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Abstract

This study investigates the distributional and welfare consequences of disinflation in emerging economies using a monetary model of a small open economy with uninsured idiosyncratic earnings risk. The model is calibrated to Turkish data and is used to compare stationary equilibria with quarterly inflation rates of 14.25% (for 1987:Q1-2002:Q4) and 2.25% (for 2003:Q1-2010:Q2). Reduction in inflationary finance is assumed to affect lump-sum transfers, since government spending-to-GDP ratios have been roughly stable during disinflation in a number of emerging economies. Disinflation is found to lower aggregate welfare by 1.23% in terms of compensating consumption variation. This is because the reduction in the distortionary impediments of inflation on the poor falls short of the decline in their redistributive transfers income that is mainly financed by the rich. The shrinkage of cash transfers also tightens natural debt limits and increases the precautionary savings motive.

Keywords: Small open economy, incomplete markets, disinflation

JEL Classification: D31, F41, E52

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1 Introduction

This paper undertakes a quantitative investigation of the distributional and welfare consequences of a sharp decline in inflation in a small open economy. One of the building blocks of the motivation of this study is the observation that globally observed disinflation in the last two decades has been more predominant in emerging economies. To that end, in Table 1, I report the time series average of the annual CPI inflation rate for a number of industrialized and emerging countries. For each country, two periods are pointed out during which inflation has been high and low, respectively. It appears that structural change in inflation has been more predominant in *emerging economies* (which have a record of high inflation) compared with industrialized countries.[1]

The second motivating theme of this article is the idea that disinflation of magnitudes observed in emerging economies might derive nontrivial distributional and welfare effects. This is because (i) inflation reduces the purchasing power of individuals, (ii) inflation distorts consumption, and (iii) governments' response to a reduction in inflation tax revenues might create redistributive wealth effects. In addition to these effects, the walkway to the research question of this paper is paved by financial system characteristics of emerging economies in relation to disinflation. Particularly, in emerging economies, (i) the distribution of monetary assets displays substantial inequality, and financial assets portfolios are not uniform across people, (ii) the financial system exhibits a high degree of dollarization that affects the vulnerability of monetary assets to inflation in a particular way, and (iii) financial dollarization (FD hereafter) is systemically more predominant in countries that have an inflationary past and that exhibit strong exchange rate pass-through.[2] Among these characteristics, the inequality of the distribution of monetary assets (whose value and return depend on inflation) creates asymmetric impacts of disinflation on heterogeneous individuals. On the other hand, the dollarization of a segment of the financial system in an emerging economy makes that segment less responsive to changes in inflation.

In order to analyze disinflation in emerging economies, this paper develops a monetary model of a small open economy with idiosyncratic earnings risk and incomplete markets. The model economy is populated by a continuum of consumers and a government. There is no aggregate uncertainty. Infinitely lived consumers face idiosyncratic earnings shocks and consume a single, tradable consumption good. They hold (i) noninterest-bearing real balances that economize trans-

[1]See Appendix A for the methodology of determining structural break dates and a complete list of countries.

[2]See Section 2 for a detailed documentation of these facts.

action costs of consumption and (ii) internationally traded, risk-free bonds that are useful for consumption smoothing. Furthermore, consumers face ad hoc borrowing constraints, which hinder their ability to smooth consumption.

I assume perfect mobility in capital and goods markets so that the domestic nominal interest rate is determined by a parity condition and the domestic price level is determined by the law of one price. Because of the latter, the domestic inflation rate is equal to the depreciation rate of currency. These assumptions cause bonds to be fully dollarized (i.e., inflation indexed), so that their real return does not depend on domestic inflation. I assume that the de facto exchange rate regime is a managed float. That is, the monetary authority is able to manipulate the level of the depreciation (devaluation) rate exogenously, and it prints as much money as the private sector demands at this given rate.

The empirical literature has documented a positive and strong relationship between fiscal deficits and inflation in emerging (high inflation) economies (see Fischer et al. (2002) and Catão and Terrones (2005)). To that end, I assume that the government uses seigniorage revenues to finance lump-sum transfers and unproductive spending. In order to explore the mediating role of fiscal policy on the distributional and welfare consequences of disinflation, I study alternative fiscal arrangements that exhibit (i) endogenous uniform transfers, (ii) endogenous government spending, and (iii) endogenous transfers that depend on individual-specific inflation tax payments.

In this model, the welfare of consumers is affected by inflation through the following channels: (i) inflation creates an *intertemporal distortion*, since it affects the relative price of financial assets, (ii) inflation creates an *intratemporal distortion*, since it makes real balances (which economize the transaction costs of consumption) less desirable, and (iii) the necessity of a balanced government budget (in equilibrium) creates *redistributive wealth effects* driven by the fiscal policy in response to changes in inflationary finance.

The theory developed in this paper is consistent with the findings of the empirical literature, which finds that the poor hold a larger fraction of their financial assets in cash. In the model, the solution to the consumers' utility maximization problem implies that money holdings are in proportion to the level of consumption. This feature causes the ratio of money to financial wealth to decline for wealthier individuals as per the typical property of Bewley-style economies that the consumption-to-wealth ratio decreases with wealth.

I calibrate the model to the low inflation period (2003:Q1-2010:Q2) of the Turkish economy, which is representative of the disinflation phenomenon and the aforementioned financial system characteristics of emerging economies. The main quantitative exercise is to compare stationary equilibria with quarterly inflation rates of 14.25% (over the period 1987:Q1-2002:Q4) and 2.25% (over the period 2003:Q1-2010:Q2) under alternative fiscal arrangements.

I find that (i) when uniform transfers are endogenous, reducing the quarterly inflation rate from 14.25% to 2.25% *lowers* aggregate welfare by 1.23% in terms of compensating consumption variation. This is because the reduction in the distortionary impediments of inflation on the poor is less than the reduction in their transfers income, which creates a redistribution of wealth from the rich in an inflationary environment. (ii) On the contrary, when wasteful spending is endogenous, disinflation *increases* aggregate welfare by 1.62%. This is because wealth effects created by inflationary finance (which favor the poor) are muted when transfers are constant. (iii) Finally, when endogenous transfers are proportional to individual-specific inflation tax payments, disinflation again *increases* aggregate welfare by 0.45%. Welfare gains in this case are lower than the endogenous spending case because wasteful government spending does not decrease following disinflation.

The impact of disinflation on portfolio choice manifests itself through substitution and wealth effects, where the latter crucially depends on the fiscal response to a reduction in inflationary finance. Specifically, when endogenous lump-sum transfers are uniform, a reduction in transfers (driven by disinflation) tightens the natural debt limits of the poor and increases their precautionary savings motive. This causes the distribution of bonds to be more equitable at the left tail. In contrast, when transfers are proportional, such wealth effects are partially neutralized and, because of substitution effects, consumers demand fewer bonds. This reduces interest income unambiguously, since the real interest rate is exogenous and constant. In fact, if wealth effects are eliminated completely, disinflation reduces welfare (by 0.32% in the aggregate) through this channel.

I abstract from the redistributive role of inflation among debtors and creditors of local currency denominated nominal contracts, as opposed to Doepke and Schneider (2006) and Meh et al. (2008). The motivation of doing so derives from (i) the phenomenon that high inflation economies have developed particular methods (such as FD) to cope with inflation and (ii) a methodological point that steady-state comparisons do not allow us to keep track of the portfolio evolution of particular agents across high and low inflation economies. As a result, portfolio revaluation effects are not traceable.

Related Literature

The work most closely related to this paper are the studies of Algan and Ragot (2010) and Berriel and Zilberman (2011). The former study explores the impact of inflation and borrowing constraints on aggregate capital accumulation in a heterogeneous agents environment. Yet, their study is contained within a closed economy framework with no welfare analysis and they find that inflation always increases precautionary savings motive, deepening physical capital accumulation. The current paper deviates from their study by assessing welfare effects of inflation and illustrating that when inflationary finance is directed to lump-sum redistributive transfers, natural debt limits of the poor are relaxed substantially, causing a collapse in the precautionary savings motive. The latter study explores the distributional and welfare consequences of cash transfers in Brazil and finds that cash transfers increase welfare and reduce the precautionary savings motive of the poor. As a result, although income inequality does not change much, wealth inequality increases with transfers. An important difference between their work and the current paper is that the redistributive nature of *cash transfers* implied by inflationary finance depends on fiscal and monetary interactions, and there is no threshold level for poverty that is exogenously determined by the government. In this paper, the redistributive effects of inflationary finance are purely driven by variation in endogenous portfolio composition and the wealth level of consumers.

Other closely related studies are the work of Erosa and Ventura (2002) and Albanesi (2007). Both studies incorporate a costly transaction technology that displays economies of scale, so that the poor choose to consume *cash* goods more in proportion to their consumption basket. The current paper mainly differs from these studies by focusing on the cross-sectional portfolio composition, as opposed to the cross-sectional consumption profile. The economies of scale assumption adopted in these studies renders inflation as a regressive consumption tax on the poor. The proportionality of consumption and cash holdings in the current paper, which is useful in generating a cross-sectional asset portfolio that is biased toward cash for the poor, renders inflation as a linear consumption tax. Consequently, if a redistributive transfers policy is enacted, the government might redistribute resources from the rich to the poor by announcing a higher inflation rate. Finally, I analyze the effect of inflation on financial wealth inequality, changing the direction of causality emphasized by the latter study.

This paper contributes to the monetary economics literature that incorporates imperfectly insured, idiosyncratic risk. Imrohoroglu (1992) and Molico (2006) study the precautionary demand for money but abstract from portfolio composition. Imrohoroglu and Prescott (1991), Chatterjee and Corbae (1992), Akyol (2004), Ragot (2010), and Wen (2010) include interest-bearing assets but do not model money as an asset that economizes transaction costs. Therefore, inflation acts as a savings tax on households (not as an indirect consumption tax), and most welfare effects originate from increased consumption volatility. Chiu and Molico (2010) explore the welfare cost of inflation in developed economies in a search-theoretic environment with costly liquidity management and find that the welfare costs of inflation are smaller than those estimated by representative agent models. Kehoe et al. (1992) analytically find that the optimal inflation rate might be positive if lump-sum transfers are considered.

Recent work by Doepke and Schneider (2006a) and Meh et al. (2008) studies the welfare effects of an inflation shock that is modeled as a zero sum redistribution of real wealth. These studies are meant to capture the redistributive role of surprise inflation between debtors and creditors of nominal contracts in a low inflation economy. The analysis in the current paper, which is interested in exploring the impact of a sharp decline in inflation in a chronic inflation economy, abstracts from those effects because inflation indexed contracts are arguably more suitable for such economies, as discussed in Section 2.1.[3]

The theoretical contribution of the current paper is to reconcile the monetary model of a small open economy (which has been commonly used to study exchange-rate-based stabilizations) with an incomplete markets, uninsured idiosyncratic risk framework. On empirical grounds, this paper contributes to the literature by documenting (i) the structural change in inflation as a worldwide phenomenon and (ii) the distributional aspects of the financial system in emerging economies by using disaggregated deposits data.

The rest of the paper is organized as follows. Section 2 reviews key facts regarding FD, the distribution of financial assets, and the relationship between fiscal policy and disinflation in emerging economies. Section 3 describes the theoretical model. Section 4 analyzes the workings of the model and defines the stationary recursive equilibrium. Section 5 presents the parameterization of the model and reports findings. Section 6 performs sensitivity analysis, and Section 7 concludes.

[3]For a rigorous empirical treatment of the redistributive impact of inflation shocks in an advanced economy, see Doepke and Schneider (2006b). For a theoretical treatment of these effects, see Iacoviello (2005).

2 Key Facts

In this section, I document three arguably relevant properties of emerging economies that experienced disinflation. Among these, financial dollarization and inequality in the deposits distribution motivate the modeling of interest-bearing assets as inflation indexed and using a heterogeneous agents framework, respectively. The absence of comovement between the government consumption-to-GDP ratio and declining inflation, however, motivates modeling government spending as exogenous and fixed during disinflation.

2.1 Financial Dollarization in Emerging Economies

Dollarization in emerging economies has typically been understood as a currency substitution phenomenon. However, as Ize and Levy Yeyati (2003) argue, what is analyzed as *currency substitution* is actually *asset substitution*, since dollarization of interest-bearing financial assets is more predominant than that of cash.[4] Following this argument, I list key observations from the dollarization literature:

1. By the end of 2000, the mean dollarization ratio (i.e., the share of FX-denominated deposits in the total system) of all developing countries was 35% (Levy Yeyati (2006)). Dollarization of deposits goes hand in hand with dollarization of loans as well. De Nicoló et al. (2003) document that the elasticity of dollarized loans with respect to dollarized deposits is 0.73 for 100 emerging, developing, and transition economies over the period 1990-2001.

2. Honohan (2007) documents that countries that have exhibited an FX-denominated deposits share of less than 50% over the period 2000-2004 are the ones that have managed to keep inflation below 35% per annum over the period 1990-2005. His finding is line with the result of Reinhart et al. (2003) that there is a positive relationship between the likelihood of having an inflationary past and the degree of dollarization. In support of the above studies, Levy Yeyati (2006) calculates the correlation between average deposits dollarization and the inflation rate to be 0.50 in developing countries. His study also reports that financial dollarization is stronger in economies that face monetary shocks that are more inflation elastic.

[4] For example, over the period 2005:Q4-2008:Q4, the average share of foreign currency (henceforth, FX) denominated demand and term deposits in Turkey were 44% and 72%, respectively. Source: Banking Regulation and Supervision Agency (BRSA).

3. Honohan and Shi (2001) explore the relationship between the exchange rate pass-through and dollarization, and document that a 10% increase in the degree of dollarization is associated with an 8% increase in the degree of the exchange rate pass-through in developing countries.[5] The studies by Ize and Levy Yeyati (2003) and Levy Yeyati (2006) later on formalize this finding that under perfect exchange rate pass-through, the real value of dollar assets becomes fixed (since their return adjusts one-to-one with the depreciation rate of the currency), and the interest-bearing segment of the financial system fully dollarizes.

In summary, the relevant findings of the dollarization literature are as follows: (i) financial dollarization is commonly observed in emerging economies, (ii) financial dollarization becomes more intense in economies that have a high (chronic) inflation problem, and (iii) the data support the prediction of the theory that the stronger the exchange rate pass-through, the stronger financial dollarization is. I now proceed to presenting some cross-sectional properties of the deposits distribution in emerging economies.

2.2 Distribution of Demand and Term Deposits

In this section, using disaggregated demand and term deposits data, I document inequality in financial asset positions and portfolio heterogeneity in a selected group of emerging economies for which such data are available. The top panels of Figure 1 display the approximated Lorenz curves of demand and term deposits for Bolivia, Peru, Thailand, and Turkey. As the figure clearly shows, demand and term deposits distributions display substantial inequality.[6] Gini coefficients implied by the Lorenz curves that are plotted in the top panels of Figure 1 vary between 65% and 95%. For Bulgaria, Chile, Georgia, and Lithuania, disaggregation into demand and term deposits is not available. Therefore, those countries cannot be included in Figure 1. Nevertheless, Gini coefficients of total deposits distribution in those countries vary between 80% and 95%.[7]

The bottom panels of Figure 1, on the other hand, represent the share of term deposits (which typically bear more interest than demand deposits) for different account sizes. For both Bolivia and Turkey, this measure increases with the account size.[8] This suggests that the portfolio of

[5] They use quarterly data from over 50 countries over the period 1980-2000. The implied t-statistic from the estimation is equal to 4.5.

[6] Deposits represent an important fraction of the financial system in emerging economies. For example, the average share of deposits in total financial assets over the period 1970-2006 was 61% in the Turkish economy. Source: State Planning Organization (SPO hereafter).

[7] In Appendix A, I report sources of disaggregated and total deposits data and describe how Figure 1 is constructed.

[8] It is puzzling to see that the share of term deposits is falling for the largest size accounts in the case of Bolivia.

heterogeneous consumers is not uniform across the wealth distribution. This observation is in line with the findings of Avery et al. (1987), Mulligan and Sala-i-Martin (2000), and Easterly and Fischer (2001) that the poor hold a financial portfolio that is more vulnerable to inflation.

The facts presented so far might play an important role in the distributional and welfare consequences of disinflation in the economies of interest. This is because a sharp decline in inflation will create asymmetric intertemporal distortions in the consumption-savings decision of heterogeneous consumers. The wealth-eroding effect of inflation will be asymmetric as well, since the portfolio composition of consumers displays heterogeneity. However, in order to better capture the wealth effects, one should also consider the response of the consolidated government to the sharp decline in inflation tax revenues. To that end, in the next section, I explore the evolution of government expenditures in emerging economies during the period in which they have experienced disinflation.

2.3 Government Expenditures and Disinflation in Emerging Economies

The work of Catão and Terrones (2005) documents a strong comovement between fiscal deficits and inflation in high inflation countries over the period 1960-2001. Nevertheless, in order to gauge the impact of disinflation on inequality and welfare, one might need to decompose the reduction in public deficit associated with the decline in inflationary finance. This is because public transfers and spending, which are both elements of the total deficit, entail different wealth effects on households. Specifically, while government spending on goods and services is typically deemed as a waste by a large number of studies, transfers to households relax budget constraints and create redistribution. Since addressing this issue is outside the scope of their paper, Catão and Terrones (2005) use a measure of public deficit that lumps transfers, net interest payments, and central government deficit into an aggregate measure of public deficit.

Well known studies by Reinhart and Végh (1995) and Calvo and Végh (1999) on inflation stabilization abstract from fiscal issues by setting government expenditures and conventional taxes equal to zero. In these environments, seigniorage revenues are modeled to finance lump-sum transfers that are returned to households. Mendoza and Uribe (2000), on the other hand, assume that some part of inflation tax finances public spending, but set it to a fixed value throughout the analysis, in order not to blur the impact of inflation stabilization on the cyclical properties of private

This could be because Bolivia experiences "currency substitution" so that even cash is dollarized and is less vulnerable to the depreciation of domestic currency. This feature reduces the asymmetric advantage of the rich in, say, Bolivia, relative to the advantage of the rich in a less dollarized economy. Yet, possession of zero return dollarized cash still provides better insurance than negative return domestic currency.

consumption and trade balance. When we focus on the dynamics of government expenditures in the recent disinflationary era, arguably, a similar picture emerges. For that matter, I carry out a simple empirical exercise and investigate the evolution of government expenditures (defined as the summation of public spending on goods and services and public gross fixed capital formation) during the disinflation period of the emerging economies that are listed in Table 1. To that end, in Figure 2, I plot the total public-spending-to-GDP ratio (the straight plots) together with the CPI inflation (the dashed plots) and show that the former does not respond to disinflation at all.[9]

Motivated by the suggestions of the literature and Figure 2 on the recent episode, in the benchmark analysis, I assume that government spending is exogenous and fixed during disinflation, whereas the reduction in seigniorage revenues are reflected to lump-sum transfers. However, as one may easily anticipate, this would create strong redistributive effects in a heterogeneous agents framework, in contrast with the representative agent setup that has been typically used to study inflation stabilization in emerging economies. Therefore, I analyze alternative scenarios regarding fiscal and monetary interactions during disinflation, namely, a scenario in which reduced seigniorage revenues cause a decline in wasteful government spending and another scenario in which disinflation reduces lump-sum transfers that are proportional to individual level cash holdings to eliminate redistribution effect, in part.[10]

Having completed the presentation of key facts, I now proceed to the next section in which I describe the theoretical framework used to analyze the distributional and welfare consequences of disinflation in emerging economies.

3 The Model Economy

I study a monetary model of a small open economy with uninsurable idiosyncratic earnings risk. There is no production. The economy is inhabited by two agents: continuum of infinitely lived households of total mass one and a government. There is no uncertainty in the aggregate level. Time is discrete. The government determines both fiscal and monetary policy.

[9] Catão and Terrones (2005) scale public deficit with GDP and M1 in different experiments and show that the comovement of fiscal deficits and inflation is evident in both cases.

[10] In order to capture the typical boom-bust cycle of inflation stabilization programs, Rebelo and Végh (1995) incorporate a reduction in government spending and an increase in tax revenues that accompany inflation stabilization. This is to capture that, for inflation stabilization to be successful, public spending should be restrained, and in a period of macroeconomic stabilization, tax revenues are expected to rise. Since such dynamics are outside of the scope of the current paper, I abstract from them. Nevertheless, in Section 6, I analyze a case in which wealth effects of disinflation are completely neutralized, which partly resembles simultaneous tax increases and transfer reductions.

3.1 Households

The stochastic process of earnings is independently and identically distributed across consumers and follows a finite state Markov chain with conditional probabilities $p_{\varepsilon'|\varepsilon} = Pr(\varepsilon_{t+1} = \varepsilon'|\varepsilon_t = \varepsilon)$ for ε' and $\varepsilon \in \boldsymbol{E}$, where $\boldsymbol{E}$ is a finite dimensional vector. The invariant distribution of this Markov process is denoted by P.

Preferences over flows of a single, tradable consumption good are given by

$$E_0 \left[\sum_{t=0}^{\infty} \beta^t u(c_t) \right], \tag{1}$$

where $0 < \beta < 1$ is the subjective discount factor (which is identical across individuals) and $u(.)$ is a continuous and strictly concave utility function defined over the flow of consumption. The function $u(.)$ satisfies the Inada condition, $\lim_{c \to 0^+} u'(c) = \infty$, and E is the mathematical expectation operator.

Households have access to two assets: real balances (demand deposits), m, issued by the monetary authority, and one-period risk-free bonds (term deposits), b, that are internationally traded.[11] The decision of real balances position is made at the beginning of the period. Consumers use real balances during the period to economize the transaction costs of consumption, and once consumption takes place, they carry over their position in this asset to the next period. Small letters denote real values of individual-specific variables. Capital letters denote aggregate real variables. If inflation from date $t-1$ to date t is π_t, then *real deposits*, a, at time t are defined as $a_t = Rb_t + \frac{m_t}{1+\pi_t}$, where R is the gross real interest rate and b_t and m_t are the beginning of period t positions in bonds and real balances, respectively.

Consumers face the budget constraint,

$$c_t \left[1 + S\left(\frac{c_t}{m_{t+1}} \right) \right] + b_{t+1} + m_{t+1} = \varepsilon_t + a_t + \tau_t. \tag{2}$$

The left-hand side of (2) represents total consumption expenditures and asset demands. Following Kimbrough (1986) and Mendoza and Uribe (2000), transaction costs are assumed to be an increasing function $S(.)$ of the consumption velocity of money, $\kappa_t = \frac{c_t}{m_{t+1}}$. The unit transaction costs function is assumed to take the form $S = \phi\kappa^\gamma$, where $\phi > 0$ and $\gamma > 1$. The terms τ_t represents a lump-sum transfer made by the government. Since the utility function satisfies the Inada condition, consumption has to be strictly positive ($c_t > 0\ \forall t$). Moreover, for the convex function $S(.)$

[11] From now on, I use the terms real balances (bonds) and demand (term) deposits interchangeably.

to be positive valued and bounded, real balances should be strictly positive as well ($m_t > 0\ \forall t$). I assume that financial markets are underdeveloped in this economy. Therefore, consumers face a borrowing constraint so that $b_{t+1} \geq \Omega$ with $\Omega \leq 0$.[12]

There is perfect mobility in capital and goods markets. Therefore, the small open economy assumption ensures that R is taken as given from the international capital markets.[13] Under the law of one price and the assumption of a zero foreign inflation rate, the domestic inflation rate, π_t, becomes identical to the depreciation rate of the currency, e_t.[14]

At any period t, a household is characterized by a double $(a_t, \varepsilon_t) \in \boldsymbol{A} \times \boldsymbol{E}$, where the terms in parentheses denote the real deposits position and earnings level of an individual, respectively. Let $\Gamma(a, \varepsilon)$ be the measure of agents who are in the idiosyncratic state (a, ε). If $\mathcal{A}$ denotes the Borel sets that are subsets of $\boldsymbol{A}$ and $\mathcal{E}$ denotes the set of all subsets of $\boldsymbol{E}$, then $(\boldsymbol{X}, \mathcal{X}) = (\boldsymbol{A} \times \boldsymbol{E}, \mathcal{A} \times \mathcal{E})$ denotes the product space, with $\boldsymbol{X}$ denoting the state space of this economy. I discretize the state space for simplicity. Therefore, real deposit holdings are members of the grid $\boldsymbol{A} = [a_1 < a_2 < ... < a_n]$, and their evolution is governed by a combination of the choices of real balances and bonds positions that lie in the grids $\boldsymbol{M} = [m_1 < m_2 < ... < m_{nm}]$ and $\boldsymbol{B} = [b_1 < b_2 < ... < b_{nb}]$, respectively. The real deposits position is used to indicate the total wealth state of an individual for both expositional simplicity and numerical tractability. However, the portfolio choice between real balances and bonds is still explicit in the model, as I describe below.

3.2 Government and Alternative Fiscal Arrangements

The budget constraint of the government is described by equation (3),

$$G_t + \tau_t = M^s_{t+1} - \frac{M^s_t}{1 + e_t}. \tag{3}$$

As part of the monetary policy, the government issues currency and announces the depreciation rate of the nominal exchange rate, e_t.[15] Since the focus is on stationary equilibria, $e_t = e\ \forall t$. Aggregate real seigniorage revenues are denoted by $M^s_{t+1} - \frac{M^s_t}{1+e_t}$, where M^s_t is the aggregate real

[12]Even without ad hoc borrowing constraints, consumers will never borrow more than a *natural debt limit* to ensure non-negative consumption in each period. This debt limit implies the lower bound $\Psi = \left(\frac{\varepsilon_{\min} + \tau_t - \frac{e}{1+e} m_t}{1-R}\right)$ for b_t and is a variation of the one studied by Aiyagari (1994).

[13]For a given R, I restrict β to satisfy $\beta R < 1$ in order to guarantee the existence of an ergodic distribution of total deposits. For a discussion of this property of incomplete markets models, see Huggett (1993).

[14]Motivated by Section 2.1, bonds are thought to be fully dollarized so that the real interest rate earned on them, R, is independent of the depreciation rate of currency by the interest parity condition.

[15]It is assumed that the government can perfectly manipulate the depreciation rate of currency, although the de jure exchange rate regime is not necessarily predetermined. To that end, I take the disinflation phenomenon as given.

money supply at the beginning of period t.[16] I abstract from international reserves for simplicity.

Fiscal policy is conducted by making unproductive expenditures, G_t, and remitting transfers, τ_t, to households. To explore the distributional role of fiscal and monetary interactions, I study alternative fiscal arrangements in response to disinflation. In Economy 1 (Economy 2), I assume that $G_t = G \ \forall t$ ($\tau_t = \tau \ \forall t$), which leaves uniform transfers (spending) as responsive to changes in seigniorage revenues. I consider Economy 1 as the benchmark case because, as suggested by Figure 2, disinflation in the emerging economies listed in Table 1 does not involve a reduction in the sum of public spending on final and investment goods. In that sense, the analysis of Economy 2 will be helpful in discovering the redistributive role of uniform transfers. Last, in Economy 3, I assume again that spending is constant, but I now model transfers as proportional to individual-specific inflation tax payments.[17] In this case, transfers are meant to partially neutralize the wealth effects caused by changes in inflation.[18]

4 Analytical Framework

In this section, I formulate the optimization problem solved by the consumer in the benchmark economy, analyze the workings of the model on portfolio heterogeneity and welfare, and define the stationary recursive equilibrium.

4.1 The Household's Decision Problem

The dynamic programming problem solved by a household who is in state (a, ε) is

$$v(a, \varepsilon) = \max_{c, m', b'} \left[u(c) + \beta E \left\{ v \left(Rb' + \frac{m'}{1+e}, \varepsilon' \right) | \varepsilon' \right\} \right], \tag{4}$$

subject to

$$c \left[1 + S \left(\frac{c}{m'} \right) \right] + b' + m' = \varepsilon + a + \tau, \tag{5}$$

$$c, m' \geq 0, \text{ and } b' \geq \Omega \tag{6}$$

[16] Money is demand determined, that is, for a predetermined depreciation rate, the central bank prints as much money as the economy demands in the aggregate.

[17] I assume that the government is not capable of identifying the money holdings of heterogeneous agents in Economies 1 and 2, whereas in Economy 3, it can perfectly track the inflation tax paid by each consumer without consumers having the chance to internalize this transfers policy.

[18] Wealth effects would be fully neutralized only if inflation tax payments and transaction costs are completely rebated in an individual-specific manner with $G = 0 \ \forall t$.

with $a = Rb + \frac{m}{1+e}$ and $-\Omega$ being an ad hoc debt limit.

The decision rules of an individual that govern the demand for real money balances, bonds, and consumption are time-invariant functions, $m' = m'(a, \varepsilon)$, $b' = b'(a, \varepsilon)$, and $c = c(a, \varepsilon)$, respectively. Optimality conditions that come out of combining the first-order conditions of this problem are

$$\lambda[1 - S'(\kappa)\kappa^2] = \frac{\beta}{1+e} E\left\{\lambda'\right\}, \tag{7}$$

$$\lambda - \varphi = \beta R E\{\lambda'\}, \tag{8}$$

$$\text{and } c[1 + S(\kappa)] + b' + m' = \varepsilon + a + \tau, \tag{9}$$

where $\kappa = \frac{c}{m'}$.

Lagrange multipliers of the budget constraint and the borrowing constraint (i.e., λ and φ) are shadow prices of total deposits and relaxing the borrowing constraint by one unit, respectively.[19] Equation (7) is the Euler equation for real balances, which equates the marginal cost of saving in real balances (i.e., the forgone utility from consumption net of the economized transaction cost associated with it) to the marginal benefit of saving in real balances. The real return from holding real balances is negative if $e > 0$. Equation (8), on the other hand, is the Euler equation for bonds, which equates the marginal cost of saving in interest-bearing bonds (net of the shadow price of relaxing the borrowing constraint by one unit) to the marginal benefit of doing so. Equation (9) is the budget constraint of the household.

4.2 Heterogeneity in Opportunity Cost of Holding Real Balances and Portfolio Composition

Proposition 1 *For a given constant depreciation rate, e, and real interest rate, R, the consumption velocity of individuals who do not face a binding borrowing constraint is identical, i.e. $\kappa(a, \varepsilon) = \kappa$ $\forall$ (a, ε) if $b'(a, \varepsilon) > \Omega$. Moreover, the consumption velocity of borrowing-constrained individuals, κ^c, is strictly greater than κ and is increasing in $\varphi(a, \varepsilon)$.* For a proof, see Appendix B.

Proposition 1 elaborates how the effective opportunity cost of holding real balances is determined across different agents. Specifically, it is higher for constrained individuals; the more constrained an individual (i.e., the larger $\varphi(a, \varepsilon)$) is, the larger the discrepancy. The intuition here

[19]Both Lagrange multipliers are functions of idiosyncratic states, due to the history dependence implied by market incompleteness.

is as follows. Consider a borrowing-constrained individual who is hit by a negative earnings shock. The only way to dissave for such a consumer is to reduce real balances holdings, m', which results in a higher consumption velocity, $\kappa^c = \frac{c}{m'}$, for a given consumption level. This is costly for such an individual because a higher consumption velocity means a higher effective price of consumption.

The second important implication of Proposition 1 is on portfolio heterogeneity. In a standard incomplete markets economy with uninsurable idiosyncratic risk, the consumption-to-wealth ratio (i.e., $\frac{c(a,\varepsilon)}{a}$ in the current model) typically falls with wealth, since the marginal utility of consumption is lower for the rich. Now, the first part of Proposition 1 (i.e., $\frac{c(a,\varepsilon)}{m'(a,\varepsilon)} = \kappa \ \forall (a, \varepsilon)$ with $b'(a, \varepsilon) > \Omega$) coupled with the aforementioned property causes $\frac{d\left(\frac{m'(a,\varepsilon)}{a}\right)}{da} < 0$. As a result, the poor hold a larger fraction of their total deposits in demand deposits, consistent with the bottom panel of Figure 1 and the empirical literature on the financial assets portfolio across the wealth distribution.[20]

4.3 Welfare Effects of Changes in Inflationary Finance in a Deterministic Setup

The current paper introduces two adverse effects of inflation: (i) a wealth-eroding effect through inflation taxation and (ii) distortion in the consumption decision led by changes in the real transaction costs per unit of consumption. These effects can be listed among the classical adverse effects of inflation. However, the particular way in which fiscal authority responds to monetary authority (which I call *fiscal and monetary interactions*) might create substantial wealth effects for consumers. Moreover, these wealth effects can be asymmetric due to the heterogeneous-agents nature of the modeled framework. In order to gain intuition on the implications of alternative fiscal policy arrangements, I make a detour here and analyze the deterministic version of the model economy described in Section 3.

4.3.1 A Deterministic Economy with Heterogeneous Households

In this section, I simplify the benchmark economy studied in Section 3 by assuming that the economy is now inhabited by a finite number of household types, $i \in \{1, ..., I\}$, who are endowed with a time-invariant flow of earnings, ε_i. Each cohort i includes a large number of identical households. If the total population is normalized to 1, the measure of each cohort becomes $\mu_i > 0$

[20]In generating this result, I do not resort to any economies of scale assumption on the transaction costs function (i.e., average transactions costs $\phi\kappa^\gamma$ do not depend on consumption), in contrast with Erosa and Ventura (2002). Note also that the focus is on the *portfolio share* of real balances. Otherwise, it follows again from Proposition 1 that the poor hold fewer real balances in *absolute terms* because they consume less.

with $\sum_i \mu_i = 1$.[21] Since the framework in this section entails no earnings risk, analytical solutions to welfare functions implied by alternative fiscal arrangements are available, and I provide them in Appendix C.

Assuming constant relative risk aversion (CRRA) utility and using the closed-form solutions for c_i^* and τ^*, the long-run welfare of a type i consumer, W_i, becomes

$$W_i = \frac{\left[\frac{\varepsilon_i + \tau^* - (1-R)\Omega}{(1+\phi\kappa^\gamma) + \frac{e}{1+e}\cdot\frac{1}{\kappa}}\right]^{1-\sigma} - 1}{(1-\beta)(1-\sigma)}. \tag{10}$$

For the matter of finding an optimal rate of inflation, which maximizes W_i, the Friedman rule establishes an important theoretical benchmark. In general, the inflation rate that follows the Friedman rule is the one that implies zero nonpecuniary returns from holding real balances.[22] The nonpecuniary returns from holding real balances in the current setup arise from money's role in facilitating consumption transactions by reducing the associated costs. An increase in inflation will reduce the money demand and make this distortion more severe, which is captured by a higher value for the $\phi\kappa^\gamma$ term in W_i. An increase in inflation will also worsen the wealth-eroding effect, since the inflation tax paid per consumption, which is denoted by the term $\frac{e}{1+e}\cdot\frac{1}{\kappa}$, will increase with inflation. However, introducing heterogeneity into the conventional setup creates room for *redistribution*, which is not captured by the representative agent nature of the Friedman setup. Specifically, W_i is also affected by consumers' *disposable income*, which depends on the changes in inflationary finance via endogenous transfers, τ^*. Indeed, equation (10) shows that the poor would *benefit* from inflationary finance, provided that the increase in seigniorage revenues (which are directed to redistributive lump-sum transfers) dominates the increase in the distortions of inflation that are discussed above. This will be the case for consumers that earn less, because aggregate transfers are financed by inflation tax revenues, and the rich pay a larger fraction of those taxes, since they hold more real balances in proportion to their larger magnitude of consumption.[23] Hence, inflationary finance operates as a redistributive tool that transfers resources from the rich

[21] The problem of a type i consumer looks similar to the problem formulated by equations (4), (5), and (6), with the only difference being that the deterministic ε_i is no longer a state variable. For the following, I denote economic variables related to type i consumers by an i subscript.

[22] In the current setup, it is the inflation rate that implies a zero consumption velocity, which would eliminate the inefficiency caused by the real transaction costs of consumption. Hence, the inflation rate that satisfies the Friedman rule is $e^{Fr} = \beta - 1$, as suggested by the closed-form solution for consumption velocity, $\kappa = \frac{c_i^*}{m_i^*} = \left[\frac{1}{\gamma\phi}\left(1 - \frac{\beta}{1+e}\right)\right]^{\frac{1}{1+\gamma}}$.

[23] This finding is numerically verified for parameter values that are used in the quantitative analysis of the model with earnings risk. To save space, those numerical results are not included here but are available from the author upon request.

to the poor.

The intriguing redistribution result adds a political economy aspect to the optimality of the Friedman rule, which is abstracted in the analysis of Friedman (1969) for simplicity. In particular (assuming that the measure of the poor is larger than the rich), the inflation rate that maximizes aggregate welfare ($\sum_i \mu_i W_i$) will be positive and high, as opposed to the Friedman rule that only aims to wash out inefficiencies caused by transaction frictions. Indeed, as inflation gets closer to the Friedman rule, although the distortions in the economy are eliminated, aggregate welfare would keep falling, since it would be inefficient to redistribute resources from the poor to the rich by means of decreasing lump-sum transfers. This can be mechanically observed, since $\kappa \to 0$ (which is satisfied under the Friedman rule) implies that $\frac{e^{Fr}}{1+e^{Fr}} \cdot \frac{1}{\kappa} \to -\infty$.

In Economy 2, long-run welfare of type i individuals might be denoted by replacing τ^* in equation (10) with a constant τ, which does not respond to changes in inflationary finance. This naturally renders the redistribution effect unresponsive to changes in inflation. As a consequence, consumers' welfare can be maximized only if inefficiencies are eliminated. Nevertheless, the Friedman rule is still suboptimal in this case because it would imply negative government spending, which is not feasible. Consequently, we have a constrained efficiency problem and the aggregate welfare, $\sum_i \mu_i W_i$, is maximized when the inflation rate is small enough to ensure that $G^* = 0$. The closed-form solution for G^* (which is provided in Appendix C) enables us to solve for this inflation rate analytically:[24]

$$e^{CE} = \frac{1}{1 - \frac{\tau\kappa(1+\phi\kappa^{\gamma})}{Y-(1-R)\Omega}} - 1, \tag{11}$$

with Y denoting the aggregate earnings level of the economy.

Last, when transfers depend on idiosyncratic inflation tax payments (Economy 3), the long-run welfare of type i consumers is represented by replacing τ^* in equation (10) with the constant, G. The denominator of the fraction in the square brackets is also modified to be denoted only by the term $(1 + \phi\kappa^{\gamma})$. This implies that the aggregate welfare, $\sum_i \mu_i W_i$, can be maximized only if $\kappa \to 0$, which is achieved when the rate of inflation is equal to the Friedman rule level. Within this fiscal arrangement, the redistribution effect is completely shut down, since changes in inflation taxation payments of consumers are exactly compensated by changes in obtained transfers that

[24]Notice that e^{CE} depends on the *parameter* τ, which may be set to the equilibrium transfers level in Economy 1 for a benchmark inflation rate.

are proportional to idiosyncratic money holdings, so that a social planner would solely care about eliminating inefficiencies created by consumption transactions.

The deterministic version of the benchmark economy would be identical to a representative agent economy if each cohort i possesses the same deterministic earnings profile, $\varepsilon_i = Y$, where Y is the GDP per capita of the economy. This replaces ε_i with Y and τ^* with the constant G in equation (10) and, similar to Economy 3, makes the denominator of the fraction in square brackets equal to $(1 + \phi\kappa^\gamma)$. It is clear that the Friedman rule is again optimal in this case, given that the disposable income of the aggregate economy does not depend on inflation, and there is no room for redistribution due to the lack of heterogeneity. Furthermore, the wealth-eroding term does not even show up in the welfare expression, since lump-sum transfers exactly match the inflation tax net of government spending.[25]

In summary, introducing heterogeneity to the small open economy (SOE) model might drive nontrivial departures from the representative agent analysis of the optimal rate of inflation, depending on the interaction between fiscal and monetary policy. Moving toward the economy with idiosyncratic uncertainty and incomplete markets brings an additional channel that would affect the disposable income, and consequently the welfare, of households. Specifically, changes in inflation (which is a relative price between bonds and real balances) will create wealth and substitution effects regarding the portfolio decision. Depending on the relative dominance of these effects, welfare impacts that are discussed above might be strengthened or weakened. Notice also that the SOE takes the interest rates as given. Therefore, the celebrated precautionary savings (PS) outcome of a reduction in the equilibrium real interest rate (see Huggett (1993)) is absent in this model. This will result in large magnitudes of movements in the equilibrium quantity of interest-bearing assets, which in turn will affect the disposable income of consumers and their welfare. Figure 3 illustrates this idea by considering the impact of an increase in the PS motive. In a closed-economy setup, an increase in the PS motive will shift the demand for assets, S_0 (supply of funds, B_0), to the right (left). This will result in a higher bond price, that is, $q_1 > q_0 = q^*$ (lower interest rate), and an increase in the PS of PS^{closed}. However, since the supply of funds, B^{open}, is flat in the small open economy, the adjustment in the PS becomes much larger, that is, $PS^{open} > PS^{closed}$. Therefore, individuals might experience sharp variations in their interest income when the PS motive changes.

Having completed the description of the framework, I now proceed to the definition of the

[25] As a result, the first-best in this economy would require $G = 0$ and $e = e^{Fr}$.

stationary recursive equilibrium in the benchmark economy with idiosyncratic uncertainty.

4.4 Stationary Recursive Equilibrium

I assume that conditions that guarantee the existence of a unique invariant measure, Γ^*, defined over the idiosyncratic state space are satisfied (see Huggett (1993)) for a stationary equilibrium. Below is a formal definition of the stationary recursive equilibrium of the model.

Definition 1 *Given a constant level of government expenditures, G, the international gross real interest rate, R, and a constant depreciation rate, e, a stationary recursive equilibrium is a time-invariant value function, v, time-invariant policy functions, $m' = m'(a, \varepsilon; e)$, $b' = b'(a, \varepsilon; e)$, and $c = c(a, \varepsilon; e)$, constant lump-sum transfers, τ^*, and a stationary distribution, Γ, such that (i) given τ^*, R, and e; v, $m' = m'(a, \varepsilon; e)$, $b' = b'(a, \varepsilon; e)$, and $c = c(a, \varepsilon; e)$ solve the household's problem (4.1); (ii) given G, Γ, e, and the policy functions of households, τ^* is consistent with the balanced budget of the government, $G + \tau^* = \left(\frac{e}{1+e}\right) M^s$; (iii) given Γ and the policy functions of households, the aggregate goods market clears (i.e., the national income identity holds), $C + G + (1 - R)B + Tr = Y$, with $C = \sum_{a,\varepsilon} \Gamma(a, \varepsilon)c$, $B = \sum_{a,\varepsilon} \Gamma(a, \varepsilon)b'$, $Y = \sum_{a,\varepsilon} \Gamma(a, \varepsilon)\varepsilon$, and $Tr = \sum_{a,\varepsilon} \Gamma(a, \varepsilon)cS(\frac{c}{m'})$. The money market equilibrium, $M^s = \sum_{a,\varepsilon} \Gamma(a, \varepsilon)m'$, follows from the de facto exchange rate regime; and (iv) given policy rules for assets and the Markov transition of earnings, $[b'(a, \varepsilon), m'(a, \varepsilon), p_{\varepsilon'|\varepsilon}]$, the distribution of total deposits and earnings satisfies the following fixed point equation: $\Gamma(a', \varepsilon') = \sum_\varepsilon \sum_{\{a: a' = Rb'(a,\varepsilon) + \frac{m'(a,\varepsilon)}{1+e}\}} \Gamma(a, \varepsilon)p_{\varepsilon'|\varepsilon}$.*[26]

5 Quantitative Analysis

In this section, I study the model's quantitative predictions using a version calibrated to the Turkish economy. As illustrated by the lower left panel of Figure 2, Turkey is representative of the recent disinflation in emerging economies. From a parameterization and calibration perspective, the focus is on the low inflation period 2003:Q1-2010:Q2, for which data on macroeconomic aggregates, inequality measures, and government transfers are available. The main experiment is to make stationary equilibria comparisons between high ($e = 14.25\%$ over the period 1987:Q1-2002:Q4) and low ($e = 2.25\%$) inflation economies. Throughout the analysis, I pass this parameterization and calibration onto Economies 2 and 3. I now describe the parameterization of Economy 1.

[26] In Economy 2, G^* closes the equilibrium for a fixed τ. In Economy 3, τ^* in (i) is replaced by $\tau^*(a, \varepsilon)$, where the latter is a state-dependent equilibrium transfers schedule. So it should satisfy condition (ii) by $\tau^*(a, \varepsilon) = \left(\frac{m'(a,\varepsilon)e}{1+e}\right) - G$ and $\tau^* = \sum_{a,\varepsilon} \Gamma(a, \varepsilon)\tau^*(a, \varepsilon)$.

5.1 Parameterization of the Benchmark Economy

The parameter values that are used in Economy 1 are reported in Table 2. Following the literature, $\sigma = 2$ is chosen as the risk aversion parameter of the CRRA utility. The model period is a quarter. R is set to 1.0276 in line with the exercise of Uribe and Yue (2006) to reflect an emerging economy country risk premium (EMBI spread) of 7% above the average US Treasury bill rate of 4% per year. Interestingly, a risk premium of 7% proves consistent with using Turkish data and the calibration strategy adopted in this paper, as I explain below.

I assume that the natural logarithm of the idiosyncratic earnings, ε_t, follows an autoregressive process of order one, subject to normally distributed disturbances u_t, with zero mean and constant variance, σ_u^2. Therefore, I have

$$\log \varepsilon_{t+1} = (1-\rho)\mu + \rho \log \varepsilon_t + u_t, \tag{12}$$

where μ is the mean of the logarithm of the earnings process and ρ is the persistence parameter. Due to the lack of longitudinal panel studies on micro-level earnings dynamics for the Turkish economy, I choose values for earnings process parameters that are in an acceptable range studied by the literature. As mentioned in Algan and Ragot (2010), parameters of persistence of about 0.90 and standard deviation of innovations in the range of 0.12 and 0.25 are used in the literature (see also Hubbard et al. (1995) and Heathcote et al. (2010). The former study even considers values for persistence around 0.95). Therefore, I fix $\rho = 0.9625$ and $\sigma_u = 0.14$. I then approximate a normally distributed log-earnings process with a Markov chain, feeding the double, (σ_u, ρ), in Tauchen's (1986) procedure. To capture most of the domain of normal density, the spread parameter is set to 3. Twenty-one nodes that are located symmetrically around zero are used on the shocks to log-earnings grid. I normalize grid points to ensure that GDP in the model is equal to 1.[27]

The value of the curvature parameter of the transaction costs function, γ, is determined by estimating an aggregate money demand equation, which posits a log-linear relationship between real balances demand, consumption, and the opportunity cost of holding money.[28] The relationship

[27] The double, (σ_u, ρ), used in the current paper implies a low level (0.55) of coefficient of variation in earnings. Nevertheless, it is necessary to have an upper bound for the volatility of earnings process in this framework because with more volatile shocks, it is considerably difficult to generate substantial inequality in wealth distribution, due to the increased precautionary savings motive.

[28] Since I do not have a measure of the *effective opportunity cost* of holding money for constrained individuals in the data, I use the quarterly nominal deposit interest rates as an explanatory variable for all individuals and estimate a single equation. This is because γ is not a parameter of consumer characteristics, such as a taste parameter for real balances in the MIU specification. In contrast, consumers have no preference over the way that the transactions are carried on. Therefore, it is plausible to use nominal interest rates as the common variable to capture the opportunity cost of holding money. For this matter, I used 1-, 3-, 6-, and 12-month maturity deposit rates. The quarterly time

is implied by the functional form of S, the optimality condition regarding real balances demand (i.e., $S'(\kappa_t)\kappa_t^2 = \frac{i}{1+i}$), and the definition of consumption velocity, $\kappa_t = \frac{c_t}{m_{t+1}} = [\frac{1}{\gamma\phi}(\frac{i}{1+i})]^{\frac{1}{1+\gamma}}$. Following Stock and Watson (1993), the estimated equation becomes

$$\log(m_{t+1}) = \alpha_1 \log(c_t) + \alpha_2 \log\left(\frac{i_t}{1+i_t}\right) + d_c(L)\Delta c_t + d_i(L)\Delta \log\left(\frac{i_t}{1+i_t}\right) + \epsilon_t, \qquad (13)$$

which accounts for the cointegrating relationship between the variables listed above. The dynamic ordinary least squares (DOLS) method is used in the estimation, where $d_c(L)$ and $d_i(L)$ are polynomial operators with two leads and two lags.[29] I use the time series for aggregate consumption and real M1 (deflated by the GDP deflator) in the estimation of equation (13) over the period 1987:Q4-2010:Q1 (after the lag adjustments).The data source for all these aggregates is the Central Bank of the Republic of Turkey (CBRT hereafter). The interest elasticity of real money demand is estimated to be equal to α_2 = -0.4594 (Lucas (2000) argues that the interest elasticity of money demand for the US economy is -0.50 over the period 1900-1994). The standard error of this coefficient is 0.0514, implying a p-value of zero. The estimation also implies close to unitary elasticity of money demand with respect to consumption. I estimate $\alpha_1 = 0.8405$, with a standard error of 0.0076 and a p-value of zero. The adjusted R^2 of the regression is 72.31%. Since $\alpha_2 = -\frac{1}{1+\gamma}$, I solve for γ to be equal to 1.1766.

I choose values for the discount factor, β, multiplicative parameter of the transactions costs function, ϕ, and negative of the debt limit, Ω, simultaneously to match moments from the data. The corresponding moments in order are (i) net-exports-to-GDP ratio, (ii) the aggregate consumption velocity of M1, and (iii) the aggregate portfolio composition.[30] The long-run net-exports-to-GDP ratio is denoted by $\frac{(1-R)B}{Y}$ in the model, which implies that this ratio depends on the economy's aggregate stock of the interest-bearing asset. I measure the total stock of assets $(B + M)$ with M2Y, which includes M1 (i.e., the currency in circulation and checkable deposits), term deposits, and foreign currency denominated deposits.[31] The aggregate portfolio composition is captured by $\frac{B}{B+M}$ in the model.

series for nominal interest rates are constructed by properly adjusting maturities and computing weighted average rates by using the share of various (maturity) type deposits in the whole system.

[29] Sequential modified LR test statistic, final prediction error, and Akaike information criteria pointed out the number 2 as the optimal lag number in the VAR. The term m_{t+1} is determined at date t.

[30] Time series averages over the period 2003:Q1-2010:Q2 are used as the aggregate targets.

[31] The interest parity condition, $1+i = (1+i^*)(1+e)$, and the law of one price, $1+\pi = (1+\pi^*)(1+e)$, imply that a local currency denominated interest-bearing asset is equivalent to a dollarized asset in rate of return. Consequently, the aggregate portfolio composition, $\frac{M2Y-M1}{M2Y}$, can be thought of as an *effective dollarization* ratio.

Calibration of the above parameters requires the solution of the model. To that end, I use the simulated annealing method to find the set of parameters that minimizes the absolute values of deviations of model-generated moments from their empirical counterparts. The empirical targets and the model-generated moments are reported in Table 2. The solution to these parameters remains within a 0.75% error level.

I pin down the exact value of R by imposing the long-run relationship between the aggregate bonds position of the small open economy and the trade balance, that is, $(1-R)\left(\frac{M2Y-M1}{GDP}\right)_{Avg} = \left(\frac{X-M}{GDP}\right)_{Avg}$, to the data. Interestingly, the implied real interest rate from this calculation (i.e., 1.0276) coincides with the value that Uribe and Yue (2006) use.[32] I then feed this fixed value of R into the model and search for a β that matches the empirical trade-balance-to-GDP ratio. Recall that in Bewley models, $\beta R < 1$ has to hold in order to obtain a well-defined ergodic distribution of wealth. Otherwise, consumers accumulate an unbounded magnitude of assets to avoid negative consumption in any state of nature.[33] Keeping track of this feature of incomplete-markets models, the fixed value of the real interest rate, $R = 1.0276$, and the objective of matching the empirical ratio of $\frac{NX}{GDP} = -0.0334$ (source: CBRT) produces a value of 0.9215 for β. As a result, the model-generated $\frac{(1-R)B}{Y}$ ratio becomes -0.0333, with a value of 0.9469 for the term βR.

The multiplicative parameter of the transaction costs function, ϕ, is calibrated to 0.00185 to match the time series average of the quarterly aggregate-consumption-to-M1 ratio of 4.1925 (source: CBRT). The model-generated value for this statistic, that is, C/M, is 4.1920.[34]

I use $\Omega = -0.0329$ (implying a debt-to-lowest-earnings ratio of 17.85%) to target the aggregate portfolio composition (i.e., $\frac{M2Y-M1}{M2Y} = 0.8493$, source: CBRT). The model-generated aggregate share of interest-bearing deposits, $B/(B+M)$, is 0.8543.

Finally, I mention parameters related to the government. The quarterly depreciation rate, e, is set to 0.0225 in the baseline economy. This is the average rate of inflation in the period 2003:Q1-2010:Q2 implied by the GDP deflator (source: CBRT). The time series average of the aggregate government-spending-to-GDP ratio was about 16% for the same period (source: CBRT).

[32] The high real interest earned on the internationally traded bonds by the *savers* in the emerging economy should be thought of as their facing a no arbitrage condition between either saving in domestic term deposits or resaving in the euro bonds issued by their own country.

[33] For examples, see Aiyagari (1994) and Ljungqvist and Sargent (2004).

[34] The aggregate consumption series that I use includes private investment expenditures added to private consumption. I lump private investment in C as well, since I do not model physical capital accumulation. Following a similar reasoning, I lump public investment in the term G while determining its constant value (source: State Planning Organization, SPO).

Therefore, I set $G = 0.1611Y$. Note that the government budget constraint in the model, which is represented by equation (3), is very simplistic. This is because some public finance elements such as government debt and conventional taxes (such as capital income tax) other than the inflation tax are omitted. Therefore, one needs to take an empirical stance on what the endogenous model variable, τ, represents. Equation (14) below illustrates the budget constraint of the consolidated government in general:

$$G_t + Transfers_t + (R-1)B_t^G = Revenues_t + B_{t+1}^G - B_t^G, \tag{14}$$

where G_t is government spending, $(R-1)B_t^G$ is the debt service, $Transfers$ are pure transfers to households, and *Revenues* are any kind of government revenues (mainly taxes). Now, one has to reconcile equation (3), which includes seigniorage revenues that do not explicitly show up in the public finance data, and τ_t as a lump-sum variable that tends to capture what is not modeled in the public side, with equation (14). For that matter, I decompose τ_t into two parts, τ_{0t} and τ_{1t}, where the former represents any component of equation (14) that is not modeled, whereas the latter represents pure transfers to households such as social security transfers, direct transfers, and transfers to the health and education sectors. The crucial feature of the baseline economy here is that I fix G and τ_{0t} so that they are independent of inflation and let τ_{1t} and $M_{t+1}^s - \frac{M_t^s}{1+e_t}$ respond to inflation.[35] Since pure transfers to households are about 4.5%, government spending is about 16%, and seigniorage revenues are about 1% of GDP over the period 2003:Q1-2010:Q2, I set $\tau_{0t} = (M_{t+1} - \frac{M_t}{1+e_t})^{Data} - G^{Data} - \tau_{1t}^{Data} = 0.0111Y - 0.1611Y - 0.0463Y = -0.1963Y$ (source: CBRT).

This closes the discussion of the parameterization and calibration of the benchmark model. The numerical solution method for the computation of the stationary recursive equilibrium is described in Appendix D. I now proceed to the quantitative analysis of the benchmark economy.

5.2 Benchmark Model vs. Data

In this section, I compare the long-run values of the aggregate and distributional variables implied by the calibrated model (Economy 1) with their empirical counterparts. The aggregate statistics that I report in Table 3 are the ratios of the stock of real balances plus bonds, $(B + M)/Y$, consumption, C/Y, trade balance, $(1 - R)B/Y$, transaction costs, Tr/Y, lump-sum transfers

[35] Economies 2 and 3 obviously deviate from this setup.

(the part that responds to inflation, i.e., τ_1/Y; see Section 5.1), and real seigniorage-revenues-to-GDP ratio, $(eM/(1+e))/Y$, consumption velocity of money, C/M, and the dollarization ratio, $B/(B+M)$. The distributional variables are the Gini coefficients of disposable income, bonds, real balances, and consumption, top-quintile-to-bottom-quintile ratios of income and consumption, mean-to-median ratio of income, and the measure of borrowing-constrained individuals. The model performs considerably well in terms of matching the ratios of the aggregate stock of deposits, consumption, and transfers to GDP, although they are not targeted. Aggregate transaction costs are estimated to be 0.9% of GDP.

To illustrate the inequality patterns of Turkey, Table 4 reports the 2004-2008 averages of percentage shares of income and consumption quintiles. Using this data, the approximated Gini coefficients for income and consumption emerge as 39% and 33%, respectively. Notably, consumption inequality is much less than inequality in deposits positions (illustrated in Figure 1) and income. Arguably, this phenomenon shall be attributed to the existence of informal insurance mechanisms, rather than the deepness of the financial system.[36]

In Figure 4, I illustrate the model-generated Lorenz curves (straight plots) for disposable income, $y = \varepsilon + (R-1)b' + \tau$, bonds, real balances, and consumption in addition to portfolio composition in comparison with their empirical counterparts (dashed plots). Consistent with the right panel of Table 3, the model does well in replicating the inequality patterns of income and consumption, partially underestimates inequality in bond positions, and considerably underperforms in capturing inequality in real balances holdings. None of these moments were targeted in the calibration routine. The Gini coefficient of real balances is larger than that of consumption because of the existence of borrowing constraints; however, since only 5.7% of the population is borrowing constrained, the distribution of real balances is only slightly decoupled from that of consumption. On the other hand, this finding proves that the distribution of consumption and cash holdings might be decoupled even in an environment in which there is a strong link between cash holdings and consumption. Last, in the bottom right panel of Figure 4, I show the portfolio (plotted in a

[36] Recall that I only model earnings, interest, and transfers as potential sources of income. Unfortunately, disaggregated (in terms of alternative sources) income inequality data are not available for the Turkish economy. However, the Income and Living Conditions Survey (2006-2010) shows that these three sources of income indeed capture total income inequality quite well. This is because (i) earnings, transfers, and interest income add up to 67.57% of aggregate disposable income, and (ii) entrepreneurial income that I do not model (which represents 24% of total income) is distributed among total disposable income quintiles, similar to the way in which earnings and social transfers are distributed. The Income and Living Conditions Survey (2006-2010) prepared by TURKSTAT may be found at http://www.turkstat.gov.tr/VeriBilgi.do?alt_id=24.

comparable way to the bottom left panel of Figure 1) as a function of the total deposits position. As discussed in Section 4.2, the model is consistent with the concavely increasing portfolio share of bonds as individuals become richer.

Having completed the assessment of the benchmark model's performance against the data, I now proceed to the discussion of the stationary equilibria consequences of disinflation under alternative fiscal arrangements.

5.3 Aggregate Implications of Disinflation

Table 5 shows that under all fiscal arrangements, the ratios Tr/Y, $\frac{Me}{1+e}/Y$, and C/M decrease when inflation declines. A reduction in inflation dominates the increase in the aggregate real balances demand, causing seigniorage revenues (inflationary finance) to diminish. Transfers decrease in Economies 1 and 3, whereas government spending decreases in Economy 2. The model is consistent with the observations of the dollarization literature that a reduction in inflation lowers the degree of dollarization, $B/(B+M)$. In Economy 3, the aggregate asset position decreases (resulting in a falling trade deficit), in contrast with Economies 1 and 2. I discuss this difference below with regard to distributional implications.

5.4 Distributional Implications of Disinflation

In the top panels of Figure 5, I plot the model-generated cumulative distribution functions (c.d.f.) of term and demand deposits for permanent depreciation rates of 2.25% (dashed plot) and 14.25% (straight plot), respectively.[37] The top right panel shows that the c.d.f. of demand deposits in the low inflation economy first-order stochastically dominates that in the high inflation economy. This is because wealth and substitution effects work in the same direction for the real balances demand: a reduction in inflation creates (i) a positive *wealth* effect that induces consumers to demand more of both assets and (ii) a *substitution* effect driven by a reduction in the relative price of real balances in terms bonds, inducing individuals to demand more real balances relative to bonds. Therefore, whether rich or poor, consumers increase their real balances demand when inflation is lower, whereas this is not the case for bonds, since the dominance of wealth and substitution effects displays heterogeneity across the wealth distribution.[38]

[37] For visual clarity, I restrict the plot in the top left panel to display a subset of the range of the c.d.f.

[38] Hence, the absence of first-order stochastic dominance between c.d.f.s of bonds across high and low inflation economies.

The bottom panels of Figure 5 illustrate the asset portfolio of households as functions of total deposits-earnings, (a, ε), and total deposits-depreciation rate, (a, e), doubles. Portfolio is defined as $\frac{b'}{b'+m'}$ at the individual level. The bottom left panel shows that earnings-poor individuals hold a portfolio that is more biased toward bonds (the whole portfolio schedule shifts up) because of the increased precautionary savings (PS) motive.[39] On the other hand, for a given earnings level, the portfolio schedule exhibits an increasing, concave shape, confirming the empirical fact documented by the literature that the wealth-poor hold a larger fraction of their portfolio in noninterest-bearing assets and the facts documented in the current paper.[40] Moving to the impact of disinflation on the portfolio, the bottom right panel illustrates that the share of bonds shifts downward when inflation is reduced. Yet, a lower portfolio share of bonds does not necessarily mean that the *absolute value* of the bond position of a particular consumer is decreasing. Indeed, the bond position of an individual may *rise* if the wealth effect dominates the substitution effect. Since the PS motive will be strong for consumers who are the most affected by wealth effects, at the heart of the analysis is the relative dominance of these effects.

Table 6 presents the distributional implications of a reduction in inflation under alternative fiscal arrangements. Rows 1-4 report the Gini coefficients of income, consumption, bonds, and real balances, and rows 5-8 show the top-quintile-to-bottom-quintile and mean-to-median ratios of income and consumption, respectively. These statistics establish that the distribution of income, real balances, and consumption is almost intact when inflation is reduced irrespective of the particular fiscal arrangement. On the other hand, when inflation is reduced, the Gini coefficient of bonds stays intact in Economy 1 and increases by about 1.5% and 2% in Economies 2 and 3, respectively. Notice that this relatively muted response of distributional aspects to disinflation does not necessarily imply offsetting welfare effects across the wealth distribution. This is because the Gini coefficients provide just a snapshot of the degree of inequality across agents, without keeping track of the individual-level wealth effects. That is, some agents, for whom the wealth effects of disinflation are asymmetric, might just switch roles, leaving the Gini coefficient the same. Such effects are taken into account in the welfare section.

The difference between alternative fiscal arrangements can be explained by variations in the equilibrium PS motive across Economies 1, 2, and 3. For a given stochastic process of idiosyncratic earnings, a *decrease* in the measure of the borrowing constrained represents an *increase* in the

[39]Notice that the PS motive would be more predominant for consumers that are hit by adverse earnings shocks.
[40]See Section 4.2 for a discussion of the mechanism that generates this phenomenon in the model.

equilibrium PS motive in the economy, since it points out the desire to avoid hitting debt limits. One might also keep track of the portfolio composition of the poorest agents in the economy, since the PS effect is the most relevant for those individuals. To that end, rows 9 and 10 in Table 6 report the fraction of the population that hit the debt limit and the portfolio share of the poorest total deposits percentile, respectively.[41]

The analysis reveals that in Economy 1, these two measures indicate a surge in the PS motive with disinflation. In particular, disinflation causes a substantial decline in the measure of the borrowing constrained (from 10.5% to 5.7%) and an increase in the portfolio share of bonds for the poor from 47% to 53%.[42] This is in contrast with the portfolio effect of disinflation in the aggregate economy (see the last row of Table 5) because the wealth effects stemming from the reduced transfers income outweigh the substitution effect stemming from the decline in the relative price of bonds.

In Economy 2, disinflation causes a smaller increase in the PS incentive (the measure of the borrowing constrained reduces from 8.4% to 5.7%) because transfers do not respond to disinflation. The smaller but evident increase in the PS motive implies that $\frac{m'(a,\varepsilon)e}{1+e}$ *increases* for the poor, rendering natural debt limits tighter. Interestingly, this finding is in contrast with the aggregate economy, since the aggregate seigniorage revenues, $\frac{Me}{1+e}$, *decline* in response to disinflation (see the sixth row of Table 5). Therefore, it follows that although the inflation tax paid by the poor increases, it declines for the rich.[43] In the absence of a strong increase in the PS motive, the portfolio of the poor becomes more biased toward real balances when inflation is lower, as opposed to Economy 1.

Finally, in Economy 3, since transfers are much smaller than those in Economies 1 and 2, this economy exhibits much tighter natural debt limits and therefore a lower measure of the borrowing constrained, irrespective of the level of inflation. Moreover, since transfers income is comoving with inflation tax payments in this economy, the wealth effects are partially neutralized so that

[41] The portfolio of the first percentile is computed as

$$\frac{\sum_{a,\varepsilon}\Gamma(a,\varepsilon;e)b'(a,\varepsilon;e)}{\sum_{a,\varepsilon}\Gamma(a,\varepsilon;e)b'(a,\varepsilon;e)+\sum_{a,\varepsilon}\Gamma(a,\varepsilon;e)m'(a,\varepsilon;e)},$$

where $a:\Phi(a;e)=0.01$ with $\Phi(.)$ being the c.d.f. of a.

[42] Observing the natural debt limit, $-\Psi=\left(\frac{\varepsilon_{\min}+\tau-\frac{e}{1+e}m_t}{R-1}\right)$, is useful here. Since uniform transfers decline with disinflation (see Table 5), the natural debt limits become tighter.

[43] In other words, the real balances demand, $m'(a,\varepsilon)$, of the poor is much more sensitive to the relative price of assets, that is, inflation.

the PS incentive is less sensitive to disinflation. A higher precautionary savings motive also brings rationale to a larger aggregate asset position in this economy relative to Economies 1 and 2 (see the first row of Table 5). Furthermore, similar to Economy 2, this economy also exhibits an increasing share of real balances in the portfolio of the poor, as opposed to Economy 1. This common property of Economies 2 and 3 illustrates that the substitution effect of disinflation is more predominant in these economies, as opposed to the benchmark economy.

Having closed the discussion of distributional implications of disinflation, I now proceed to the analysis of welfare consequences.

5.5 Welfare Implications of Disinflation

The welfare consequences of disinflation depend crucially on fiscal and monetary interactions as illustrated in Section 4.3. However, when uninsurable idiosyncratic risk is introduced to the model, welfare assessment requires numerical approximation. To that end, I follow Mendoza et al. (2007) and approximate welfare gains from disinflation as the proportional increase in consumption, η, in the 14.25% inflation stationary equilibrium that would make an individual consumer indifferent about remaining in that economy versus shifting to an economy with the inflation rate of 2.25%. For each agent i who is initially in state (a, ε), $\eta(a, \varepsilon)$ solves

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^{i,14.25\%}(1 + \eta(a, \varepsilon))) = E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^{i,2.25\%}), \tag{15}$$

where $\{c_t^{i,14.25\%}\}_{t=0}^{\infty}$ and $\{c_t^{i,2.25\%}\}_{t=0}^{\infty}$ are infinite sequences of consumption of agent i in the high and low inflation economies, respectively.[44]

Once I establish the consumption equivalent of welfare gains at the *individual* level, as a natural next step, I proceed to aggregation in order to obtain a normative assessment of disinflation on the economy as a whole. The practice is to fix the wealth distribution of the high inflation economy, $\Gamma^{14.25\%}(a, \varepsilon)$, as an initial condition and use it to compute a weighted average of the welfare gains in terms of compensating consumption variation (CCV hereafter).[45] Hence, the consumption equivalent of the *aggregate* welfare gain from permanently reducing the inflation rate to 2.25% can

[44]Given the particular form of the utility function and the notation so far, $\eta(a, \varepsilon)$ solves

$$[(1 - \beta)(1 - \sigma)v^{14.25\%}(a, \varepsilon) + 1](1 + \eta(a, \varepsilon))^{1-\sigma} = [(1 - \beta)(1 - \sigma)v^{2.25\%}(a, \varepsilon) + 1], \tag{16}$$

where $v^{14.25\%}(a, \varepsilon)$ and $v^{2.25\%}(a, \varepsilon)$ are equilibrium value functions in the high and low inflation economies, respectively.

[45]Since the focus is on stationary equilibria, I abstract from the effects of transitional dynamics on welfare.

be written as

$$W^{2.25\%} = \sum_{a,\varepsilon} \Gamma^{14.25\%}(a,\varepsilon)\eta(a,\varepsilon). \tag{17}$$

Table 7 presents the welfare consequences of reducing inflation (from 14.25% to 2.25%) in model economies. The first row denotes the aggregate welfare gain (as defined above) of waking up in the low inflation stationary equilibrium. Rows 2, 3, and 4 include the disaggregation of this measure into the average gains of the poorest quintile, the 50^{th} percentile, and the top percentile (ranked according to total deposits positions). Row 5 shows the welfare gains in the deterministic cases that are studied in Section 4.

When transfers are uniform (Economy 1), the rich *benefit* (a welfare gain of 0.97% in terms of CCV) from disinflation at the *expense* of the poor (a welfare loss of 3.56% in terms of CCV). This is because disinflation causes the poor to lose the redistributive cash transfers that are mainly financed by the inflation tax payments of the rich. Since the welfare loss of the poor is disproportionately large, the aggregate economy incurs a welfare loss of 1.25%.

If wasteful government spending responds to monetary policy (Economy 2), the welfare gains schedule observed in Economy 1 shifts up because transfers are not reduced following a contraction in inflationary finance. Since the redistribution scheme is unresponsive to disinflation in this economy, the poor no longer incur a welfare loss from disinflation. Interestingly, however, the welfare gain of the poor (1.24%) is smaller than that of the rich (1.76%). Indeed, the welfare gains from disinflation get larger as individuals get wealthier, as opposed to the findings in Erosa and Ventura (2002). Aggregate welfare increases by 1.62% when inflation is reduced to 2.25% in this economy.

Finally, when transfers are individual specific (i.e., $\tau(a,\varepsilon) = \frac{m'(a,\varepsilon)e}{1+e} - G$), fiscal policy does not cause any redistribution among heterogeneous agents. As a result, reducing inflation in Economy 3 creates welfare gains mainly due to reduced transactions costs and wealth eroding. On the other hand, welfare gains in this economy are much lower than those in Economy 2. This is mainly due to the absence of positive wealth affects created by a reduction in government spending in Economy 2. Furthermore, when wealth effects are not strong and the real interest rate is constant, a reduction in inflation causes consumers to earn unambiguously lower interest income because of the reduced bonds demand induced by the substitution effect (see a discussion of this property of the model in Section 4.3).[46]

The welfare analysis suggests two intriguing findings: (i) redistribution might completely shift the welfare gains scheme due to wealth effects, and (ii) the nature of the portfolio composition suggests that welfare gains from disinflation monotonically increase as individuals get wealthier. Figure 6 illustrates these findings in a unified framework. The three panels of the figure display welfare gains from disinflation under alternative fiscal arrangements. Moreover, the plots are constructed in such a way as to reflect the disaggregation along the dimensions of total deposit holdings and earnings. The main message of the figure is that the disaggregated welfare gains schedule shifts up when adverse wealth effects are mitigated in response to disinflation. On the other hand, consistent with the findings reported in Table 7, welfare gains increase as individuals get richer in terms of both earnings and total deposits.

Why do we obtain this result as opposed to the study by Erosa and Ventura (2002), in which inflation works as a regressive consumption tax? The answer lies within the difference in institutional assumptions regarding the transaction technology. Their study assumes that purchasing consumption goods via credit as opposed to cash is less costly for wealthier individuals. Therefore, inflation makes the means of consumption asymmetrically more costly for the poor, so that it becomes a regressive consumption tax. The current paper does not make this assumption on the transaction technology, which leads to the finding that $\frac{c}{m}$ is fixed for all individuals, rendering inflation as a linear consumption tax.[47] On the other hand, constant consumption velocity is useful in obtaining the portfolio heterogeneity result that the share of bonds in the asset portfolio increases as individuals get wealthier, as illustrated in the lower right panel of Figure 4. Moving toward the impact of disinflation, the lower right panel of Figure 5 shows that the portfolio share of bonds shifts down due to the substitution effect. The whole schedule is *concave* in wealth, implying that the collapse in the portfolio share of bonds *increases* as individuals get *poorer*. This hurts the poor asymmetrically more because they are the ones who need consumption smoothing more severely.

What is the role of uninsurable earnings risk on the welfare consequences of disinflation? To answer this question, I compute aggregate welfare gains with deterministic earnings profiles and report the results in the last row of Table 7. This analysis reveals that in contrast with Economies 2 and 3, aggregate welfare loss is much larger in Economy 1 (1.23% versus 0.12%) when there is id-

[46] In the sensitivity analysis section, I show that disinflation is welfare *reducing* due to this reason when there are no wealth effects.

[47] Specifically, the total tax outlay of an individual who is in state (a, ε) is $c(a, \varepsilon)\left\{S(\kappa) + \frac{e}{1+e}\frac{1}{\kappa}\right\}$.

iosyncratic risk, as opposed to the deterministic case. This is because in Economy 1, a reduction in inflationary finance (and redistributive transfers) substantially tightens natural debt limits, which is only a feature of the stochastic economy. Economies 2 and 3 do not display this fundamental difference when uncertainty is introduced, since transfers are fixed in the former and natural debt limits do not change with inflation at all in the latter.

In summary, I argue that the welfare consequences of disinflation depend crucially on the particular fiscal arrangement. The main results are as follows. (i) If the transfers system is redistributive, inflationary finance might be good for the poor at the expense of the rich. I also argue that this redistribution story might be a modest explanation for the chronic inflation experience of some emerging economies, such as Turkey. (ii) Inflationary finance causes substantial welfare losses if it is directed to government consumption. (iii) If agents' financial wealth and their transfers income are positively related, then inflationary finance is again costly in terms of welfare.

So far, the focus has been on comparing two inflation rates in the context of the empirically observed disinflation. But this experiment is silent on the welfare consequences or precautionary savings motive impacts of too-high or too-low inflation rates or the aggregate money demand of the economy as a whole. In order to shed light on these issues, in the next section, I make a brief extension and analyze the stationary equilibria obtained for various inflation rates.

5.6 Extension: Long-Run Comovements

In this section, I analyze the aggregate, distributional, and welfare consequences of inflation in a broader context (i.e., without limiting the focus only on two different values of inflation). In particular, I lay out the stationary equilibrium implications of the model for a grid of inflation rates, $\{-2\%, 0\%, 2.25\%, 5\%, 7\%, 14.25\%, 20\%, 30\%, 50\%\}$, where these values are meant to capture some degree of variation in the opportunity cost of holding money, $\frac{i}{1+i}$.

5.6.1 Aggregate Money Demand Curve

Arguably, the most important aggregate implication of the model is the predicted aggregate money demand curve in relation to the opportunity cost of holding money. Figure 7 plots the model-implied aggregate money per consumption (the dashed plot) as a function of the opportunity cost of holding money, where the latter is computed by using the Fisher equation, $(1+i) = R(1+e)$, under no aggregate uncertainty. R coincides with the calibrated value used in the model, and inflation rates, e, are the values used in this section. Circles (stars) represent the high (low) inflation period used in our aggregate money demand estimation in Section 5.1. As the figure highlights, the model performs well in capturing the convex, downward-sloped pattern of the aggregate money demand curve as a function of the opportunity cost of holding money.

5.6.2 Inflation and Precautionary Savings

To shed light on the PS implications of inflation, Figure 8 is included to sketch the relationship between the fraction of the borrowing constrained and inflation under alternative fiscal arrangements. When $e = 0\%$ is treated as a reference point, the figure conveys three important pieces of information. First, the wealth effects on the poor dominate substitution effects as inflation rises. This induces the poor to demand fewer bonds, and consequently, the measure of the borrowing constrained increases with inflation. Second, this fraction becomes the largest (smallest) in Economy 1 (3). This is because the wealth effects are the strongest in Economy 1 (the straight plot with circles), as manifested by aggressive increases in transfers, weaker in Economy 2 (the dashed plot), in which transfers are constant, and the weakest in Economy 3 (the straight plot with squares), in which transfers depend on individual money holdings. Third, for negative inflation rates, again more individuals start hitting debt limits. In addition, the ordering among the three economies for this matter is now reversed. This is because the relaxation of debt limits is reversed when the inflation tax paid by the poor becomes negative.

5.6.3 Inflation and Welfare

Finally, I analyze the long-run relationship between inflation and aggregate welfare as measured in Section 5.5. Figure 9 strikingly suggests that the aggregate welfare consequences of inflation crucially depend on fiscal arrangements. To be consistent with the analysis in Section 5.5, CCV units of changes in the aggregate welfare, led by switching to an alternative inflation rate regime, are plotted vis-à-vis the economy with $e = 14.25\%$. As per the analysis in Section 4.3.1, aggregate welfare monotonically increases with inflation in Economy 1. This is because redistributive transfers are always increasing with inflation, as highlighted by Lucas (2000) that seigniorage revenues are monotonically increasing with inflation with a log-log money demand function. On the other hand, in Economy 2, aggregate welfare is monotonically decreasing with inflation, since changes in seigniorage revenues are directed to government spending. Finally, Economy 3 interestingly implies that the *optimal inflation rate* must be zero, as opposed to the Friedman rule suggested by the deterministic version of the same economy. This finding can be explained again by referring to Figure 8: despite the decrease in distortions created by inflation, negative inflation rates cause more of the poor to hit debt limits. Since the real interest rate is fixed, this unambiguously causes them to earn less interest income, limiting their consumption opportunities.

Having closed the analysis of some of the long-run implications of inflation, I now proceed to the next section in which I explore the sensitivity of findings to the parameter values and fiscal arrangements.

6 Sensitivity Analysis

In this section, I perform sensitivity analysis along two dimensions. First, I explore the role of changing calibrated parameters, one at a time, on the main findings (rows 2-17 of Table 8) related to the distributional and welfare consequences of reducing inflation from 14.25% to 2.25%. Second, I tweak the transfers policy of the fiscal authority by considering variations that might induce qualitatively and quantitatively different wealth effects (rows 18-21). I report equilibrium lump-sum transfers-to-GDP ratios in columns 1-2, Gini coefficients of asset holdings and the fraction of the borrowing constrained in columns 3-8, and disaggregated/aggregate welfare gains in columns 9-11. For comparison, the benchmark results are reproduced in row 1.

Discount factor and the real interest rate (β, R): In Bewley-style economies, a higher βR implies a stronger PS incentive of households. The second row of Table 8 shows that a higher (lower) β reduces (increases) the measure of borrowing-constrained individuals. As a result, a lower Gini coefficient for bonds is obtained when $\beta = 0.94$ and the distribution of real balances is more decoupled from that of consumption when $\beta = 0.90$. The increasing (decreasing) real return of bonds, R, has implications similar to that of a higher β because the higher R, the stronger the asset-buffering motive of individuals is. Equilibrium transfers-to-GDP ratios and welfare implications are quite insensitive to these parameters.

Risk aversion (σ): A higher σ of 3 makes consumers more risk averse. Therefore, regardless of the inflation rate, almost no one hits the debt limit. In this case, the distribution of bonds becomes significantly more equitable, and welfare implications become very similar to those in the benchmark economy. In the case of log utility, $\sigma = 1$, the welfare losses of the poor reduce substantially because despite the reduced transfers income followed by disinflation, consumers continue to borrow (the fraction of the constrained is between 49% and 41% for high and low inflation rates, respectively). This is because consumers' risk aversion is lower compared with the benchmark case.

Parameters of the transaction costs function (γ, ϕ): When the transactions function has more curvature (i.e., $\gamma = 1.75$), the elasticity of money demand with respect to the opportunity cost of money becomes lower. This causes transaction costs to be more sensitive to changes in consumption velocity and increases the comovement between seigniorage revenues and inflation, which in turn increases welfare changes in absolute value. On the other hand, when curvature is less (i.e., $\gamma = 1.05$), welfare changes are diminished in absolute value as expected. Similar to γ, when ϕ is increased (decreased), transaction costs become more (less) sensitive to changes in consumption velocity. Consequently, welfare changes become more (less) emphasized. The distributional implications do not seem to be affected substantially by these parameters, as shown by the implied Gini coefficients.

Lower bound of bonds (Ω): The distributional and welfare results are almost the same as in the benchmark parameterization when I increase or decrease the lower bound for bonds.

Parameters of the earnings process (ρ, σ_u): The PS motive is lower and consumers are willing to borrow more when shocks are less volatile and persistent (i.e., when ρ, σ_u are lower). Therefore, welfare changes are less emphasized when earnings shocks are less severe. As expected, when shocks are more volatile and persistent, nobody hits the debt limit, the distribution of bonds become substantially more equitable, and welfare changes are asymmetrically emphasized.

Alternative fiscal arrangements: Rows 18 and 19 in Table 8 keep the baseline calibration but additionally rebate transaction costs and set $G = 0$, respectively. The welfare results show that adding transactions costs shifts down the welfare changes schedule. Setting $G = 0$, on the other hand (which is the case for rows 19-21), substantially reduces welfare changes. The reason is that when $G = 0$, transfers are already high. Therefore, the disinflation-induced change in redistribution is less emphasized. Row 20 shows the proportionate transfers case with $G = 0$. In comparison to Economy 3, changes in welfare are now lower due to the absence of wealth effects caused by $G > 0$. The last row of Table 8 is especially important because it corresponds to the case with no wealth effects from reducing inflation. In particular, all costs of inflation are rebated in an individual-specific way, and $G = 0$. Although the welfare impacts are lower than those in Economy 1, disinflation is again found to be welfare reducing. This is due to the presence of substitution effects that lead consumers to decrease their bond demand when inflation is lower. This unambiguously lowers their interest income, implying a reduction in their welfare. In the deterministic case with no wealth effects, inflation is welfare neutral because interest income in the deterministic model is exogenous and fixed. Consequently, the last row of Table 8 shows that introducing idiosyncratic uncertainty with incomplete markets is enough to find disinflation to be welfare reducing in this framework. Finally, notice that debt limits become substantially relaxed in these economies with reduced (and even absent) wealth effects. This causes both the measure of the borrowing constrained and the degree of inequality in the distribution of bonds to increase at the inflation rates analyzed in the paper.

7 Conclusion

This paper investigates the distributional and welfare implications of disinflation in a small open economy. The motivation of the study derives from the recently observed structural disinflation in emerging economies and financial system characteristics of these countries that highlight heterogeneity. The inflationary past of these countries caused their financial system to evolve in a particular way, which is reflected in the analytical framework adopted in this paper.

The analysis in this paper shows that apart from the classical adverse effects of inflation, the way in which fiscal authority responds to monetary policy might create intriguing wealth effects. The main policy conclusion is that unless the transfers system is of a redistributive nature, inflationary finance reduces welfare. Another interpretation of this result is that if emerging economies are to experience inflationary episodes in the future, they are better to direct the inflationary finance to social transfers of a redistributive nature. The redistribution story may also be considered as a modest explanation as to why emerging economies endured a chronic inflation experience for long periods of time.

For further research, several avenues may be followed. The empirical literature has shown that fiscal deficits and inflation are positively related in (high inflation) developing economies. The normative findings of this paper suggest that it is important to rigorously identify whether the comovement between the two are driven by wasteful government spending or by transfers of a redistributive nature. Finally, to point out some caveats of the current paper, it would be an important robustness check to incorporate additional costs of inflation into a production economy and include the cross-sectional analysis of consumption patterns. It would be especially interesting to explore whether the redistribution effect is still predominant when aggregate uncertainty via interest rate shocks or productivity shocks are introduced. Such features might prove important, since the dynamics of the relative returns of financial and real assets would tweak the substitution effect created by disinflation.

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Appendix A. Data

Structural change in inflation: In order not to bias the structural change results, I omit data points that correspond to annual inflation rates of more than 200%. In Table 9, I report a complete list of developing and industrialized countries for which the annual CPI inflation data for the period 1989-2008 are available from the International Financial Statistics database, published by the International Monetary Fund, (IMF). Observing this general pattern, I regress the time series of inflation for each country on a constant and perform the Chow test that incorporates two structural break dates, one around the mid-1970s and another around the mid-1990s. If a country displays a high-low profile, I use only one structural break point. If there is no pattern at all for a country, I just compute averages for the aforementioned periods. For each country, I search alternative break dates and choose the ones that imply the highest F-statistic in the Chow test. Since I focus on disinflation, I include only the period averages for which inflation has been high and low historically. Countries are listed in descending order according to their average inflation rates in the first period. Among the 134 countries listed in Table 9, 104 pass the structural break test (at a 99% significance level). Countries that did not pass the test are marked with an asterisk.

Deposits distributions: The data used to plot Figure 1 include demand and term deposit account bins that are differentiated by the intervals of account sizes. For each bin, the number of *accounts* (as opposed to *depositors*) is reported. This creates a caveat because if an individual possesses multiple accounts that fall in different bins, then inequality in the distribution of these deposits would be understated. Furthermore, depending on the country-specific institutional arrangements, demand deposits might be dollarized or effectively pay interest that is closely related to the inflation rate, missing the vulnerability of cash to inflation. Considering the fact that the existing Gini coefficients are already too high, the first caveat is arguably not crucial. The second issue, on the other hand, is difficult to address, since data on the currency composition of deposits are typically not available at the disaggregated level.

The deposits data sources for mentioned economies are Autoridad de Supervision del Sistema Financiero (Bolivia), Bulgarian National Bank, Superintendencia de Bancos e Instituciones Financieras (Chile), National Bank of Georgia, Bank of Lithuania, Central Reserve Bank of Peru, Bank of Thailand, and Banking Regulation and Supervision Agency (Turkey). The compiled data set for these countries is available from the author upon request.

Appendix B. Proof of Proposition 1

The Lagrange multiplier on the borrowing constraint (φ) will be equal to zero for unconstrained individuals. Therefore, one can combine equations (7) and (8) to obtain the following:

$$\left(\frac{1}{1+e}\right)\left(\frac{1}{1-S'(\kappa)\kappa^2}\right)=R, \tag{18}$$

which can also be rewritten as

$$S'(\kappa)\kappa^2=\frac{i}{1+i}, \tag{19}$$

by using the definition of the nominal interest rate, $1+i=(1+e)R$, under the absence of aggregate uncertainty. Given that $S(\kappa)=\phi\kappa^{\gamma}$ is a strictly convex and increasing function of κ, equation (19) implies a unique solution for the consumption velocity, that is, $\kappa=[\frac{1}{\gamma\phi}(\frac{i}{1+i})]^{\frac{1}{1+\gamma}}$. Clearly, κ does not depend on any idiosyncratic variable. On the other hand, for borrowing-constrained individuals, we have $\varphi(a,\varepsilon)>0$. Now, equations (7) and (8) imply that

$$\frac{\beta E\{\lambda'\}}{\lambda}=(1+e)[1-S'(\kappa^c)\kappa^{c2}]=\frac{1}{R}\Big[1-\frac{\varphi}{\lambda}\Big]. \tag{20}$$

The first equality follows from equation (7), and the second equality follows from equation (8) after dividing the whole equation by $R\lambda$. It is straightforward to show that the definition of the nominal interest rate and rearranging terms imply

$$S'(\kappa^c)\kappa^{c2}=\frac{i+\frac{\varphi}{\lambda}}{1+i}. \tag{21}$$

The proof can be completed by imposing the functional form of $S(.)$ again and solving for the consumption velocity of a constrained individual, that is, $\kappa^c=\Big[\frac{1}{\gamma\phi}\Big(\frac{i+\frac{\varphi}{\lambda}}{1+i}\Big)\Big]^{\frac{1}{1+\gamma}}$. Since $\varphi>0$ and $\lambda>0\ \forall\ (a,\varepsilon)$, $\kappa^c>\kappa\ \forall\ (a,\varepsilon)$. Furthermore, $\gamma,\phi,\lambda,i>0$ implies that κ^c is increasing in φ.

Appendix C. Solution of Deterministic Economies

Economy 1; A Deterministic Economy with Heterogeneous Households and Endogenous Uniform Transfers: The steady-state equilibrium is characterized by a time-invariant profile for endogenous real variables, $\lambda_{it}=\lambda_i^*$, $\varphi_{it}=\varphi_i^*$, $c_{it}=c_i^*$, $M_t^s=\sum_i\mu_i m_{it}=\sum_i\mu_i m_i^*=m^*$, $b_{it}=b_i^*$, $\tau_t=\tau^*\ \forall\ t$ and the system of equations (22)-(27) evaluated at these constant values:

$$u'(c_i^*)=\lambda_i^*\left[1+\phi(1+\gamma)\left(\frac{c_i^*}{m_i^*}\right)^{1+\gamma}\right] \tag{22}$$

$$\left[1-\phi\gamma\left(\frac{c_i^*}{m_i^*}\right)^{1+\gamma}\right]=\frac{\beta}{1+e} \tag{23}$$

$$\lambda_i^*(1-\beta R)=\varphi_i^* \tag{24}$$

$$c_i^*\left[1+\phi\left(\frac{c_i^*}{m_i^*}\right)^{\gamma}\right]+b_i^*+m_i^*=\varepsilon_i+Rb_i^*+\frac{m_i^*}{1+e}+\tau^* \tag{25}$$

$$b_i^* \geq \Omega \tag{26}$$

$$G + \tau^* = \sum_i \mu_i m_i^* \frac{e}{1+e}, \tag{27}$$

which is a system of $(5 \times I) + 1$ conditions and $(5 \times I) + 1$ unknowns, $c_i^*, m_i^*, b_i^*, \tau^*, \varphi_i^*,$ and λ_i^*.[48] It is possible to find a closed-form solution to this system. If I assume that $\beta R < 1$, then, since $\lambda_i^* > 0$, equation (24) implies that the borrowing constraint is binding (i.e., $\varphi_i^* > 0$). Therefore, by equation (26), $b_i^* = \Omega$, that is, consumers roll over a constant interest payment of $(R-1)\Omega$. It is straightforward to show that equation (23) implies a consumer type-independent consumption velocity, which can be denoted by[49]

$$\kappa = \frac{c_i^*}{m_i^*} = \left[\frac{1}{\gamma\phi}\left(1 - \frac{\beta}{1+e}\right)\right]^{\frac{1}{1+\gamma}}. \tag{28}$$

The budget constraint denoted by equation (22), $b_i^* = \Omega$, and equation (28) yield

$$m_i^* = \frac{\varepsilon_i + \tau^* - (1-R)\Omega}{\kappa(1+\phi\kappa^\gamma) + \frac{e}{1+e}}. \tag{29}$$

Aggregating this equation and using the government budget constraint imply

$$(G + \tau^*)\frac{1+e}{e} = m^* = \sum_i \mu_i \left[\frac{\varepsilon_i + \tau^* - (1-R)\Omega}{\kappa(1+\phi\kappa^\gamma) + \frac{e}{1+e}}\right] = \frac{Y + \tau^* - (1-R)\Omega}{\kappa(1+\phi\kappa^\gamma) + \frac{e}{1+e}}, \tag{30}$$

which delivers equilibrium transfers as $\tau^* = \frac{(e/_{1+e})[Y - G - (1-R)\Omega]}{\kappa(1+\phi\kappa^\gamma)} - G$. Finally, plugging this solution into equation (29) yields

$$m_i^* = \frac{\varepsilon_i - G - (1-R)\Omega + \frac{(e/_{1+e})[Y-G-(1-R)\Omega]}{\kappa(1+\phi\kappa^\gamma)}}{\kappa(1+\phi\kappa^\gamma) + \frac{e}{1+e}} \tag{31}$$

as the closed-form solution for real balances. Now, by equation (28), $c_i^* = m_i^* \kappa$.[50]

Economy 2; A Deterministic Economy with Heterogeneous Households and Endogenous Government Spending: In this economy, the stationary equilibrium conditions (22)-(27) would again follow, only with the difference that the endogenous unknowns are now $c_i^*, m_i^*, b_i^*, G^*, \varphi_i^*$, and λ_i^*, whereas τ is just a parameter. Straightforward calculations deliver that equation (31) is replaced by

[48]Note that if equation (25) is aggregated with $\sum_i \mu_i m_i^* = M^*$, $\sum_i \mu_i c_i^* = C^*$, $\sum_i \mu_i b_i^* = B^*$, $\sum_i \mu_i \varepsilon_i^* = Y^*$ and substituted in equation (27), then the resource constraint, $C + Tr + G + (1-R) = Y$, with $Tr = \sum_i \mu_i c_i \phi(\frac{c_i}{m_i})^\gamma$, obtains.

[49]Consumption velocity is increasing in the inflation rate by $\frac{d\kappa}{de} = \frac{\beta}{(1+\gamma)\kappa^{\frac{\gamma}{1+\gamma}}\phi\gamma(1+e)^2} > 0$, given that $\beta, \gamma, \kappa, \phi > 0$.

[50]If $\beta R = 1$, then equation (24) implies that $\varphi_i^* = 0$, and therefore, the equilibrium bond position is determined by the initial conditions, $b_i^* = b_{i0}$, which are given. Therefore, all-closed form solutions hold, except for the difference that Ω is replaced by b_{i0}. Note that $b_{i0} \geq \Omega$ should be satisfied in this case.

$$m_i^* = \frac{\varepsilon_i + \tau - (1-R)\Omega}{\kappa(1+\phi\kappa^\gamma) + \frac{e}{1+e}}, \tag{32}$$

which is now a closed-form solution, since τ is a known parameter. Equilibrium conditions and aggregation imply that $G^* = \frac{({}^e/_{1+e})[Y+\tau-(1-R)\Omega]}{\kappa(1+\phi\kappa^\gamma)+\frac{e}{1+e}} - \tau$. The rest of the system can be solved in a straightforward way. The optimal rate of inflation in this case is computed by setting $G^* = 0$.

Economy 3; A Deterministic Economy with Heterogeneous Households and Endogenous Proportional Transfers: In this economy, transfers received by type i consumers become $\tau_i(a_i) = \frac{m_i e}{1+e} - G$, so that any change in the inflation tax paid by type i consumers is reflected to transfers that they obtain. Stationary equilibrium conditions (22)-(27) of the benchmark economy again follow, with the modification that the budget constraint, (25), now includes type-specific transfers, τ_i, and the budget constraint of the government, (27), is replaced by a set of definitions for type-specific transfers, $\tau_i = \frac{m_i e}{1+e} - G$, as I additional equilibrium conditions.[51] Therefore, the equation system is composed of $6 \times I$ unknowns, $c_i^*, m_i^*, b_i^*, \tau_i^*, \varphi_i^*$, and λ_i^* and $6 \times I$ equations. These conditions would yield[52]

$$m_i^* = \frac{\varepsilon_i - G - (1-R)\Omega}{\kappa(1+\phi\kappa^\gamma)}. \tag{33}$$

The rest of the system can again be solved in a straightforward way by following a similar strategy, as in the case for Economies 1 and 2.

Appendix D. Numerical Solution Algorithm

Economy 1: I solve the household optimization problem formulated in Section 4.1 by value function iteration on a discretized state space defined over total deposits-idiosyncratic earnings pairs. I use separate grids for real balances and bonds choices. The grids that I use for total deposits, earnings, bonds (in [Ω,30]), and real balances (in [0.001,5]) have 100, 21, 3200, and 400 nodes, respectively. When $b' > \Omega$, by Proposition 1, consumption can be computed for given states and the bond choice. On the other hand, when, $b' = \Omega$, the budget constraint of consumers becomes nonlinear in consumption, and therefore the real balances choice needs to be handled separately.[53] For each pair of real balances and bonds choice, I keep track of the law of motion of real deposits and linearly interpolate the next iteration's value by using this law of motion. Once I find the decision rules, I solve for the stationary distribution of total deposits by employing standard methods, aggregate over heterogeneous agents by using the stationary distribution, and compute the public surplus, $\frac{Me}{1+e} - G - \tau$, from the government budget constraint.

[51] The aggregation of these transfers implies the government budget constraint.

[52] In this case, $\varepsilon_i - G - (1-R)\Omega \geq 0 \ \forall i$ should hold for the real balances and consumption to be non-negative.

[53] I exploit this property of the model by solving the nonlinear budget constraint only when the borrowing constraint binds. I achieve this by implementing Newton's univariate method for solving the roots of nonlinear equations.

The solution algorithm that I implement to compute the stationary recursive equilibrium is as follows:

- Pin down two lump-sum transfers levels, τ^1 and τ^2, for which the above-mentioned solution of the consumers' problem substituted in the budget equation of the government implies a public surplus, that is, $\frac{Me}{1+e} - G - \tau^1 > 0$, and a public deficit, that is, $\frac{Me}{1+e} - G - \tau^2 < 0$, respectively.
- Initialize lump-sum transfers by setting $\tau_0 = \frac{(\tau^1+\tau^2)}{2}$. If there is a public surplus, update lump-sum transfers in order to bring them closer to the public deficit-generating transfers level, that is, set $\tau_1 = \frac{(\tau_0+\tau^2)}{2}$ and $\tau^1 = \tau_0$. If there is a public deficit, update lump-sum transfers in order to bring them closer to the public surplus-generating transfers level, that is, set $\tau_1 = \frac{(\tau_0+\tau^1)}{2}$ and $\tau^2 = \tau_0$.
- Repeat the previous step until the absolute value of the public surplus is smaller than a tolerance level.[54]

Economy 2: The numerical solution algorithm of Economy 2 involves fixing τ and iterating on G by using a procedure in the spirit of the above-mentioned steps.
Economy 3: The solution of Economy 3 involves initiating a state-dependent matrix of lump-sum transfers, $\tau^0(a,\varepsilon) = \tau_1^0(a,\varepsilon) + \tau_0$ (instead of a uniform value), and solving the decision problem of consumers using this transfers schedule.[55] Once the decision problem of households is solved and the aggregation is done, the transfers schedule is updated as

$$\tau_1^1(a,\varepsilon) = \omega\tau_1^0(a,\varepsilon) + (1-\omega)\Big(\frac{m'(a,\varepsilon)e}{1+e} - G - \tau_0\Big), \tag{34}$$

where ω is a number between 0 and 1 and $m'(a,\varepsilon)$ is the policy function for the real balances of an agent who is in state (a,ε).[56] Once I find $\tau^1(a,\varepsilon) = \tau_1^1(a,\varepsilon) + \tau_0$, I use it as the new candidate transfers schedule and repeat the above steps until the whole transfers schedule converges, that is, $sup||\tau^0(a,\varepsilon) - \tau^1(a,\varepsilon)|| < 10^{-4}$, and the implied public surplus is less than a tolerance level.

[54] I use 10^{-6} as the tolerance value.
[55] Notice that total transfers still have the lump-sum component, τ_0, which tends to capture the taxes that are not modeled.
[56] I set $\omega = 0.75$. This parameter might change depending on the inflation rate. The second term on the right-hand side of equation (34) might also change in accordance with what the government rebates back to households.

Table 1: Disinflation as a Structural Change

Advanced	**High (Per.)**	**Low (Per.)**	**Emerging**	**High (Per.)**	**Low (Per.)**
Italy	15[a] (73-85)	4 (86-08)	Brazil	135 (60-94)	11 (95-08)
UK	10 (70-91)	3 (92-08)	Argentina	115 (75-94)	6 (95-08)
France	9 (68-85)	2 (86-08)	Peru	71 (74-91)	9 (92-08)
Japan	7 (60-81)	1 (82-08)	Turkey	60 (77-02)	10 (03-08)
US	7 (70-85)	3 (86-08)	Mexico	53 (74-88)	14 (89-08)
Canada	7 (71-91)	2 (92-08)	Bolivia	35 (73-83)	9 (84-08)
Advanced[b]	7 (60-90)	2 (91-08)	Emerg.&Dev.[b]	49 (79-95)	10 (96-08)

[a] Period average of annual CPI inflation rate, %.
[a] Data points that correspond to annual inflation rate of more than 200% are omitted.
[b] These classifications reflect aggregations in the International Financial Statistics database of the IMF.

Table 2: Benchmark Parameter Values

Symbol	**Value**	**Description**	**Target**	**Moment**
Fixed				
σ	2.0000	Risk aversion	Literature	N/A
R	1.0276	Gross real interest rate	US Treasury + 7% spread	N/A
ρ	0.9625	Persis. of earnings shocks	Literature	N/A
σ_u	0.1400	Volat. of shocks to log earnings	Literature	N/A
γ	1.1766	Curv. of the trans. costs function	Int. elas. of M1 demand = -0.4594	N/A
G/Y	0.1611	Real gov. spending-to-GDP	Average of 2003:1-2010:2	N/A
Jointly Calibrated				
β	0.9215	Discount factor	$NX/GDP = -0.0334$	-0.0333
ϕ	0.00185	Multip. trans. costs parameter	$C/M1 = 4.1925$	4.1914
Ω	-0.0329	Lower bound for bonds	$(M2Y - M1)/M2Y = 0.8493$	0.8543

Table 3: Benchmark Model vs. Data, $e = 2.25\%$

Aggregates	*DATA*	*E1*	**Distributional Variables**[a]	*DATA*	*E1*
$(B+M)/Y^b$	1.423	1.414	$Gini_y$	0.390	0.338
C/Y	0.871	0.863	$Gini_b$	0.781	0.637
TB/Y	-0.033	-0.033	$Gini_m$	0.775	0.345
Tr/Y	N/A	0.009	$Gini_c$	0.330	0.335
C/M	4.193	4.191	$({}^{Top20}/_{Bottom20})_y$	9.146	6.089
SE/Y	0.011	0.005	$({}^{Mean}/_{Median})_y$	1.350	1.210
τ_1/Y	0.046	0.040	$({}^{Top20}/_{Bottom20})_c$	5.984	6.192
$B/(B+M)$	0.849	0.854	Frac. of constrained	N/A	0.057

[a]Empirical moments for distributional variables are calculated by using data from the Household Budget Survey (2004-2005), the Income and Living Conditions Survey (2006-2007), and the Consumption Expenditures Survey (2004-2008) conducted by TURKSTAT.
[b]Y denotes the GDP of the economy.

Table 4: Income and Consumption Inequality in Turkey, 2004-2008

Average	1^{st} **Quintile**	2^{nd} **Quintile**	3^{rd} **Quintile**	4^{th} **Quintile**	5^{th} **Quintile**
Income, 2004-2007	5.26[a]	10.03	14.86	21.75	48.1
Consumption, 2004-2008	7.09	11.95	16.28	22.23	42.45

[a]Percentage share of quintiles in total household income and consumption.
Data sources are the Household Budget Survey (2004-2005), the Income and Living Conditions Survey (2006-2007) and the Consumption Expenditures Survey (2004-2008) conducted by TURKSTAT.

Table 5: Aggregate Implications of Disinflation

	Uniform τ		**Endogenous** G		**Proportionate** τ	
Aggregates	$e = 14.25\%$	$e = 2.25\%$	$e = 14.25\%$	$e = 2.25\%$	$e = 14.25\%$	$e = 2.25\%$
$(B+M)/Y$	1.323	1.414	1.403	1.414	1.555	1.493
C/Y	0.856	0.863	0.848	0.863	0.863	0.866
TB/Y	-0.033	-0.033	-0.035	-0.033	-0.040	-0.035
Tr/Y	0.016	0.009	0.016	0.009	0.016	0.009
C/M	7.014	4.191	6.996	4.191	6.981	4.173
SE/Y	0.015	0.005	0.015	0.005	0.015	0.005
τ_1/Y	0.050	0.040	0.040	0.040	0.051	0.040
$B/(B+M)$	0.908	0.854	0.914	0.854	0.921	0.861

$^*G/Y = 16.1\%$ in Economy 2 when $e = 14.25\%$.

Table 6: Distributional Implications of Disinflation

	Uniform τ		**Endogenous** G		**Proportionate** τ	
Aggregates	$e = 14.25\%$	$e = 2.25\%$	$e = 14.25\%$	$e = 2.25\%$	$e = 14.25\%$	$e = 2.25\%$
$Gini_y$	0.335	0.338	0.338	0.338	0.338	0.339
$Gini_b$	0.636	0.637	0.624	0.637	0.606	0.622
$Gini_m$	0.341	0.345	0.341	0.345	0.339	0.341
$Gini_c$	0.332	0.335	0.335	0.335	0.335	0.335
$({}^{Top20}/{}_{Bottom20})_y$	5.941	6.088	6.094	6.088	6.088	6.130
$({}^{Top20}/{}_{Bottom20})_c$	6.002	6.192	6.185	6.192	6.239	6.254
$({}^{Median}/{}_{Median})_y$	1.204	1.209	1.210	1.209	1.201	1.214
$({}^{Mean}/{}_{Median})_c$	1.151	1.172	1.167	1.172	1.185	1.184
Frac. of constrained	0.107	0.057	0.086	0.057	0.060	0.035
Portf. of the 1^{st} percentile	0.462	0.523	0.574	0.523	0.676	0.595

Table 7: Welfare Consequences of Reducing Inflation from 14.25% to 2.25%

Welfare Gains[a]	**Uniform** τ_1	**Endogenous** G	**Proportionate** τ_1
Aggregate	-1.227	1.615	0.448
Bottom 20%[b]	-3.528	1.230	0.170
Median	-1.214	1.648	0.473
Top 1%	0.971	1.751	0.525
Deterministic[c]	-0.117	1.810	0.628

[a]Welfare gains are computed as the percentage change in terms of compensating consumption variation.
[b]Average welfare gains of percentiles are ordered according to total deposits positions.
[c]Refers to the aggregate welfare effects in economies studied in Section 4.3.

Table 8: Sensitivity Analysis

	τ_1/Y		$Gini_b$		$Gini_m$		**Fraction of Constrained**		**Aggregate**[a] **Welfare Gain**	**Gain of Bottom 20%**	**Gain of Top 1%**
	$e = 14.25\%$	$e = 2.25\%$	$e = 14.25\%$	$e = 2.25\%$	$e = 14.25\%$	$e = 2.25\%$	$e = 14.25\%$	$e = 2.25\%$			
Benchmark	0.050	0.040	0.636	0.637	0.341	0.345	0.107	0.057	-1.227	-3.528	0.971
$\beta = 0.94$	0.051	0.040	0.579	0.567	0.319	0.320	0.042	0.019	-0.990	-3.371	1.063
$\beta = 0.90$	0.050	0.040	0.614	0.637	0.370	0.376	0.240	0.150	-1.276	-3.802	0.938
$R = 1.04$	0.051	0.040	0.603	0.589	0.333	0.335	0.058	0.025	-1.103	-3.455	1.008
$R = 1.01$	0.050	0.040	0.648	0.685	0.367	0.369	0.219	0.122	-1.181	-3.782	0.982
$\sigma = 3$	0.052	0.040	0.468	0.452	0.305	0.306	0.004	0.001	-1.379	-4.387	1.027
$\sigma = 1$	0.049	0.039	0.559	0.553	0.400	0.412	0.488	0.412	-0.507	-1.532	1.089
$\gamma = 1.75$	0.062	0.042	0.644	0.658	0.333	0.335	0.055	0.014	-2.074	-5.266	1.481
$\gamma = 1.05$	0.048	0.039	0.649	0.638	0.350	0.349	0.149	0.076	-1.049	-3.155	0.860
$\phi = 0.003$	0.054	0.041	0.644	0.646	0.342	0.340	0.099	0.036	-1.403	-4.088	1.216
$\phi = 0.001$	0.047	0.039	0.644	0.629	0.345	0.349	0.143	0.077	-1.028	-2.977	0.742
$\Omega = -0.01$	0.051	0.040	0.638	0.640	0.341	0.345	0.109	0.059	-1.218	-3.525	0.972
$\Omega = -0.05$	0.051	0.040	0.636	0.634	0.341	0.344	0.107	0.054	-1.234	-3.549	0.971
$\sigma_u = 0.15$	0.051	0.040	0.597	0.568	0.350	0.350	0.033	0.002	-2.627	-8.111	0.976
$\sigma_u = 0.13$	0.050	0.040	0.657	0.664	0.334	0.339	0.171	0.102	-0.798	-2.589	0.958
$\rho = 0.97$	0.045	0.045	0.557	0.416	0.370	0.369	0.000	0.000	-14.080	-47.758	0.967
$\rho = 0.95$	0.045	0.045	0.647	0.653	0.309	0.314	0.166	0.111	-0.584	-2.042	0.905
$\tau^* = \frac{Me}{1+e} + Tr - G$[c]	0.052	0.043	0.657	0.651	0.341	0.346	0.138	0.070	-2.761	-5.887	0.472
$\tau^* = \frac{Me}{1+e}$	0.017	0.005	0.697	0.731	0.321	0.326	0.219	0.137	-0.299	-1.551	0.980
$\tau^*(a,\varepsilon) = \frac{m'(a,\varepsilon)e}{1+e}$	0.018	0.005	0.672	0.721	0.313	0.322	0.155	0.120	0.370	0.095	0.517
$\tau^*(a,\varepsilon) = \frac{m'(a,\varepsilon)e}{1+e} + c(a,\varepsilon)\phi\left(\frac{c(a,\varepsilon)}{m'(a,\varepsilon)}\right)^{\gamma}$	0.037	0.017	0.692	0.757	0.314	0.344	0.184	0.193	-0.324	-0.414	-0.273

[a] Welfare gains of reducing the inflation rate from 14.25% to 2.25% in terms of compensating consumption variation.
[b] Implications of disinflation for the benchmark parameterization of the model. See Table 2 for parameter values.
[c] This row and the following three rows consider alternative fiscal arrangements that are different from the ones considered in Economies 1,2, and 3.

Table 9: Appendix: Disinflation as a Worldwide Phenomenon

Country	**High**	**Low**	**Country**	**High**	**Low**
Brazil	135[a] (60-94)[b]	11 (95-08)	Gambia*	14 (75-94)	6 (95-08)
Argentina	115 (75-94)	6 (95-08)	Myanmar*	14 (75-94)	25 (95-08)
Uganda	106 (60-88)	12 (89-08)	Egypt	14 (72-95)	6 (96-08)
Zambia	104 (60-93)	25 (94-08)	Guatemala	14 (73-90)	10 (91-08)
Indonesia	96 (60-69)	13 (70-08)	Cote D.	14 (72-79)	5 (80-08)
Israel	91 (77-86)	8 (87-08)	Swaziland	14 (73-94)	8 (95-08)
Sierra Leo.	75 (81-91)	18 (92-08)	Algeria	14 (75-94)	6 (95-08)
Peru	71 (74-91)	9 (92-08)	Honduras	14 (79-97)	9 (98-08)
Congo, Dem.	69 (75-97)	18 (98-08)	Spain	13 (71-87)	4 (88-08)
Ghana	66 (74-83)	24 (84-08)	Gabon	13 (73-81)	4 (82-08)
Uruguay	63 (75-94)	13 (95-08)	Samoa	13 (71-86)	5 (87-08)
Turkey	60 (77-02)	10 (03-08)	South Af.	12 (71-95)	6 (96-08)
Sudan	60 (78-96)	13 (97-08)	New Zealand	12 (70-86)	3 (87-08)
Mexico	53 (74-88)	14 (89-08)	Trinidad & T.	12 (72-93)	6 (94-08)
Guinea-B.	51 (60-96)	7 (97-08)	Barbados	12 (60-83)	3 (84-08)
Venezuela	51 (87-97)	22 (98-08)	Ireland	12 (67-86)	3 (87-08)
Emerg.&Dev.	49 (79-95)	10 (96-08)	Haiti*	12 (75-94)	17 (95-08)
Mozambique	46 (60-94)	16 (95-08)	Papua N.G.	12 (60-03)	9 (04-08)
Ecuador	42 (82-00)	10 (01-08)	Botswana	12 (60-93)	9 (94-08)
Nigeria	41 (87-95)	13 (96-08)	Sri Lanka*	11 (75-94)	11 (95-08)
Suriname	38 (86-00)	16 (01-08)	St. Lucia	11 (60-80)	4 (81-08)
Poland	37 (81-96)	5 (97-08)	Solomon I.*	11 (75-94)	10 (95-08)
Iceland	36 (71-88)	6 (89-08)	Thailand	11 (72-82)	4 (83-08)
Bolivia	35 (73-83)	9 (84-08)	Dominica	11 (60-81)	3 (82-08)
Chile	29 (74-90)	7 (91-08)	Pakistan	10 (73-97)	7 (98-08)
Dom. Rep.	28 (83-90)	13 (91-08)	Neth. Ant.	10 (72-81)	3 (82-08)
Tanzania	25 (74-95)	9 (96-08)	Burundi*	10 (75-94)	14 (95-08)
Colombia	24 (72-94)	11 (95-08)	UK	10 (70-91)	3 (92-08)
Jamaica	23 (73-96)	10 (97-08)	Tonga*	10 (60-94)	7 (95-08)
Lao P.D.R.*	22 (75-94)	27 (95-08)	Bhutan	10 (60-98)	5 (99-08)
Nicaragua	22 (60-93)	10 (94-08)	Ethiopia*	10 (75-94)	8 (95-08)
Costa Rica	21 (72-82)	15 (83-08)	Nepal*	10 (75-94)	6 (95-08)
Congo, Rep.	21 (94-98)	3 (99-08)	Senegal	9 (60-85)	3 (86-08)

[a] In percentage terms.
[b] The numbers in parentheses denote years for which the average inflation is computed.

Table 9 Continued

Country	**High**	**Low**	**Country**	**High**	**Low**
Saudi Arab.	20[a] (72-77)[b]	1 (78-08)	Australia	9 (71-90)	3 (91-08)
Hungary	20 (86-98)	7 (99-08)	Denmark	9 (71-85)	3 (86-08)
Iran, I.R.	18 (71-95)	17 (96-08)	Rwanda*	9 (75-94)	7 (95-08)
Malawi*	18 (74-94)	24 (95-08)	Niger	9 (60-82)	2 (83-08)
Paraguay	18 (72-95)	9 (96-08)	Cameroon*	9 (75-94)	3 (95-08)
Portugal	18 (71-91)	4 (92-08)	Fiji	9 (60-87)	4 (88-08)
Madagascar	17 (74-96)	10 (97-08)	Morocco	9 (71-86)	3 (87-08)
Syrian A.R.	17 (73-94)	4 (95-08)	France	9 (68-85)	2 (86-08)
Maldives	17 (60-93)	3 (94-08)	Libya*	8 (75-94)	1 (95-08)
Philippines	17 (70-85)	7 (86-08)	Sweden	8 (70-91)	2 (92-08)
Mauritius	17 (72-80)	7 (81-08)	Vanuatu	8 (60-88)	3 (89-08)
Seychelles	16 (60-80)	4 (81-08)	Jordan*	8 (75-94)	4 (95-08)
World	16 (75-94)	6 (95-08)	China, H.K.	8 (60-97)	0 (98-08)
Grenada	16 (60-83)	3 (84-08)	Norway	8 (70-91)	2 (92-08)
Zimbabwe*	16 (74-94)	53 (95-08)	India*	8 (75-94)	6 (95-08)
Kenya	16 (73-93)	11 (95-08)	China, M.*	8 (75-94)	2 (95-08)
Greece	16 (71-97)	3 (98-08)	Panama	8 (72-80)	2 (81-08)
Italy	15 (73-85)	4 (86-08)	Togo*	8 (75-94)	4 (95-08)
Korea	15 (60-82)	4 (83-08)	Finland	8 (60-90)	2 (91-08)
Bahrain,K.	15 (73-80)	1 (81-08)	Cyprus	7 (71-85)	3 (86-08)
El Salvador	15 (71-95)	4 (96-08)	Advanced	7 (60-90)	2 (91-08)
Mauritania*	7 (75-94)	6 (95-08)	Bangladesh*	6 (75-94)	6 (95-08)
Japan	7 (60-81)	1 (82-08)	Malaysia	6 (70-82)	3 (83-08)
Malta	7 (71-82)	2 (83-08)	Belgium	5 (60-85)	2 (86-08)
Singapore	7 (71-82)	2 (83-08)	Chad*	5 (75-94)	4 (95-08)
U.S.	7 (70-85)	3 (86-08)	Austria	4 (60-92)	2 (93-08)
Burkina F.*	7 (75-94)	3 (95-08)	Aruba*	4 (75-94)	4 (95-08)
Canada	7 (71-91)	2 (92-08)	St. Kitts &N.*	4 (75-94)	4 (95-08)
St. Vincent	7 (60-91)	3 (92-08)	Switzerland	4 (60-93)	1 (94-08)
Luxembourg	7 (71-85)	2 (86-08)	Cent Af.*	4 (75-94)	4 (95-08)
Cape Verde	7 (60-97)	3 (98-08)	Belize*	4 (75-94)	2 (95-08)
Tunisia	7 (60-94)	3 (95-08)	Kuwait*	3 (75-94)	3 (95-08)
Bahamas	6 (60-92)	2 (93-09)	Qatar*	3 (75-94)	6 (95-08)
Netherlands	6 (60-84)	2 (85-08)	Equatorial G.*	1 (75-94)	6 (95-08)

[a] In percentage terms.
[b] The numbers in parentheses denote years for which the average inflation is computed.

Figure 1: Deposits Distributions and Portfolio Share in Emerging Economies

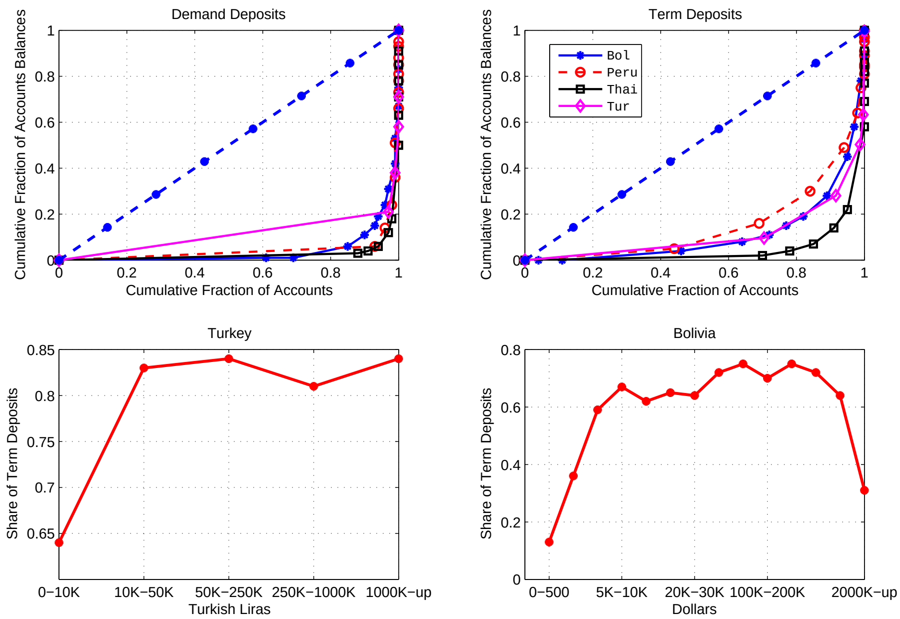
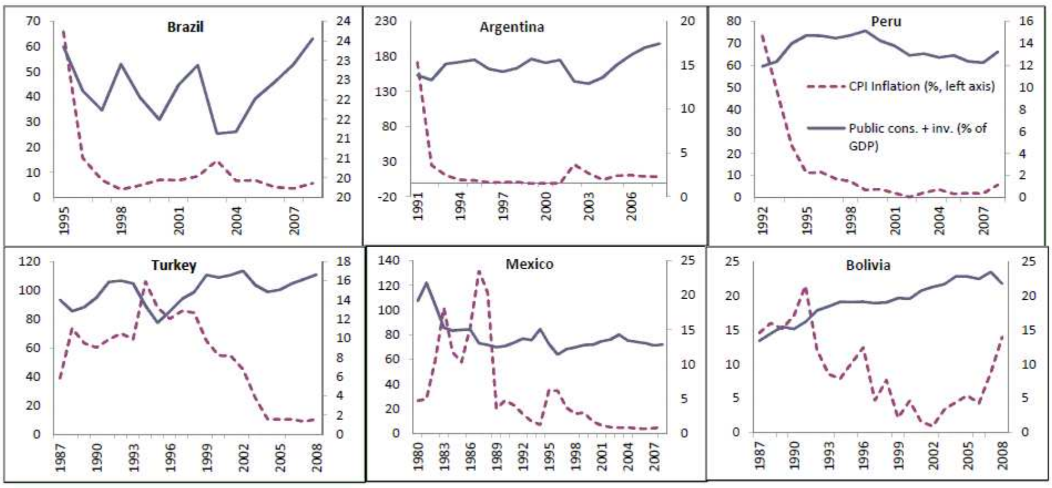


Figure 2: Disinflation and Evolution of Government Expenditures in Emerging Economies



*The sources for the CPI inflation and government expenditures data are the International Financial Statistics database of the IMF and the World Development Indicators database of the World Bank Group, respectively.

**Government expenditures data for Brazil are taken from the study of Catão and Terrones (2005).

Figure 3: Precautionary Savings in the Small Open Economy

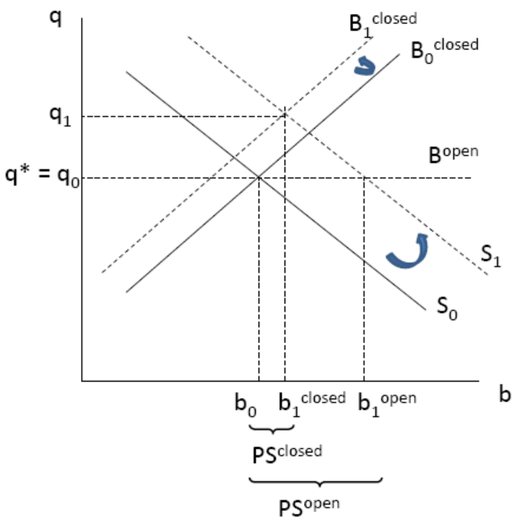


Figure 4: Lorenz Curves and Portfolio Composition in the Benchmark Economy, e=2.25%

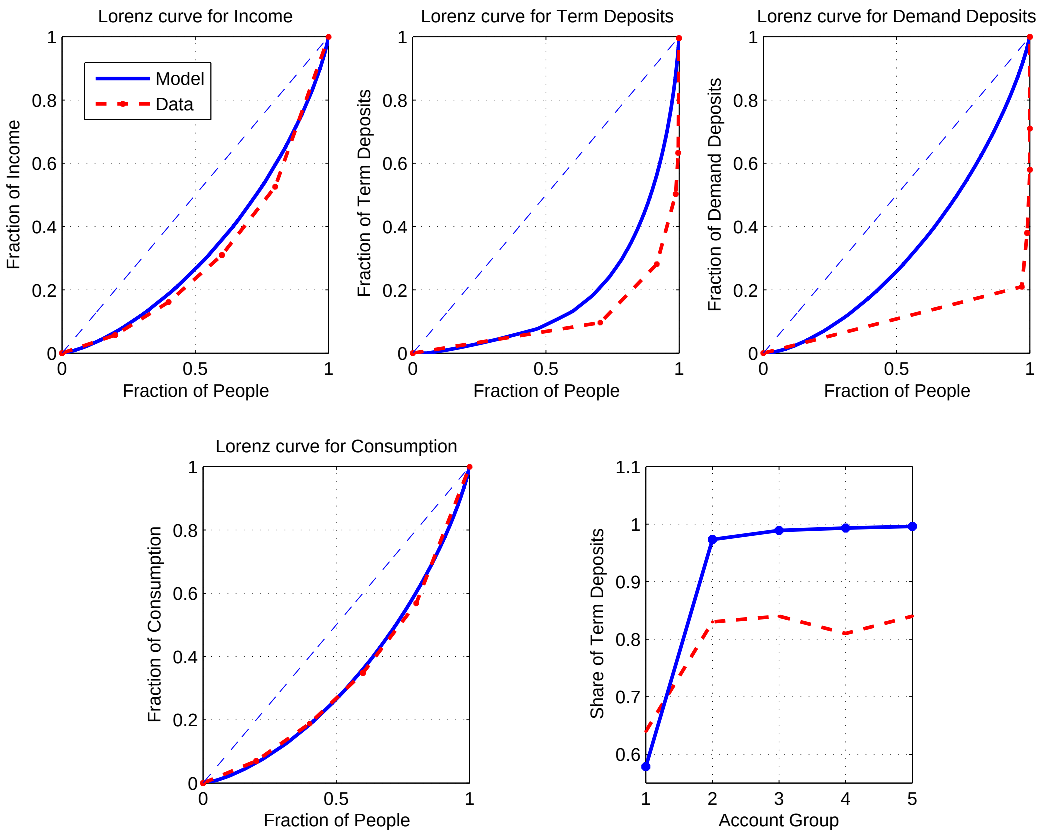


Figure 5: Disinflation, Portfolio and Asset Distributions (Economy 1)

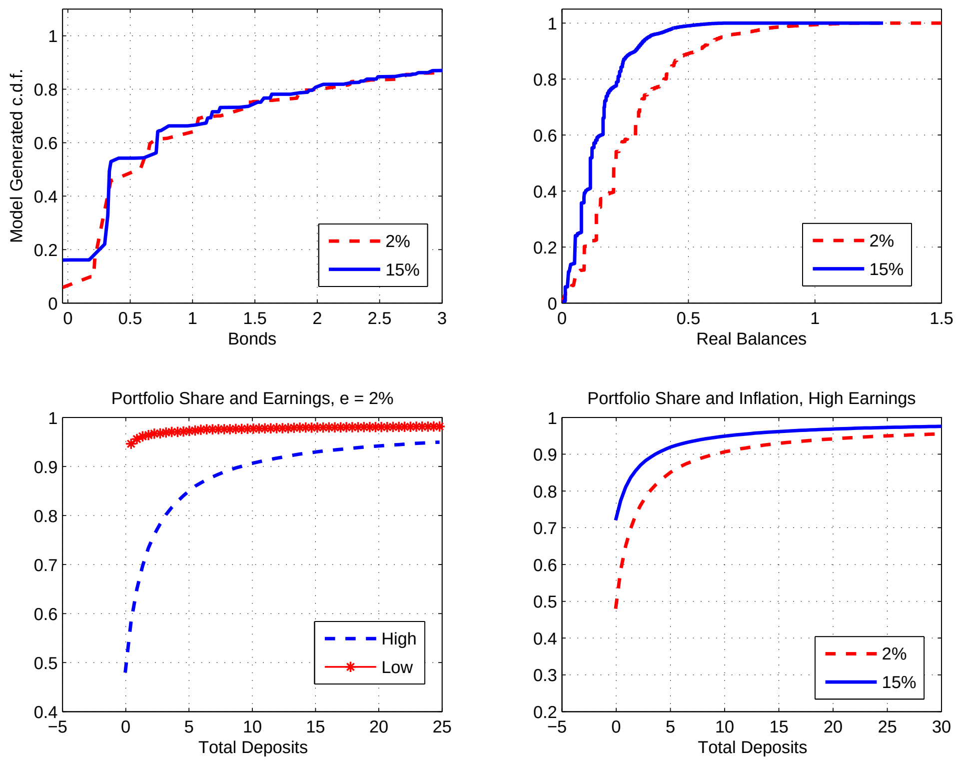


Figure 6: Disaggregated Welfare Gains from Disinflation

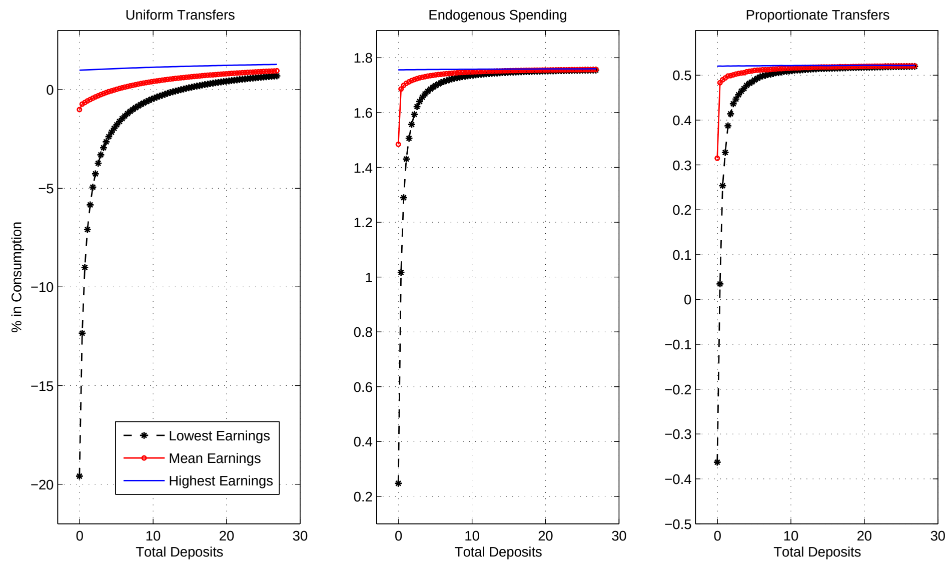


Figure 7: Aggregate Money Demand Curve

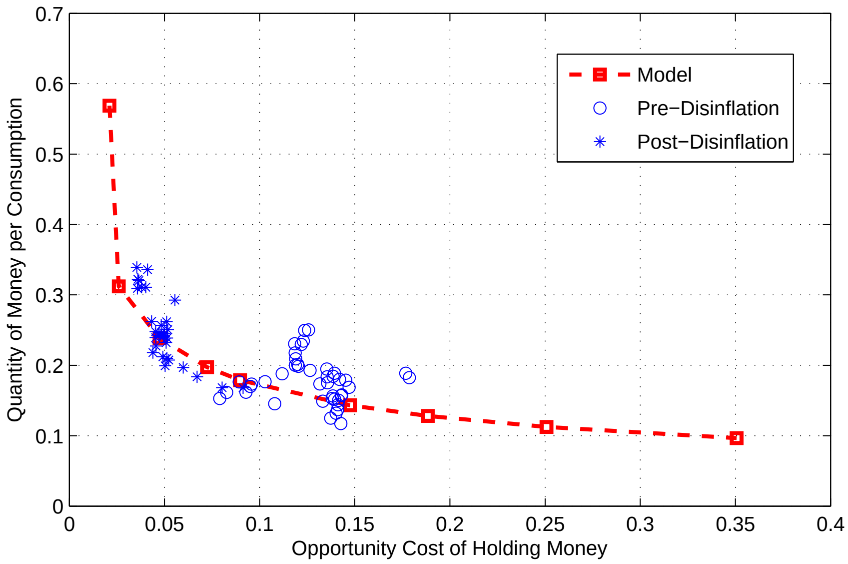


Figure 8: Inflation and Precautionary Savings

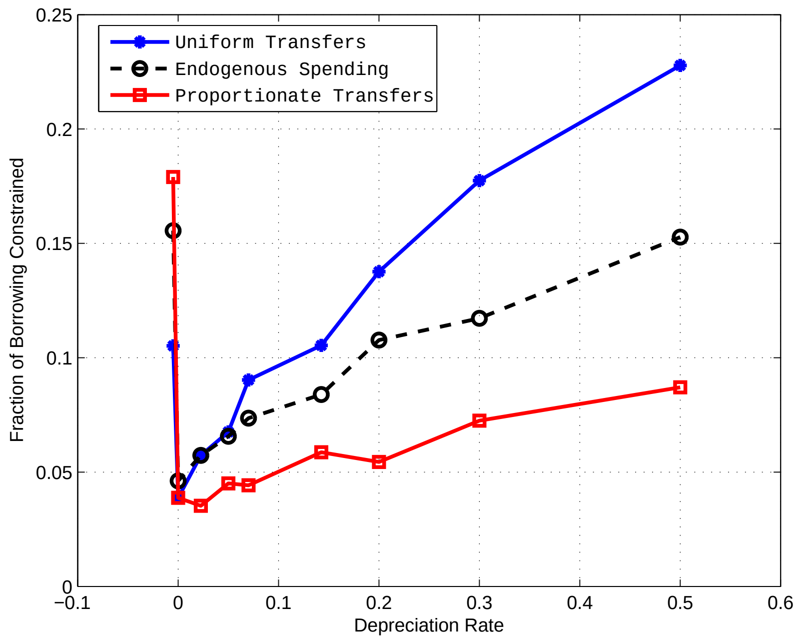
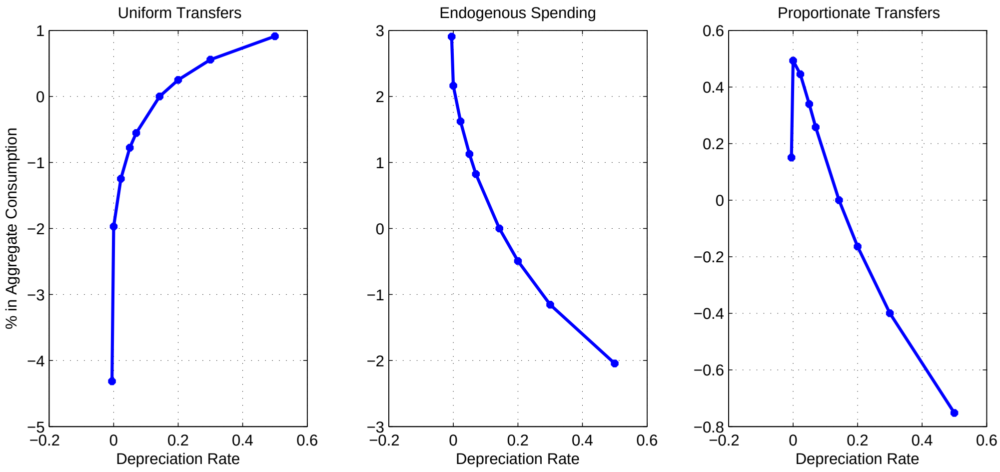


Figure 9: Inflation and Welfare (Relative to $e = 14.25\%$)



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