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On the distributive effects of inflation

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Non-Technical Summary

Two well-received ideas in monetary policy making are, first, that an inflation rate of 2% should be targeted and, second, that inflation acts as a tax on poorer households because money is foremost a mean of transaction. In fact, since poor households' consumption is a higher fraction of their wealth, the inflation tax affects them more than rich households. Whereas this idea is well documented in the literature, the first idea is at odds with a large strand of research that advocates the Friedman Rule. Yet, since the financial crisis, the case for higher long-run inflation rates has been revived since it could ease the constraint on monetary policy from the zero bound on interest rates.

This paper presents a mechanism that attributes to a higher long-run inflation target a welfare-improving feature because it redistributes wealth from debtor households to creditor households. This mechanism provides an additional argument in favor of the idea that a higher inflation target, of say 4%, has welfare improving features beyond easing policy makers' constraint from the zero lower bound.

Data from the Survey of Consumer Finance on household financial wealth suggests that about a third of the US population holds all its financial assets in transaction accounts. The remaining two-third of the US population holds most of their financial assets outside transaction accounts. This evidence suggests that for a large fraction of the population money is not only a mean of transaction but also a savings instrument. This paper shows that accounting for this evidence brings to the fore a mechanism that highlights that inflation redistributes wealth from creditor households to debtor households. A higher inflation rate reduces the benefits of holding money relative to capital, thereby crowding-in capital, which lowers the long-run real interest rate. Conversely this policy eases the budget constraint of indebted households and tightens the budget constraint of creditors, thereby redistributing wealth from households with a low marginal utility to households with a high marginal utility. Given empirical evidence on the debtor-creditor structure of households in the US, this paper shows numerically that a higher inflation rate can improve welfare.

On the distributive effects of inflation *

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Abstract

This paper undertakes a quantitative investigation of the effects of anticipated inflation on the distribution of household wealth and welfare. Consumer Finance Data on household financial wealth suggests that about a third of the US population holds all its financial assets in transaction accounts. The remaining two-third of the US population holds most of their financial assets outside transaction accounts. To account for this evidence, I introduce a portfolio choice in a standard incomplete markets model with heterogeneous agents. I calibrate the model economy to SCF 2010 US data and use this environment to study the distributive effects of changes in anticipated inflation. An increase in anticipated inflation leads households to reshuffle their portfolio towards real assets. This crowding-in of supply for real assets lowers equilibrium interest rates and thereby redistributes wealth from creditors to borrowers. Because borrowers have a higher marginal utility, this redistribution improves aggregate welfare. First, this paper shows that inflation acts not only a regressive consumption tax as in Erosa and Ventura (2002), but also as a progressive tax. Second, this paper shows that the welfare cost of inflation are even lower than the estimates computed by Lucas (2000) and Ireland (2009). Finally, this paper offers insights into why deflationary environments should be avoided.

Keywords: Anticipated Inflation, Monetary Policy, Incomplete markets, Heterogeneous agents, Endogenous Asset Market Participation

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1 Introduction

The aim of this paper is to evaluate the effects of anticipated inflation rate on the distribution of wealth, allocation and welfare. The literature on the welfare cost of inflation (Lucas 2000, Ireland 2009) inferred economic behavior at low levels of nominal interest rates by fitting monetary models to time series evidence from U.S. money demand. Lucas (2000) uses a model specification where money demand is not satiated and infers that reducing the annual inflation rate from 10 percent to zero is equivalent to an increase in real income of just under 1 percent. Based on post-2000 time series evidence, Ireland (2009) argues that the money demand is satiated at low level of nominal interest rates, implying that the deadweight loss from positive inflation rates is substantially lower and closer to 0.25 percentage point of consumption equivalence. Both Lucas (2000) and Ireland (2009) agree that the welfare cost of inflation are small and conclude their analysis by stressing the need to enrich the analysis of the welfare cost of inflation with additional evidence from cross-sectional data. In particular, the extensive margin, household's decision to enter or exit financial markets, may be important enough to cancel out potential welfare gains from reducing inflation. In fact, ceteris paribus, a lower inflation rate reduces the cost of holding money, thereby making money a more valued asset and thus reducing the resources wasted in economizing on cash holdings.[1] This paper contributes to this literature by showing how insights from cross-sectional evidence on household portfolio choice enriches our understanding of the welfare cost of inflation, in particular because of its distributive component. I account for the heterogeneity of portfolio holdings by embedding both an extensive margin, namely households' decision to participate in financial markets, and a nominal asset (money) into an incomplete markets economy with heterogeneous agents which I calibrate to US data. I show that accounting for the extensive margin nuances the conclusions from the literature on the welfare cost of inflation: higher inflation rates can be welfare improving across steady state equilibria.

The main mechanism of the model is reminiscent of the Mundell-Tobin Effect (Tobin 1965, Mundell 1963). A higher anticipated inflation rate renders holding money more costly while making the fixed cost of participating in financial markets more worthwhile. Therefore, a higher inflation rate crowds capital into financial markets thereby reducing the equilibrium interest rate. In spite of more resources being wasted in paying participation costs, due to higher financial market participation rates, and lower lump sum transfer, due to lower aggregate money holdings, aggregate welfare is improved. The increased equi-

[1] "... work by Mulligan and Sala-i Martin (1996) assumes that there is a fixed cost of holding positive amounts of interest bearing securities, and that households who hold only cash do not incur this cost. In this case, if a monetary policy driving interest rates to zero were implemented, more and more households would decide not to incur this fixed cost, which is to say that fewer and fewer households would be using resources to economize on cash holdings. The presence of such cost might be undetectable in aggregate time series, yet important enough to completely negate any welfare gain from reducing interest rates from, say, 1.5 percent to zero."(Lucas 2000)

librium inflation rate redistributes wealth at the household level (via changes in decision and equilibrium prices) an thereby generates an endogenous distribution of the welfare cost of inflation. In a nutshell, this paper shows that the welfare cost of inflation is even smaller than those previously estimated in frameworks that do not take into account cross-sectional evidence on portfolio holdings of households. The mechanism quantified herein improves our understanding of the distributive effects of inflation in models with agent heterogeneity and contrast previous evidence (Erosa and Ventura 2002). Whereas Erosa and Ventura (2002)Albanesi (2007) show that if money is motivated for its transaction motive, inflation acts as a tax on wealth poor households, in this paper where money is motivated as asset, a higher inflation rate redistributes wealth from wealth rich (creditors) households to wealth poor (debtors) households, and thereby acts as a progressive tax.

This paper is at the nexus of the literature on the welfare cost of inflation and the quantitative macroeconomics literature with heterogeneous households. Although the idea that inflation redistributes wealth is not a new one (Baumol 1952, Tobin 1956, Mundell 1963), only few papers have attempted to shed light on the effect of monetary policy in frameworks that allow to account for endogenous distribution of wealth (Heathcote, Storesletten, and Violante 2009). The existing literature on the distributive effects of anticipated inflation suggests that the burden of inflation is mostly born by (wealth) poor households (Erosa and Ventura 2002, Albanesi 2007). Empirical evidence from the Survey of Consumer Finance, [2] consistently shows that a Lorenz curve of liquid assets relative to financial wealth displays substantial heterogeneity in patterns of liquid assets holdings. In particular, it shows that the fraction of liquid, mostly nominal, assets decreases with financial wealth. As shown in Erosa and Ventura (2002), this empirical observation can be rationalized with a standard incomplete markets model with a cash-in-advance constraint. In fact, when money is modelled as a means of transaction (via a cash-in-advance constraint), wealth poor households hold relatively more cash than wealthy households to satisfy their consumption needs. Given that in such environments inflation acts as a tax on consumption, a higher anticipated inflation rate taxes poor households at a higher rate than rich households. However, as pointed out by Ragot (2013) the heterogeneity in money holdings generated by a transaction technology, does not allow to account for the fact that the distribution in money holdings across households resembles the distribution of financial wealth rather than the distribution of consumption expenditures. Ragot (2013) shows that only by modelling both a friction in the goods market (CIA constraint) and a friction in financial markets (an adjustment cost) allows to generate a realistic joint distribution of money and financial assets. In particular, he shows that the financial motive, induced by the adjustment cost, accounts for 78% of money demand. Whereas the focus of Ragot (2013) is on matching the joint distribution of money demand and financial wealth by taking prices as given, this paper focuses on matching the creditor-debtor structure of

[2] See Section 2 but also Kennickell and Starr-McCluer (1997)

household wealth, so as to account for the distributive effects of inflation via its effect on the equilibrium interest rate.

In parallel a literature has been assessing the effects of changes in unanticipated inflation. In particular Doepke and Schneider (2006b) document that unanticipated inflation redistributes wealth from wealth rich, retired households towards mostly young, middle class households, who have access to debt (mostly fixed rate mortgage debt). In contrast to Erosa and Ventura (2002) and Ragot (2013), they account for the role of money as a unit of account for assets and liabilities. Whereas in Erosa and Ventura (2002) money is only motivate for its transaction purpose, Doepke and Schneider (2006b) consider nominal assets more broadly, and account for both nominal asset (directly and indirectly held) and cash positions, which magnifies the magnitude of wealth redistribution. Based on these empirical findings, Doepke and Schneider (2006a) feed their empirical finding into a partial equilibrium life cycle model to assess the aggregate effects of inflation. Unanticipated inflation hurts retired households because they can not adjust their labor supply, and benefits young household who take up more leisure. Both responses lead to a drop in labor supply. Regarding the capital stock level, young households increase their savings by a fraction of the gained redistribution, whereas the old households reduce their consumption (given that it is optimal for them to reduce their wealth), which means that the capital stock rises as a response to an unanticipated inflation shock. The initial drop in output due to the reduction in labor supply is compensated within two decades, point at which the economy grows faster than its balance growth path, and returns to it's initial level in 40 year's time. The present paper shows that the redistribution from creditors to debtors that is a well documented consequence of unanticipated inflation is also at work for anticipated inflation. Whereas in the case of unanticipated inflation it is a direct accounting effect (via the value of the unit of account), in the case of anticipated inflation the redistribution is indirect and works via its general equilibrium effect on the interest rate and wages.

This paper contributes to the debate on the welfare cost of inflation by emphasizing three facts. Firstly, this paper contributes to our understanding of importance of the creditor debtor structure of households for the conduct of monetary policy. Secondly, it delivers insights into the financial motive to hold money, and in particular how this motive makes deflationary environments welfare reducing. Finally, this paper completes the analysis on the welfare cost of inflation as offered by Lucas (2000) Ireland (2009), and shows that the extensive margin further reduces the welfare cost of inflation.

The paper proceeds as follows. Section 2 documents empirical evidence from US household data. Section 3 presents the model. Section 4 calibrates the model to the US economy and assesses the quantitative performance of the model. Section 5 and 6 documents the distributive effects effects of inflation through the lens of the model. Section 7 concludes.

2 Empirical evidence on household portfolio data

2.1 Data

In this subsection, I describe and justify the measures of assets and debts that I consider for my empirical analysis of household portfolio holdings and the creditor debtor structure of the household side of economy. I use the 2010 Survey of Consumer Finances (SCF). The SCF is a triennial cross-sectional survey that offers detailed information on household assets and liabilities.

The key effect that this paper aims at disentangling is the redistribution between debtors and creditors induced by changes in anticipated inflation. The sample therefore includes households with negative net worth, which is not typically the case in the household finance literature. For instance, when this literature documents the stockholding puzzle, they condition their sample to households with positive net-worth (Vissing-Jorgensen 2003). Similarly the literature on the agent heterogeneity and macroeconomic policies usually assumes away borrowing. In fact, although there is a substantial literature on the effect of borrowing constraint (Aiyagari 1994, Ríos-Rull, Corbae, and Chatterjee 2007, Ábrahám and Cárceles-Poveda 2010), borrowing has been assumed away in the context of fiscal (Domeij and Heathcote 2004) or monetary policy (Erosa and Ventura 2002, Ragot 2013), where a non-negativity constraint on asset/capital holdings is usually imposed. This paper goes alongside the recent evidence that documents the importance of the liability side of households' balance sheet and it's potential impact for macroeconomic policies (Vissing-Jø rgensen 2007, Guiso and Sodini 2012).

Given that our model disentangles the effects of anticipated inflation on the debtor creditor structure of the economy, we need to define the notion of wealth to which the model presented in section 3 will be calibrated. On the liability side of the households balance sheet, we incorporate only unsecured debt (OTHLOC, CCBAL, INSTALL, ODEBT) and not secured debt, as it is widely acknowledged that taking up unsecured and secured debt involve different decision making mechanism. On the asset side, we consider total financial assets (FIN) and we ignore total non-financial assets as our model does not offer scope for accounting for durables/non-durables consumption. The assets that we will call nominal are all types of transaction accounts (LIQ), as in Telyukova (2013) and Ragot (2013), and the assets that we will consider to be real, i.e. shielded against anticipated inflation, are the remainder of the financial assets. Subsequently, total net worth is defined as the sum of unsecured debt and total financial wealth. For a detailed account of the household balance sheet and the acronyms in parenthesis, see Appendix 8.1.

2.2 Stockholding puzzle

A large literature pioneered by Haliassos and Bertaut (1995) documents the stockholding puzzle, namely that a large fraction of households do not hold financial assets beyond

their deposit account. In fact, empirical evidence from the household finance literature documents the low participation rates of households in financial markets across OECD economics (See Table 1). Mulligan and Sala-i Martin (2000) and Guiso (2003) estimate that 59% and 48% respectively of the US population hold no interest-bearing financial assets.

Table 1: Proportion of households investing in stocks (Source: Table 1 in Guiso, Sapienza, and Zingales (2008))

% of population	FR	DE	IT	NL	SWE	UK	US
Direct Participation	14.4	14	4	17.2	41	21.6	19.2
Direct and Indirect Participation	23	22.9	8.2	24.1	66.2	31.5	48.9

Several attempts have been made using micro-econometric techniques to test various frictions (Participation costs, non-standard preferences and belief heterogeneity) that can rationalize this puzzle. As argued by Guiso and Sodini (2012), the literature (Vissing-Jorgensen 2002, Paiella 2007, Attanasio and Paiella 2011) computed cost estimates that are sufficiently small to be reasonable and make the cost friction a likely candidate to rationalize the stockholding puzzle. Yet this literature offers competing theories as to which cost-type can rationalize the non-participation observed in the data. Vissing-Jorgensen (2002) tests various cost types, namely variable, entry and per-period costs and evaluates which costs are most successful at explaining the stockholding puzzle. Her results suggest that the fixed per-period cost performs best. She estimates that yearly costs of \$260 (\$1000) can respectively rationalize 2/3 (the whole) non-participation of US households. This evidence shows that the low percentage of households participation in financial markets is a salient feature of the data and suggests that the extensive margin of households financial decision is key to understanding the heterogeneity in portfolio holdings and thereby the welfare cost of inflation, as suggested by Lucas (2000).

2.3 Cross-sectional heterogeneity in household portfolio holdings

The previous subsection revisited the empirical fact that few households participate in financial markets. This subsection documents, based on the SCF (2010), what portfolio allocation rule accommodates the cross-sectional heterogeneity of households' portfolio choices well. The empirical evidence presented herein shows that the fraction of nominal assets held by households decreases with their financial wealth. Figure 1 shows a Lorenz curve for nominal assets, where the cumulative density function of wealth is plotted against the cumulative density function of nominal assets. The bottom 20% of households in terms of financial wealth hold 83% of the total amount of nominal assets, suggesting a higher than average holding of nominal assets. Symmetrically, the top 20% of households in

terms of financial wealth barely holds any nominal assets. This suggests that the exposure of households to inflation, which can be understood as a tax on nominal assets, is more than proportional for households at the bottom of the wealth distribution and less than proportional for households at the top of the wealth distribution. This observation goes along with most of the existing literature on the distributive effect of inflation, as they usually reach the conclusion that inflation is a tax on the poor (Erosa and Ventura 2002, Albanesi 2007)). However, as argued in Ragot (2013), figure 1 shows that indeed the distribution of money holdings is similar to that of net wealth and very different from that of consumption, as would suggest Erosa and Ventura (2002).

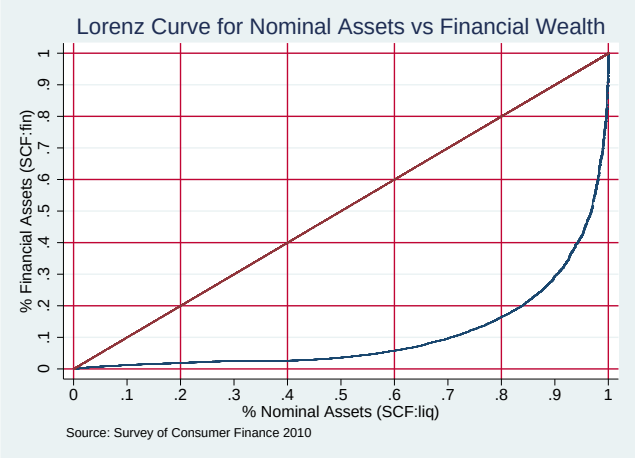

Figure 1: Lorenz Curve of money holdings

From the above figure, little can be inferred about households' portfolio composition. To document this, I compute the ratio of money holdings to total financial assets, and plot the kernel density of this ratio in figure 2.

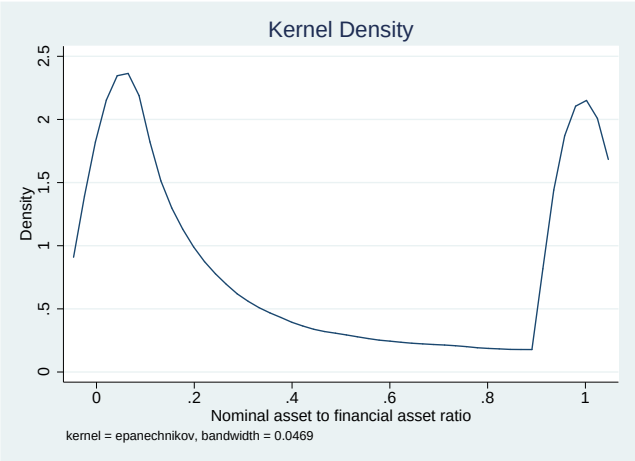

Figure 2: Density function of the money holdings to total financial assets ratio

The density function is bimodal, suggesting that a lot of the heterogeneity in patterns of portfolio allocation between nominal and real assets can be explained by a rule of thumb according to which households either hold all their financial assets in nominal assets or very little of it (relative to their financial asset holdings). This evidence strengthens the argument in favour of the importance of fixed per-period costs to participating in financial markets: in an environment with a fixed cost and 2 assets (one strictly dominating the other but requiring a fixed cost), it is optimal to allocate all financial wealth in the return-dominating asset once the fixed cost is sunk. This evidence suggests that a fixed cost argument delivers a reasonable approximation of the evidence on cross-section of portfolio allocation rules: households do not participate in financial markets and have a high nominal asset to financial wealth ratio (right mode), or they have a low nominals asset to financial wealth ratio (left mode) and hold their wealth in the return dominating asset.

3 A monetary economy

The outlined economy consists of many, ex-ante identical, infinitely lived households. Asset markets are incomplete and households self-insure against an idiosyncratic productivity risk by holding money, or interest-bearing real claims to capital if they pay a fixed per-period participation cost. In equilibrium, in spite of money being dominated in return, the mass of households that can't afford the per-period participation cost will hold money as in Imrohoroglu (1992). However, conditionally on paying the participation cost, households face an economic environment identical to Aiyagari (1994).

3.1 Model Description

Preferences Households derive utility from consumption and supply labor inelastically. Their objective is to maximize the discounted sum of expected utility.

$$\sum_{t=0}^{\infty} \beta^t U(c_{i,t})$$

where $0 < \beta < 1$ is the discount factor and $c_{i,t}$ consumption level of household i at time t. The utility function is assumed to be of the CRRA type and γ is the coefficient of relative risk aversion.

Idiosyncratic earnings Household are subject to idiosyncratic shocks ($\epsilon_{i,t}$) on their labor productivity ($z_{i,t}$) which follows an autoregressive process with persistence (ρ) and variance (σ_ϵ^2).

$$\log(z_{i,t}) = \rho \log(z_{i,t-1}) + \epsilon_{i,t}$$

Firm The representative firm produces a composite good using a production function $F(K_t, N_t)$, where K_t is the aggregate capital stock and N_t is aggregate labor measured in efficiency units. The production technology is Cobb-Douglas and capital depreciates at the rate δ.

Factor markets are competitive, the rental rate on capital is denoted by r_t and the real wage per efficiency unit by w_t.

Central Bank The Central Bank sets μ_t, the growth rate of the nominal money stock, which is denoted by $\tilde{M}_t$. The law of motion of the aggregate nominal money stock reads as follows:

$$\tilde{M}_{t+1} = (1 + \mu_t)\tilde{M}_t$$

The revenues from seigniorage are redistributed in a lump-sum fashion to all households and I abstract from government spending. The central bank budget constraint determines the level of lump sum transfers as a function of the real money stock (M_t), the money growth rate, and the inflation rate (π_t).

$$\tau_t = \frac{\mu_t}{1 + \pi_t} M_t$$

Asset Markets In this economy, two assets are traded, namely money and claims to capital. The purchase of an interest-bearing real asset in period t of value $a_{i,t+1}$ means that the household entered into a financial contract with a firm which promises $a_{i,t+1}(1 + r_{t+1})$ in period $t + 1$. For the financial agency to take place, it is assumed that a fixed per period cost q is levied onto the household. This is independent on whether she is lending or borrowing.

Alternatively, households can store their wealth in money. If households decide in period t to hold an amount $m_{i,t+1}$ of real money holdings, they are subject to the inflation tax, as in period $t+1$ the real value of the real wealth transfer is $\frac{m_{i,t+1}}{1+\pi_t}$, where π_t denotes the inflation rate.

3.2 Decision Problems

The timing of the economy is as follows. (i) idiosyncratic shocks $s_{i,t}$ are drawn, (ii) capital and labor are rented, and production takes place, (iii) household decide on asset market participation and on borrowing/savings decisions, and (iv) consumption of the composite good takes place. In the following, I will focus on steady state equilibria, where $w = w_t$, $r = r_t$ and $\pi = \pi_t$. [3]

Household Problem Let $\mathbf{s} = (x, z)$ denote the vector of individual state variables, namely financial wealth x and labor productivity z and $V(\mathbf{s})$ the value function which

[3] For the sake of notational clarity the following recursive formulation of households' decision problem denotes any period t variable x_t by x and any period $t + 1$ by x'.

denotes its expected lifetime utility. The value function of the household is

$$V(\mathbf{s}) = \max_{\mathbf{1}(\mathbf{s})=\{0,1\}} \{V_0(\mathbf{s}), V_1(\mathbf{s})\} \tag{1}$$

where $V_0(\mathbf{s})$ and $V_1(\mathbf{s})$ are the value function of participating in the nominal asset market (holding money) and the value function of participating in the real asset market, respectively.

The policy function for the participation decision ($\mathbf{1}(\mathbf{s})$) can be derived as follows.

$$\mathbf{1}(\mathbf{s}) = \begin{cases} 1, & \text{if } \overline{x} \in X_p, \\ 0, & \text{otherwise.} \end{cases} \tag{2}$$

where $X_p \equiv \{\overline{x} : V_1(\overline{x}, z) > V_0(\overline{x}, z)\}$ defines the state space in which household will find it worthwhile to pay the fixed cost and participate in financial markets.

A household who chooses to remain outside the real asset market solves the following dynamic problem:

$$V_0(\mathbf{s}) = \max_{c,m'} U(c) + \beta E_{z'} V(\mathbf{s}'|z) \tag{3}$$

s.t.

$$c + m' = wz + \frac{m}{1+\pi} + \tau \quad m' > 0 \tag{4}$$

where m' denotes tomorrow's money holdings, wz the labor income of the household given productivity level z, τ the lump-sum transfer from the government and $\frac{m}{1+\pi}$ denotes today's money holdings adjusted by the inflation tax. Beyond the budget constraint, the household faces a non-negativity constraint on his real money holdings.

A household who chooses to enter financial markets solves the following dynamic problem:

$$V_1(\mathbf{s}) = \max_{c,a'} U(c) + \beta E_{z'} V(\mathbf{s}'|z) \tag{5}$$

s.t.

$$c + a' + q = wz + (1+r)a + \tau \quad a' > -\phi \tag{6}$$

where a' denotes tomorrow's real asset holdings, and a denotes today's real asset holdings. A household that participates in financial markets can borrow up to the exogenously set borrowing limit ϕ.

Firms The representative firm faces a static optimization problem and maximizes profits. The necessary conditions for profit maximization imply the following prices for capital and labor.

$$w = (1-\alpha)\left(\frac{K}{L}\right)^{\alpha}$$

$$r = \alpha \left(\frac{L}{K}\right)^{1-\alpha} - \delta$$

where w, r denote the real wage and real interest rate, L the aggregate labor supply, K the aggregate capital stock, α the capital share, and δ the capital depreciation rate.

Central Bank In a monetary equilibrium, money growth rate must equal the inflation rate (π). This equilibrium condition determines the following expression for lump-sum transfers (τ).

$$\tau = \frac{\pi}{1+\pi} M$$

where M is the equilibrium level of real money holdings.

3.3 Market Clearing and Stationary Equilibrium

In this subsection, I define the stationary monetary competitive equilibrium of this economy.

Definition 3.1 (Equilibrium definition)**.** Given a borrowing limit ϕ, a positive fixed cost q and an exogenous money growth rate $\mu \in \Pi$, a stationary monetary competitive equilibrium is a set of strictly positive prices w, r, strictly positive quantities of aggregate capital K and aggregate real money M, decision rules $a'(x,s), m'(x,s)$, $\mathbf{1}_{a\neq 0}(x,s)$ and a probability distribution $\lambda(x,s)$ such that:

1. The prices (w,r) satisfy the static optimization problem of the representative firm.
2. The policy functions $c(x,s)$, $a'(x,s)$, $m'(x,s)$, $\mathbf{1}'_{a\neq 0}(x,s)$ solve the household's maximization problem.
3. The probability distribution $\lambda(x,s)$ is a stationary distribution s.t.

$$\lambda(x',s') = \int_s \int_x \lambda(x,s)\Gamma(s,ds')$$

4. The asset market clears.

$$\int_x \int_s \mathbf{1}_{a\neq 0}(x,s) a'(x,s) \lambda(x,s) = K$$

5. The money market clears.

$$\int_x \int_s (\mathbf{1} - \mathbf{1}_{a\neq 0}(x,s)) m'(x,s) \lambda(x,s) = M$$

6. The commodity market clears.

$$K + C + q \int_s \int_x \mathbf{1}_{a\neq 0}(x,s)\lambda(x,s) = F(K,L) + (1-\delta)K$$

7. The Central bank budget constraint is satisfied.

$$\tau = \frac{\pi}{1+\pi} M$$

By Walras law, the commodity market will clear when the money and capital markets are in equilibrium.

For a steady state to exist such that $K > 0$, given that $q > 0$, the set of feasible inflation rates need to be restricted. By applying a no-arbitrage argument, equilibrium existence requires $\pi_{min} > -\frac{r-q/a'}{1+r-q/a'}$. If this condition is not fulfilled, all household will find it worthwhile to not participate in financial markets, as a consequence the capital stock will be nil, and the equilibrium as defined in Definition 3.1 does not exist.

4 Calibration

The model period is one year. Tables 2 and 3 show the parameter values at an annual frequency in the benchmark model.

Table 2 document the parameters that are fixed exogenously. The preference and technology parameters have been set to standard values. The risk aversion parameter (γ) is set to 2 and the capital share (α) is set to 0.36. The inflation rate (π) is fixed to 2% as suggests the average US inflation rate since 1949.

Table 2: Parameter values

β	γ	δ	α	π
0.96	2	0.08	0.64	0.02

Table 3 document the parameters that are calibrated and those that are estimated from data. The parameters guiding the household productivity process (ρ,σ) are estimated using PSID data (2003-2009) on hourly wages, following Floden and Lindé (2001). The obtained parameter values are slightly higher than those obtained by Floden and Lindé (2001) which suggests that earnings inequality has risen over the past decade in the US, and they are consistent with other estimates in the literature (Heathcote, Storesletten, and Violante 2010).

The participation cost (q) and the borrowing limit (ϕ) are jointly calibrated so as to match the fraction of households with negative wealth and the fraction of household who only hold nominal assets. The two targets are computed from SCF (2010) data, where the notion of nominal asset and wealth are adjusted as described in section 2.1. As documented in table 3, the fraction of household who hold all their wealth in nominal

Table 3: Calibrated and estimated parameters

Parameter	Value	Target	Source
q	0.0201	$\int \lambda(x)(\mathbf{1}=0)dx = 0.14$	SCF (2010)
ϕ	1.2367	$\int_{\phi}^{0} \lambda(x)dx = 0.28$	SCF (2010)
ρ	0.96	Estimated	PSID (2003-2009)
σ_{ϵ}^{2}	0.023	Estimated	PSID (2003-2009)
r	0.0236	Endogenous	

Table 4: Quantitative performance of the model

Variable Description	Source	US Data	Model
M1/GNP	Erosa and Ventura (2002)	11.8%	0.54%
Asset Gini Coeff.	Ríos-Rull, Corbae, and Chatterjee (2007)	0.78	0.743
Wealth Gini Coeff.	Diaz-Giménez, Glover, and Ríos-Rull (2011)	0.82	0.743
Money Gini Coeff.	Ragot (2013)	0.83	0.96
Financial sector (%GNP)			0.72%
$\phi/\bar{y}$			119%
$q/\bar{y}$	Vissing-Jorgensen (2002)	[.7-2.7]%	1.2%
Unsecured Debt (%GNP)			13.24%

assets amounts to 14%, and the fraction of household with negative net-worth amounts to 28.7%. Finally, the endogenous equilibrium interest rate that clears the capital market is 2.36%, which implies a nominal interest rate of the calibrated economy amounts to 4.36%.

Table 4 displays some variables from the model economy and contrasts them with data in order to put the quantitative performance of the model into perspective.

The calibrated economy generates a real money stock which amounts to 0.5% of GNP. Erosa and Ventura (2002) computes a ratio of 11.8% for US data over the 1980-1996 period and adjusts for the fact that roughly a quarter of US currency is not in the hand of US residents. This model generates an equilibrium money stock that is substantially lower than the one observed in aggregate data. However, this money stock is held only due to the presence of participation cost in financial markets. Combining this motive with a transaction motive as in Ragot (2013) allows to obtain a better quantitative match in terms of monetary aggregates. The focus of this paper is however, simply to show how the existence of this motive for holding money generates redistribution when the anticipated inflation rate changes via general equilibrium effects. An alley for future research would indeed be to combine the insights of Ragot (2013) into a general equilibrium model to account fully for the redistributive effects of long-run anticipated inflation.

In terms of wealth and asset heterogeneity, the model performs rather well compared to standard exogenously incomplete markets model (in general equilibrium). Both the Gini coefficients for wealth and asset holdings are relative close to empirical estimates, which

is attributable to the fact that this paper puts substantial discipline via the calibration on credit-debt structure of household wealth. However, in terms of ordering the model fails to account for the fact that wealth is more unequally distributed than asset holdings, which is due to the low level of money stock held in equilibrium. The Gini coefficient for money holdings is very high, which is a bi-product to the full asset market segmentation. Because households either hold money or assets, and in equilibrium 14% of them hold all their wealth in money, this framework generates a high degree of inequality in money holdings. This is roughly in line with the ordering of Gini coefficients as table 4 shows.

The calibrated parameters, namely the borrowing limit (ϕ) and the annual participation cost (q) amount both respectively to 1.19 and 0.012 of average annual income. To generate a fraction of net-debtors of 28%, households need to be able to borrow up to 119% of their annual income. Moreover in order to generate a fraction of household that hold all their wealth in nominal assets a fixed annual participation cost that amounts to 1.2% of average annual income is required. Mapped this calibrated estimate into the estimates of Vissing-Jorgensen (2002), these estimates are reasonable.

5 The distributive effects of inflation

In this section, I document the aggregate effects as well as the distributive effects of anticipated inflation.

5.1 Endogenous Full Asset Market Segmentation

The annual participation cost endogenously gives rise to asset market segmentation. For a given set of prices, a fraction of household will decide to remain outside financial markets ($\mathbf{1}(x) = 0$). However, if households participate in financial markets ($\mathbf{1}(x) = 1$) and pay the fixed cost q, they are can either borrow or lend. The household that becomes a debtor can borrow up to the amount ϕ. It is important to note that because of the non-negativity constraint on money holdings, a fraction of household that is close to the borrowing limit has to roll-over debt if their productivity draw does not allow them to repay the amount they borrowed. In other words, there is not only a borrowing limit for asset market participants, but also a participation constraint for money holders, such that households can only become money holder if their wealth is greater than $\underline{x}$.

$$\underline{x} \geq -\frac{wz + \tau}{1 + r}$$

This participation constraint is the mere reformulation of the budget constraint of an indebted household that would switch and become a money holder.

In equilibrium, we therefore have a fraction of indebted households (debtors) that rolls over debt to finance consumption, a fraction of household (money holders) that can not

afford to participate in financial markets and smooths consumption with a nominal asset, and finally, a fraction of households (creditors) that participates in financial markets, incurs the fixed participation cost and smooths consumption with a real asset.

In the following subsection, I will discuss the effect of anticipated inflation in light of these three types of households.

5.2 Aggregate Effects of Inflation and Deflation

Table 5 shows that the effects of inflation on economic aggregates are very small unless the inflation rate is negative. This model economy offers insights into why a deflationary environment is to be avoided, as I will discuss below. Moreover, although aggregate effects are small, substantial redistribution takes place, and inflation affects the debtor-creditor structure of the economy.

An increase in the rate of anticipated inflation lowers the indirect utility of smoothing consumption with a nominal assets and reduces the fraction of money holders and the aggregate money stock. As a bi-product, a larger fraction households find it worthwhile to pay the participation cost and becomes creditors (at least for non-deflationary equilibria). The fraction of debtors remains somewhat stable around 26% when inflation rates are non negative. The increased fraction of creditors crowds savings away from the money market into the capital market, which increases capital supply and, in equilibrium, lowers the real interest rate. Because labor is inelastically supplied, the increased level of capital stock maps into higher levels of production. This effect is reminiscent of the Mundell-Tobin effect (Mundell 1963, Tobin 1965), and implies that money is non-neutral in this environment.

$\pi(\%)$	K	M	r (%)	Creditors	Debtors	Money Holders	Υ
-2	8.009	0.489	2.458	0.435	0.185	0.381	-23.849
-0	8.080	0.034	2.399	0.604	0.255	0.141	-23.517
2	8.086	0.011	2.395	0.634	0.259	0.107	-23.504
4	8.091	0.007	2.391	0.641	0.263	0.096	-23.501
6	8.091	0.004	2.391	0.651	0.262	0.087	-23.498
8	8.093	0.004	2.389	0.651	0.262	0.086	-23.494
10	8.095	0.002	2.387	0.658	0.265	0.078	-23.494
12	8.096	0.002	2.387	0.658	0.263	0.079	-23.491
14	8.097	0.002	2.386	0.659	0.259	0.080	-23.486

Table 5: Aggregate effects of anticipated inflation

Whereas inflation has small aggregate effects on economic aggregates, a deflation has distinct aggregate effects. A shift from a low inflation environment to a deflationary environment significantly affects the creditor debtor structure of the economy: the fraction of creditor is reduced significantly as well as the fraction of debtors, whereas more households find it worthwhile to smooth consumption with nominal assets (which now earn positive

interests). Given that money now earns positive interest, fewer households are required to borrow. This leads to a higher equilibrium money stock and crowds real asset supply out of the capital market. For the capital market to clear, households need to be compensated with a higher real interest rate. By reducing the incentive to save and accumulate capital, deflation has negative effect on output and on welfare. This can be rationalized by 2 mechanisms: first, given that the money stock contracts, households are taxed uniformly in a lump-sum fashion to engineer this deflation. Second, as the real interest rate rises, equilibrium wages are reduced, as a consequence of the assumption of inelastic labor supply and Cobb-Douglas technology. Both these effects negatively affects the continuum of households.

The desirability of policies is evaluated based upon a utilitarian welfare criterion that measures welfare.

$$\Upsilon(\pi) = \int_x \int_s V(x, s; \pi) d\lambda(x, s; \pi) \tag{7}$$

where $\Upsilon(\pi)$ denotes the average expected life time utility of households in an economy with an anticipated inflation rate π. As the last column in table 5 shows, a utilitarian welfare criterion shows that higher inflation rates improves welfare monotonically.

5.3 The distributive effects of inflation

In this section, I document the distributive effects of inflation, in particular its effects on the distribution of household wealth and decompose welfare into its aggregate and distributional component as in Domeij and Heathcote (2004).[4] Table 6 disentangles the distributive effects of inflation by looking at average consumption, average wealth and average consumption equivalence measures for the three sub-group of households at various levels of anticipated inflation.

The average consumption of debtors is hump-shaped with inflation. A higher anticipated inflation rate reduces the equilibrium interest rate which both reduces the cost of debt and increases wages, and incites debtors to frontload consumption. This effect dominates the reduction of lump-sum transfer that goes along with a lower equilibrium money stock.

The average consumption of money holders is U-shaped with inflation. A negative inflation rate induces a positive return on money holdings, which leads to a high level of consumption for the households that hold their wealth in nominal assets. For negative inflation rates this effects dominates the negative effects due to the lower wage level and lump-sum taxation. As the anticipated inflation rate increases, money holders' incentive to save is reduced (due to the higher inflation tax) and they front-load consumption, when

[4]The calculation presented in this section do not take into account the welfare cost on the transition across steady state.

inflation is above 2 percent.

Creditors' average consumption decreases monotonically with inflation. The reduction of creditor's household wealth due to lower interest rates, wages, and lump-sum transfers outweighs the incentive to front-load consumption given the lower equilibrium interest rate.

$\Pi(\%)$	HH-Type	Mean Consumption	Mean Wealth	$\Delta_{HH}(\%)$
-2	debtor	0.740	-1.500	-5.81
-2	money	1.365	1.285	-1.17
-2	creditor	2.341	19.066	1.99
-0	debtor	0.790	-1.358	0.00
-0	money	1.277	0.243	0.00
-0	creditor	2.133	13.899	0.00
2	debtor	0.793	-1.352	0.28
2	money	1.272	0.106	1.07
2	creditor	2.098	13.387	-0.82
4	debtor	0.795	-1.345	0.45
4	money	1.278	0.074	2.17
4	creditor	2.087	13.124	-1.02
6	debtor	0.793	-1.343	0.42
6	money	1.277	0.047	2.74
6	creditor	2.077	13.029	-1.31
8	debtor	0.793	-1.344	0.38
8	money	1.282	0.041	3.26
8	creditor	2.076	13.006	-1.32
10	debtor	0.793	-1.340	0.38
10	money	1.279	0.031	3.93
10	creditor	2.068	12.799	-1.39
12	debtor	0.791	-1.339	0.27
12	money	1.280	0.030	3.93
12	creditor	2.068	12.796	-1.37
14	debtor	0.784	-1.350	-0.18
14	money	1.282	0.030	3.93
14	creditor	2.067	12.791	-1.36

Table 6: Distributive effects of changes in anticipated inflation

To disentangle the effects of anticipated inflation on welfare, I first compute the average variation in consumption (Δ_{HH}) for each sub-group of households across steady states that makes each household type indifferent between the economy defined by the proposed monetary policy and the benchmark economy, chosen to be an economy with an inflation rate of zero percent.[5]

From a welfare perspective, recall that on average, aggregate welfare increases by 0.1

[5]I choose this benchmark economy, in order to map my results into the literature on the welfare cost of inflation (Lucas 2000, Ireland 2009)

percent if anticipated inflation is at 10 percent rather than 0 percent. In the last column of table 6, I compute the average consumption equivalence that would make the average household type indifferent across steady state equilibria. As to be expected, debtors favour a higher anticipated inflation rate, whereas creditors favour a lower level of anticipated inflation. Interestingly, money holders prefer a higher level of inflation. This can be explained by the fact, that money holders net worth is nearly exclusively composed of labor income. The effect that affects them most is therefore the increase in equilibrium wage brought along by higher inflation rates.

In addition to the average welfare gain, Δ discussed above, I decompose these average welfare change into an average aggregate component, Δ^a, and a distributional component, Δ^d as in Domeij and Heathcote (2004), with the important difference that the computation presented herein are mere steady state comparison. In their case, the welfare effects from a policy change are qualitatively different from an ex post perspective.

Define as $\lambda(z, x; \pi = 0)$ the measure of agents with productivity z and wealth x in the economy with an inflation rate of $\pi = 0$. The policy functions can be defined accordingly. We consider a change from $\pi = 0$ and an alternative anticipated inflation rate π. The average welfare gain Δ is defined as the percent consumption increase that has to be given to all households in system $\pi = 0$ such that aggregate welfare is the same as in the system π. If Δ is positive, welfare is higher in π.

$$\frac{1}{1-\beta}\int_z\int_x u((1+\Delta)c(z,x;\pi=0))\lambda(z,x;\pi=0)dzdx \tag{8}$$

$$= \frac{1}{1-\beta}\int_z\int_x u(c(x,x;\pi))\lambda(z,x;\pi)dzdx \tag{9}$$

The average aggregate effect is defined as the percentage increase in consumption that needs to be given to all households to equate aggregate welfare assuming that the distribution of consumption remains unchanged. Define

$$\hat{c}(z,x,\pi) = \frac{c(z,x;\pi=0)}{C(\pi=0)}C(\pi). \tag{10}$$

Then

$$\frac{1}{1-\beta}\int_z\int_x u((1+\Delta^a)c(z,x;\pi=0))\lambda(z,x;\pi=0)dzdx \tag{11}$$

$$= \frac{1}{1-\beta}\int_z\int_x u(\hat{c}(z,x;\pi))\lambda(z,x;\pi)dzdx \tag{12}$$

The distributional component of welfare can be computed from

$$(1+\Delta) = (1+\Delta^a)(1+\Delta^d) \tag{13}$$

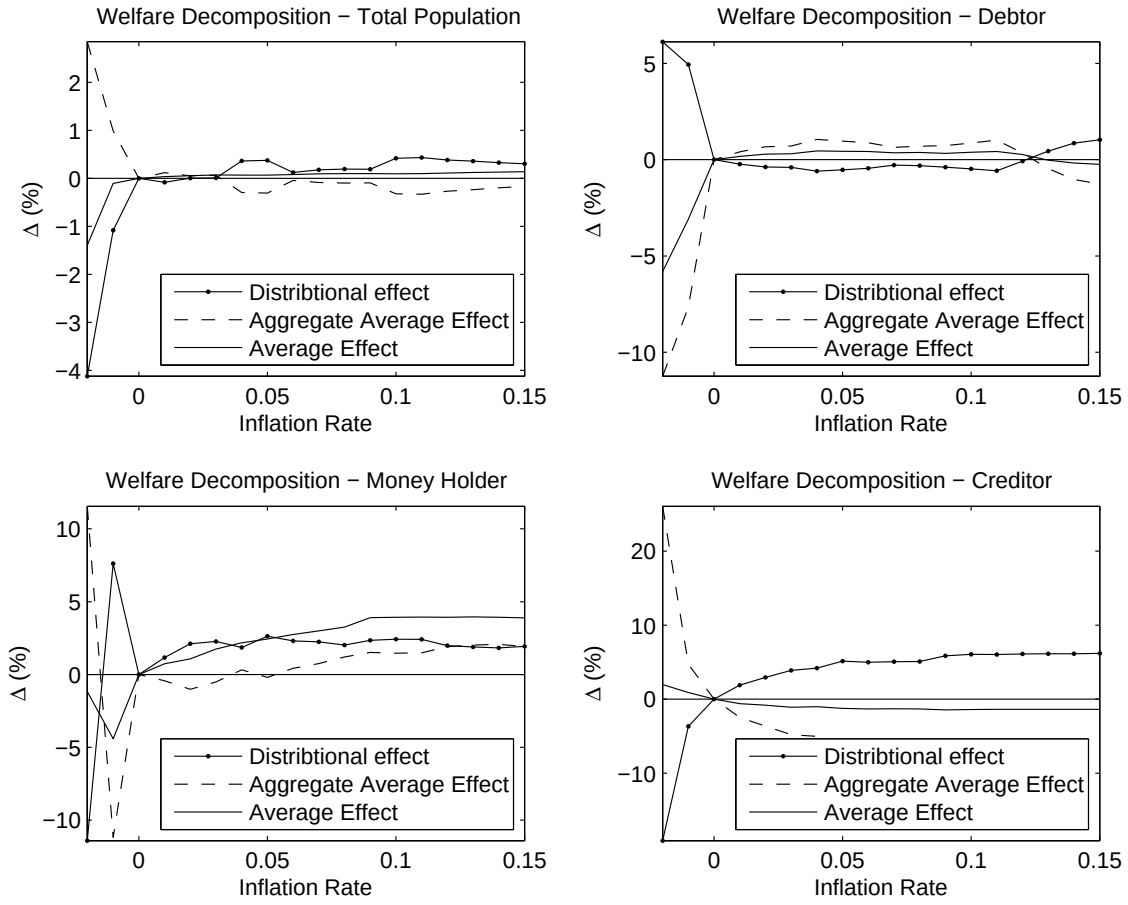

Figure 3: Consumption Equivalence as a function of individual wealth

The results are shown in the remaining four panels of figure 3. The upper left panel displays the welfare decomposition for the whole population, and the three other panel show the welfare decomposition for creditors, money holders and debtors separately.

The welfare decomposition for the whole population shows that the welfare gains from increased inflation are due to distributional effects. The standard deviation of consumption is reduced by higher levels of anticipated inflation rate. This distributional effect dominates the level effect on consumption, as increased inflation leads to a slight decrease in average consumption. In a nutshell, the welfare gains can be attributed to an improved risk-sharing.

As for debtors, the welfare decompositions shows that the welfare gains are driven by an aggregate average effect, i.e. an increase in average consumption. A higher rate of anticipated inflation lowers the equilibrium interest rate and allows debtors to roll-over their debt at a lower price, and increase their consumption. Also they benefit from a higher wage rate. However, the upper panel of figure 3 shows that the distributional component of welfare is negative. Indebted households income is in an equilibrium with higher inflation

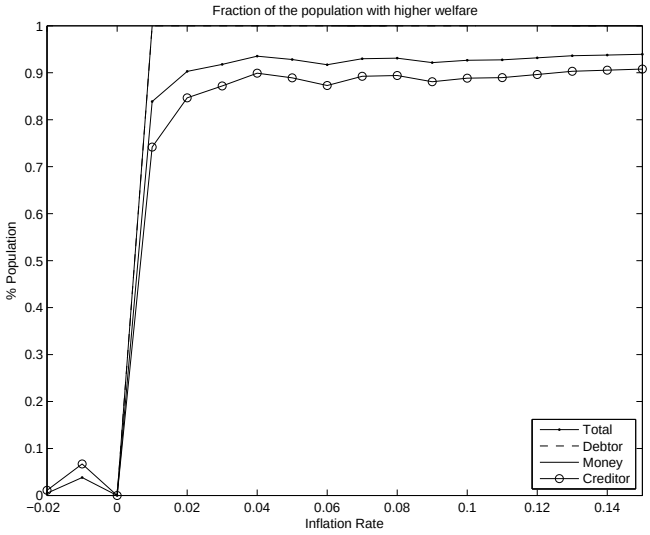

Figure 4: Fraction of population / sub-groups for which the inflation rate is welfare enhancing

rate mostly composed of labor income, which in this environment is subject to uncertainty, thereby increasing the dispersion in consumption levels within the debtor group.

The lower right panel of figure 3 shows the welfare decomposition of creditors. The average decrease in consumption equivalence is driven by an aggregate effect. The reduction in interest rate jointly with the increase in wages, reduces creditors' average consumption level, and also its dispersion, justifying the negative aggregate effect and the positive distributional effect induced by higher levels of anticipated inflation.

Overall, this welfare decomposition shows that both debtors and money holders gain from increased anticipated inflation, whereas creditors are worse-off. Yet the previous welfare decomposition masks the fact that within the group of creditor a large majority (70-90 percent) gains from a higher inflation rate (as shown in figure 4). This can be explained by the income composition of creditor. The high degree of heterogeneity in wealth implies that for most of the creditors, a large fraction of their income is labor income rather than capital income. Therefore, even creditors benefit more from the wage increase than from the reduction in capital income induced by a higher inflation rate.

6 The Welfare Cost of Inflation and Deflation

How does this paper contribute to the literature on the welfare cost of inflation ? Lucas (2000) estimated that the gain from reducing the annual inflation rate from 10 percent to zero is equivalent to an increase in real income of slightly less than one percent. The main mechanism in his framework relies on the fact that a lower inflation rate reduces the time

spent economizing on cash use, thereby enhancing welfare. His contribution consists in showing that in low interest rate environment these costs are small. Ireland (2009) shows that they are even smaller and reducing inflation from 10 percent to 0 amounts to a 0.2 percent of increase in income.

This paper shows that in low interest rate environments, accounting for the extensive margin of households portfolio allocation reduces those estimates further. Accounting solely for the effect of reduced inflation on the extensive margin generates an drop in average consumption equivalence of 0.1 percent. [6] Beyond confirming Lucas (2000) intuition, this paper further emphasizes that a key dimension to the discussion of the welfare cost of inflation is the debtor creditor structure of household wealth, and in particular the income composition of household's income. In fact, although the main mechanism hinges on redistribution from creditor to debtors, a large majority of creditors also gains from increased inflation as a substantial fraction of their income consists in labor income, which increases as a result of higher anticipated inflation.

Finally, this paper delivers insights into the welfare cost of deflation. Contrary to most monetary models, in the model presented here the Friedman Rule is not the optimal policy. As figure 3 suggests, deflationary environment reduce welfare. Although pursuing a deflationary monetary policy brings the capital stock closer to its first best level, it worsens the welfare properties of the economy. As can be seen in the upper left panel of figure 3 the average welfare effect are, as suggested by the existing literature on the welfare cost of inflation, welfare enhancing, however, the distributional effect induced by a deflationary policy dominates the average effect. In other words, the gains from increased in average consumption are overshadowed by an increase in the dispersion of consumption levels. Because the most creditors' income composition of household consists of labor income, the deflationary policy benefits only a small fraction of creditors, the creditors whose income share consists mostly of capital income.

7 Conclusion

Looking forward this paper suggests two alleys for future research. From a quantitative perspective, a natural extension would be to embed the transaction motive for money so as to deliver a better match of the distribution of nominal assets as in Ragot (2013) and look at the implications of monetary policy when equilibrium prices are endogeneous. Not only would this allow to obtain a better quantitative performance of the model, but also it would allow to disentangle whether the distributive effects documented in this paper that render inflation welfare enhancing dominate the welfare cost induced by the transaction motive to hold money. From a theoretical perspective, this paper suggests that further

[6] This result has to be nuanced by the fact that we do steady state comparison and do not take into account transitional dynamics. However, the aggregate effects being very small, transitions are likely to be short-lived an not as costly as for instance in the case of fiscal policy (see Domeij and Heathcote (2004))

insights on the welfare effects of inflation can be gained from the analysis of monetary policy in frameworks with incomplete financial markets. In particular, understanding how a monetary authority can by controlling inflation affect pecuniary externalities arising from capital over/under accumulation, as outlined in Davila, Hong, Krusell, and Rios-Rull (2012), and bring equilibrium allocation closer to first-best allocation, is a potent alley for future research.

References

Ábrahám, A., and E. Cárceles-Poveda (2010): "Endogenous trading constraints with incomplete asset markets," *Journal of Economic Theory*, 145(3), 974–1004.

Aiyagari, S. R. (1994): "Uninsured Idiosyncratic Risk and Aggregate Saving," *The Quarterly Journal of Economics*, 109(3), 659.

Albanesi, S. (2007): "Inflation and inequality," *Journal of Monetary Economics*, 54(4), 1088–1114.

Attanasio, O. P., and M. Paiella (2011): "Intertemporal consumption choices, transaction costs and limited participation to financial markets: reconciling data and theory," *Journal of Applied Econometrics*, 26, 322– 343.

Baumol, W. (1952): "The Transactions Demand for Cash: An Inventory Theoretic Approach," *Quarterly journal of Economics*.

Davila, J., J. Hong, P. Krusell, and J. Rios-Rull (2012): "Constrained Efficiency in the Neoclassical Growth Model with Uninsurable Idiosyncractic Shocks," *Econometrica*.

Diaz-Giménez, J., A. Glover, and J.-V. Ríos-Rull (2011): "Facts on the Distributions of Earnings , Income , and Wealth in the United States : 2007 Update Facts on the Distributions of Earnings , Income , and Wealth in the United States : 2007 Update," *Federal Reserve bankd of Minneapolis Quarterly Review*, 34(1 (February)), 2–31.

Doepke, M., and M. Schneider (2006a): "Aggregate implications of wealth redistribution: the case of inflation," *Journal of the European Economic Association*, 4(May), 493–502.

Doepke, M., and M. Schneider (2006b): "Inflation and the redistribution of nominal wealth," *Journal of Political Economy*.

Domeij, D., and J. Heathcote (2004): "On the distributional effects of reducing capital taxes," *International Economic Review*, 45(2).

Erosa, A., and G. Ventura (2002): "On inflation as a regressive consumption tax," *Journal of Monetary Economics*, 49(4), 761 – 795.

Floden, M., and P. Lindé (2001): "Idiosyncratic Risk in the United States and Sweden : Is There a Role for Government Insurance?," *Review of Economic Dynamics*, 4, 406–437.

Guiso, L. (2003): "Household stockholding in Europe: where do we stand and where do we go?," *Economic Policy*, 18(36), 123–170.

Guiso, L., P. Sapienza, and L. Zingales (2008): "Trusting the Stock Market," *The Journal of Finance*, 63(6), 2557–2600.

Guiso, L., and P. Sodini (2012): "Household Finance. An Emerging Field," *CEPR Discussion Paper*, DP8934.

Haliassos, M., and C. Bertaut (1995): "Why do so few hold stocks?," *The Economic Journal*, 105(432), 1110–1129.

Heathcote, J., K. Storesletten, and G. L. Violante (2009): "Quantitative Macroeconomics with Heterogeneous Households," *Annual Review of Economics*, 1(1), 319–354.

——— (2010): "The Macroeconomic Implications of Rising Wage Inequality in the United States," *Journal of Political Economy*, 118(4), 681–722.

Imrohoroglu, a. (1992): "The welfare cost of inflation under imperfect insurance," *Journal of Economic Dynamics and Control*, 16(1), 79–91.

Ireland, P. N. (2009): "On the Welfare Cost of Inflation and the Recent Behavior of Money Demand," *American Economic Review*, 99(3), 1040–1052.

Kennickell, A. B., and M. Starr-McCluer (1997): "Household Saving and Portfolio Change: Evidence from the 1983-89 SCF Panel," *Review of Income and Wealth*, 43(4), 381 – 99.

Lucas, R. (2000): "Inflation and welfare," *Econometrica*.

Mulligan, C., and X. Sala-i Martin (1996): "Adoption of financial technologies: implications for money demand and monetary policy," .

Mulligan, C., and X. Sala-i Martin (2000): "Extensive margins and the demand for money at low interest rates," *Journal of Political Economy*, 108(5), 961–991.

Mundell, R. (1963): "Inflation and Real Interest," *Journal of Political Economy*, 71(3), 280.

Paiella, M. (2007): "The Forgone Gains of Incomplete Portfolios," *Review of Financial Studies*, 20(5), 1623–1646.

Ragot, X. (2013): "The case for a financial approach to money demand," *Journal of Monetary Economics*, pp. 1–14.

Ríos-Rull, J.-V., D. Corbae, and S. Chatterjee (2007): "A quantitative theory of unsecured consumer credit with risk of default," *Econometrica*, 75(6), 1525–1589.

Telyukova, I. a. (2013): "Household Need for Liquidity and the Credit Card Debt Puzzle," *The Review of Economic Studies*, 80(3), 1148–1177.

Tobin, J. (1956): "The Interest-Elasticity of Transactions Demand for Cash," *The Review of Economics and Statistics*, 38(3), 241–247.

Tobin, J. (1965): "Money and Economic Growth," *Econometrica: Journal of the Econometric Society*, pp. 671–684.

Vissing-Jø rgensen, A. (2007): "Household Finance: The Liability Side," .

Vissing-Jorgensen, A. (2002): "Towards an explanation of household portfolio choice heterogeneity: nonfinancial income and participation cost structures," *NBER working paper*, 8884(April).

Vissing-Jorgensen, A. (2003): "Perspectives on Behavioral Finance: Does 'Irrationality' Disappear with Wealth? Evidence from Expectations and Actions," *NBER, Macroeconomics Annual*, pp. 139–208.

8 Appendix

8.1 Household Balance Sheet - SCF(2010)

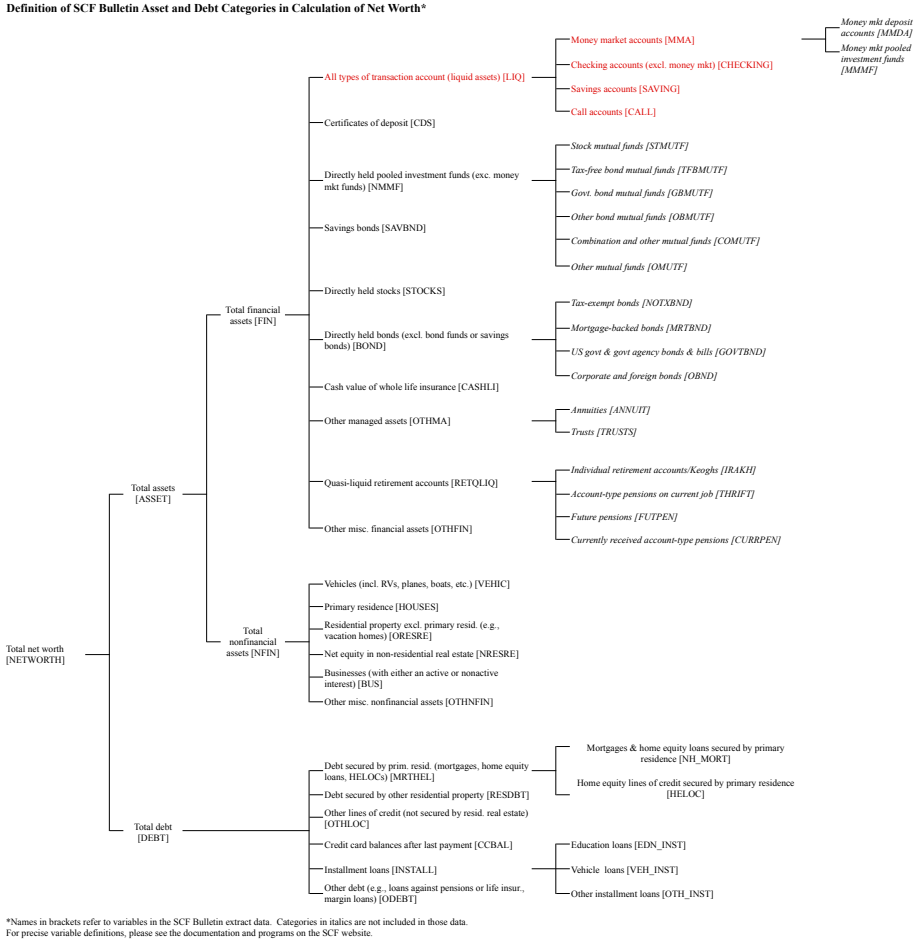

Figure 5: Household Balance Sheet - Survey of Consumer Finance (2010)

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