[1]The definition is very broad. It includes all types of bank and broker accounts, money market funds, prepaid credit cards, mutual funds, government and corporate bonds, and stocks. For detailed sub-categories please refer to `https://sda.berkeley.edu/sdaweb/docs/scfcomb2019/NetworthFlowchart.pdf`.

[2]See for instance Kaplan and Violante (2014)

[3]See for example Graves (2020) Table 2: only 13% of households that experienced time unemployed, had IRA accounts and can be classified as liquid hand-to-mouth decided to withdraw money from pensions funds.

[4]This includes any type of bank deposit: checking, savings, and money market deposits account. Households that report not having a checking account are included as Bank-Dependent because they are cash holders and get the same return as if they hold a checking account.

Figure 1: Share of Bank-Dependent Households and Market Returns



Note: Bank-Dependent households refers to households with all their financial assets held in bank deposits or currency. The data comes from the Survey of Consumer Finances.

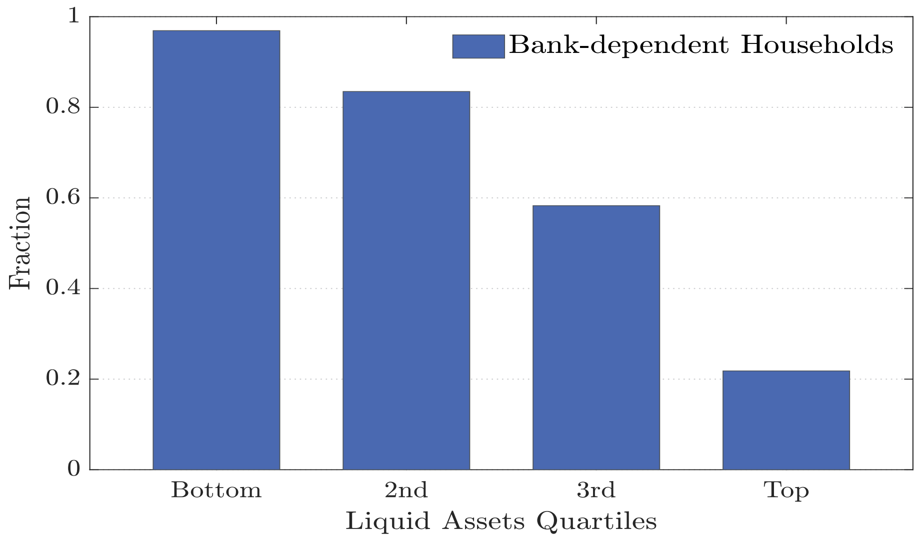
The consequences of changes in returns on Bank-Dependent households will depend on the quantity of assets that these households hold. To document this, Figure 2 splits the 2007 population into liquid assets quartiles and calculates the share of Bank-Dependent households in each quartile[5]. The figure shows that Bank-Dependent households are not merely poor households: 60% of households in the third quartile of the liquid asset distribution and 20% in the top quartile choose to hold all their financial assets in the form of bank deposits.

Holding deposits is costly only if the return on them is lower than what can be obtained in the market for a similar product. To understand the opportunity cost of deposits, Figure 3 shows the time series for deposit returns for different types of deposits -checking and savings accounts- together with a proxy for safe return households can obtain on the market, the Fed funds rate[6]. Two main points arise from the figure. First, there is a spread between the market return with the deposit returns. Second, the spread is larger in periods when the

[5]This pattern is robust to the choice of the year. 2007 is chosen because is the closest survey wave before the zero lower bound period.

[6]Some checking accounts do pay interests. However, 70% of Bank-Dependent households in the 2004 wave of the SIPP survey reported holding a zero-interest checking account, and 75% of those who hold one report earned less than one dollar of interest. Therefore, I see zero interest as an accurate proxy for checking returns.

Figure 2: Distribution of Bank-Dependent Households in 2007



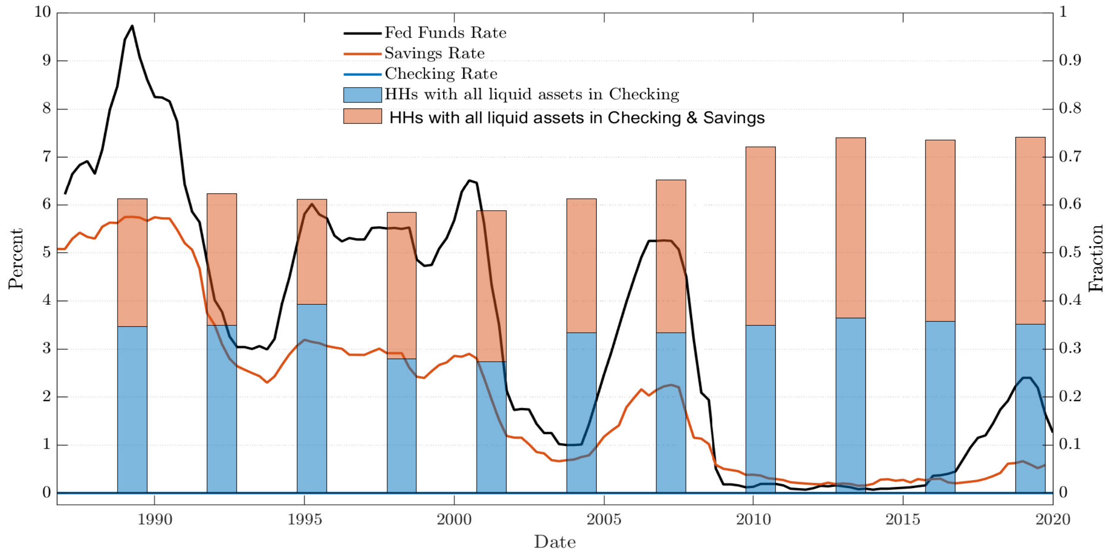
Note: Bank-Dependent households refers to households with all their financial assets held in bank deposits. It also includes households that do not report having a bank account (cash holders). Data is from the SCF. Average financial assets over income for households in the bottom quartile is less than one week, for those in the second approximately a month, in the third is four months, and in the top more than a year of household income.

nominal return is high.[7] In other words, holding deposits is costly, and is even more costly in periods of high market returns. Figure 3 also decompose Bank-Dependent households between the share of these households that hold all their assets in checking deposits -represented in the blue bars- and those who additionally hold some saving deposits -in red bars-. From the figure, we can see that around half of Bank-Dependent households -30% of total households- hold all their assets in zero interest-bearing accounts.

To summarize, historically approximately 60% of U.S. households hold deposits are their only source of liquid assets. Half of these households, 30% of the total, keep them in zero interest-bearing accounts. These shares have been stable in periods when holding deposits was very costly. Finally, these households are not poor: one in five households in the top liquid assets quarterly can be labeled as Bank-Dependent.

[7]This fact is not novel. Its implications for monetary policy have been widely studied in Drechsler, Savov, and Schnabl (2017), Drechsler, Savov, and Schnabl (2020), and **?** among others

Figure 3: Deposits, Market returns and Bank-Dependent households decomposition



Note: Savings return has been computed as average expenses over average holdings on savings deposits using Call reports. The checking return is assumed to be zero for reasons explained in the text. Blue bars correspond to Bank-Dependent households whose holdings are only in the form of checking deposits. Red bars are those that also hold checking. Household data comes from the SCF.

Additional Results

This section enumerates additional evidence on Bank-Dependent households and deposits. For details on calculations and figures refer to Appendix A.2 and Appendix A.3.

Figure 17 shows that Bank-Dependent households hold between 30% to 40% of total bank deposits, besides holding less than 10% of total financial assets. Additionally, Figure 18 shows that they earn around 40-50% of total household income. Although the cross-sectional nature of the SCF does not allow the computation transition of households in and out of the Bank-Dependent state, using the SIPP survey one can estimate a transition matrix between states. Table 8 shows that the Bank-Dependent state is very persistent.

On the deposits side, Figure 21 shows that besides the rigid extensive margin documented in Figure 16 and Table 8, deposits quantities are negatively correlated with market returns, and the magnitude of the correlation is large. Additionally, I show that the result on the imperfect passthrough from market to deposit rates in Figure 3 and the facts that deposits fluctuate with market returns are not just a correlation but there is also suggestive evidence on causality from monetary policy to the variables studied. Figure 22 shows the result of an instrumented local projection on savings returns and Figure 23 on deposit quantities.

3 Model

Motivated by previous empirical facts, in this section, I introduce a model of heterogeneous households that features segmented asset markets and an imperfect passthrough from market returns to multiple bank deposits. The model combines the recent literature of heterogeneous agent models with nominal rigidities ("HANK")[8] with models of non-competitive banking[9]. I show that this model can reproduce the empirical findings and use it to study the consequences of a rise in inflation in the short and long run.

3.1 Households

The economy is populated by a unit mass of households. Households have access to three different assets: checking and savings deposits issued by the banks, and bonds issued by the government. All assets are liquid, mature in one period, and are safe in real terms[10]. Assets differ only in their rate of return, with bonds having the highest and checking the lowest return. At the beginning of each period, households face a discrete choice asset decision in which they determine their asset choice in which to store their funds. That is, households will hold only one type of asset per period.[11]

Households are divided into two ex-ante heterogeneous groups: a share μ of *unsophisticated* (U) households and $1 - \mu$ of *investors* (I). Members of these groups differ only on the cost to access high return assets[12]. In particular, I assume that Unsophisticated households can freely

[8]For some references on this literature see for example Kaplan, Moll, and Violante (2018a) and Auclert, Rognlie, and Straub (2018).

[9]For some references on this literature see Monti (1972), Klein (1971) and Drechsler, Savov, and Schnabl (2017)

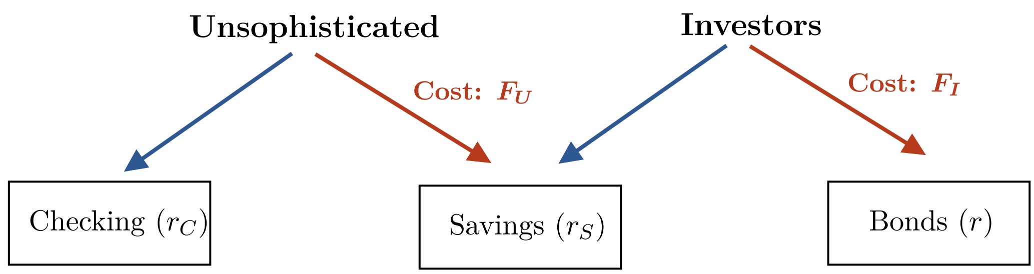
[10]Since I will assume perfect foresight, both the maturity of the assets and nominal vs real will be irrelevant in steady state and for the long-run results because absent uncertainty all returns are equalized. In the short run -after a shock hits- this assumption allows me to isolate from the effect of redistribution through inflation surprises on nominal contracts and price changes of long-lived assets, and focus on the effect of inflation on deposit returns.

[11]This assumption, although extreme, helps to isolate the role of assets as a saving instrument. In other words, households that decide to hold bonds do not keep some funds in the bank for convenience.

[12]Groups have identical income processes and preferences.

store funds in the checking account and need to exert a non-pecuniary cost F_U if they want to store their funds in the savings account. Unsophisticated households find it prohibitively costly to access the bond market. Conversely, Investors can store funds freely in savings accounts but can access the bond market only after paying a cost F_I. Trading costs F_g for each group $g = \{\text{U,I}\}$ will be assumed to follow a logistic distribution with heterogeneous means but equal scale $F_g \sim \text{Logistic}\left(\mu_F^g, \sigma_F\right)$. Households get an independent and identically distributed draw of the trading cost at the beginning of the period. Figure 4 illustrates the discrete choice asset decision.

Figure 4: Households' Discrete Portfolio Choice



A household member of the group g starts the period with some assets holdings a, a draw of the trading cost F_g, and idiosyncratic labor productivity s that determines its labor income. Given that members of each group of households choose between two asset options -a low and a high return option- I describe the problem of a representative household of the group g. The problem of the households can be divided into two subproblems. In the first stage, the household chooses between the high and the low return asset of its group. In the second, it decides how much to save and consume. Equation (1) describes the first stage.

$$V\left(s, a, F_g\right) = \max_{\left\{\mathbf{Low}_g, \mathbf{High}_g\right\}} \left\{ \boldsymbol{v}_{\mathbf{Low}_g}\left(\boldsymbol{s}, \boldsymbol{a}\right), \boldsymbol{v}_{\mathbf{High}_g}\left(\boldsymbol{s}, \boldsymbol{a}\right) - \boldsymbol{F}_g \right\} \tag{1}$$

In the second part of the problem, households choose their consumption-saving decision. Equation (2) describes the second stage.

$$\nu_j\left(s, a\right) = \max_{\{c, a'\}} u\left(c\right) - v\left(n\right) + \beta\, \mathbb{E}_{F', s'}\left[V\left(s', a', F'\right) | s\right] \tag{2}$$

subject to,

$$c + \frac{a'}{(1+r_j)} = a + (1-\tau) \cdot w \cdot n \cdot s$$
$$a' \geq 0$$
$$\log s' = \rho_s \log s + \sigma_s u'$$

where c is household consumption that provides a flow utility $u(c)$, a' the savings decision, and the household receives $w \cdot n \cdot s$ for its effective hours worked that are taxed linearly by the government at the rate τ and that generate a disutility $v(n)$. Households face a no-borrowing constraint and the labor productivity follows a simple AR(1) process normalized such that $\mathbb{E}(s) = 1$. Note that households are not able to choose working hours due to frictions in the labor market I will explain later. Finally, notice that the only difference between the low and high branches in equation (1) is on the saving return for that period r_j.

Optimal decisions of the households imply policy functions for consumption and saving $\{c_j^g(s,a), a_j'^g(s,a)\}$. These decisions depend on the level of labor productivity s, initial assets a, and the choice of the asset for that period. The asset choice j can be either checking $\mathcal{C}$, savings $\mathcal{S}$, or bonds B. Additionally, the households' problem delivers the share of households with states (s,a) choosing each type of asset j: $P_j^g(s,a)$. Appendix B.1 describes the households' optimal conditions in detail, its aggregation together with details on computation.

Given a distribution of households across the idiosyncratic states $\{\Psi^U(s,a), \Psi^I(s,a)\}$ I can aggregate households' optimal saving decisions to obtain the demand for checking $\mathcal{C}$ and savings $\mathcal{S}$, a key object for the banking problem:

$$\mathcal{C} = \mu \cdot \int_{(s,a)} \left[P_{\mathcal{C}}^U(s,a) \frac{a_{\mathcal{C}}'^U(s,a)}{1+r_{\mathcal{C}}} \right] d\Psi^U(s,a) \tag{3}$$

$$\mathcal{S} = \mu \cdot \int_{(s,a)} \left[P_{\mathcal{S}}^U(s,a) \frac{a_{\mathcal{S}}'^U(s,a)}{1+r_{\mathcal{S}}} \right] d\Psi^U(s,a) + (1-\mu) \cdot \int_{(s,a)} \left[P_{\mathcal{S}}^I(s,a) \frac{a_{\mathcal{S}}'^I(s,a)}{1+r_{\mathcal{S}}} \right] d\Psi^I(s,a) \tag{4}$$

3.2 Commercial Banks

There exist a measure one of commercial banks. Each bank monopolizes the deposit issuance to a small random sample of the population independently drawn each period. It is assumed that households cannot switch the bank they were allocated. Banks internalize their influence on the consumption-saving decision of their customers, but individual banks are too small to affect aggregates and prices. Banks issue two types of deposits to households that differ only on their return: checking accounts at a return r_C and savings accounts at a return r_S. Banks invest the funds in government bonds at a rate r.

Banks choose the return on their accounts subject to a zero lower bound[13]. The bank faces a demand for checking $\mathcal{C}(r_C, r_S)$ and for savings $\mathcal{S}(r_C, r_S)$ from households that depend only on the savings return only in the current period[14]. The problem of the bank is then to choose $\{r_C, r_S\}$ to maximize current period profits π'_B:

$$\pi'_B = \max_{\{r_C, r_S\}} \; \mathcal{C}\left(r_C, r_S\right) \cdot \left(r - r_C\right) + \mathcal{S}\left(r_C, r_S\right) \cdot \left(r - r_S\right) \tag{5}$$

subject to,

$$r_C, r_S \geq -\frac{\pi'}{1+\pi'}$$

Nominal returns are defined as usual $1 + i_j = (1+\pi')(1+r_j)$ where π' is next period price inflation $1+\pi' \equiv \frac{P'}{P}$ with P the price of the final good. Therefore, the real return on checking accounts is $r_C = -\frac{\pi'}{1+\pi'}$. I will assume that bank profits are taxed away by the government.

3.3 Supply Side

Production is done in two layers: intermediate unions demand task-specific labor from households and sell it to a labor packer that aggregates into final labor units. Then, the labor packer sells final labor hours to a competitive final good producer for the production of the consumption good. Given that this block is relatively standard, I only briefly discuss the key

[13]Cash is thought as a latent competitor that is a perfect substitute with bank deposits. If nominal rates on deposits go below zero, households will switch all their funds to cash.

[14]Key here is the assumption that new random sample of households is drawn each period. If this were not the case, then the problem will be a dynamic monopoly problem and the demand for savings would depend on the current but also future deposit returns.

equations and relegate a detailed discussion to Appendix B.4.

Final Good Producer

A competitive final good producer hires final labor hours N from the labor packer and produces a final consumption good Y using a linear technology:

$$Y = N \tag{6}$$

Perfect competition ensures that nominal wage W equals the final good price P -and wage inflation equals price inflation $\pi = \pi_w$-, real wage is constnat and equal to one $w = 1$, and there are no profits on the production side.

Labor Unions

There is a continuum of unions $k \in [0,1]$ that demand task-specific labor k from each household and aggregates it into effective hours $n_k = \int_i s_i n_{ik} \mathrm{d}i$. Each union sells its task-specific labor to a competitive labor packer that packages these tasks into employment services using a constant elasticity function with parameter ε_w. This elasticity might vary exogenously over time which I will interpret as a supply shock. Unions satisfy labor demand by rationing labor equally across all households.

Unions need to pay a Rotemberg-type cost to adjust nominal wages. I assume that there is perfect wage indexation to the inflation target so that the adjustment cost is paid only when wage changes deviate from trend inflation. Adjustment costs enter households' disutility of labor. It is assumed that when setting the wage unions evaluate the benefits of higher after-tax income using the marginal utility of average consumption. In the short run, this gives rise to a wage Phillips curve, which linearized around the inflation target is,

$$\widehat{\pi}_w = \kappa^w \left(\varphi \widehat{N} + \sigma \widehat{C} \right) + \beta \widehat{\pi}'_w + \frac{\kappa^w}{\varepsilon_w} \widehat{\varepsilon}_w \tag{7}$$

where $\widehat{\pi}_w$ is wage inflation deviations from trend, $\kappa^w \equiv \frac{\varepsilon_w n v'(n)}{\psi}$, $\varphi \equiv \frac{v''(n)n}{v'(n)}$, $\sigma \equiv \frac{u''(c)c}{u'(c)}$ and $(\widehat{C}, \widehat{N})$ represent log deviations of aggregate consumption and labor from the steady state.

In the steady state, labor supply is determined by

$$v'(N) = \frac{\varepsilon_w - 1}{\varepsilon_w}\,(1-\tau)\,w\,u'(C) \tag{8}$$

3.4 Government

The government issues bonds B_G, chooses their nominal return i, collects labor taxes T and bank profits π_B, and set the level of trend inflation $\overline{\pi}$. Government budget constraint is,

$$B_G = T + \frac{B'_G}{1+r} + \pi^B \tag{9}$$

where tax revenue comes from taxing labor income at rate τ over all households i:

$$T = \int_i \tau \cdot w \cdot s_i \cdot n \;\; \mathrm{di} = \tau Y$$

Monetary policy will follow a Taylor rule

$$(1+i) = (1+\bar{i}) \cdot \left(\frac{1+\pi}{1+\overline{\pi}}\right)^{\phi_\pi} \cdot \epsilon_i \tag{10}$$

where ϵ^i is a shock to the Taylor rule and $\bar{i}$ is the steady state value of the nominal rate. Fiscal policy is assumed to follow a smoothing rule in case of short run deviations from steady state,

$$T' = \phi_T \left(\frac{B'_G}{1+r} - \frac{\overline{B}_G}{1+\overline{r}}\right)$$

where $\overline{r}$ and $\overline{B}_G$ are steady state values. When I study different steady states, I will assume that the level of debt B_G will adjust to clear the budget (9).

Note that all the assets in the model, including government bonds, are assumed to be safe in real terms. This implies that even if inflation surprises expectations, the real return on the contracts is preserved.[15]

[15] This is only relevant in the period when an unexpected shock arrives. One way to understand the dynamics in the period of the shock is to think that even if the government promised a nominal return i is anyway willing to compensate for any surprise in inflation.

3.5 Equilibrium

A perfect foresight equilibrium in this economy is a collection of paths for exogenous shocks $\{\widehat{\varepsilon}_{wt}, \varepsilon_{it}\}_{t=0}^{\infty}$, government policies $\{\tau_t, i_t, \overline{\pi}_t, B_t^G\}_{t=0}^{\infty}$, a set of aggregates $\{C_t, Y_t, N_t, \mathcal{C}_t, \mathcal{S}_t, B_t, w_t, r_t, r_{St}, r_{Ct}, \pi_t, \pi_t^w, \pi_t^B\}_{t=0}^{\infty}$ and a distribution over individual states for each group of households $\{\Psi_t^U(s_t, a_{t-1}), \Psi_t^I(s_t, a_{t-1})\}_{t=0}^{\infty}$ such that:

1. The path of aggregate consumption $\{C_t\}_{t=0}^{\infty}$ and savings $\{\mathcal{C}_t, \mathcal{S}_t, B_t\}_{t=0}^{\infty}$ is consistent with the aggregated optimal households policy described in Section 3.1.

2. Real wage $\{w_t\}_{t=0}^{\infty}$ is consistent with final good firms problem in Section 3.3 and nominal wage is consistent with unions problem in Section 3.3. Aggregate production and labor $\{N_t, Y_t\}_{t=0}^{\infty}$ is consistent with production function in equation (6).

3. The paths for price and wage inflation, the output gap, and the markup shock $\{\pi_t, \pi_t^w, \widehat{\varepsilon}_{wt}\}_{t=0}^{\infty}$ are consistent with the Phillips curve in equation (7).

4. The paths for checkings and savings returns, and bank profits $\{r_{St}, r_{Ct}, \pi_t^B\}_{t=0}^{\infty}$ are consistent with banks' decisions of section Section 3.2.

5. Government debt and taxes $\{\tau_t, B_t^G\}_{t=0}^{\infty}$ are consistent with the budget equation (9). The nominal rate on bonds and the inflation target $\{i_t, \overline{\pi}_t\}_{t=0}^{\infty}$ follows Government choices.

6. The path for households' distributions over the idiosyncratic income state and wealth for each group $\{\Psi_t^U(s_t, a_{t-1}), \Psi_t^I(s_t, a_{t-1})\}_{t=0}^{\infty}$ is consistent with households' optimal policy.

7. Goods and savings markets clear:

$$C_t = Y_t$$
$$\mathcal{C}_t + \mathcal{S}_t + B_t = \frac{B_t^G}{1 + r_t}$$

3.6 Equilibrium Deposit Rates and Aggregate Elasticities

This section describes the optimal rate setting by commercial banks. It beings by understanding how the aggregate deposit elasticities as well as the multi-product nature of the banks shape their choices. Then, the section illustrates the role of the wealth distribution in shaping aggregate elasticities.

Optimal Deposit Rates

In order to understand the optimal rate setting by banks, we first need to recognize how deposits demand from equation (3) and (4) respond to changes in returns. As an illustrative example, consider the case of an increase in the savings return r_S. Figure 5 shows households' two margins of adjustment after the increase. In the first place, households that demand savings deposits now find it more attractive and reduce consumption to increase savings demand ($\uparrow a'_S$), an increase in the intensive margin. Secondly, the increase in the savings returns incentives households' to switch their saving choice of asset into savings deposits ($\uparrow P_S$).[16] This migration of households into the saving deposits happens from both groups: marginal Unsophisticated households abandon checking and park their funds into savings chasing the more attractive return, and also those Investors at the margin decide to stop exerting the cost F_I and use savings deposits are their saving vehicle.

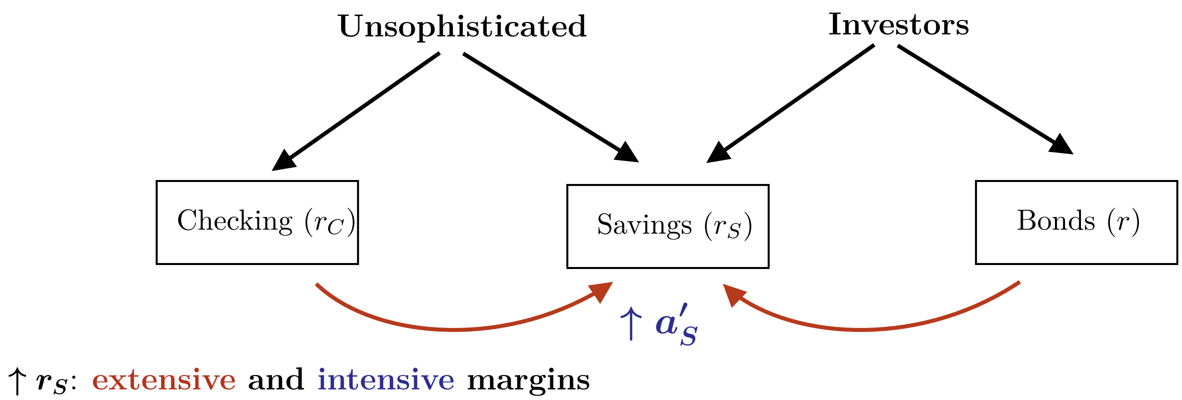
When setting their returns, monopolistic banks internalize households' respond to changes in returns. The first-order necessary conditions of the bank characterize the optimal rate settings:

$$[r_C]: \quad \frac{\partial \mathcal{C}(r_C, r_S)}{\partial r_C} \cdot (r - r_C) \;\leq\; \mathcal{C}(r_C, r_S) - \frac{\partial \mathcal{S}(r_C, r_S)}{\partial r_C} \cdot (r - r_S) \tag{11}$$

$$[r_S]: \quad \underbrace{\frac{\partial \mathcal{S}(r_C, r_S)}{\partial r_S} \cdot (r - r_S)}_{\text{MB}} \;\leq\; \underbrace{\mathcal{S}(r_C, r_S) - \frac{\partial \mathcal{C}(r_C, r_S)}{\partial r_S} \cdot (r - r_C)}_{\text{MC}} \tag{12}$$

[16] Both effects can revert if the household is very wealthy due to the income effect dominating the substitution. This happens, however, at the very top of the wealth distribution.

Figure 5: Households' Response to an Increase in r_S



Note: the figure illustrate the two margins of adjustment after an increase in the return on savings r_S. The intensive margin refers to changes in a'_S in equation (4). The extensive margins to changes in P_S.

The left hand side of equations (11) and (12) represent the marginal benefit of increasing the rate on checking and savings deposits respectively, and the right hand side the marginal cost. Focus on the case of savings deposits in equation (12). For each extra point in the savings rate, the bank is able to attract $\frac{\partial \mathcal{S}(r_C, r_S)}{\partial r_S}$ funds to the savings account and profit $(r - r_S)$ from each of them. The marginal cost of increasing the rate on savings has two components. The first one is the standard component of a monopolistic firm: for each extra point increase in the savings return, the monopoly bank internalizes that it will have to pay it on all existing funds $\mathcal{S}(r_C, r_S)$. The second one comes from the fact that the bank is a multi-product firm that offers substitute products. When the bank increases the rate of savings it attracts funds from its own checking account into savings, cannibalizing its profits from the checking account. That is, given that $\frac{\partial \mathcal{C}(r_C, r_S)}{\partial r_S} < 0$, for each point increase in the savings rate, the bank suffers an outflow from the checking deposits of $\frac{\partial \mathcal{C}(r_C, r_S)}{\partial r_S}$ causing a fall in profits of $\frac{\partial \mathcal{C}(r_C, r_S)}{\partial r_S} \cdot (r - r_C)$. The inequality arises due to the lower bound on deposits: banks might want to cut down on returns to increase profits but the presence of cash as an outside option poses a hard lower bound.

Throughout the paper, I will focus on equilibrium in which the bank chooses the return on checking at the lower bound $r_C \approx -\pi$ and equation (12) holds with strict inequality. This result arises as an optimal decision of the banks because funds in the checking account are sufficiently inelastic, i.e. $\frac{\partial \mathcal{C}}{\partial r_C}\frac{1}{\mathcal{C}}$ is low, and banks would like to increase the spread $(r - r_C)$ but hit the lower bound fist.

As in the data, the optimal rate on savings deposits will not be constrained by the zero lower bound. To understand the forces that drive this spread, call $\varepsilon^{\mathcal{D}} \equiv \left|\frac{\partial \mathcal{D}(r_C, r_S)}{\partial r_S}\right|$ the semi-elasticity and cross semi-elasticity of checking or savings deposits ($\mathcal{D} = \{\mathcal{C}, \mathcal{S}\}$) with respect to the return on savings. Then, I can rewrite the optimal spread on savings as:

$$r_S = \underbrace{r}_{\text{Competitive}} - \overbrace{\frac{1}{\varepsilon^{\mathcal{S}}}}^{\text{Monopoly}} - \underbrace{\frac{\varepsilon^{\mathcal{C}}}{\varepsilon^{\mathcal{S}}} \cdot \frac{\mathcal{C} \cdot (r - r_C)}{\mathcal{S}}}_{\text{Multi-product}} \tag{13}$$

Equation (13) provides clear insights into the two main components of the model shaping the markdown from a competitive banking model in which banks pay the market rate ($r_S = r$). The first one is the classical inverse elasticity of a monopoly $\frac{1}{\varepsilon^{\mathcal{S}}}$. The more inelastic the savings market is, i.e. $\varepsilon^{\mathcal{S}}$ moving towards zero, the higher the spread the monopoly will want to charge. The second component comes from the multi-product nature of the bank. The bank internalizes that if the funds in the checking deposits are very elastic, i.e. $\varepsilon^{\mathcal{C}}$ is large, then even small movements in r_S will cause large fluctuations of funds from checking to savings. Therefore, if the bank is making large profits with the checking funds -$\mathcal{C} \cdot (r - r_C)$ is sizable- then it is in its best interest to keep r_S low to keep Unsophisticated households' funds in the checking account.

Overall there are three key components shaping the optimal rate on savings deposits: the elasticity of savings funds and checking funds with respect to the savings return $(\varepsilon^{\mathcal{S}}, \varepsilon^{\mathcal{C}})$ and the importance of checking in bank profits $(\mathcal{C} \cdot (r - r_C))$. Additionally, as long as the funds in the checking account are sufficiently inelastic, banks will want to keep the return on checking at the lower bound. In order to understand the dynamics of interest rates, we need to dive into what shapes aggregate elasticities.

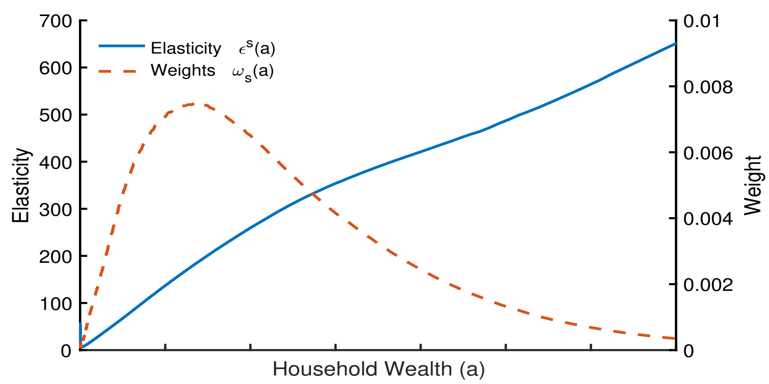
Aggregate Elasticities

Elasticities of deposits will play a key role in shaping the response of interest rates to shocks and in counterfactual steady states. In the model, these elasticities are the result of aggregating individual households' responses. Call $\varepsilon^{\mathcal{D}}$ to the semi-elasticity of checking or savings deposits funds $\mathcal{D} = \{\mathcal{C}, \mathcal{S}\}$ with respect to the savings return.[17] I can decompose these elasticities into the weighted average of individual elasticities

$$\varepsilon^{\mathcal{D}} \equiv \frac{\partial \mathcal{D}_j / \partial r_S}{\mathcal{D}} = \int_{(s,a)} \boldsymbol{\varepsilon^{\mathcal{D}}(s,a)} \cdot \boldsymbol{\omega_{\mathcal{D}}(s,a)} \tag{14}$$

where $\varepsilon^{\mathcal{D}}(s,a)$ represents the semi-elasticity of the funds in asset $\mathcal{D}$ controlled by households with states (s,a) and $\omega(s,a)$ the relative importance of those households demand in the aggregate demand of asset $\mathcal{D}$.[18] Individual elasticities, $\varepsilon^{\mathcal{D}}(s,a)$, depend on the household state variables. Figure 6 illustrates the two components of equation (14) for the case of savings deposits using the parameters chosen in Section 3.7.[19]

Figure 6: Decomposition of aggregate semi-elasticity of savings funds



Note: Figure shows the two components of aggregate savings deposits elasticity from equation (14).

As shown in the blue solid line of Figure 6, funds controlled by wealthier households are more sensitive to interest rate movements.[20] Appendix B.1.5 (MENTION THE FIGURE HERE) shows that this pattern is driven by the extesive margin being stronger for high levals of wealth. That is, the share of households that switch in and out of savings deposits is higher for wealthier households. Intuitively, the opportunity cost for households of choosing

[17]The focus on the savings return only is because the return on checking will be optimally held fixed by banks.

[18]Appendix B.1.5 derives and defines the objects of equation (14).

[19]Similar qualitative results for checking are shown in Appendix B.1.5

[20]The relationship is actually non-monotonic, as these elasticies decrease for values of wealth close to zero as households become more wealthy. The region of decreasing elasticities is negligible from the bank's perspective since their weight $\omega_S(s,a)$ is very small. Appendix B.1.5 shows that this non-monotonicity is driven by the intensive margin being relevant for values of wealth close to zero.

the low return asset is increasing in wealth, and movements in interest rate generate larger movements in utility for richer households. Given that the trading cost F is fixed, a larger mass of wealthier relative to poorer households fluctuates as r_S moves.

What determines the aggregate elasticity is, however, the weighted average of individual elasticities. The red dashed line in Figure 6 reproduces this weight for the case of the savings deposit. The relevant participants in the savings deposit market are not the top wealthy households -because they are active almost exclusively in the bond market- but the mid-wealth ones. Importantly, the distribution of deposit holdings is the key object in shaping the aggregate elasticity. As they fluctuate along the cycle and in alternative steady states, this will affect funds elasticities and the equilibrium interest rates.

Appendix B.1.5 show additional results about funds elasticities. It is shown that one can decompose the individual elasticities into an extensive and intensive margin and that numerically the extensive margin is relevant in shaping the result. Additionally, I give conditions under which the extensive margin is increasing for general distribution functions of the fixed cost and that they are valid for the most popular functions. Finally, results for the checking funds are presented.

3.7 Calibration

The objective of the calibration is to accurately capture the wealth distribution of Bank-Dependent households, as well as the opportunity cost of keeping funds in deposits. These moments will be key later in understanding the distributional costs of a rise in inflation.

The model is quarterly. For all possible parameters that have a standard value in the literature or can be mapped directly to the data, I do so. The remaining parameters are chosen to match informative steady state moments. Table 1 shows the calibrated parameters.

I assume log preferences for consumption $u(c) = \log(c)$ and $v(n) = n^{(1+\varphi)}/(1+\varphi)$ with a Frisch elasticity equals 0.5. For the income process, I use the persistence estimated in Floden and Lindé (2001) and convert it to quarterly values. For the standard deviation of the innovations, σ_s, the value targets the cross-sectional standard deviation of pre-tax log income of 0.7.[21]. To capture the non-linear taxation system in the U.S. I scale down the variance of

[21]The parametrization of the income process is in the neighborhood of the earlier literature of heterogeneous

Table 1: Parameter Selection

Assigned			Calibrated		
σ	1	CRRA coefficient	$\mathcal{F}_U$	Mean trading cost (Unsophisticated)	0.06
φ	2	Inverse Frisch elasticity	$\mathcal{F}_I$	Mean trading cost (Investors)	0.01
ρ_s	0.975	Persistence of log income	σ_F	Scale trading cost	0.04
σ_s	0.155	S.d. of log income innovations	μ	Share of Unsophisticated	0.4
B^G/Y	1.3	Assets/GDP			
$\overline{\pi}$	0.03	Trend inflation			
κ	0.05	Slope of Philips curve			
ϕ_T	0.1	Tax smoothing			

the innovation by $(1-0.181)^2$ where 0.181 is the value used in Heathcote, Storesletten, and Violante (2017).[22] For the level of liquid assets over output, B_G/Y, I match the sum of liquid assets in the SCF -as defined in Section 2- and divide it by total income in the same survey for the year 2007, which delivers a value of 1.3. The slope of the Phillips curve κ is chosen to be 0.05, a common value in the New Keynesian literature. The tax smoothing parameter ϕ_T is set to 0.1 following Auclert, Rognlie, and Straub (2020).

The rest of the calibration choices play a direct role in determining the opportunity cost of holdings deposits over market bonds. I pick the real rate on bonds to be $r = 3\%$ in annual terms[23] and trend inflation to be $\overline{\pi} = 3\%$, which delivers a $r_C = -3\%$ return on the checking account funds in steady state. These numbers approximate the values prior to the Great Recession. The parameters governing trading costs and the share of Unsophisticated households are chosen to match the moments shown in Table 2. The spread on savings deposits is chosen to be $r - r_S = 3\%$, which implies a null return on savings in real terms $r_S = 0\%$. Also, I target the fraction of households that keep all their funds in the bank in 2007, 65%, and the share that keep all in checking accounts, 33%. Finally, the dispersion of the trading cost, σ_F, plays a key role in matching the joint distribution of wealth and asset choice[24]. In particular, target the share of households in the top assets quartile that keep all

agent models. See for example the parametrization in McKay, Nakamura, and Steinsson (2016) and Guerrieri and Lorenzoni (2017).

[22]This is also done in Auclert, Rognlie, and Straub (2020) among others.

[23]The discount rate $\beta = 0.988$ is calibrated together with the other parameters match this target.

[24]The model mechanism to generate wealthy households choosing the low return account is by allowing

their assets in bank deposits, 22%.

Table 2: Moments Used in Calibration

	Data	**Model**
Bank-Dependent households	65%	64%
Households with all assets in checking	32%	32%
Top quartile Bank-Dependent households	22%	24%

Note: Bank-Dependent households refers to the fraction of households with all their assets in deposits (checking and savings). Top quartile Bank-Dependent households is the share of the households in the top quartile that are Bank-Dependent.

The model does a good job at matching the targeted moments. Additionally, and besides its simplicity and few parameters, the model does a decent job at matching the asset distribution conditional on asset choice. Figure 7 compares the model with the data. The figure splits households by their asset choice into the three panels and shows for each of the assets the share of households in the bottom 50%, in percentile 50th to 75th, and the top 25% of the wealth distribution. The model reproduces the key data patterns: low-wealth households keep their funds in checking accounts, mid-wealth in savings, and wealthy households are investors. Getting this distribution accurately is important to determining the heterogeneous consequences of inflation.

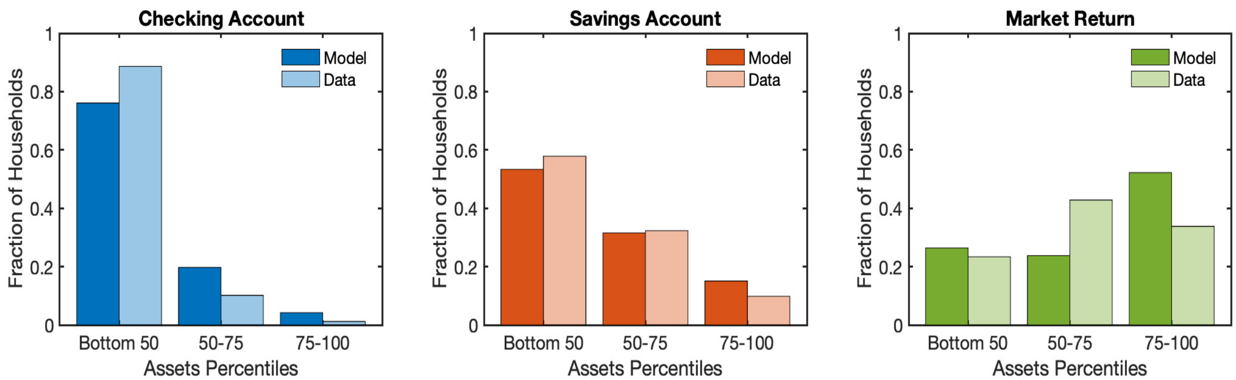
Appendix B.2 shows additional model results and compares them to the data. In particular, results on the wealth distribution, the persistence of the Bank-Dependent state, marginal propensity to consume, and the size of the banking sector are explored.

3.8 Model Dynamics

This section is twofold. First, I will show that even though the model was calibrated to match only steady state moments, it can achieve similar bussiness cycles movements on interest rates and portfolio movements as we saw in the empirical section. Second, I will explore the mechanism. In particular, how movements in the wealth distribution and asset holdings will shape the response of interest rates to shocks.

for large trading costs via a disperse Logistic distribution.

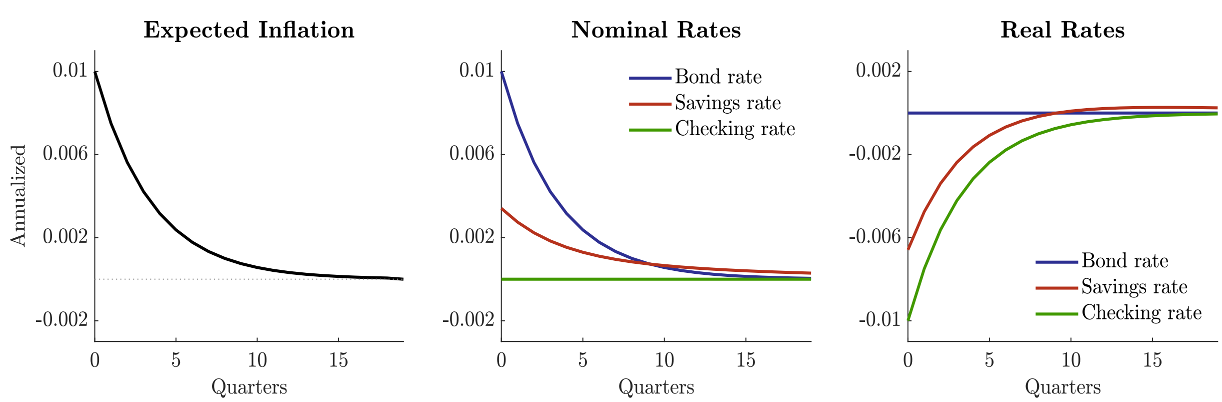
Figure 7: Wealth distribution conditional on asset choice



Note: Figure reports the fraction of households that belong to each asset bin conditional on the choice of savings. The data is from the SCF 2007 wave.

To keep the environment simple, this section studies a markup shock, i.e. a positive increase in $\widehat{\varepsilon}_w$ in equation (7) with persistence, under the assumption that the central bank moves the nominal rate in such way that keep the real rate on bonds fixed. Similar results for a monetary shock can be found in Appendix X. Figure 8 reproduces the dynamics of expected inflation, nominal and real rates after the shock.

Figure 8: Response to a Supply Shock



Note: The figure shows the response of expected inflation, nominal and returns output after a shock to the Phillips curve (7) with persistence assuming the central bank keeps the real return constant.

The left panel of Figure 8 reproduces the path of expected inflation, which is pushed up by the shock on desired markups by unions. In response to this shock, the central bank is assumed to lift the rate on bonds -as shown in the blue line of the mid panel- to keep the real constant, as the right panel reproduces, isolating bond holders returns from the shock.[25] The opposite is true for checking account holders, whose nominal return are held at zero by the bank and expected inflation translate directly into negative real rates.[26] Figure 8 also shows that bank's optimal decision is to only imperfectly passthrough the movements of the bond rate to their savings account customers, a decision that pushes the real return on savings to negative territory. To understand this last point, we need to understand how the shock changes banks' incentives.

The shock pushes down the real return on checking deposits r_C -whose nominal return is optimally held at zero by banks- which increases the spread between bonds and checking account funds $(r - r_C)$. This pushes up banks' profits per dollar in the checking account and gives banks additional incentives to keep Unsophisticated households' funds in the checking account and prevent their migration into savings deposits. To prevent such migration, the bank does not lift the nominal return on savings one-to-one with the bond return and optimally chooses to increase the spread between bonds and savings deposits $(r - r_S)$. The increase in the spread between bonds and savings triggers a migration from wealthy elastic Investors' funds into the bond market, reducing the elasticity of savings demand and giving additional incentives to increase the spread.

Bank first order condition (13) gives a clearer insight into why the spread increases. I rewrite it here for convenience:

$$r - r_S = \frac{1}{\varepsilon^{\mathcal{S}}} + \frac{\varepsilon^{\mathcal{C}}}{\varepsilon^{\mathcal{S}}} \cdot \frac{\mathcal{C} \cdot (r - r_C)}{\mathcal{S}} \tag{15}$$

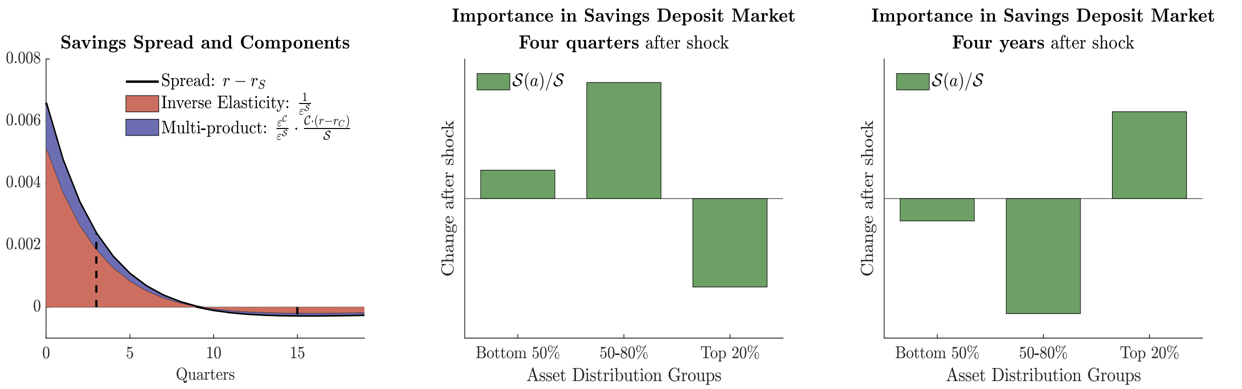
Inflation increases the profits in the checking account $\mathcal{C} \cdot (r - r_C)$ since $r - r_C = r + \pi'$ on the right hand side of equation (15). But this increase in the spread generates a migration of wealthy investors into the bond market which lowers the elasticity ε^S. The new equilibrium spread is shaped by these two forces. Figure 9 decompose the contributions of the two terms on the right-hand side of equation (15).

The black line in the left panel of Figure 9 shows the evolution of the spread between

[25] Remember that contracts are real, therefore the surprise inflation at period zero does not affect realized returns in that period.

[26] The study of small perturbations rules out the possibility of banks lifting the return on checking from zero which might arise if the shock is sufficiently large.

Figure 9: Decomposing the Increase in Spreads



Note: Figure decompose the contributions of the interest elasticity of savings funds and the profits in the checking account in the increase in the spread after the shock.

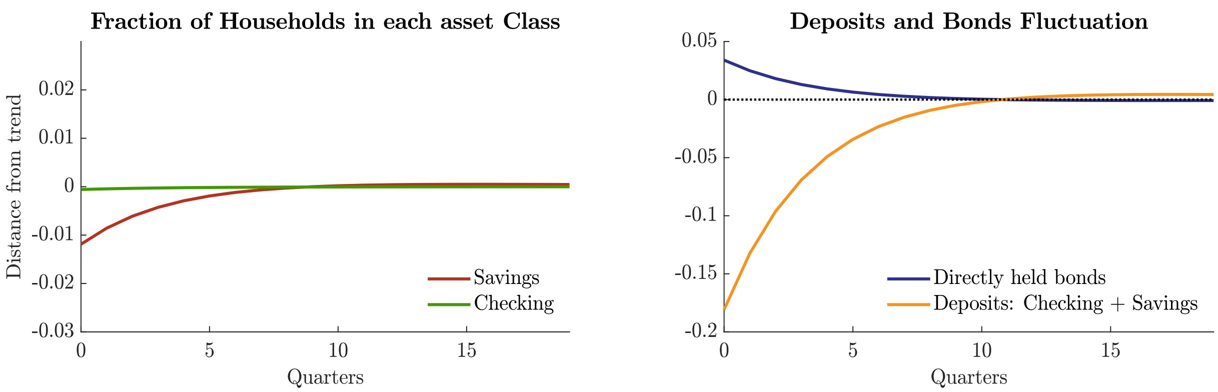
the bond market and the savings market $(r - r_S)$ -i.e. the distance between the solid blue line and the red line in Figure 8-. The shaded area below it decomposes the contributions between the two terms in the right-hand side of the equation (15). We can see from the panel that the new equilibrium spread is shaped mainly by a large movement in the aggregate elasticity of savings deposits. This elasticity changes along the transition because wealthy elastic households abandon the savings deposit market. The central panel plots the changes in the relative importance of households in different wealth groups in the savings deposit market four periods after the shock. We see in the graph that top wealthy households reduce their relative holdings of savings deposits, and the relative share of mid-wealth -and more inelastic- households increases. The right panel shows that once the shock vanishes, however, these elastic investors return to the savings market, but now with relatively more wealth since they have been accumulating funds in the bond market. Therefore, their relative importance increases and pushes up the elasticity of the market, which lowers the spreads.[27]

The previous discussion showed that the model can account for the imperfect passthrough of market rates to savings returns documented in the data. But in order to deliver a sensitive assessment of the cost of inflation, the model needs to capture the portfolio substitution reasonably well. The evidence presented in Section 2.2 on adjustments shows that the extensive margin is relatively stable, even after fluctuations. Figure 10 shows that this is also

[27]In Appendix X I show that movements in the elasticity are driven by movements in the weights and not by changes in individual elasticities.

true in the model after a supply shock. Additionally, evidence shown in Appendix A.3 shows that besides the rigid extensive margin, quantities of deposits do fluctuate. This is also true in the model, as the right panel of Figure 10 shows. The reason for this comes from the fact that those households leaving the bank are the very wealthy ones, and large funds move with them.

Figure 10: Response to a Supply Shock



Note: The figure shows the response of the changes in the fraction of households that chooses checking and savings deposits in the left panel, and the fluctuation in quantities of deposits and directly held bonds in the right panel after a shock to the Phillips curve (7) with persistence assuming the central bank keeps the real return constant

Overall this section shows that besides being calibrated using only steady state moments, the model delivers a dynamic of variables after a shock that resembles the evidence: deposits rates are insensitive to market returns and households do not adjust their portfolio. Additionally, this section showed that movements in the relative importance of households in the deposit market shape the elasticity that the bank face and therefore the spreads. This will be key in the next section to understand the interest rate in the new steady state.

4 Consequences of Inflation

In this section, I explore the consequences of a rise in inflation. I perform two different exercises. First, I compare the calibrated steady state with another one in which inflation is ten percentage points higher, a typical exercise on the inflation cost literature. Then, I study the business cycle implications of a temporary shock that pushes up inflation.

4.1 Long-run Consequences of Inflation

I model a long-run rise in inflation as an increase in trend inflation from the benchmark calibration of three percent $\overline{\pi} = 3\%$ to a new trend of thirteen percent $\overline{\pi} = 6\%$, that is, a 3pp growth. I will focus on comparing the new steady state with the benchmark calibration. In this section, I will assume that if the new equilibrium brings changes in government net income, government debt will adjust to clear the budget (9).[28]

The spillover of inflation into assets' real return will shape the welfare consequences of higher inflation. Table 3 compares the real returns of assets in the benchmark calibrated economy with the ones in the high inflation steady state. The high inflation translates negatively one to one into the real return on checking which now is at -6%. In the new equilibrium, the bank would still like to push the nominal return on checking into negative territory but the zero lower bound does not allow it to do it. This implies that in the new equilibrium, the bank still faces a sufficiently inelastic demand for checking funds that would like to exploit further by pushing the return lower. Also, bondholders appear isolated from inflation in the new equilibrium and, opposite to the short-run result, savings deposit return raised by more than the change in bonds return, going from the benchmark 0% real return to 0.5%. This means that the passthrough from market rates to savings deposits is greater than one in the long run.[29] To understand why savings rates increase by more than the bond rate in the long run, it is useful to first see the implications of inflation for the wealth distribution.

The change in returns in the new equilibrium directly benefits Investors, who can access a higher return in the savings market at no cost and have not lost returns on the bond. Unsophisticated households, however, only benefit from the higher savings rate if they decide to pay the trading cost and access the savings market. Table 4 shows the consequences of high inflation into wealth inequality. On one side, inflation increases asset holdings of wealthy households: the Gini index rises from 0.82 to 0.83, and the top 20% now hold 89.3% of total

[28] Changes in taxes τ will induce different output levels in both equilibriums, modifying average consumption. For transparency on the sources of welfare gain/loss, the adjustments are done through the level of debt B^G, which keeps the labor supply (8) constant. The unions' assumption here delivers the same result as GHH preferences.

[29] In nominal terms, the nominal bond return went from 6% in the benchmark economy to 9%, increasing 3%, while the savings rate went from 0% to 3.5%, increasing more than 3%.

Table 3: Response of Real Rates to High Inflation

	Benchmark ($\overline{\pi} = 3\%$)	**High-inflation ($\overline{\pi} = 6\%$)**
Bonds (r)	3%	3%
Savings deposits ($r_{\mathcal{S}}$)	0%	0.5%
Checking deposits ($r_{\mathcal{C}}$)	-3%	-6%

assets, 1.3pp more than in the benchmark.[30] On the other side, poor households are now pushed against the borrowing constraint because high inflation destroyed their incentives to accumulate assets. As a consequence, in the high inflation equilibrium the share of households that are hand-to-mouth rises from 36% to 42%.[31]

Table 4: Distributional Consequences of High Inflation

	Benchmark ($\overline{\pi} = 3\%$)	**High-inflation ($\overline{\pi} = 13\%$)**
Gini Assets	0.82	0.83
Asset holdings by top 20%	88%	89.3%
Hand-to-mouth share	36%	42%

Note: Hand-to-mouth households refers to the share of households that consume all their income.

To understand why the savings return increases in the high inflation equilibrium we can combine the results derived in Section 3.6 with the implications of inflation in the wealth distribution. Recall that the savings deposit rate is determined by equation (13) in which the semi-elasticity of savings deposits ($\varepsilon_{\mathcal{S}}$) and the profits from checking ($\mathcal{C} \cdot (r - r_C)$) are the key components. In the first place, high inflation redistributes funds to wealthy investors. From Figure 6 we know that funds controlled by wealthy households are more elastic. This redistribution of funds pushes up the elasticity of the savings market. Additionally, the fall in checking real rate disincentivizes households from keeping funds in the form of checking

[30] To understand the size of the results one can compare with the historical rise in concentration in the U.S. Using the SCF I computed the Gini for Financial assets as defined in Section 2.2. From 1989 to 2019 the Gini rise by 0.04. Moreover, holdings by the top 20% raised by 1.3pp.

[31] Table 12 in the appendix provides additional results.

deposits, which reduces banks' incentives to lower the savings return in order to keep the funds in the form of checking. Both forces combined result in a higher return on savings in the new steady state.

Finally, I explore the welfare cost of inflation, with particular emphasis on who bears the cost. To do this, I calculate the lifetime consumption equivalent change that will let an agent indifferent between the benchmark economy and the new steady state with high inflation. That is, for each household with state variables (s, a) I found the percentage increase in consumption in every period that will let it be indifferent between the benchmark economy and a high inflation environment.[32] Table 5 reports the average consumption equivalent change due to high inflation, as well as the average across groups of households.

Table 5: Consumption Equivalent Loss of High Inflation

	Consumption Equivalent
Average	$\approx 0\%$
Average Investors	0.077%
Average Unsophisticated	-0.11%

Note: Consumption equivalent refers to the change in lifetime consumption that will let the household indifferent between the steady state benchmark economy and one under high inflation. Average consumption equivalent loss is computed under the benchmark steady-state distribution.

Inflation is on average not costly for households. That is, the households' average consumption equivalent loss of inflation is zero. However, this is masking a great amount of heterogeneity. On the one side, Investors benefit from the increase in the return on savings. On the other side, Unsophisticated households are left with no choice but to reduce savings or find shelter from inflation in the costly savings deposits market. Both options are harmful: the first one reduces the ability to smooth consumption, while the second forces them to exert extra non-pecuniary costs. As a result, their welfare is reduced.

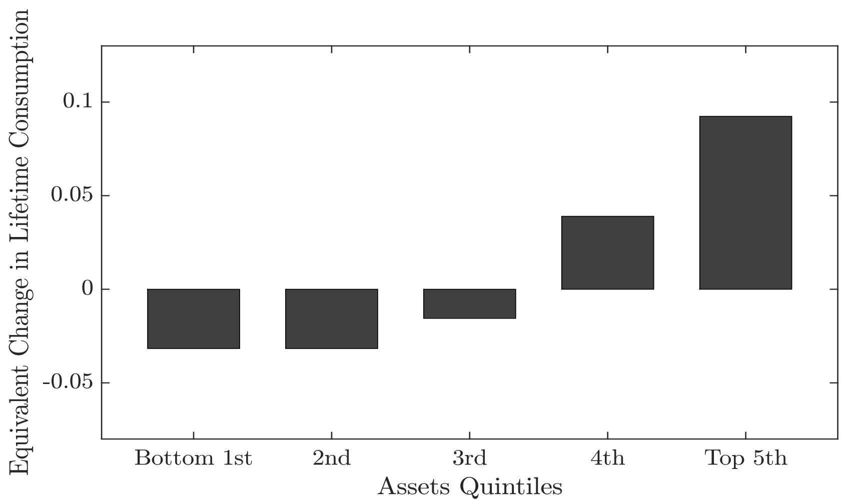
To understand the magnitude of the change in welfare, I compare the size of the losses with an autarky benchmark in which households have no ability to smooth consumption. That is, I compare results in Table 5 with a scenario without a savings market in which all

[32] See details on the calculation in Appendix B.1.7.

households are hand-to-mouth.[33] For Unsophisticated households, the average loss of high inflation is 61% of the potential losses of autarky. This implies that for these households an increase in inflation of 3pp has non-negligible consequences.

Alternatively, we can describe the costs of inflation along the wealth distribution. Figure 11 splits the population in assets quintiles and computes the average consumption equivalent change. Inflation hurts households at the low end of the wealth distribution because it destroys the savings market, but benefits those at the top due to higher returns.

Figure 11: Consumption Equivalent Change from High Inflation by Assets Quintiles



Note: Figure reproduces the average consumption equivalent change $\gamma(s, a)$ for households in each quintile of assets in the benchmark steady state.

I conclude this section with the main message: in the long run, inflation has mainly redistributive consequences. On average, households do not lose from inflation, but this is due to averaging those households who benefit from higher savings returns with those who lose due to negative checking rates.

4.2 Short-run Consequences of Inflation

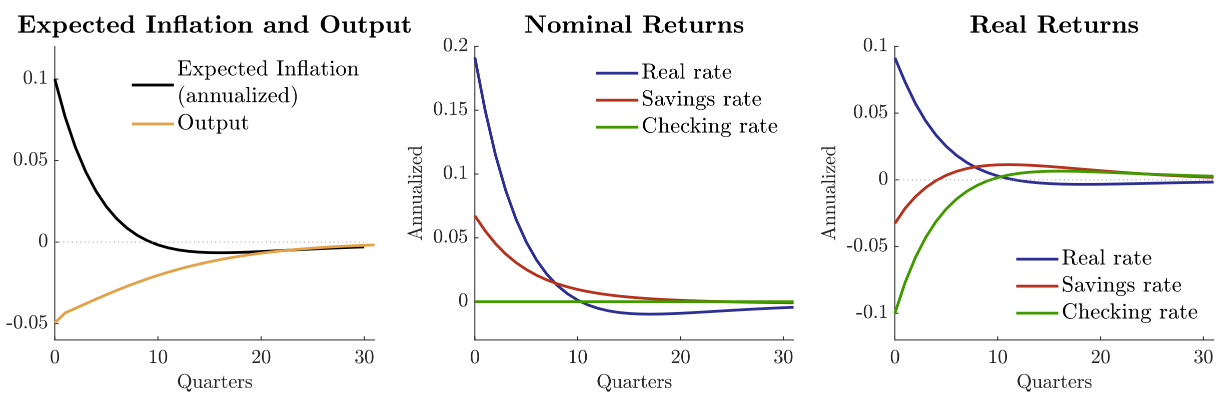
In this section, I discuss the implications of a shock that pushes up future inflation. In particular, I focus on a shock on the Phillips curve (7) that increases the desired markup of

[33] In this scenario an agent with states (s, a) will consume all their assets and income in the first period, followed by consuming just the income.

the unions which I will interpret more broadly as a supply shock.[34] I choose the size of the shock to generate an increase in the next quarter's inflation of 10%, resembling the recent experience of high inflation during Covid. I conclude the section by comparing the response of a counterfactual economy in which deposit returns mimic bonds' movement. For additional results see Appendix D.

Figure 12 shows the response of inflation, interest rates, and output after the shock. The left panel shows that the shock pushes up expected inflation for several quarters. In response to the shock, and following its rule from equation (10), the government lifts the nominal rate on bonds to prevent higher inflation, generating a lift in the real bond return, as the blue line in the central and right panel show. The banks, facing similar incentives as described in Section 3.8, decide optimally to keep the nominal return on checking at zero and pass only imperfectly the rise in the bond rate to its savings deposits customers, as the red and blue lines show. As is traditional in these models with nominal rigidities the rise in the real bond rate pushes the output below its trend, as the yellow line in the left panel shows.

Figure 12: Response to a Supply Shock



Note: The figure shows the response of inflation, output, and returns after a shock to the Phillips curve (7) with persistence.

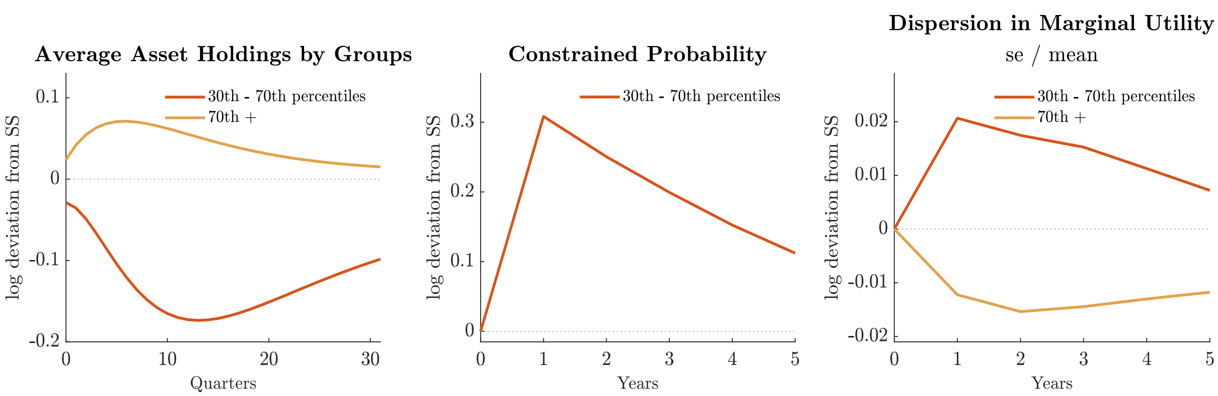
Interestingly, even though the Fed is tightening to fight inflation the increase in the real return on bonds does not translate into higher real returns for deposit holders because banks optimally decide to keep nominal returns low. This generates an unequal response of asset accumulation across the wealth distribution as Figure 13 shows in the left panel. Those

[34]The shock process follows an AR(1) with a persistence of 0.85.

households that belong to the top thirty percent of the wealth distribution at the moment of the shock -represented in the yellow line of the left panel- take advantage of the high bond rates and increase their asset holdings on average. Note that this happens even though the economy is going into a recession and their income is falling. On the contrary, mid-wealth households -those between the 30th and 70th asset percentile- who are mainly deposit holders, decide to drain their assets from the accounts in response to the negative returns.

This behavior of the interest rates reduces mid-wealth households' ability to self-insure and leaves them more exposed to future income fluctuations. The central panel of Figure 13 shows how the probability of being constrained in the future increases for these households relative to the steady state. That is, due to the reduction in assets and income, mid-wealth households find it more likely to hit the borrowing constraint in the future. The right panel shows how the future marginal utility becomes more dispersed for mid-wealth households, in opposite contrast to what happened to top-wealth households, who thanks to the early extra asset accumulation, now can smooth the shocks better.

Figure 13: Assets Groups Response to a Supply Shock



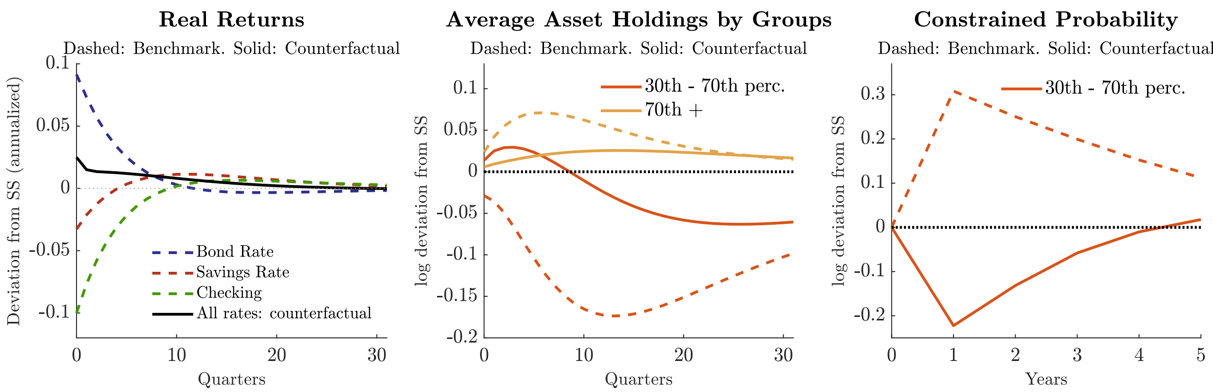
Note: The figure shows the response of average asset holdings, probability of hitting the borrowing constraint, and the dispersion in the marginal utility after a shock to the Phillips curve (7) with persistence. Wealth groups are computed before the shock hits and the response of these same households are tracked.

I will now use this model to understand the implications under an alternative scenario in which there is no imperfect passthrough from the market rate to deposit rates, i.e. movements in interest rates are equalized: $\Delta r = \Delta r_S = \Delta r_C$. I will call this scenario a competitive banking counterfactual.[35] Under competition, spreads will be held constant at the steady

[35]Fully accounting for bank competition in this model will imply also changes in the spreads in the steady

state level even after a shock. To make the counterfactual cleaner, I will assume that the government engineers the movements in the bond rate (r) to achieve the same path of output -and therefore of inflation- as in Figure 12. Figure 14 shows the result and compares the competitive with the benchmark economy.

Figure 14: Competitive Banking Counterfactual



Note: The figure shows the response of real returns on assets, the movements in average asset holdings, and changes in the probability of hitting the borrowing constraint after a shock to the Phillips curve (7) with persistence. The benchmark economy refers to the calibrated version. The counterfactual assumes that movements in interest rates are equalized (full passthrough). Wealth groups are computed before the shock hits and the response of these same households are tracked.

The left panel compares the response of the real rates in the benchmark calibration in dashed lines with the counterfactual of competitive banking on the black solid line. Note that in the counterfactual competitive economy, the lift on interest rates required to achieve the same path of inflation and output is much smaller. That is when the economy features full passthrough, changes in interest rates reach all households and make monetary policy more effective.[36]

The central panel of Figure 14 compares the response of average asset holdings for mid-wealth in red and top-wealth households in yellow. The solid lines reproduce the response under the competitive banking counterfactual and the dashed benchmark economy. From the figure, we see that, even though the economy is going through the same recession, mid-wealth households can now take advantage of the high interest rate and accumulate some assets,

state. The objective of this exercise is to understand how changing the dynamics of the interest rates can alter the responses of the economy even without altering the steady state.

[36] I will explore this point further later in Section 5.1 where I conclude that monetary policy is more effective at controlling inflation in the competitive scenario.

in sharp contrast to the benchmark scenario where these same households reduced their holdings.[37] This generates a reduction in their probability of hitting their borrowing constraint in the future, as the right panel shows.

The counterfactual exercise shows that the unequal response of interest rates to inflationary shocks exposes mid-wealth households to an additional cost from inflation traditionally left unexplored in the literature. This cost arises from the fact that high inflation periods generate low real return on deposits incentivizing deposit holders to reduce their assets and leaving them more exposed to future idiosyncratic shocks. Notoriously, this cost arises even if the central bank increases the policy rate to fight inflation.

5 Additional Results

This section presents two sets of additional results. First, I explore the consequences of imperfect banking competition and segmented assets market in the ability of the central bank to control inflationary pressures. Then, I study the importance of banking spreads for wealth inequality.

5.1 Controlling Inflation Under Imperfect Banking Competition

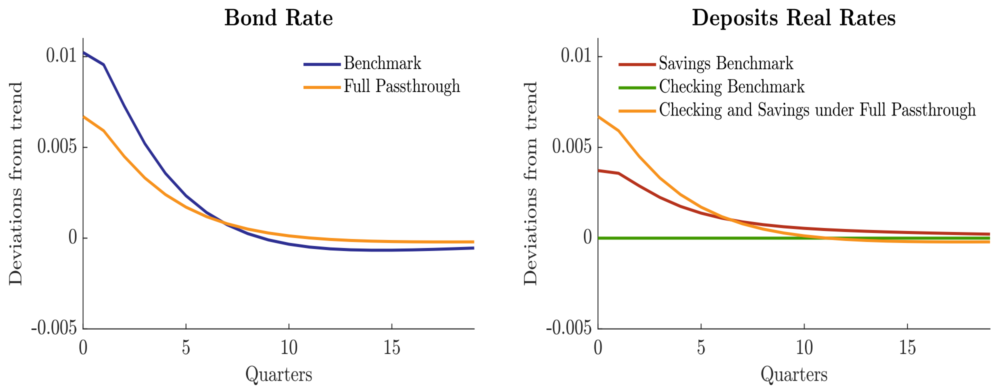
In this section, I argue that the presence of market power in the banking sector impairs central banks' ability to control inflationary shocks. This implies that if the passthrough of the central bank rate to deposit rates were perfect, smaller increases in the market returns would be needed to control inflation. To show this, consider again a shock to the Phillips curve (7) with persistence and a central bank that targets full price stability $\widehat{\pi} = 0$.

The blue line in the left panel of Figure 15 shows the necessary changes in the real rate on bonds that the central bank needs to do to achieve zero inflation in the benchmark calibrated economy. Additionally, the yellow line shows the path that would be needed in an environment with a full passthrough, that is, if all movements in deposits are coordinated $\Delta r = \Delta r_S = \Delta r_C$. From the figure, we observe that much smaller deviations from the trend in

[37] The path of inflation and output in both scenarios is identical. After-tax income, however, is different in both economies. In Appendix D I argue that the difference in paths is mainly driven by the different interest rates in both economies, and not by taxes.

the return on bonds would be needed if the passthrough to deposits rate were perfect.[38] The reason is that the movements in the bond rate in the benchmark economy do not translate to all households. As the right panel shows, savings and checking real rates only imperfectly reproduce the changes in the bond rate, wheres in the full passthrough counterfactual, all agents in the economy are exposed to the same changes.

Figure 15: Response to a Supply Shock



Note: The figure shows the response of the real return on assets after a shock to the Phillips curve (7) with persistence in an economy in which the central bank achieves full price stability. It compares the necessary change needed in the benchmark calibrated economy with a counterfactual scenario of full passthrough.

5.2 Deposit Spreads and Wealth Inequality

In this section, I ask how would wealth distribution look in a steady state without spreads in the banking sector. That is, I compare the calibrated benchmark with an alternative steady state in which all bank spreads are removed: $r = r_S = r_C$. Table 6 shows that the implications for wealth inequality from deposit spreads are substantial. The equalization of the return on assets gives extra incentives to poor paper to save, which reduces wealth inequality and concentration of holdings at the top.

6 Conclusion

[38]The average deviation from trend is 50% larger in the first two years.

Table 6: Deposit Spreads and Wealth Inequality

	Benchmark	**No Deposit Spreads ($r = r_S = r_C$)**
Bond return (r)	3%	2%
Savings return (r_S)	0%	2%
Checking return (r_C)	-3%	2%
Gini Assets	0.82	0.71
Asset holdings by top 20%	88%	73%
Hand-to-mouth share	36%	19%

Note: The table compares the benchmark calibrated economy with an alternative in which the spreads on deposits are removed. Hand-to-mouth households refers to the share of households that consume all their income.

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Appendix

A Data Appendix

This section complements the evidence presented in Section 2.2 and show details on data computations.

A.1 Call reports sample selection and definitions

Data from Call Reports is obtained from WRDS for years between 1987 and 2021. Data is quarterly and account for the entire universe of depository institutions in the US. My main reference paper for sample selection and definitions is Acharya and Mora (2015). In particular, banks are aggregated to top holder level (RSSD9348). Bank organizations with assets less than $100 million are excluded. As a merger control, bank organizations with asset growth greater than 10% during a quarter are excluded in that quarter. Rates are trimmed at the 1% and 99% level. Interest rates on savings deposits are computed as:

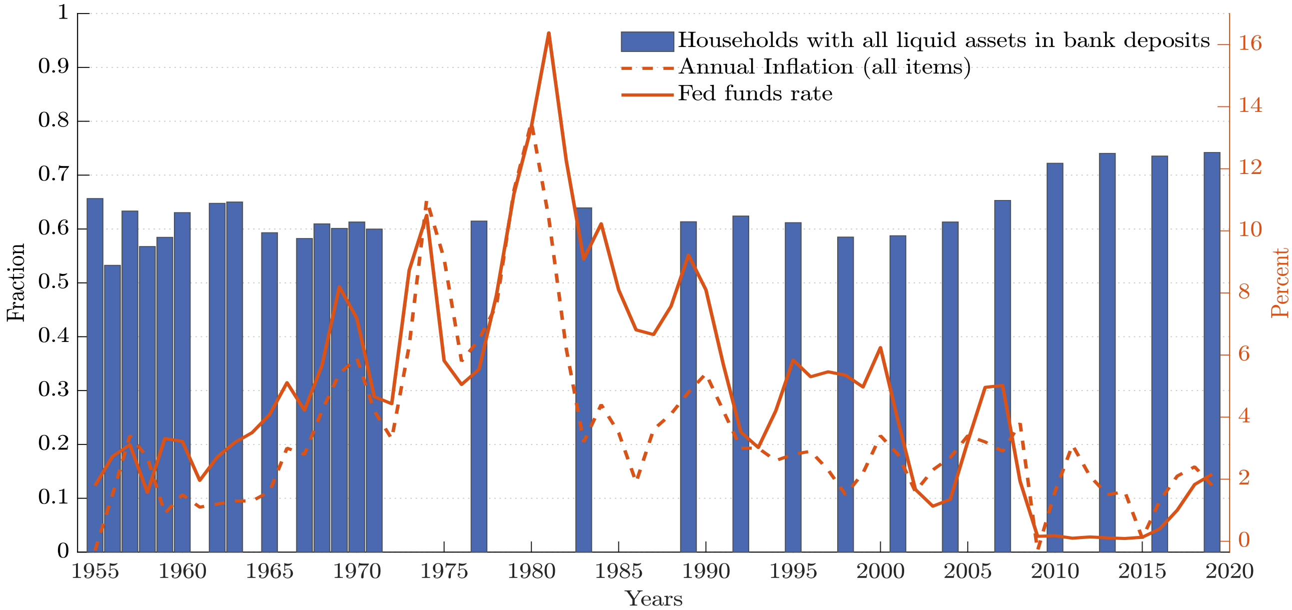
- Savings Account interest rate: is computed as interest expenses on saving accounts (RIAD0093 and RIAD4509 + RIAD4511 before 2001) divided by quarterly average savings (RCONB563 and RCON3486+RCON3487 before 2001). This includes MMDA and other savings accounts.

A.2 Additional Results on Households Portfolio

Bank-Dependent Households Share and Inflation

We can add inflation to Figure 16. From the figure, we see that inflation and the Federal Funds rate comove closely before 1980. Also, that inflation has been relatively stable since then.

Figure 16: Share of Bank-Dependent Households, Market Returns, and Inflation



Note: Bank-Dependent households refers to households with all their financial assets held in bank deposits. It also includes households that do not report having a bank account (cash holders). Data is from the SCF.

Income and Assets share of Bank-Dependent Households

We saw in Section 2.2 that around 60% of U.S. households can be classified as Bank-Dependent. Figure 17 shows that they account for around one third of the total market of deposits, but less than ten percent of total financial assets. Additionally, Figure 18 shows that they account for between forty and fifty percent of income.

Portfolio of Investors

Figure 19 shows that once households broke the barrier of bank dependency, they choose to hold a small share of deposits in their portfolio, especially of low interest rate deposits like checking and normal savings accounts. In particular, it shows that around one third of investor households hold near zero low return deposits in the portfolio and the median investor holds only close to 25%.

What do investors hold in their financial portfolio? Table 7 reproduces the average holdings of each class of assets for 2007

Figure 17: Share of deposits and financial assets held by Bank-Dependent households

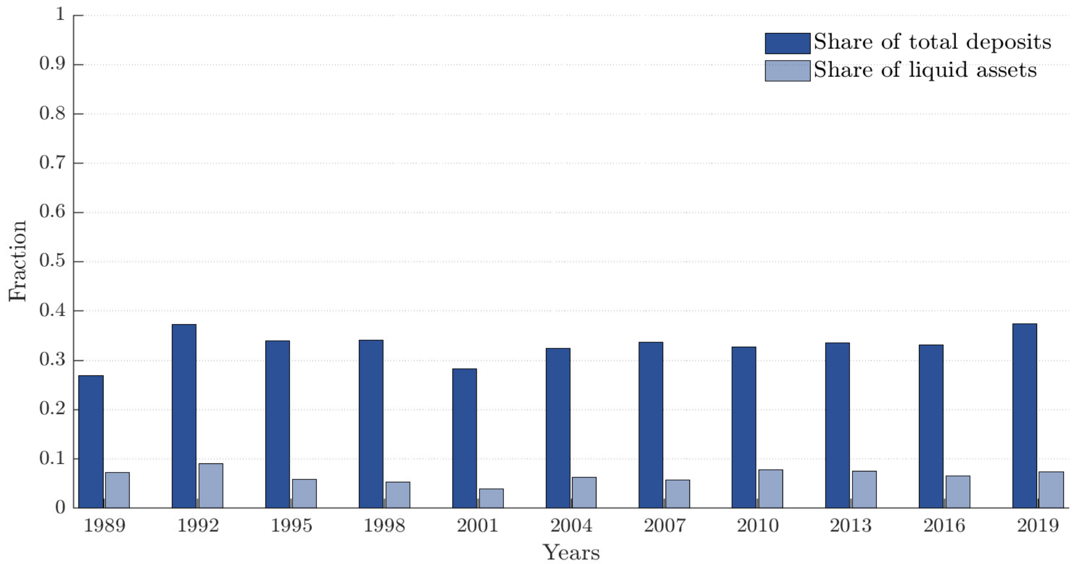
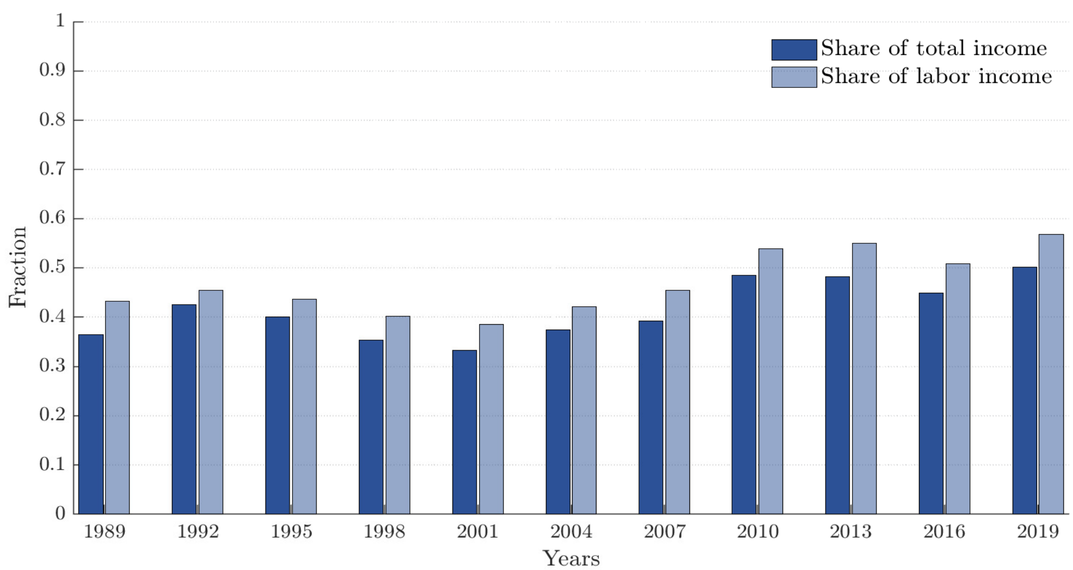


Figure 18: Share of labor and total income by Bank-Dependent households



Transition Matrix

The data used in Section 2.2 to calculate the share of Bank-Dependent households is a collection of cross-sectional surveys whose nature does not allow to compute the persistence

Figure 19: Distribution of deposits over financial assets for investors

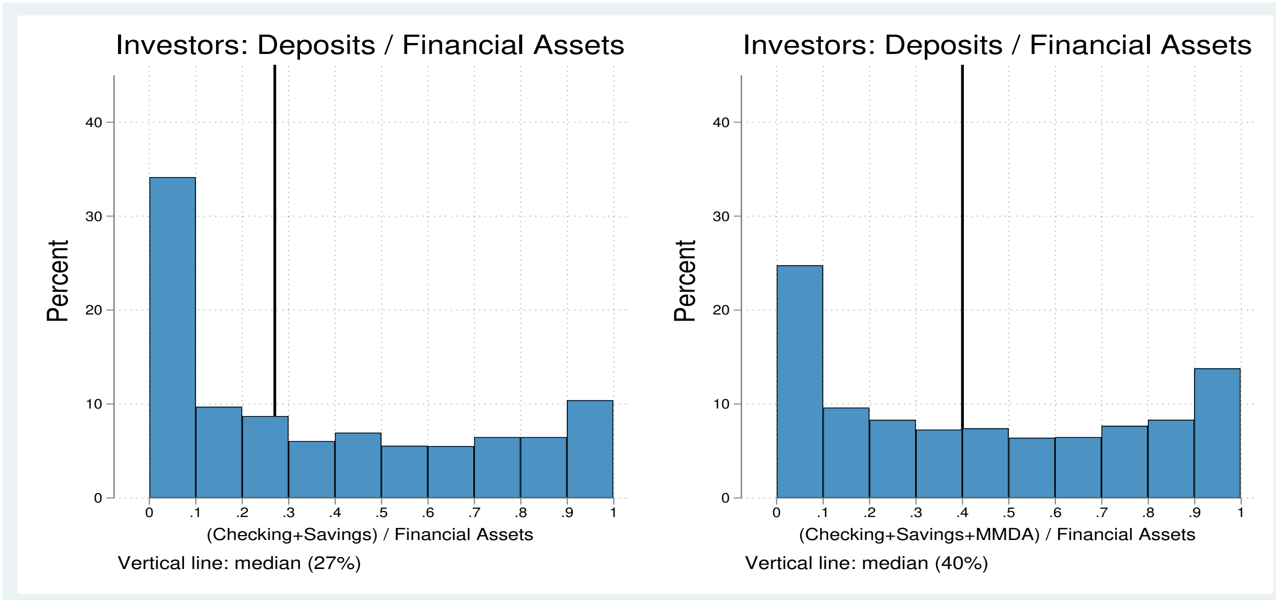


Table 7: Average Portfolio of Investors

	Share of total portfolio	Share in market portfolio	Fraction with zero holdings
Money market funds	4%	6%	≈ 75%
Call accounts	1%	1%	≈ 90%
Directly held investment funds (exc. money mkt funds)	18%	24%	≈ 50%
Savings bonds	8%	28%	≈ 50%
Directly held stocks	22%	40%	≈ 38%
Other directly held bonds	1%	2%	≈ 95%
Bank deposits	45%	-	≈ 1%

of being Bank-Dependent. However, the Survey of Income and Program Participation (SIPP) has data that allows making an idea of the likelihood of transitioning in and out of the Bank-Dependent state. For this purpose, I use the 2004 wave of the SIPP and bundle individual records at the household-quarter level. Participants of the survey are asked to indicate if they hold or not different types of assets. For those households that report only having bank deposit accounts, I classify them as Bank-Dependent. If they report holding financial assets apart from bank deposits, I label them as investors[39]. Table 8 indicates the quarterly likelihood of transitioning between the Bank-Dependent state and the Investor state computed as the number of households that switch divided by the number of households in the departing state in the previous quarter.

Table 8: Quarterly Transition Matrix

	Deposits	**Investor**
Deposits	0.94	0.06
Investor	0.02	0.98

Wealth and Deposits Classes

Here I reproduce Figure 2 but now decomposing it by type of deposits. That is, I split Bank-Dependent households into those that hold all their assets in checking deposits, those that hold some funds in savings, and those that hold some positive value in high-return money market accounts (and potentially some in checking and/or savings). Figure 20 shows the results. From the figure, we can observe that most of the households with very few assets hols all their money in checking accounts, mid-wealth households use mainly savings deposits, and rich households use high-return money market deposit accounts.

A.3 Additional Results on Deposits and Rates

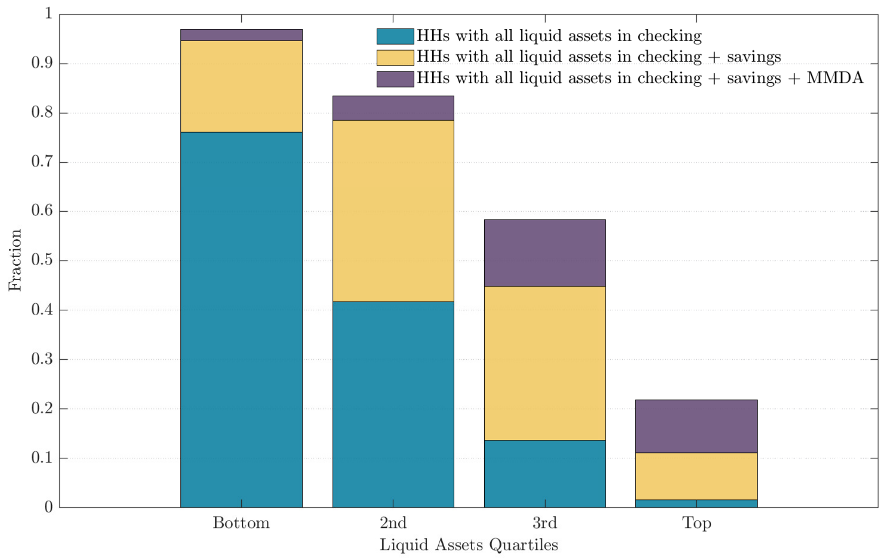
Deposits Fluctuation

We have seen in Figure 16 that the share of households in the Bank-Dependent state is very rigid and does not fluctuate. Nevertheless, deposit quantities do fluctuate, and its growth correlates negatively with market returns.[40] The black line in Figure 21 shows the log annual change in deposits around a linear trend. The measure for deposits used in the figure is the

[39]There is a difference between this definition and the one used in Section 2. SIPP does not report if you hold a positive amount of the assets you declare. Suppose then that a household opened a money market account in the past but now it is empty, and also that they have no other liquid asset outside bank deposits. In the SCF I will label this household as Bank-Dependent. In the SIPP, however, it will appear as investor

[40]This point is also present in Drechsler, Savov, and Schnabl (2017).

Figure 20: Distribution of Bank-Dependent Households in 2007 by Type of Assets



Note: Bank-Dependent households refers to households with all their liquid assets held in bank deposits. It also includes households that do not report having a bank account (cash holders). Data is from the SCF. MMDA refers to money market deposit accounts at banks.

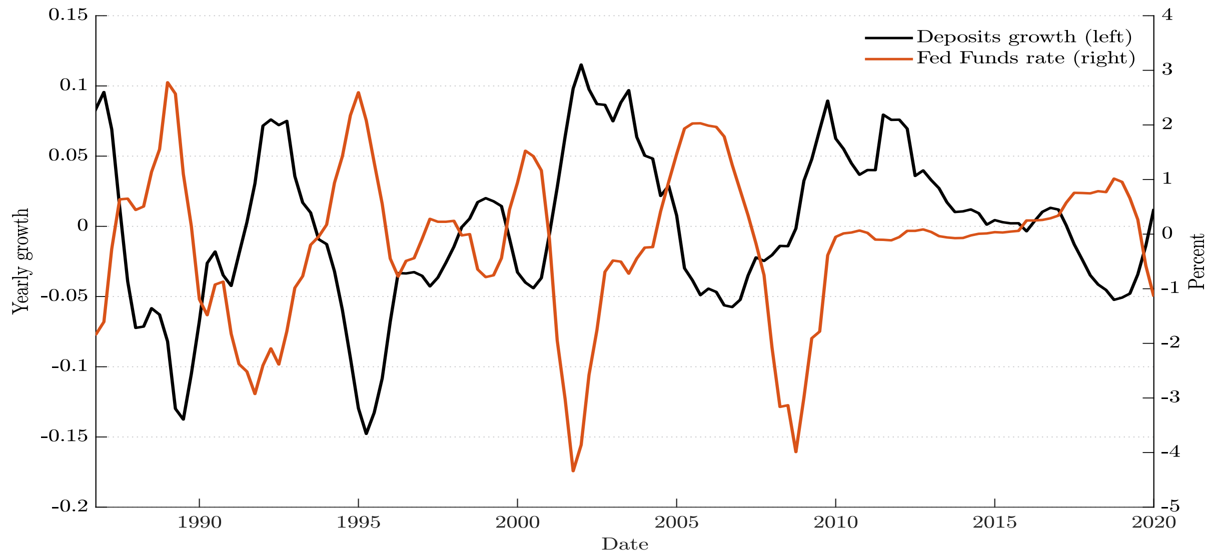
sum of checkable and savings deposits from the Fed's H.6 Money Stock Measures report. Additionally, the figure shows the yearly change in the Fed funds rate in the red line. We can see from the plot that the magnitude of deposits inflows and outflows is large and that they follow a clear negative correlation with changes in the Fed rate.

Instrumented Local Projections

Instead of showing the simple correlations between rates and the Fed's rate in Figure 3 and on quantities in Figure 21 we can show some evidence of the causal mechanism. In order to do it, I run Jordà (2005) type local projection using an instrument for changes in the Fed Funds rate. Specifically, I run

$$y_{t+h} = \alpha_h + \beta_h \, \epsilon_t + \gamma_h \, \text{controls}_{t-1} + u_{t+h} \tag{16}$$

Figure 21: Deposits Fluctuations and Fed Funds Rate



Note: Deposits growth is the log annual difference around a linear trend. The measure of deposits used is the sum of checkable and savings deposits from the Fed's H.6 Money Stock Measures report.

where y_{t+h} is the outcome of interest -deposits or interest rates- and ϵ_t is a measure of monetary shocks for which I use Bauer and Swanson (2022) measure of surprises normalize to have an impact of 1pp in the Fed Funds rate. In the controls, I include four quarter[41] lags on the outcome variable y_t, together with industrial production, CPI, and the Fed Funds rate. Figure 22 and Figure 23 show the time series of the β_h for savings deposit rates and for deposits respectively.

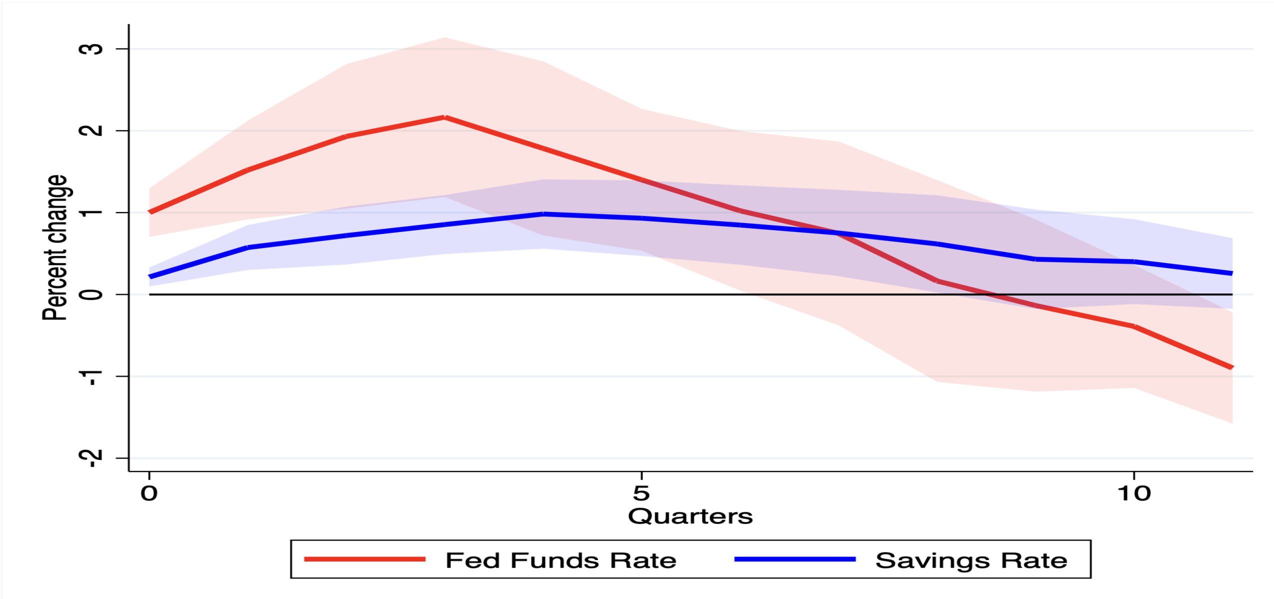
We see from the figures that the same patterns observed in Figure 3 and Figure 21 are present in the instrumented local projections. This suggests that the causal effect goes from the Fed return changes to changes in savings rates and deposits. Moreover, we see that the passthrough to savings rate is imperfect and that the magnitude of the fluctuations in deposits is large.

B Model

This section contains details and derivations of the model part.

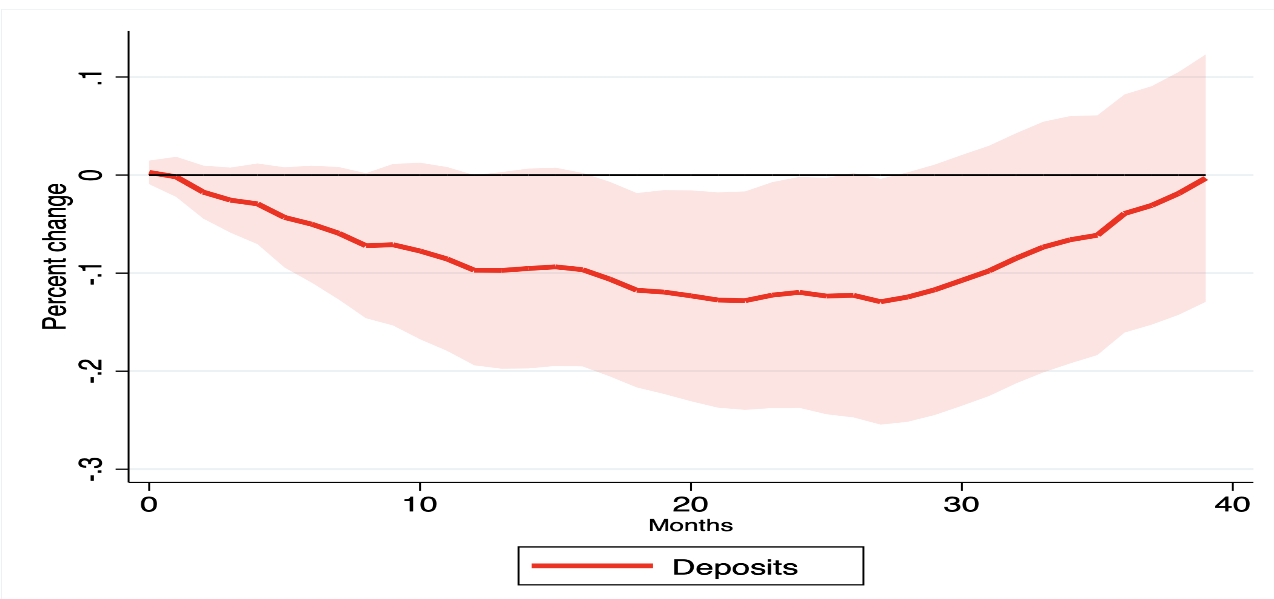
[41]The deposits data is monthly, so I use 12 months instead.

Figure 22: Savings Rate and Fed Funds Rate



Note: Figure shows the collection of the β_h coefficients in equation (16) for savings rates. Savings returns are expenses over average holdings on savings deposits using Call reports.

Figure 23: Deposits Fluctuations and Fed Funds Rate



Note: Figure shows the collection of the β_h coefficients in equation (16) for deposits. The measure of deposits used is the sum of checkable and savings deposits from the Fed's H.6 Money Stock Measures report.

B.1 Households

B.1.1 Optimal Decisions

After observing its productivity level for the period a household of group g chooses between the low (L) and high (H) return assets of its group g. This optimal choice delivers a probability $P_H^g(s,a)$ that the high return asset is chosen by households with these state variables. Given the assumption on the distribution of trading cost F_g being Logistic(μ_F^g, σ_F), the probability for household of group g with states (s,a) of choosing the high return asset is given by,

$$P_H^g(s,a) = \frac{\exp\left[\frac{\nu_H(s,a)-\mu_F^g}{\sigma_F}\right]}{\exp\left[\frac{\nu_H(s,a)-\mu_F^g}{\sigma_F}\right] + \exp\left[\frac{\nu_L(s,a)}{\sigma_F}\right]} \tag{17}$$

and $P_L(s,a) = 1 - P_H(s,a)$ is the probability of choosing the low return asset on the group. Note that this delivers four probabilities:

$P_B^I(s,a)$:the probability of Investors of choosing the bond

$P_{\mathcal{S}}^I(s,a)$: the probability of Investors of choosing savings deposits

$P_{\mathcal{S}}^U(s,a)$: the probability of Unsophisticated of choosing savings deposits

$P_{\mathcal{C}}^U(s,a)$: the probability of Unsophisticated of choosing checking deposits

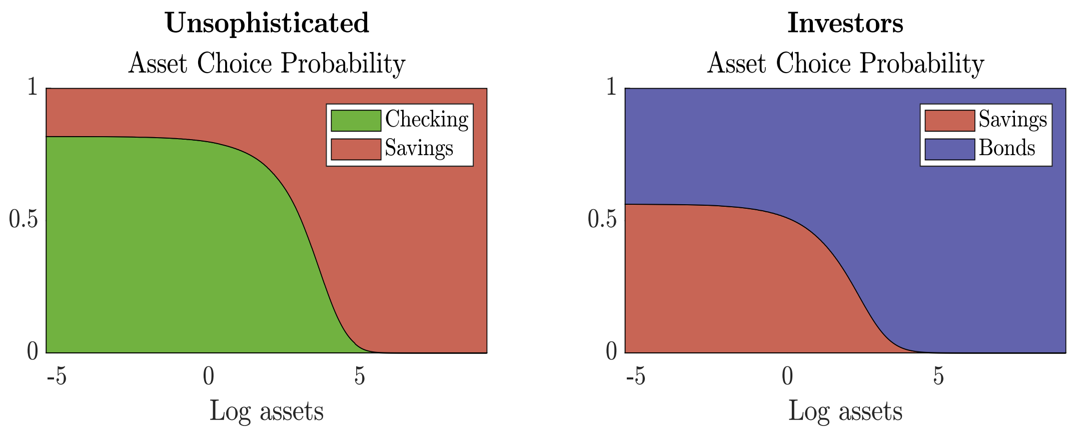
For the calibrated economy these probabilities are shown in Figure 24. Remember from the calibration that the distribution of the trading shock F is in part chosen to get the right share of households as Bank-Dependent along the wealth distribution.

Once the asset choice $j = \{\mathcal{C}, \mathcal{S}, B\}$ is done by the household, it has to choose its optimal level of consumption and saving. This decision is dictated by the Euler equation,

$$u'(c_j(s,a)) \geq \beta(1+r_j)\mathbb{E}\left[\partial_a V(s',a')\right] \tag{18}$$

where equality holds if $a' > 0$. This delivers a set of policy functions for consumption and

Figure 24: Asset choice conditional on assets



saving:

$$c^I_B(s,a) : \text{consumption of Investors choosing the bond}$$

$$c^I_{\mathcal{S}}(s,a) : \text{consumption of Investors choosing savings deposits}$$

$$c^U_{\mathcal{S}}(s,a) : \text{consumption of Unsophisticated choosing savings deposits}$$

$$c^U_{\mathcal{C}}(s,a) : \text{consumption of Unsophisticated choosing checking deposits}$$

$$a'^I_B(s,a) : \text{saving of Investors choosing the bond}$$

$$a'^I_{\mathcal{S}}(s,a) : \text{saving of Investors choosing savings deposits}$$

$$a'^U_{\mathcal{S}}(s,a) : \text{saving of Unsophisticated choosing savings deposits}$$

$$a'^U_{\mathcal{C}}(s,a) : \text{saving of Unsophisticated choosing checking deposits}$$

The issue with solving this problem is that the first-order conditions are necessary but not sufficient. Random fixed costs make the problem continuous and differentiable but do not necessarily convexify the problem. The following section describes how to efficiently compute the solution to this type of problem.

B.1.2 Computation of Household's Problem

This section briefly describes how to compute the optimal policy functions for the household problem. The method used is an extension of the original Endogenous Grid Method (EGM) (Carroll (2006)) to non-convex problems. In doing so, I rely on advances done in Fella (2014), Iskhakov, Jørgensen, Rust, and Schjerning (2017) and Bardóczy (2020).[42] For details on solution methods for non-convex optimization, please refer to the cited papers.

For the computation of the household problem, initiate the algorithm by discretizing the state space (s, a) and a guess for the value functions $\{\nu_L(s, a), \nu_H(s, a)\}$ for each group. I will label this original grid on assets A^{exo} in order to distinguish it from the endogenous one. Use the guess of the value functions to calculate the implied probability of choosing the high return asset using equation (17) and numerically obtain the partial derivative of the value function with respect to assets $\partial_a \nu_j$. The right-hand side of the Euler equation (18) can be computed using these two objects,

$$\mathbb{E}_{s',F'}\left[\partial_a V(s', a')\right] = \mathbb{E}_{s'}\left[(1 - P_H(s', a')) \cdot \partial_a \nu_L(s', a') + P_H(s', a') \cdot \partial_a \nu_H(s', a')\right]$$

Next, invert the Euler equation -as done in the typical step in the EGM- to obtain an implied consumption function $c_j(s, a)$ for each asset choice and replace into the budget constraint to obtain an endogenous grid A_j^{endo}. In the classic EGM the next step is to interpolate the implied cash-on-hand generated by the endogenous grid into the exogenous one generated by the grids. The problem here is that A^{endo} might not be increasing and the obtained $c_j(s, a)$ not be optimal.

The final step is a quick implementation of an upper envelope method to discard sub-optimal points. The key is to partition the endogenous grid into increasing and decreasing regions. For the increasing regions, EGM works well to identify optimal consumption levels. For the non-increasing regions, if multiple segments contain an exogenous grid point, discard the one that provides less utility. For this last step use that the expected value under Logistic

[42] I would also like to thank Bence for generous conversations that helped to improve the computation.

cost distribution as follows:

$$\mathbb{E}_{s',F'}\left[V\left(s',a'\right)\right]=\mathbb{E}_{s'}\left\{\sigma_F\ln\left[\exp\left(\frac{\nu_L\left(s',a'\right)}{\sigma_F}\right)+\left(\frac{\nu_H\left(s',a'\right)-\mu_g}{\sigma_F}\right)\right]\right\}$$

Finally update the marginal value of assets using the envelope theorem valued on the obtained consumption $\partial_a\nu_j(s',a')=u'(c_j(s,a))$ and repeat until convergence.

B.1.3 Aggregation and other statistics

Given a distribution over idiosyncratic states for Unsophisticated and Investors households $\left\{\Psi^U(s,a),\Psi^I(s,a)\right\}$ aggregate consumption is,

$$\begin{aligned}C=\mu\cdot\int_{(s,a)}\left[P^U_{\mathcal{C}}(s,a)c^U_{\mathcal{C}}(s,a)+P^U_{\mathcal{S}}(s,a)c^U_{\mathcal{S}}(s,a)\right]d\Psi^U(s,a)+\\+(1-\mu)\cdot\left[P^I_{\mathcal{S}}(s,a)c^I_{\mathcal{S}}(s,a)+P^I_B(s,a)c^I_B(s,a)\right]d\Psi^I(s,a)\end{aligned}$$

Aggregate demand for checking deposits is,

$$\mathcal{C}=\mu\cdot\int_{(s,a)}\left[P^U_{\mathcal{C}}(s,a)\frac{a'^U_{\mathcal{C}}(s,a)}{1+r_{\mathcal{C}}}\right]d\Psi^U(s,a)$$

Demand for savings is,

$$\mathcal{S}=\mu\cdot\int_{(s,a)}\left[P^U_{\mathcal{S}}(s,a)\frac{a'^U_{\mathcal{S}}(s,a)}{1+r_{\mathcal{S}}}\right]d\Psi^U(s,a)+(1-\mu)\cdot\int_{(s,a)}\left[P^I_{\mathcal{S}}(s,a)\frac{a'^I_{\mathcal{S}}(s,a)}{1+r_{\mathcal{S}}}\right]d\Psi^I(s,a)$$

Demand for directly held government bonds is,

$$B=(1-\mu)\cdot\int_{(s,a)}\left[P^I_B(s,a)\frac{a'^I_B(s,a)}{1+r}\right]d\Psi^I(s,a)$$

The share of Bank-Dependent households is the share of households that choose deposits as their savings vehicle:

$$BD=\mu+(1-\mu)\cdot\int_{(s,a)}P^I_{\mathcal{S}}(s,a)d\Psi^I(s,a)$$

B.1.4 Numerical Computation of Elasticities

Calculating the elasticity of the demand for checking and savings is a key step for getting optimal deposit returns. Given that no close form exists for aggregate demands, these elasticities have to be computed numerically.

Due to the perfect foresight assumption, the household problem depends on the entire path for aggregates and prices. When calculating the current period elasticities, but since banks are small they take the path of aggregates (including its rates $\{r_C, r_S\}$) as given. Then, given a path for aggregates, the current period elasticity of checking and savings deposits with respect to the current r_S is computed numerically using simple differences. Take $h = 10^{-5}$, then:

$$\mathcal{S}'(r_S) = \frac{\mathcal{S}(r_S + h) - \mathcal{S}(r_S)}{h}$$

and therefore $\varepsilon_{\mathcal{S}} = \frac{\mathcal{S}'(r_S)}{\mathcal{S}(r_S)}$. Identically for checkings,

$$\mathcal{C}'(r_S) = \frac{\mathcal{C}(r_S + h) - \mathcal{C}(r_S)}{h}$$

and therefore $\varepsilon_{\mathcal{C}} = -\frac{\mathcal{C}'(r_S)}{\mathcal{C}(r_S)}$. Note that this cross elasticity is defined with the negative sign. To compute the elasticity with respect to the checking return repeat these steps.

B.1.5 Additional Results on Households Elasticities

This section explores additional results on households' elasticities in Section 3.6. I begin by decomposing individual elasticities into an extensive and intensive margin and show that numerically the extensive margin is responsible for the increasing pattern of Figure 6. Later, I show that this result depends on the distribution of the fixed cost, but that the result is valid for the classical distribution functions used in the literature. I will show the results for the savings market but the steps are equivalent for the checking market.

The aggregate semi-elasticity of savings funds is

$$\varepsilon^S \equiv \frac{\partial \mathcal{S}/\partial r^S}{\mathcal{S}}$$

and can be decomposed into

$$\varepsilon^S = \int_{(s,a)} \varepsilon^S(s,a) \cdot \omega_S(s,a)$$

In which I have used that,

$$\varepsilon^S(s,a) \equiv \frac{\partial d_S(s,a)}{\partial\, r_S} \cdot \frac{1}{d_S(s,a)} \tag{19}$$

$$\omega_S(s,a) \equiv \frac{d_S(s,a) \cdot \mathrm{d}\Psi(s,a)}{\int_{(s,a)} d_S(s,a) \cdot \mathrm{d}\Psi(s,a)} \tag{20}$$

Where $d_S(s,a)$ stands for average savings deposits held by households with states (s,a):

$$d_S(s,a) = \frac{P_S^U \frac{a_S'^U}{1+r_S}\, \mu\, \mathrm{d}\Psi^U(s,a) + P_S^I \frac{a_S'^I}{1+r_S}\, (1-\mu)\, \mathrm{d}\Psi^I(s,a)}{\mu\, \mathrm{d}\Psi^U(s,a) + (1-\mu)\, \mathrm{d}\Psi^I(s,a)}$$

and the measure Ψ is,

$$\Psi(s,a) = \mu\, \Psi^U(s,a) + (1-\mu)\, \Psi^I(s,a)$$

The following analysis will be clearer if I work with elasticities for one group at a time. First note that the elasticity of equation (19) for households with state (s,a) is a weighted average between groups:

$$\varepsilon^S(s,a) = \frac{\varepsilon^{U,S}(s,a) \cdot P_S^U \frac{a_S'^U}{1+r_S}\, \mu\, \mathrm{d}\Psi^U(s,a) + \varepsilon^{I,S}(s,a) \cdot P_S^I \frac{a_S'^I}{1+r_S}\, (1-\mu)\, \mathrm{d}\Psi^I(s,a)}{d(s,a)\, [\mu\, \mathrm{d}\Psi^U(s,a) + (1-\mu)\, \mathrm{d}\Psi^I(s,a)]}$$

where each individual elasticity is the object I will study in detail:

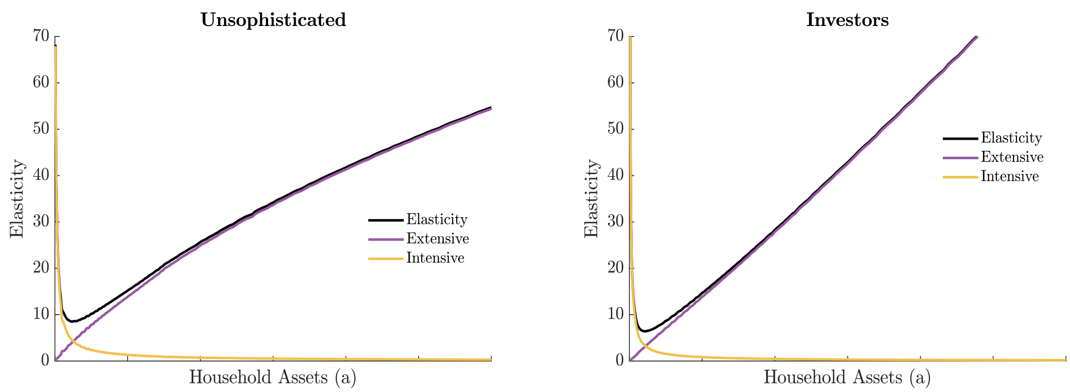
$$\varepsilon^{g,S}(s,a) = \frac{\partial \left[\frac{a_S'(s,a)}{1+r_S} P_S(s,a)\right]}{\partial r_S} \cdot \frac{1}{\left[\frac{a_S'(s,a)}{1+r_S} P_S(s,a)\right]}$$

I can now decompose $\varepsilon^{g,S}(s,a)$ into an extensive and an intensive margin. Call $\widehat{a}_S(s,a) \equiv \frac{a_S'(s,a)}{1+r_S}$ to the savings of a household that choose the savings market for simplicity. Expand the product to get

$$\varepsilon^{g,S}(s,a) = \underbrace{\frac{\partial \widehat{a}_S(s,a)}{\partial r_S}\frac{1}{\widehat{a}_S(s,a)}}_{\text{Intensive Margin}} + \underbrace{\frac{\partial P_S(s,a)}{\partial r_S}\frac{1}{P_S(s,a)}}_{\text{Extensive Margin}}$$

Note what these two terms represent: the intensive margin describes the semi-elasticity of the funds of those households that have chosen the savings market, and the extensive margin represents the semi-elasticity of households switching to/from the savings market. Figure 25 next show how these two margins shape household elasticity.

Figure 25: Decomposition of Elasticities



The figure shows that for low values of wealth, this elasticity is decreasing, driven by the intensive margin, which converges to zero as wealth increases. It is later increasing in wealth driven exclusively by the extensive margin. I can explore further the reasons behind these shapes.

Using the budget equation of the households we can get an intuition on why the intensive margin falls

$$\frac{\partial \widehat{a}_S(s,a)}{\partial r_S}\frac{1}{\widehat{a}_S(s,a)} = -\frac{\partial c_S(s,a)}{\partial r_S}\frac{1}{\widehat{a}_S(s,a)}$$

In incomplete market models, as households get wealthier, policy functions approach full insurance. We know that in full insurance models, the sensitivity of consumption to interest rate is small, then $\frac{\partial \widehat{a}_S(s,a)}{\partial r_S}\frac{1}{\widehat{a}_S(s,a)}$ is close to zero. Moreover, as the household gets wealthy, this number is divided by a large denominator, which pushes the intensive margin to zero. In other words, as the household gets wealthier, consumption is not sensitive to interest rates, especially relative to savings.

For the extensive margin, remember that a household will choose savings deposits that period if the draw in the cost F is such that,

$$\text{Unsphisticated: } \nu_{\mathcal{C}}^{U}(s,a) \leq \nu_{\mathcal{S}}^{U}(s,a) - F$$
$$\text{Investors: } \nu_{\mathcal{S}}^{I}(s,a) \geq \nu_{B}^{I}(s,a) - F$$

I assume that F was Logistically distributed, but let's keep it general for now and call G_g the distribution of F for each group $g = \{U, I\}$. Then, the share of households that choose the savings market of each group is,

$$\text{Unsphisticated: } P_S^U(s,a) = G_U\left(\nu_{\mathcal{S}}^{U}(s,a) - \nu_{\mathcal{C}}^{U}(s,a)\right)$$
$$\text{Investors: } P_S^I(s,a) = 1 - G_I\left(\nu_{B}^{I}(s,a) - \nu_{\mathcal{S}}^{I}(s,a)\right)$$

Two objects are key to generating an increasing extensive margin: the response of $\nu(s,a)$ to interest rates and the shape of $G(\cdot)$. The extensive margin therefore is,

$$\frac{\partial P_S^U(s,a)}{\partial r_S}\frac{1}{P_S^U(s,a)} = \frac{G_U'\left(\nu_{\mathcal{S}}^{U}(s,a) - \nu_{\mathcal{C}}^{U}(s,a)\right)}{G_U\left(\nu_{\mathcal{S}}^{U}(s,a) - \nu_{\mathcal{C}}^{U}(s,a)\right)} \cdot \frac{\partial \nu_S^U(s,a)}{\partial r_S} \tag{21}$$
$$\frac{\partial P_S^I(s,a)}{\partial r_S}\frac{1}{P_S^I(s,a)} = \frac{G_I'\left(\nu_{B}^{I}(s,a) - \nu_{\mathcal{S}}^{I}(s,a)\right)}{1 - G_I\left(\nu_{B}^{I}(s,a) - \nu_{\mathcal{S}}^{I}(s,a)\right)} \cdot \frac{\partial \nu_S^I(s,a)}{\partial r_S} \tag{22}$$

Using the Envelope theorem on the household's problem we get,

$$\frac{\partial \nu_S^g(s,a)}{\partial r_S} = u'(c_S^g)\widehat{a}_S^g\frac{1}{1+r_S}$$

For the log utility case used in the calibration the right hand side simplifies to assets holdings over consumption $u'(c_S^g)\widehat{a}_S^g\frac{1}{1+r_S} = \frac{\widehat{a}_S^g}{c_S^g}\frac{1}{1+r_S}$ which in these class of incomplete markets models is increasing in wealth. Then, we have the second component of the product in the right of equations (21) increasing in wealth. Next, I look at the first component that depends on $G(\cdot)$.

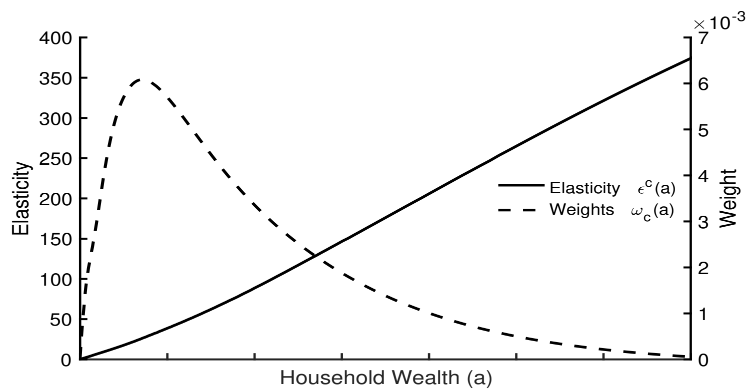
Let's focus first on the case of the investors. The denominator $\left[1 - G_I \left(\nu_B^I(s,a) - \nu_S^I(s,a)\right)\right]$ is decreasing in wealth since the value of bonds vs savings deposits increases with wealth.[43] Then, what we need for the investors' extensive margin to be increasing is that the slope of $G(\cdot)$ does not fall too quickly.[44] For the Logistic case, as well as Exponential or Uniform distribution, this is true.

Conditions for Unsophisticated households having an increasing elasticity are more strict. The reason is that once this households become very wealthy, savings deposits is their best option for consumption smoothing. Therefore, the extensive margin -the percent increase in the number of households- elasticity drops for high levels of wealth because the denominator $G_U(\cdot)$ becomes very large. At this point, however, the slope of the elasticity is controlled by Investors, given that they are a large presence in the savings market.

Decomposition of Checking funds semi-elasticity

In the same way that in Figure 6 is shown the decomposition of the semi-elasticity of savings funds into individual elasticities and weights, Figure 26 does for the checking funds.

Figure 26: Decomposition of aggregate semi-elasticity for checking funds



Note: Figure shows the two components of aggregate elasticity from equation (14).

[43]This is true for the relevant part of the wealth distribution. For the very top wealth holders, the relationship reverts. The reason is that in this model top wealthy households will not pay the cost and invest since the marginal value of consumption converges to zero.

[44]A sufficient condition is that the second derivative of G satisfies: $G'' \geq -\frac{(G')^2}{1-G}$.

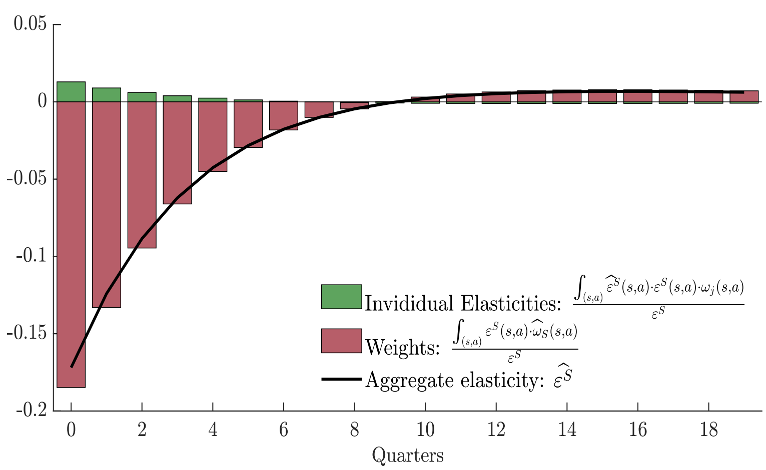
B.1.6 Additional Results on Households Elasticities: Dynamics

After a shock, movements in the aggregate elasticity of savings deposits can arise from changes in individual elasticities $\varepsilon^S(s,a)$ as well as movements in weights $\omega^S(s,a)$, as equation (14) shows. This section numerically shows that the moving piece of equation (14) after the shock are the weights and not the elasticities. To do this, differentiate equation (14) in logs around the steady state:

$$\widehat{\varepsilon}^S = \frac{\int_{(s,a)} \widehat{\varepsilon}^S(s,a) \cdot \varepsilon^S(s,a) \cdot \omega_j(s,a)}{\varepsilon^S} + \frac{\int_{(s,a)} \varepsilon^S(s,a) \cdot \widehat{\omega}_S(s,a)}{\varepsilon^S} \tag{23}$$

Where variables with a hat "$\widehat{\ }$" refer to deviations from steady state. Figure 27 shows the contribution of each component to the movement in aggregate elasticity after the same shock studied in Section 3.8. As shown in the figure, the redistribution of weights between households with different elasticities is responsible for the movements in the aggregate.

Figure 27: Decomposing the Movements in Elasticity



Note: The figure shows movements in the components of equation (23) after the the Phillips curve (7) with persistence studied in Section 3.8.

B.1.7 Computing Consumption Equivalent Changes

In this section, I show how to compute the required change in lifetime consumption to compensate between two economies with different aggregates paths. I focus on steady state environments which exclude deviations of inflation from trend.[45]

The welfare in the calibrated benchmark economy for an agent with state variables (s, a) -before the trading cost is realized- is given by the discounted value of optimal consumption c_t^* and trading decisions I_t^*:

$$V(s, a) = \mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t \left(u(c_t^*) - I_t^* \cdot F_t\right)\right]$$

(note that labor cost is not present because will be the same if both economies). If consumption in the benchmark economy increases by $\gamma\%$ -keeping the trading and savings decisions constant- the welfare of the agent is,

$$V_{\text{Bench}}(s, a; \gamma) = \mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t \left(u(c_t^*(1+\gamma)) - I_t^* \cdot F_t\right)\right]$$

Take an economy with high inflation, I will search for the value of γ such that

$$V_{\text{Bench}}(s, a; \gamma) = V_{\text{Inf}}(s, a)$$

for each pair (s, a). The computation of γ is not straightforward because $V(\cdot)$ is not homogenous in γ. However, the consumption part of the welfare is homogenous:

$$V_{\text{Bench}}(s, a; \gamma) = \mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t \left((1+\gamma)^{1-\sigma} u(c_t^*) - I_t^* \cdot F_t\right)\right]$$

Define,

$$U(\gamma) \equiv \mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t (1+\gamma)^{1-\sigma} u(c_t^*)\right]$$
$$\mathcal{F} \equiv \mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t I_t^* \cdot F_t\right]$$

[45]Inflation deviations from trend is relevant only in the short run. Since I only calculate welfare changes between steady states in the paper or under flexible prices, I exclude them from the equations. Adding this cost is straightforward.

Then, the consumption equivalent needed is obtained by,

$$\gamma(s,a) = \left[\frac{V_{\text{Inf}}(s,a) + \mathcal{F}_{\text{Bench}}(s,a)}{U_{\text{Bench}}(0)(s,a)}\right]^{\frac{1}{1-\sigma}}$$

The average γ is then computed as,

$$\overline{\gamma} = \int \gamma(s,a)\mathrm{d}\Psi(s,a)$$

where $\Psi(s,a)$ is the steady state distribution.

B.2 Additional Results on Calibration

This section shows additional results from the model and compares them with the data. All these moments have not been targeted.

Table 9 shows the model performance on measures of asset distribution. Getting this distribution right on simple heterogeneous agent models has been shown to be a challenge. The table shows that the model does a reasonable job in getting the asset distribution, especially if compared to the trimmed data, even without assuming a very unequal income process. The counterfactual scenario performed in Section 5.2 points to the heterogenous returns being the source of this success.

The size of the deposits market is 20% of GDP in the model which is very close to the 22% calculated using the definition of deposits in Section 2 and total income from the SCF in 2007. Also, bank profits are 0.76% of output in the model, which is very close to the 0.8% of the profits in the financial U.S. sector relative to private industry GDP.

The model generates an average marginal propensity to consume of 39%, a number on the upper bound of the range generally targetted in this class of models. It does so because the share of hand-to-mouth agents -those that are borrowing constrained- is 36%, which can be viewed as a large share.[46]

Finally, I compute the model counterpart of the transition matrix in Appendix A.2 (reproduced again here for clarity). As Table 10 shows, the model is able to generate some

[46] Although estimations of hand-to-mouth agents in the data can be greater than this number. See Table 2 of Boar, Gorea, and Midrigan (2021).

Table 9: Model performance on assets holdings distribution

	Model	Data	Data trimmed top 1%
Gini Assets	0.82	0.925	0.86
Gini Income	0.37	0.64	
Asset holdings share			
Top 10%	0.68	0.896	0.79
Top 20%	0.88	.955	0.9
50-80%	0.11	0.04	.08
0-50%	0.01	0.005	0.02

Note: Data calculations are for the year 2007 and are calculated using the SCF for the definition of liquid assets in Section 2. Income refers to total income. Data Trimmed re-do the calculation excluding the top 1% of asset holders from the sample.

persistence between Bank-dependency and the market investor-state, generated by the fact that wealth is persistent in these models. The assumption of idiosyncratic trading cost shocks needs to be relaxed for one that depends on the departing state if one wants to target this transition matrix.

Table 10: **Model**

	Deposits	Investor
Deposits	0.81	0.19
Investor	0.33	0.67

Table 11: **Data**

	Deposits	Investor
Deposits	0.94	0.06
Investor	0.02	0.98

B.3 Dynamics' Computation

The economy starts in the calibrated steady state with only idiosyncratic risk. I will study perfect foresight transition sequences after a small departure from steady state. By certainty equivalence, if the shock is transitory and small, the solution will be identical to the analogous economy with aggregate risk solved using conventional first-order perturbation techniques with respect to aggregate variables.

A fast and accurate methodology to solve these type of problems has been developed in

Auclert, Bardóczy, Rognlie, and Straub (2021) and extended to discrete choice problems in Bardóczy (2020). The idea is to obtain the truncated Jacobians of the equilibrium equations of the model. A key assumption for the accurate implementation of this method in my model is the presence of random trading costs in order to make aggregate demands smooth. For details on the method refer to the cited papers.

B.4 Labor Unions

Unions adjust nominal wages subject to a quadratic adjustment cost that enters into households' utility. In particular, I will assume that preferences of the households are $\tilde{v}(n_{ti}) = v(n_{ti}) + \frac{\psi}{2}\int_k \left(\frac{W_{kt}}{W_{kt-1}} - (1+\overline{\pi}_t)\right)^2 dk$ where $v(n_{ti})$ takes the functional form assumed in Section 3.7 and $\overline{\pi}_t$ is trend price inflation.[47] Total labor supplied by a household i is the aggregation over all the tasks k: $n_{ti} = \int_k n_{tik}\mathrm{dk}$[48]. It is assumed that unions use a uniform rule and call their members to work the same number of hours independently of their productivity and wealth $n_{tik} = N_{tk}$ where N_{tk} is the total hours in union k. Under this assumption the marginal cost of an extra hour supplied is equalized across households.

Given that the value of extra income is not equalized across households due to incomplete markets, union k is assumed to value income using the marginal utility of consumption valued at the average[49]. Under this assumptions, union k set wages following,

$$(1-\tau_t)(1-\varepsilon_{wt})N_{kt}\frac{1}{P_t}u'(C) + \varepsilon_{wt}v'(N)\frac{N_{kt}}{W_{kt}} = \psi\left[\frac{W_{kt}}{W_{kt-1}} - \overline{\pi}_t\right] - \beta\psi\left[\frac{W_{kt+1}}{W_{kt}} - \overline{\pi}_{t+1}\right]\frac{W_{kt+1}}{W_{kt}^2}$$

Note that the problem is symmetric in k. Simplifying and avoiding the time notation I get the non-linear Phillips curve on wages,

$$\widehat{\pi}_w(1+\pi_w) = \frac{\varepsilon_w}{\psi}N\left[v'(N) - (1-\tau)wu'(C)\frac{\varepsilon_w - 1}{\varepsilon_w}\right] + \beta\widehat{\pi}'_w(1+\pi'_w) \tag{24}$$

where $\widehat{\pi}_w$ are deviations from price trend inflation $\widehat{\pi}_w \equiv \pi_w - \overline{\pi}$. Under flexible prices -and in

[47] This assumes full indexation of wages to trend inflation at no cost

[48] Effective hours are $n_{ti} = \int_k s_{ti}n_{tik}\mathrm{dk}$

[49] This assumption has been previously used in Wolf (2021) among others and has been shown to have only negligible differences if compared to a union that maximizes the average utility of its members.

steady state-:

$$v'(N) = (1-\tau)wu'(C)\frac{\varepsilon_w - 1}{\varepsilon_w}$$

Linearizing equation (24) around steady state trend inflation gives equation (7).[50]

C Long-run Consequences of Inflation

This section complements Section 4.1 in the paper with additional results and explanations. It begins with deepening the understanding of why the passthrough from bond rates to savings rates is greater than one in the long run. Later, it presents additional results.

Response of Savings Return

From Section 3.6 we know that two key elements shape banks' optimal return on savings: the semi-elasticity of savings deposits ($\varepsilon^{\mathcal{S}}$) and the profits from checking ($\mathcal{C} \cdot (r - r_C)$).

How does the semi-elasticity of savings deposits ($\varepsilon^{\mathcal{S}}$) change in the new equilibrium and why? Remember from the analysis of Section 3.6 that the elasticity of deposits is the weighted sum of individual elasticities. I can decompose equation (14) into an average component and a covariance

$$\varepsilon^{\mathcal{S}} = \mathbb{E}\left[\varepsilon^{\mathcal{S}}(s,a)\right] + \operatorname{cov}\left(\varepsilon^{\mathcal{S}}(s,a), \frac{d^{\mathcal{S}}(s,a)}{\mathcal{S}}\right) \tag{25}$$

where the expectations are taken over the distribution of states $\Psi(s,a)$ and $d^{\mathcal{S}}(s,a)$ are the average holdings of savings deposits by households with states (s,a). The increase in inflation redistributes funds towards wealthy investors, which from Figure 6 we know are also the elastic households. This, pushes up the covariance term in equation (25). In the new steady state, the funds in the savings deposit market are now in the hands of the more elastic households, which pushes up the interest rate in equilibrium.[51]

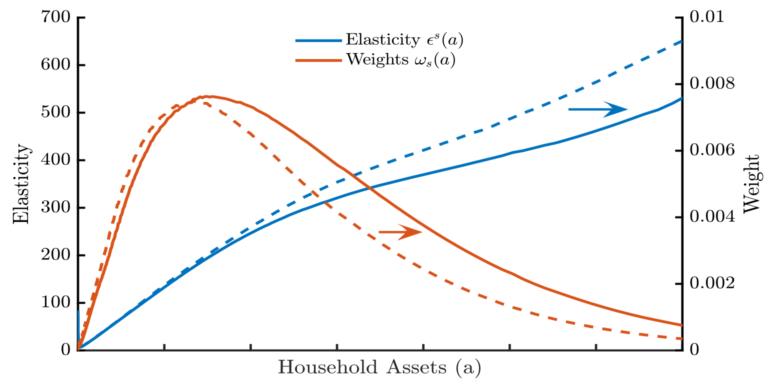
We can also reproduce Figure 6 again under high inflation to see how the new equilibrium shifts the holdings of savings deposits. The dashed line of Figure 28 reproduces the benchmark

[50]Note that in the linearization it is assumed that $\pi_w \approx 0$ and short run movements in tax rate are excluded. This decision does not have any substantial implication for my results and is just to get a standard Phillips curve. Some papers assume that short run tax adjustments are done using a different set of taxes, and not the labor tax, which is sufficient to get the derived Phillips curve.

[51]In fact, almost the entire rise in the elasticity is due to the increase in the covariance term.

equilibrium and the solid the new under high inflation.

Figure 28: Decomposition of aggregate semi-elasticity of savings funds



Note: Figure shows the two components of aggregate savings deposits elasticity from equation (14). The solid lines represent the high inflation steady state and the dashed ones the calibrated benchmark.

Additionally, the fall in checking rates disincentivizes households from keeping funds in the form of checking deposits. Therefore, even though the profits per unit of checking deposit $(r - r_{\mathcal{C}})$ increased, the quantity of checking deposits fall by more, reducing the incentives to lower the rate on savings in order to keep the funds in the form of checking. This force adds to the higher elasticity of savings deposits in pushing up the rate on savings in equilibrium.

Additional Results

Table 12 shows additional results in the equilibrium under high inflation and compares them with the benchmark economy.

D Short-run Consequences of Inflation

This section complements Section 4.2 in the paper with additional results and explanations.

Consumption Response

Figure 29 shows the response of consumption for different wealth groups and types of households after the shock studied in Section 4.2. The different pattern in the consumption

Table 12: Distributional Consequences of High Inflation

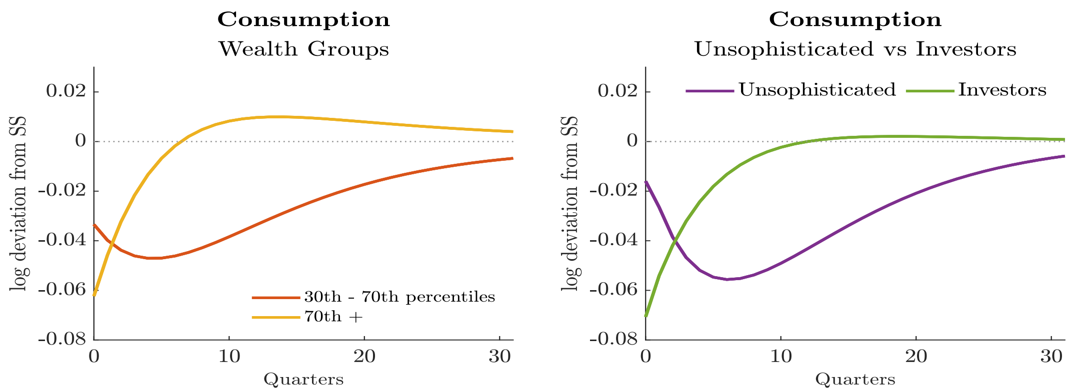
	Benchmark ($\bar{\pi} = 3\%$)	**High-inflation ($\bar{\pi} = 13\%$)**
Government bonds/Output	130%	126%
Share assets Unsophisticated	5.5%	2.8%
Share deposits Unsophisticated	34.5%	18%
Share assets 50-80th percentiles	11%	10%
Share assets bottom 50%	1.1%	0.5%
Bank-Dependent households	63.5%	64.1%
Share of deposits in total assets	15.8%	17.9%
Share of checking in deposits	23.6%	8.3%
Bank profits/Output	0.76%	0.62%
S.d. Consumption	0.516	0.523
S.d Consumption Unsophisticated	0.54	0.56
S.d Consumption Investors	0.497	0.496

response arises because households are exposed to different paths of real rates. In particular, households cut down consumption due to the decrease in income, but mid-wealth households decide to drain their assets and prevent a sharper drop because they are exposed to negative real rates.

Households Types Response

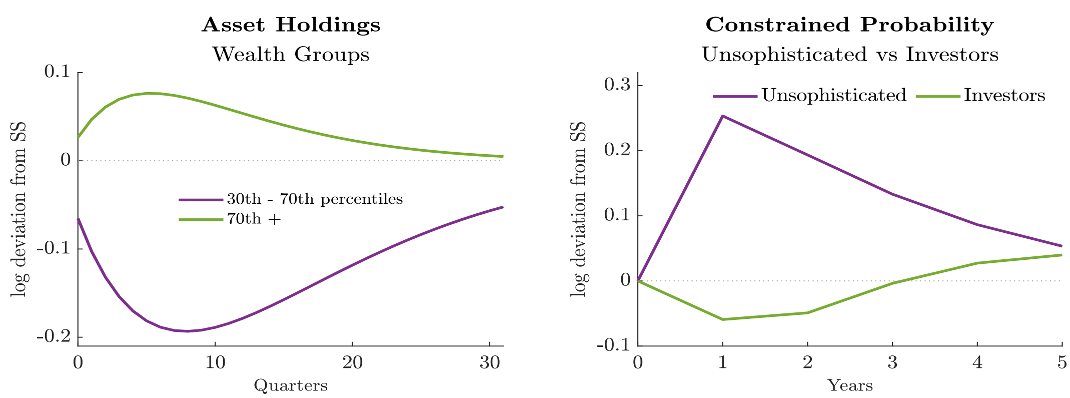
Figure 30 shows the average response to the shock studied in Section 4.2 but now splitting the population between the two ex-ante heterogeneous households. Note that the pattern is very similar to the case study in the body of the paper: Unsophisticated households are mainly poor households who save in the form of deposits and are exposed to negative real rates.

Figure 29: Consumption Response to a Supply Shock



Note: The figure shows the response of consumption after a shock to the Phillips curve (7) with persistence. Wealth groups are computed before the shock hits and the response of these same households are tracked.

Figure 30: Groups Response to a Supply Shock

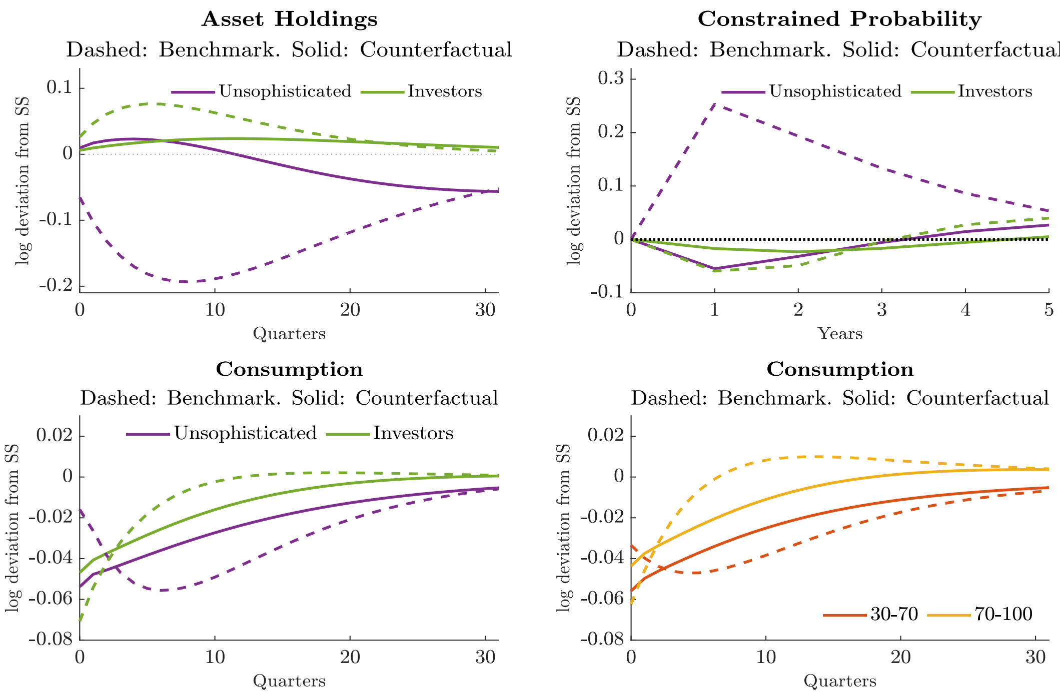


Note: The figure shows the response of average asset holdings and constrained probability after a shock to the Phillips curve (7) with persistence.

Full Passthrough Counterfactual

Figure 31 shows the response of additional variables to the supply shock and compares them with the counterfactual scenario that features full passthrough from market returns to deposit rates. The two bottom panels show how differently consumption responds when al;l interest rates move together. In particular, it is clear that mid-wealth households do not have extra incentives to reduce their asset holdings when there is full passthrough.

Figure 31: Groups Response to a Supply Shock



Note: The figure shows the response of the movements in average asset holdings, changes in the probability of hitting the borrowing constraint, and consumption after a shock to the Phillips curve (7) with persistence. The benchmark economy refers to the calibrated version. The counterfactual assumes that movements in interest rates are equalized (full passthrough). Wealth groups are computed before the shock hits and the response of these same households are tracked.

Full Passthrough: Unpacking the Different Response

In Section 4.2 it was shown that the same recession under full passthrough generates different paths of asset accumulation and constrained probability for mid-wealth households. However, the different path of bond rates between the two economies also generates a different path of taxes. This section decomposes the contribution of interest rates and taxes in driving the different responses between the two economies. For illustrative purposes, I focus here on the drivers of the path for average asset holdings.

The left panel of Figure 32 shows the path of average asset holdings for mid-wealth households in the benchmark and counterfactual economy. I will argue that the heterogeneous path of the interest rate plays an important role in driving the difference between the solid and dashed lines.

To decompose the effect between taxes and returns, I compute the response of average asset holdings of mid-wealth households fitting the path of taxes and returns, one at a time. That is, consider the path of interest rates and taxes in the benchmark economy $\{dr, dr_S, dr_C, d\tau\}$ and in the counterfactual economy $\{d\hat{r}, d\hat{r}_S, d\hat{r}_C, d\hat{\tau}\}$. Label the average path for mid-wealth asset holdings along the path $d\mathcal{A}(dr, dr_S, dr_C, d\tau, dS)$.

The violet bars in the right panel show the size of the distance between the solid and the dashed line in the left panel if only interest rates change between economies. That is, $d\mathcal{A}(d\hat{r}, d\hat{r}_S, d\hat{r}_C, d\tau) - d\mathcal{A}(dr, dr_S, dr_C, d\tau)$. The yellow bars in the right panel show the size of the distance between the solid and the dashed line in the left panel if only taxes change between economies. That is, $d\mathcal{A}(dr, dr_S, dr_C, d\hat{\tau}) - d\mathcal{A}(dr, dr_S, dr_C, d\tau)$. The sum of the violet and yellow bars add to the linear distance between the solid and dashed lines in the left panel.

What we can see in the figure is that the changes in the interest rates are the main driver, especially in early periods, of the extra asset accumulation by mid-wealth households in the counterfactual economy that features full passthrough.

Figure 32: Decomposing the Role of Interest Rates and Taxes