Transitional Dynamics of Disinflation in a Small Open Economy with Heterogeneous Agents

Sunel, Enes

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Enes Sunel †
Central Bank of Turkey

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Abstract

This study investigates quantitative properties of the transitional dynamics produced by gradual disinflation in a small open economy inhabited by heterogeneous consumers. The main exercise is to feed the empirically observed declining path for inflation into the calibrated model and account for its macroeconomic, distributional and welfare effects under alternative fiscal arrangements. The results show that (i) when uniform transfers are endogenous, gradual decline in the inflation rate from 14.25% to 2.25% increases aggregate welfare by 0.28%. (ii) When wasteful spending is endogenous, aggregate welfare increases by 0.53%. These welfare effects are substantially different from those implied by steady state comparisons. This is because when transition is accounted for, fiscal variables do not jump to their low inflation steady state levels immediately.

Keywords: Small open economy, incomplete markets, welfare effects of inflation

JEL Classification: D31, F41, E52

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†Research and Monetary Policy Department; enes.sunel@tcmb.gov.tr; sites.google.com/site/enessunel/

1 Introduction

The goal of this paper is to quantitatively investigate macroeconomic, distributional and welfare consequences of transitional dynamics produced by recent disinflation in the Turkish economy. The analysis derives its motivation from stylized macro implications caused by gradual decline in inflation observed in Turkey in the last decade.

The bottom-right panel of figure 1 shows the quarterly change in the GDP deflator (straight plot) in the period 1987:2-2010:3. This plot is consistent with the disinflation profile of emerging economies that generally starts around the mid-1990s. On the other hand, it shows that disinflation does not take place overnight. In particular, it takes about 6 years for the inflation rate to decline from 15.46% to 1.86% (the plot with asterisks) where the numbers are the time series average of inflation rates in the periods 1987:2-1999:2 and 2004:4-2010:3 respectively.

Panels 1-5 of figure 1 plot the dynamics of main macroeconomic variables with a particular focus on the period 1999:2-2010:3, that encompasses the gradual decline in inflation (in the first 6 years). The straight plots represent actual data for aggregate consumption, M2Y-M1, M1 and trade balance-to-GDP ratios and aggregate consumption velocity along disinflation.[1] In all panels, the plots with asterisks denote the linear HP trend computed at quarterly frequency (for the bottom-right panel, HP trend is computed only for the period 1999:2-2004:4 that represent the gradual decline in inflation). First and foremost, the impact of the severe 2001 banking crisis is evident in the dynamics of consumption, trade balance and M2Y-M1-to-GDP ratios. Keeping this observation in mind, the most highlighted stylized facts that are present in figure 1 can be listed as;

1. There is a secular rise in the aggregate money demand and a secular decline in consumption velocity along disinflation.
2. There is a consumption boom coupled with an increase in trade deficit.
3. Interest-bearing and dollarized deposits decline for two years right after the 2001 crisis and maintain a positive trend along disinflation.

Welfare dimension of the study finds its roots at the idea that disinflation of magnitudes observed in the Turkish economy might derive non-trivial wealth effects in an emerging economy. This is because, inflation *(i)* reduces the purchasing power of individuals; *(ii)* distorts consumption; and *(iii)* government budget's (dynamic) response to reduction in inflation tax revenues might matter from a redistributive aspect. Distributional dimension of the framework, on other hand, is thought to be important because the distribution of monetary assets

[1] M2Y is the monetary aggregate that includes currency in circulation, checkable deposits, term deposits and foreign currency denominated deposits. In the plot, M2Y-M1 is meant to capture the interest-bearing segment of the deposits system that is less vulnerable to inflation.

in emerging economies displays substantial inequality. This suggests asymmetric vulnerability of individual portfolios to inflation, which creates heterogeneity in the afore-mentioned wealth effects.

This paper develops a monetary model of a small open economy with uninsured idiosyncratic risk and incomplete markets. The model economy is populated by a continuum of consumers and a government. Infinitely-lived consumers face idiosyncratic earnings shocks and consume a tradable consumption good. They hold *(i)* non-interest bearing real balances that economize transactions costs of consumption and *(ii)* internationally-traded risk-free bonds that are useful for consumption smoothing under the presence of idiosyncratic earnings shocks. Furthermore, financial system of this model economy is underdeveloped so that consumers face ad-hoc borrowing constraints.

I assume that there is perfect mobility in capital and goods markets so that domestic nominal interest rate is determined by a parity condition and domestic price level is determined by the law of one price. Because of the latter, domestic inflation rate is equal to the depreciation rate of the currency. These assumptions cause bonds to be fully dollarized (inflation-indexed) so that their real return does not depend on domestic inflation.

Turkish monetary authority in reality achieved disinflation by adopting a floating exchange rate regime coupled with inflation targeting after the 2001 crisis. However, since then, the Central Bank of Republic of Turkey has intervened the foreign exchange market many times with the discourse of "preventing excess volatility in the nominal exchange rate" and accordingly, accumulated substantial amount of international reserves. Consequently, I assume that the *de facto* exchange rate regime is practically a managed float so that monetary authority is able to manipulate the level of the depreciation rate exogenously. Moreover, to focus on disinflation, I abstract from any kind of aggregate uncertainty, except for a one-time, unanticipated announcement of a disinflationary path, made by the government.

The assumption of using inflation-indexed bonds is motivated by the idea that high inflation economies have developed particular methods (such as financial dollarization) to cope with this phenomenon.[2] Therefore, I abstract from nominal valuation effects created by surprise inflation that drive redistribution of wealth from creditors to debtors. Indeed, Iacoviello (2005) argues that debt-deflation effects are more important in low inflation (developed) economies. To explore this, Doepke and Schneider (2006) and Meh et. al (2008) study welfare effects of an inflation shock that is modeled as a zero sum redistribution of real wealth in the context of industrialized economies. Berriel (2011), on the other hand, presents a provocative finding that endogenous portfolio decision (which is absent in the framework of Doepke and Schneider (2006)) offsets portfolio valuation effects in a general equilibrium setting even for the case of the U.S. economy.

[2]Berument and Guner (1997) and Berument and Gunay (2003) find that nominal deposit and treasury auction rates have provided a good hedge against inflation and currency depreciation during the high inflation period of the Turkish economy.

The current paper is immune to Lucas' critique in this sense that portfolio decisions in this model endogenously change with inflation.

In order to focus on the mediating role of fiscal policy on the consequences of disinflation, I study alternative fiscal arrangements with *(i)* endogenous uniform transfers; and *(ii)* endogenous government spending. Adjustments in these fiscal variables will naturally depend on the gradual decline in inflationary finance along the transition.

I calibrate the model to the low inflation period of the Turkish economy in the last decade. The main quantitative exercise is to feed the calibrated declining path for inflation rates (illustrated in figure 1) into the model and to explore the macroeconomic and distributional dynamics and welfare consequences of disinflation under alternative fiscal arrangements. It is obvious that studying gradual disinflation rules out steady state comparisons. Therefore, I assume that the economy is initially at the 14.25% inflation equilibrium and the government makes an unanticipated, time-consistent and credible announcement at date 0 that inflation will follow a "declining path" for the next 6 years and will stay at 2.25% forever. These numbers are average inflation rates in the periods 1987:2-2002:4 and 2003:1-2010:3 that are separated by a structural change in inflation.

I find that accounting for the gradual disinflation is crucial for generating the secular downward pattern in consumption velocity and upward pattern in aggregate money demand. Strikingly, irrespective of the fiscal arrangement, model generated time profile of these macro variables are almost identical with their trends presented in figure 1. The model is also qualitatively consistent with the dynamics of consumption and trade balance-to-GDP ratios.

Second, the evolution of Gini coefficients of bonds display non-trivial dynamics which are impossible to capture within a steady state comparison framework.

Third, welfare changes from disinflation are affected substantially from transitional dynamics. In particular, when transfers are endogenous, aggregate welfare loss of 1.25% (with no transition) in terms of compensating consumption variation is transformed into a gain of 0.28% (with transitional dynamics). This is because the reduction in the costs of inflation to the poor is smaller than the reduction in their transfers income implied by disinflation. While transfers plummet immediately in the stationary world, in the transitional dynamics equilibrium, they follow a gradual path mainly dictated by the announced path of inflation. As a result, the reduction in the magnitude of redistribution from the rich to the poor is limited in the transitional dynamics economy. Due to a similar reason, when government spending is endogenous, aggregate welfare gain of 1.62% reduces to 0.53% with transitional dynamics.

Sensitivity analysis of this paper establishes that the secular pattern of afore-mentioned macro variables cannot be captured when disinflation is modelled as a one-time, unanticipated announcement of a sharp decline in inflation. In this case, welfare consequences are qualitatively similar to those implied by the steady state analysis when transfers are endogenous; and are exactly identical to those implied by the steady state analysis when government spending is endogenous. The reason for the discrepancy is that in the latter economy, sharp reversals in spending does not feed back to the utility maximization problem of consumers, whereas in the former economy, sharp reversals in transfers create excess consumption volatility.

This paper contributes to the monetary economics literature that incorporates imperfectly insured idiosyncratic risk framework. Among this vast literature, the work of Algan and Ragot (2010), Berriel and Zilberman (2011), Erosa and Ventura (2002) and Albanesi (2007) should be highlighted as Bewley-Huggett-Aiyagari type stationary environments within monetary framework. However, none of these studies incorporate the transitional dynamics of disinflation by using a calibrated model of a small open economy.

The rest of the paper is organized as follows. Section 2 describes the theoretical model. Section 3 shows the workings of the model and defines the stationary (pre-disinflation) equilibrium and the transitional dynamics (disinflation) equilibrium. Section 4 describes the parameterization of the model and reports findings. Sensitivity analysis is performed in Section 5 and finally, Section 6 concludes the paper.

2 The Model Economy

The model in this chapter will essentially follow the one described in Chapter 1 with the only difference that the path of inflation is not static anymore. In particular, I study a monetary model of a small open economy with uninsured idiosyncratic earnings risk. There is no production. The economy is inhabited by two agents: A continuum of infinitely lived households of total mass 1 and a government. To highlight the unexpected decline in inflation at date 0, I abstract from any other type of aggregate uncertainty. Time is discrete. The consolidated government determines fiscal and monetary policy.

2.1 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 (which does not depend on inflation) is denoted by P.

Households derive utility from consumption. 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 the same across individuals) and $u(c)$ is a continuous and strictly concave function defined over the flow of consumption. Utility function satisfies the Inada condition, $\lim_{c \to 0^+} u'(c) = \infty$. E is the mathematical expectation operator.

Households have access to two financial assets: Real balances (demand deposits), m, issued by monetary authority, and one-period, risk free bonds (term deposits), b, that are internationally traded. 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, 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 equation (2) represents total consumption expenditures and asset demands. Transactions costs are assumed to be an increasing function S of consumption velocity of money, $\kappa_t = \frac{c_t}{m_{t+1}}$. The unit transactions costs function is assumed to take the form $S = \phi \kappa^\gamma$, where $\phi > 0$ and $\gamma > 1$. τ_t is a lump-sum transfer made by the government. I assume that financial markets are underdeveloped, therefore consumers face a borrowing constraint so that $b_{t+1} \geq \Omega$ with $\Omega \leq 0$.

There is perfect mobility in capital and goods markets. Therefore, small open economy assumption ensures that R is taken as given from the international capital markets. Under the law of one price and the assumption of zero foreign inflation rate, domestic inflation rate, π_t, becomes identical to the depreciation rate of currency, e_t. Motivated by financial dollarization in emerging economies, I assume that the real interest rate earned on bonds stays constant even if there is a surprise change in inflation, i.e. nominal interest reflects the change in the depreciation rate of currency by the interest parity condition. Therefore, nominal portfolio valuation effects from unanticipated changes in inflation will be omitted in this framework.

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 real deposits position and earnings level of an individual. Let $\Gamma_t(a_t, \varepsilon_t)$ be the measure of agents who are in the idiosyncratic state (a_t, ε_t) at date t. I discretize the state and policy spaces. This omits one state variable and eases computation. However, portfolio choice between real balances and bonds is still explicit in the model, as I describe below.

2.2 Government and Alternative Fiscal Arrangements

Equation (3) describes the budget constraint of the government. As part of monetary policy, the government issues currency and announces the depreciation rate of nominal exchange rate, $\{e_t\}_{t=0}^{\infty}$. I do not bring any foundation to the disinflation phenomenon and model it as an unanticipated and credible policy announcement made by the monetary authority. Aggregate real seigniorage revenues are denoted by $M_{t+1}^s - \frac{M_t^s}{1+e_t}$, where M_t^s is aggregate real money supply at the beginning of period t. Money is demand determined, i.e., for a pre-determined depreciation rate, the central bank prints as much money as the economy demands on aggregate. I abstract from international reserves for simplicity.

$$G_t + \tau_t = M_{t+1}^s - \frac{M_t^s}{1+e_t} \tag{3}$$

Fiscal policy is conducted by making unproductive expenditures, G_t, and remitting transfers, τ_t to households. To explore the distributional role of disinflation, I study alternative fiscal arrangements in response to monetary policy described above. In Economy 1, I assume that government spending is constant, $G_t = G\ \forall t$, which leaves uniform transfers as responsive to changes in seigniorage revenues. In Economy 2, I assume that uniform transfers are constant, $\tau_t = \tau\ \forall t$, so that spending responds to changes in seigniorage revenues. These two arrangements are meant to capture the redistributive role of uniform transfers. I consider Economy 1 as the benchmark case, since a well-known practice in the literature is to couple monetary creation by lump-sum transfers.

From a policy-making perspective, the idea is to study a credible stabilization plan which is in practice achieved by controlling the depreciation rate of currency. Indeed, Central Bank of the Republic of Turkey (CBRT) was able to reduce inflation gradually by employing inflation targeting as the main policy rule since the 2001 crisis. Yet, during this period, Turkish residents have witnessed many occasions in which CBRT has intervened the foreign exchange market with the discourse of "preventing excess volatility in the exchange rate". This supports the perspective of modelling the exchange rate regime as a *de facto* managed float in this paper. Consequently, I assume that at $t = 0$, the government announces a declining time profile for the future sequence of inflation rates in an unanticipated way. That is

$$e_t = e^0 \text{ for } t = 0 \tag{4}$$
$$\{e_t\}_{t=1}^{\infty} = \{e_t^1\}_{t=1}^{\infty} \text{ for } t > 0$$

3 Analytical Framework

In this section, I formulate the optimization problem solved by the consumer in the benchmark economy, and define the stationary and transitional dynamics recursive equilibria.

3.1 The Household's Decision Problem

Dynamic programming problem solved by a household who is in state (a_t, ε_t) at date t is:

$$v_t(a_t, \varepsilon_t; e_t) = \max_{c_t, m_{t+1}, b_{t+1}} \left[u(c_t) + \beta E_t \left\{ v_{t+1}\left(a_{t+1}, \varepsilon_{t+1}; e_{t+1}\right) | \varepsilon_{t+1}, e_{t+1} \right\} \right] \tag{5}$$

subject to

$$c_t\left[1+S\left(\frac{c_t}{m_{t+1}}\right)\right]+b_{t+1}+m_{t+1}=\varepsilon_t+a_t+\tau_t \tag{6}$$

$$c_t, m_{t+1}\geq 0 \text{ and } b_{t+1}\geq \Omega \tag{7}$$

where $a_t = Rb_t + \frac{m_t}{1+e_t}$ $\forall$ t and $-\Omega$ is an ad-hoc debt limit.

Decision rules of an individual that govern the demand for real money balances, bonds and consumption are functions $m_{t+1} = m_{t+1}(a_t, \varepsilon_t)$, $b_{t+1} = b_{t+1}(a_t, \varepsilon_t)$ and $c_t = c_t(a_t, \varepsilon_t)$. Notice that the recursive problem of the household incorporates variations in inflation and transfers. Therefore, I use time subscripts for the value function and policy rules.

3.2 Equilibrium

I assume that conditions that guarantee the existence of unique invariant measure Γ^{*0} for the initial inflation rate and transfers are satisfied (see Hugget (1993)). Definitions 1 and 2 below describe the stationary recursive equilibrium (that represents pre-disinflation) and recursive transitional dynamics equilibrium (that represents disinflation) respectively:

Definition 1 (Pre-disinflation) *Given a constant level of government expenditures G, the international gross real interest rate R and a constant depreciation rate e^0, a stationary recursive equilibrium is a time invariant value function v^0, time invariant policy functions $m'^0 = m'^0(a,\varepsilon;e)$, $b'^0 = b'^0(a,\varepsilon;e^0), c^0 = c^0(a,\varepsilon;e^0)$, constant lump-sum transfers τ^{*0} and a stationary distribution Γ^{*0}, such that: (i) Given τ^{*0}, R, and e^0; v^0, $m'^0 = m'^0(a,\varepsilon;e^0)$, $b'^0 = b'^0(a,\varepsilon;e^0)$ and $c^0 = c^0(a,\varepsilon;e^0)$ solve the household's problem (2.3.1); (ii) Given G, Γ^{*0}, e^0 and the policy functions of households; τ^{*0} is consistent with the balanced budget of the government; $G+\tau^{*0} = \left(\frac{e^0}{1+e^0}\right)M^s$; (iii) Given Γ^{*0} and the policy functions of households, aggregate goods market clears (i.e. the national income identity holds), $C+G+(1-R)B+Tr = Y$ with $C = \sum_{a,\varepsilon}\Gamma^{*0}(a,\varepsilon)c^0$, $B = \sum_{a,\varepsilon}\Gamma^{*0}(a,\varepsilon)b'^0$, $Y = \sum_{a,\varepsilon}\Gamma^{*0}(a,\varepsilon)\varepsilon$, and $Tr = \sum_{a,\varepsilon}\Gamma^{*0}(a,\varepsilon)c^0 S(\frac{c^0}{m'^0})$. Money market equilibrium, $M^s = \sum_{a,\varepsilon}\Gamma^{*0}(a,\varepsilon)m'^{*0}$ follows from the de facto exchange rate regime; (iv) Given the policy rules for assets and the Markov transition of earnings, [$b'^{*0}(a,\varepsilon), m'^{*0}(a,\varepsilon), p_{\varepsilon'|\varepsilon}$], the distribution of total deposits and earnings satisfies the following fixed point equation: $\Gamma^{*0}(a',\varepsilon') = \sum_{\varepsilon}\sum_{\{a:a'^0=Rb'^0(a,\varepsilon)+\frac{m'^0(a,\varepsilon)}{1+e^0}\}}\Gamma^{*0}(a,\varepsilon)p_{\varepsilon'|\varepsilon}$.*[3]

Definition 2 (Disinflation) *Given a constant level of government expenditures G, the international gross real interest rate R and the sequence of depreciation rates $\{e_t\}_{t=0}^{\infty}$ which satisfies the disinflation profile described in (2.2.2), a recursive transitional dynamics equilibrium is a sequence of functions $\{v_t, m_{t+1}, b_{t+1}, c_t\}_{t=0}^{\infty}$, lump-sum transfers $\{\tau_t^1\}_{t=0}^{\infty}$ and distributions*

[3]In Economy 2, G^{*0} closes the equilibrium for a fixed τ.

$\{\Gamma_t^1\}_{t=0}^{\infty}$, *such that: (i) Given* $\{\tau_t^1\}_{t=0}^{\infty}$, *R, and* $\{e_t\}_{t=0}^{\infty}$; $\{v_t, m_{t+1}, b_{t+1}, c_t\}_{t=0}^{\infty}$ *solve the household's problem (2.3.1); (ii) Given G,* $\Gamma_t^1(a, \varepsilon)$, $\{e_t\}_{t=0}^{\infty}$ *and the policy functions of households,* $\{\tau_t^1\}_{t=0}^{\infty}$ *is consistent with the balanced budget of the government;* $G + \tau_t^1 = M_{t+1}^s - \frac{M_t^s}{1+e_t}$; *(iii) Given* $\{\Gamma_t^1\}_{t=0}^{\infty}$ *and the policy functions of households, aggregate goods market clears (i.e. the national income identity holds),* $C_t + G + B_{t+1} - RB_t + Tr_t = Y$ *with* $C_t = \sum_{a,\varepsilon} \Gamma_t^1(a_t, \varepsilon_t) c_t$, $B_{t+1} = \sum_{a,\varepsilon} \Gamma_t^1(a_t, \varepsilon_t) b_{t+1}$, $Y = \sum_{a,\varepsilon} \Gamma_t^1(a_t, \varepsilon_t)\varepsilon$, *and* $Tr_t = \sum_{a,\varepsilon} \Gamma_t^1(a_t, \varepsilon_t) c_t S(\frac{c_t}{m_{t+1}})$ $\forall t$. *Money market equilibrium,* $M_{t+1}^s = \sum_{a,\varepsilon} \Gamma_t^1(a_t, \varepsilon_t) m_{t+1}$ $\forall t$, *follows from the de facto exchange rate regime; (iv) Given the policy rules for assets and the Markov transition of earnings,* $[b_{t+1}(a, \varepsilon), m_{t+1}(a, \varepsilon), p_{\varepsilon_{t+1}|\varepsilon_t}]$; *the distribution of total deposits and earnings follows the law of motion:* $\Gamma_{t+1}^1(a_{t+1}, \varepsilon_{t+1}) = \sum_{\varepsilon} \sum_{\{a: a_{t+1} = Rb_{t+1} + \frac{m_{t+1}}{1+e_t}\}} \Gamma_t^1(a_t, \varepsilon_t) p_{\varepsilon_{t+1}|\varepsilon_t}$.

3.3 Characterization of Equilibrium

The optimality conditions that come out of combining the first order conditions of this problem are:

$$\lambda_t[1 - S'(\kappa_t)\kappa_t^2] = \frac{\beta}{1 + e_{t+1}} E_t\{\lambda_{t+1}\} \tag{8}$$

$$\lambda_t - \varphi_t = \beta R E_t\{\lambda_{t+1}\} \tag{9}$$

$$c_t[1 + S(\kappa_t)] + b_{t+1} + m_{t+1} = \varepsilon_t + a_t + \tau_t \tag{10}$$

where $\kappa_t = \frac{c_t}{m_{t+1}}$ and $a_t = Rb_t + \frac{m_t}{1+e_t}$.

Lagrange multipliers of the budget constraint and the borrowing constraint (λ_t and φ_t) are shadow prices of total (real) deposits and relaxing the borrowing constraint by one unit respectively. Equations (8) and (9) are Euler equations for real balances and bonds demand respectively. Equation (10) is the budget constraint of the household.

Disinflation at $t = 0$ is unanticipated and agents re-optimize. Yet, since the government announces a deterministic path (which is credible) for the sequence of depreciation rates starting from period 1 and on, the one-period ahead depreciation rate, e_{t+1}, does not enter into the expectation operator in equation (8). Given this feature, for consumers who are not borrowing constrained (i.e. $\varphi_t(a_t, \varepsilon_t) = 0$), equations (8) and (9) can be combined to obtain,

$$\left(\frac{1}{1 + e_{t+1}}\right)\left(\frac{1}{1 - S'(\kappa_t)\kappa_t^2}\right) = R. \tag{11}$$

which can also be rewritten as

$$S'(\kappa_t)\kappa_t^2 = \frac{i_{t+1}}{1 + i_{t+1}} \tag{12}$$

by using the definition of the nominal interest rate between periods t and $t+1$, $1+i_{t+1} = (1+e_{t+1})R$ under the absence of aggregate uncertainty. Given that $S(\kappa_t) = \phi\kappa_t^{\gamma}$ is a strictly convex and increasing function of κ_t, equation (12) implies a unique solution for the consumption velocity as, $\kappa_t = \left[\frac{1}{\gamma\phi}(\frac{i_{t+1}}{1+i_{t+1}})\right]^{\frac{1}{1+\gamma}}$. Clearly, κ_{t+1} does not depend on any idiosyncratic variable, therefore, consumption velocities of unconstrained individuals become identical. On the other hand, for borrowing constrained individuals, we have $\varphi(a_t, \varepsilon_t) > 0$. Now, equations (8) and (9) imply that

$$\frac{\beta E_t\left\{\lambda_{t+1}\right\}}{\lambda_t} = (1+e_{t+1})[1 - S'(\kappa_t^c)\kappa_t^{c2}] = \frac{1}{R}\Big[1 - \frac{\varphi_t}{\lambda_t}\Big]. \tag{13}$$

The first equality follows from equation (8) and the second equality follows from equation (9) after dividing the whole equation by $R\lambda_t$. It is straightforward to show that the definition of nominal interest rate and rearranging terms yield

$$S'(\kappa_t^c)\kappa_t^{c2} = \frac{i_{t+1} + \frac{\varphi_t}{\lambda_t}}{1+i_{t+1}} \tag{14}$$

which implies the consumption velocity of constrained individuals to be, $\kappa_t^c = \left[\frac{1}{\gamma\phi}\left(\frac{i_{t+1}+\frac{\varphi_t}{\lambda_t}}{1+i_{t+1}}\right)\right]^{\frac{1}{1+\gamma}}$. Since $\varphi_t(a_t, \varepsilon_t) > 0$ and $\lambda_t(a_t, \varepsilon_t) > 0 \; \forall \; (a_t, \varepsilon_t)$, $\kappa_t^c > \kappa_t \; \forall \; (a_t, \varepsilon_t)$. Furthermore, $\gamma, \phi, \lambda_t, i_{t+1} > 0$ implies that κ_t^c is increasing in φ_t. This means that consumers who are borrowing constrained have a higher consumption velocity than those who are not. Moreover, the more constrained an individual (i.e. the larger $\varphi_t(a_t, \varepsilon_t)$) is, the larger the discrepancy.

3.4 Transitional Dynamics of Disinflation

In this section, I discuss the mechanics of transitional dynamics implied by gradual disinflation. First and foremost, from a methodological point of view, stationary equilibria analysis cannot incorporate gradual disinflation observed in the data. Therefore, one has to resort to the numerical solution of the transitional dynamics equilibrium. Coming to the expected implications, as equation (12) illustrates, consumption velocity of consumers depends on next period's inflation rate. The calibrated disinflationary path will then imply a declining profile for consumption velocities along the transition. This will consequently cause aggregate consumption velocity to follow a secular decline as in data. Seigniorage revenues are also expected to decline over time as opposed to collapsing immediately. This point is rather crucial because redistributive implications are closely tied to the time profile of seigniorage revenues. As a result, welfare consequences are expected to be less emphasized in the transitional dynamics experiment in comparison with the study of steady states.

Inflation does not cause any distortions in the production sector in this model. This would strengthen the transmission from the calibrated path of inflation to the variables in the government budget constraint (i.e., seigniorage revenues, government spending and transfers). However, in any case, the evolution of precautionary savings during disinflation will be non trivial. This is because there is a certain degree of persistence in the stochastic earnings process governed by, $p_{\varepsilon'|\varepsilon} = Pr(\varepsilon_{t+1} = \varepsilon'|\varepsilon_t = \varepsilon)$. Take the case of Economy 1. Now, persistence in earnings process would cause some poor consumers to be hit by adverse earnings shocks and stay borrowing constrained although the precautionary savings motive increases due to the lack of insurance provided by uniform transfers. As I establish above, the opportunity cost of holding real balances will be higher for those individuals and they will hold less real balances in comparison with unconstrained consumers. This might affect aggregate money demand together with consumption velocity and welfare consequences of disinflation.

I finish the discussion of analytical framework here and proceed to the quantitative assessment of disinflation in the next section.

4 Quantitative Analysis

In this section, I study the model's quantitative predictions using a version calibrated to the Turkish economy. From a parameterization and calibration perspective, the focus is on the low inflation steady state represented by the period 2003:1-2010:2, for which data on aggregates, inequality measures and government transfers are available. The model period is a quarter. The main experiment is to assess the transitional dynamics of macroeconomic and distributional variables and welfare consequences of a gradual decline in inflation from $e^0 = 14.25\%$ to $e^1 = 2.25\%$. Following the exercise in plotting figure 1, I HP filter the time series of inflation rates during disinflation (1999:2-2004:4) and feed the trend levels into the model to establish $\{e_t^1\}_{t=1}^{T}$ for $T = 23$.[4] I use the same parameter values in the analysis of Economy 2. The major difference of Economy 2 is that (as opposed to uniform transfers in Economy 1) government spending is now an endogenous equilibrium object that responds to changes in seigniorage revenues to satisfy the government budget constraint.

4.1 The Parameterization of the Benchmark Economy

The parameters of Economy 1 are determined by treating the period 2003:1-2010:2 as a benchmark. Table 1 below includes a list and description parameter values used in the quantitative analysis. To avoid repetition, I skip the detailed description of the parameterization of Economy 1. The reader could find such a detailed description in Sunel (2010). The numerical solution algorithm of the transitional dynamics equilibrium is described in the appendix.

[4] As mentioned in Introduction, average inflation in the periods 1987:2-1999:2 and 2004:4-2010:3 are 15.46% and 1.86% respectively. These inflation rates are not significantly different from the "high" and "low" inflation rates (14.25% and 2.25%) analyzed in the steady-state comparisons. For comparability, I use those values as initial and terminal conditions of the transitional dynamics equilibrium.

Table 1: 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	1.2175	Curv. of the trans. costs function	Int. elas. of M1 demand = -0.4510	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	0.00175	Multip. trans. costs parameter	$C/M1 = 4.1925$	4.1920
Ω	-0.0329	Lower bound for bonds	$(M2Y - M1)/M2Y = 0.8493$	0.8543

Parameters with an asterisk are determined jointly to match empirical moments. The average CPI inflation in the period 2004:1-2009:4 is equal to 2.25%.

4.2 Macroeconomic Consequences of Disinflation

In this section, I discuss the macroeconomic dynamics of gradual disinflation (calibrated to data) under alternative fiscal arrangements that govern how inflationary finance is used.

4.2.1 Uniform Transfers

Figure 2 below illustrates the time profile for main aggregate variables, the depreciation rate and the fraction of borrowing constrained when inflationary finance is directed to transfers. I plot ratios of aggregate transfers, consumption, net foreign assets position, money supply, transactions costs and trade balance-to-GDP in the top panels 1-6. Panels in the lower part of Figure 2 display the path of aggregate consumption velocity, measure of borrowing constrained and inflation. The dashed plots represent the dynamics observed in the data (see figure 1).

The most striking observation is that the model is able to capture the secular decline in consumption velocity and rise in aggregate money supply. Following the "unanticipated decline" in inflation at date 0, money demand (and therefore supply) starts to increase. The upward slope of money supply causes seigniorage revenues to even increase slightly in early periods. The path of transfers is in turn driven by the path of seigniorage revenues, since government spending is constant. After reaching a maximum in about a year, transfers start decreasing during disinflation. However, since inflation is still relatively high in comparison with the terminal steady state, the reduction in seigniorage revenues becomes limited. When the economy gets closer to the point at which agents know that inflation will be permanently lower in about 6 years, transfers sharply get closer to their terminal steady-state level.

This finding is rather interesting and needs to be elaborated: Inflation does not create any distortions in the "production" sector of this model economy since earnings are exogenous. It only creates *(i)* wealth effects transmitted by transactions costs of consumption and inflation taxation and *(ii)* substitution effects distorting the portfolio choice margin between money and bonds. Furthermore, as illustrated in section 3.3, as long as "unconstrained" agents learn that opportunity cost of holding money will be lower permanently, they will immediately settle to the same consumption velocity which is pinned down by the terminal steady state.

While consumption velocity and transactions costs monotonically decrease along the transition, aggregate consumption and net foreign asset position follows a path guided by the evolution of transfers. A 1.25% increase in consumption is achieved in about 6 years. Notice that the sharp decline and then recovery around 2001 in figure 1 is due to the most severe financial crisis of the Turkish economy in the last decade. Therefore, 2001 remains as an outlier within the disinflation period, around which most macroeconomic variables exhibit sharp movements (see figure 1). Keeping this in mind, I argue that the model is qualitatively consistent with the upward trend in aggregate consumption during disinflation. On the other hand, bond position of the model economy exhibits a downward trend during the first 5 years. This is mainly due to relaxed debt limits facilitated by high transfers in that period. This also causes the fraction of borrowing constrained to follow a smooth declining path along the transition. Since output and government spending are fixed in this economy, trade surplus follows an exactly opposite time profile to that of consumption. This is again qualitatively in line with the data since the trade balance starts deteriorating after 2001.

4.2.2 Endogenous Government Spending

Figure 3 below illustrates the time profile for same set of variables included in figure 2 under the assumption that inflationary finance is now directed to wasteful spending. The transitional path of consumption velocity, transactions costs and the fraction of borrowing constrained are similar to the endogenous transfers case. Government spending follows a path very similar to that of transfers in the previous economy. This model is also able to explain the secular decline in consumption velocity and rise in money supply as does the previous model.

However, the endogeneity of government spending causes different dynamics for consumption and bonds position of the economy. In particular, the decline in spending and in the distortions created by inflation during 6 years imply an almost monotonically increasing path for consumption. The initial decline in consumption is due to the slight surge in government spending caused by the unanticipated change. But now, since the immediate fall in spending as the economy approaches to the terminal conditions does not feed back into consumers' optimization problem described in section 3.1, consumption does not plummet in year 6 in sharp contrast with Economy 1. Moreover, the path of trade balance reflects the combined effect of changes in consumption and government spending along the transition. Specifically, the increasing trade deficit along the transition is corrected by a discrete jump when spending collapses to its terminal equilibrium value. In line with these observations, net foreign asset position decreases for 5 years and settles down to its terminal value without showing a reversal as opposed to Economy

Table 2: Time Series Averages of Macroeconomic Variables Along Disinflation

	Data[a]	**Uniform** τ_1	**Endogenous** G
C/GDP	0.857	0.862	0.862
NFA/GDP	1.175	1.198	1.225
$M1/GDP$	0.190	0.194	0.194
TB/GDP	-0.021	-0.033	-0.035
$C/M1$	4.772	4.552	4.547

[a]Disinflation period spans 1999:2-2004:4 as illustrated in figure 1

1. This is again due constant transfers in Economy 2, which shut down redistributive wealth effects. Since transfers do not respond to disinflation in this economy, natural debt limits do not tighten as much, causing a limited increase in the precautionary savings motive. Therefore, the measure of borrowing constrained falls less in comparison with Economy 1. Notice that natural debt limits depend on the inflation tax payments of the poorest as well. Therefore, even transfers are fixed, natural debt limits are affected by inflation in Economy 2.

Finally, in Table 2, I compare the time series averages of macroeconomic variables during disinflation, i.e., 1999:2-2004:4, to those implied by Economies 1 and 2. The model proves successful in predicting time series averages for consumption and money supply-to-GDP ratios and consumption-velocity that are very close to their empirical counterparts.

This completes the analysis of macroeconomic implications of disinflation in Economies 1 and 2 and I now proceed to comment on distributional consequences.

4.3 Distributional Consequences of Disinflation

In Figures 4 and 5, I present the time profile of Gini coefficients of bonds, money, consumption and income in Economies 1 and 2 respectively. Although the degree of inequality in bonds position is very similar at initial and terminal conditions in Economy 1, accounting for the transitional dynamics shows that the Gini coefficient increases by about 1.5% in the first 6 years (top-left panel of Figure 4). This coincides with the reduction in precautionary savings motive, due to high level of endogenous transfers in this economy. This also prevents income inequality to increase (bottom-right panel) until transfers collapse to their low inflation steady state level. Money demand is a function of total deposits which is mainly composed of bonds. Consequently, more inequality in bonds imply more inequality in the distribution of money holdings. Specifically, the Gini coefficient of money holdings rise about 1% in 7 years and then settles down to its low inflation steady state value. Recall that as shown in figure 2, the measure of borrowing constrained is declining along the transition. This requires inequality of consumption to get closer to that of real balances. Therefore, Gini coefficient of consumption surges by about 1 percentage point in a discrete way when disinflation starts.

Evolution of money holdings and consumption inequality in Economy 2 is similar to those in Economy 1 (see Figure 5 below). From a quantitative point of view, income inequality is almost intact and does not display a discrete jump as the economy approaches to the terminal conditions in contrast with Economy 1. However, inequality in bonds secularly increases in the first 6 years and ultimately stays at a higher level in comparison with the high inflation steady state. Since transfers are fixed in Economy 2, reduction in precautionary savings motive is less in comparison with Economy 1. This prevents consumers from buffering bonds that leads to a more dispersed distribution.

4.4 Welfare Consequences of Disinflation

I develop a measure of aggregate welfare. Following Mendoza et al. (2007), welfare effects are computed as the proportional increase in consumption in the 14.25% inflation stationary equilibrium, η, that would make an individual consumer indifferent about remaining in that state versus shifting to an economy that exhibits the disinflation profile described above. For each agent i who is at the initial state (a_0, ε_0), $\eta(a_0, \varepsilon_0)$ solves

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^{i,14.25\%}(1 + \eta(a_0, \varepsilon_0))) = E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^{i,Dis}) \tag{15}$$

where $\{c_t^{i,14.25\%}\}_{t=0}^{\infty}$ is the infinite sequence of consumption of agent i in state (a_0, ε_0) in the high inflation economy and $\{c_t^{i,Dis}\}_{t=0}^{\infty}$ is the corresponding sequence of consumption in the disinflation economy.[5]

Once I establish the consumption equivalent of welfare gains on the individual level, as a natural next step, I need to do an aggregation to achieve a normative assessment regarding the economy as a whole. The practice is to fix the deposits distribution of the high inflation economy as an initial condition, $\Gamma^{14.25\%}(a_0, \varepsilon_0)$ and use it to compute a weighted average of the welfare gains in terms of compensating consumption variation (CCV hereafter). Hence, the consumption equivalent of the aggregate welfare gain from disinflation becomes

$$W^{Dis} = \sum_{a,\varepsilon} \Gamma^{14.25\%}(a_0, \varepsilon_0)\eta(a_0, \varepsilon_0) \tag{16}$$

Table 3 below presents welfare consequences of reducing inflation from 14.25% to 2.25% under alternative fiscal arrangements. Furthermore, for each arrangement, I compare welfare consequences of immediately switching to the low inflation steady state versus experiencing the transitional dynamics. The first row denotes aggregate welfare gain of settling at the low inflation stationary equilibrium. Rows 2, 3 and 4 include the disaggregation of this measure into the average gains of the bottom quintile and the top percentile and the median gain (ordered

[5] Given the particular functional form for the utility function and the notation so far, $\eta(a_0, \varepsilon_0)$ also solves

$$[(1-\beta)(1-\sigma)v^{14.25\%}(a, \varepsilon) + 1](1 + \eta(a_0, \varepsilon_0))^{1-\sigma} = [(1-\beta)(1-\sigma)v_0^{Dis}(a_0, \varepsilon_0) + 1]$$

where $v^{14.25\%}(a, \varepsilon)$ is the equilibrium time invariant value function in the high inflation economy and $v_0^{Dis}(a_0, \varepsilon_0)$ is the $t = 0$ value of experiencing disinflation. Notice also that as per the recursive representation of households' optimization problem, $v_0^{Dis}(a_0, \varepsilon_0)$ incorporates the value of experiencing the transitional dynamics of disinflation.

Table 3: Welfare Consequences of Reducing Inflation from 14.25% to 2.25%

	Uniform τ_1		**Endogenous G**	
Welfare Gains[a]	**Steady States**	**Transition**	**Steady States**	**Transition**
Aggregate	-1.247	0.284	1.622	0.528
Bottom 20%	-3.564[b]	0.264	1.236	0.447
Median	-1.226	0.280	1.655	0.566
Top 1%	0.967[b]	0.326	1.756	0.351

[a]Welfare gains are computed as percentage change in terms of compensating consumption variation.
[b]Average welfare gains of percentiles ordered according to total deposits positions.

according to total deposits positions). The results show that apart from capturing the secular downward (upward) pattern of consumption velocity (money demand), accounting for the gradual decline in inflation also has significantly different welfare consequences in comparison to stationary equilibria analysis. In particular, as illustrated in Sunel (2010), instantaneous switch to the low inflation equilibrium in Economy 1 causes a sharp reduction in endogenous transfers. This causes the poor to incur substantial welfare losses (3.56% in terms of CCV) caused by a large reduction in redistributive transfers, which surpasses the reduction in distortions created by inflation (see the first column of Table 3). However, when transitional dynamics are taken into account, the evolution of transfers is gradual. This keeps redistribution alive for about 6 years and transforms welfare losses of the poor into gains (0.26%). It is straightforward at this point to see that welfare gains of the rich in the stationary world (0.97%) are diminished in the transitional dynamics world (0.33%), since they are financing redistributive transfers by paying more inflation tax in comparison to the poor.

Moving to Economy 2 with endogenous spending, it is again observed that transitional dynamics dampen welfare consequences of steady state comparisons. This is mainly due to the persistently high level of government spending that distorts the production possibilities frontier of this economy. However, the magnitude of the change in welfare effects is not as strong as in Economy 1 so that disinflation is still welfare improving for all segments of the society (see the third and fourth columns of table 3).

As implied by the steady state analysis, instantaneous adjustments in fiscal variables financed by seigniorage create strong wealth effects. Although marginal utility of consumption is higher for the rich, immediate collapse of transfers/government spending in these economies increases the consumption of the rich substantially. Therefore, welfare gains are monotonic (and concave) in earnings and total deposits in Economies 1 and 2 but are larger in the latter, since spending has no value to consumers.

In figure 6, I plot the disaggregated welfare gains implied by the transitional dynamics exercise. I let earnings to take 21 values in the numerical computation of the model and plot percentage changes in welfare as a function of earnings $\varepsilon_1 < \varepsilon_3 < \varepsilon_{11} < \varepsilon_{19} < \varepsilon_{21}$ (plots with dashes, diamonds, no dashes or shapes, circles and asterisks) and total deposits. Both panels suggest that disaggregated welfare changes are highly non-linear and non-monotonic in contrast with the steady state analysis. The left panel illustrates the reversal of welfare changes in Economy 1. Consumers who are poor both in terms of earnings and total deposit positions enjoy substantial welfare gains thanks to persistently high redistributive transfers along the transition. Furthermore, welfare gains of the rich now start from a low level and are not increasing in total deposits position anymore. This is due to the limited increase in rich individuals' consumption, because, gradual decline of transfers produce diminished wealth effects. On the other hand, in Economy 2, welfare gains of the earnings poor increases for low deposits levels. This explains why median gain is the largest in the fourth column of table 3. Earnings rich individuals finance more of the fiscal spending with their inflation tax payments. Therefore, their welfare gains from disinflation are larger. But now, wealth effects of reducing spending is again spilled over time, which produces diminishing welfare gains in total deposits.

This completes the analysis of macroeconomic, distributional and welfare consequences of transitional dynamics of disinflation. It should be obvious at this point that accounting for gradual disinflation (which is observed in the data) improves this stylized model of small open economy with heterogeneous agents upon the steady state comparisons in three dimensions: First, stylized dynamics of consumption velocity and money demand during disinflation periods are captured better. Second, it shows that the path of financial assets inequality can be volatile along disinflation and third, welfare consequences are substantially different than those implied by steady state comparisons. Therefore, I argue that the most relevant sensitivity experiment within this framework would be to focus on the importance of calibrating the path of "gradual disinflation". Consequently, in the next section, I perform sensitivity analysis by computing the transitional dynamics equilibrium, which now entails a stabilization policy of unanticipated "sudden" decline in inflation.

5 Sensitivity Analysis

In this section, I repeat the transitional dynamics exercise with the only difference that the calibrated disinflation path now involves a one time, unanticipated decline in inflation. That is,

$$\begin{aligned} e_t &= e^0 \text{ for } t = 0 \\ \{e_t\}_{t=1}^{\infty} &= e^1 \text{ for } t > 0 \end{aligned} \tag{17}$$

with $e^0 = 14.25\%$ and $e^1 = 2.25\%$.

5.1 Macroeconomic Consequences of Sudden Disinflation

Macroeconomic dynamics implied by sudden disinflation (illustrated in figures 7 and 8) are strikingly different from those implied by gradual disinflation (illustrated in figures 2 and 3). When transfers are endogenous, unanticipated disinflation causes discrete jumps in money demand and transfers-to-GDP ratios on impact (a huge 10% for the latter, see figure 7). The surge in money (which economizes transactions costs) and transfers, make people richer, cause consumption-to-GDP ratio to increase by about 5 percentage points and create a trade deficit on impact. The surge in consumption causes a slight increase in consumption velocity on impact and transactions costs immediately collapse to 50% of their original level. The most striking observation is that the model is now unable to capture the endured secular decline in consumption velocity and increase in money demand along the transition. This is because transfers quickly adjust by plummeting to very low levels as per consumers' perfect information on disinflation that it will be implemented credibly. Consequently, debt limits are tightened, precautionary savings motive increases substantially and a discrete fall in the fraction of borrowing constraint of almost 10% takes place. This coincides with an increase in bonds position-to-GDP ratio that follows a one time decline created by the surge in transfers. Along the transition, the measure of borrowing constrained and net foreign assets converge to their terminal values gradually. Since government spending is fixed, trade balance again follows the opposite of the path of consumption.

Figure 8 illustrates macroeconomic dynamics of sudden disinflation when spending is endogenous. The plots have a very stark message. Except for the measure of borrowing constrained, all other variables settle down to their terminal values almost instantaneously. This is again because there is no feedback from the adjusting variable, spending, to consumers' optimization problem. The surge in spending on impact is the result of unanticipated disinflation because money demand shoots up on impact. Since transfers are fixed in this economy, fraction of borrowing constrained does not display any movement on impact but converges to its terminal value along transition. The gradual convergence of this measure (as opposed to steady state comparisons) is purely attributable to the persistence in idiosyncratic earnings process (see the discussion in section 3.4). The increase in aggregate consumption on impact is now very limited because government spending increases a lot. Substantial rise in domestic absorption deteriorates the trade balance about 10% and causes a decline in the net foreign asset position. Most notably, similar to the endogenous transfers case, this model also cannot resemble the persistent decline in consumption velocity and increase in aggregate money demand.

5.2 Distributional Consequences of Sudden Disinflation

Figure 9 suggests that reducing inflation overnight with endogenous transfers is a short-term remedy for inequality in financial assets and consumption. The reduction in the measure of borrowing constrained causes the Gini coefficient of bonds to decline by about 7%. The initial surge in redistributive transfers causes the distribution of money holdings and consumption to be almost perfectly equitable on impact. The distribution of the two are also very similar as per the collapse in the fraction of constrained. Similar to gradual disinflation (see figure 4), income inequality resembles the opposite of the path of redistributive transfers.

Distributional implications of sudden disinflation with endogenous spending are displayed in figure 10 below. The paths of Gini coefficients clearly establish that sudden disinflation with endogenous spending would have undesired distributional consequences in the short run. This is because the rise in spending on impact creates adverse wealth effects that dominate the typical increase in the precautionary savings motive caused by disinflation in this model. In particular, Gini coefficients of bond holdings, money holdings and consumption increase by about 2%, 1.5% and 1% on impact. Income inequality does not exhibit a substantial change.

5.3 Welfare Consequences of Sudden Disinflation

Table 4 reports the comparison of welfare consequences of disinflation within steady state and transitional dynamics frameworks where the latter now incorporates the unanticipated announcement of reduction in inflation from 14.25% to 2.25%. The main observation is that unlike gradual disinflation, accounting for transitional dynamics within sudden disinflation produces qualitatively similar welfare consequences in Economy 1 and exactly identical consequences in Economy 2. In comparison with the steady state analysis, welfare changes in Economy 1 are magnified due to the volatility in transfers. In Economy 2, since there is no feedback from spending to households' utility maximization problem, consumers immediately adjust their portfolio decisions according to the low inflation steady state. This is a very interesting finding that if one limits focus on sudden disinflation in Economy 2, steady state comparisons perform (in welfare dimension) almost as good as explicitly accounting for transitional dynamics.

Finally, for completeness, I illustrate disaggregated welfare gains from sudden disinflation with transitional dynamics in figure 11. As in Figure 6, welfare gains are plotted as function of earnings and total deposits. The left panel (representing Economy 1) shows that welfare losses of the poorest are magnified by the sharp decline in redistributive transfers that follows the initial hike as per the unanticipated announcement. The reader should be urged at this point that in this economy, most of the population lie in the range of [Ω - 5] in the total deposits dimension. Therefore, only the rich enjoy welfare gains from disinflation. Finally, as the right panel of figure 11 illustrates, disaggregated welfare changes in Economy 2 are strikingly identical to those implied by the steady state analysis, consistent with table 4.

In summary, the main message of the sensitivity analysis is that accounting for "the gradual decline" in inflation which is modeled as an unanticipated, time consistent and credible announcement *(i)* is necessary to produce the stylized macroeconomic consequences of disinfla-

Table 4: Welfare Consequences of Reducing Inflation from 14.25% to 2.25%

	Uniform τ_1		Endogenous G	
Welfare Gains[a]	**Steady States**	**Transition**[b]	**Steady States**	**Transition**
Aggregate	-1.247	-8.317	1.622	1.622
Bottom 20%	-3.564[c]	-35.939	1.236	1.237
Median	-1.226	-6.535	1.655	1.655
Top 1%	0.967[c]	4.268	1.756	1.763

[a]Welfare gains are computed percentage change in terms of compensating consumption variation.
[b]Transition columns represent unanticipated, $t = 0$ announcement of sudden disinflation.
[c]Average welfare gains of percentiles ordered according to total deposits positions.

tion; and *(ii)* produces qualitative and quantitative differences from the steady state framework. The transitional dynamics exercise fails in improving upon steady state analysis in these dimensions if disinflation is modeled as an unanticipated announcement of a sudden collapse in the inflation rate.

6 Conclusion

This paper explores the relatively less investigated question of "what might be the macroeconomic, distributional and welfare consequences of recent disinflation in emerging economies?". The analysis starts with documenting stylized macroeconomic facts for the case of Turkey's disinflation which has endured since the last two decades. Apart from disinflation, Turkey constitutes a good example of important financial system characteristics of emerging economies, such as financial dollarization and substantial inequality in the distribution of monetary assets.

To that end, I calibrated the disinflation profile of the Turkish economy and fed it into a monetary model of a small open economy with uninsured idiosyncratic earnings risk and incomplete markets. The policy experiment is to have the monetary authority make an unanticipated, time-consistent and credible announcement of a disinflation profile at date 0.

As established in Sunel (2010), fiscal and monetary interactions play a decisive role on part of distributional and welfare consequences of disinflation. Guided by those findings, I incorporate alternative adjustment rules in the government budget constraint in response to reduction in inflationary finance and find that, explicitly accounting for transitional dynamics is a necessary condition to capture the stylized dynamics of macroeconomic variables. Moreover, analyzing gradual disinflation produces interesting welfare consequences that are different from those implied by the steady state analysis. Another important finding is that due to the absence of disruptive effects of inflation in the production sector, the first order impact of disinflation is observed on macro variables related to public finance. This implied that accounting for transitional dynamics does not matter much if policy experiment is switched to one that involves a sharp, one-time decline in inflation.

The most relevant research avenue for further work would be to study an environment in which idiosyncratic and aggregate uncertainty coexists. In such an environment, volatility of inflation (which appears to be reducing in the disinflation era), beside total factor productivity shocks should be modelled as the source of aggregate uncertainty. That framework would enrich the distortions created by inflation (specifically in the production sector) and provide an enhanced metric of macroeconomic, distributional and welfare consequences of both the level and the volatility of inflation.

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Appendix: Numerical Solution Algorithm of Transitional Dynamics Equilibrium

Economy 1

The numerical solution algorithm of the transitional dynamics exercise involves the following steps:

1. Solve for the stationary equilibria that correspond to high (14.25%) and low (2.25%) inflation rates by following the algorithm presented in Sunel (2010). Store $v^{14.25\%}(a,\varepsilon), \Gamma^{14.25\%}(a,\varepsilon)$, $B = \sum_{a,\varepsilon} \Gamma^{14.25\%}(a,\varepsilon) b'^{14.25\%}, M = \sum_{a,\varepsilon} \Gamma^{14.25\%}(a,\varepsilon) m'^{14.25\%}$ as initial conditions and $v^{2.25\%}(a,\varepsilon), \Gamma^{2.25\%}(a,\varepsilon), \tau^{2.25\%}$ as terminal conditions.

2. Feed the calibrated time profile for depreciation rates,

$$e_t = 14.25\% \text{ for } t = 0 \tag{18}$$

$$\{e_t\}_{t=1}^{T_1} = \{e_t^{2.25\%}\}_{t=1}^{T_1} \text{ for } t > 0$$

   where $\{e_t^{2.25\%}\}_{t=1}^{T_1}$ is the finite sequence of depreciation rates that satisfies, $e_0 > e_1^{2.25\%} > e_2^{2.25\%} ... > e_T^{2.25\%}$ and $\{e_t^{2.25\%}\}_{t=T+1}^{T_1} = 2.25\%$ for finite T and T_1.

3. Set $\tau_{T_1} = \tau^{2.25\%}$. Guess a sequence of uniform transfers $\{\tau_t^0\}_{t=0}^{T_1-1}$. Set $v_{T_1}(a,\varepsilon) = v^{2.25\%}(a,\varepsilon)$. Solve for the sequence of functions $\{v_t, b_{t+1}, m_{t+1}, c_t\}_{t=0}^{T_1-1}$ by backward recursion. The solution takes as given the guessed sequence for transfers.

4. Compute the sequence of distributions over total deposits and earnings, $\{\Gamma_t\}_{t=1}^{T_1-1}$ by using the Markov transition probabilities of the earnings process and the policy functions for assets.

$$\Gamma_{t+1}(a_{t+1}, \varepsilon_{t+1}) = \sum_{\varepsilon} \sum_{\{a:a_{t+1}=Rb_{t+1}+\frac{m_{t+1}}{1+e_t}\}} \Gamma_t(a_t, \varepsilon_t) p_{\varepsilon_{t+1}|\varepsilon_t} \tag{19}$$

5. Use the obtained decision rules and distributions to do aggregation. Since the economy is at the 14.25% inflation rate equilibrium at $t = 0$, set $B_0 = B_0^{14.25\%}$ and $M_0 = M_0^{14.25\%}$. Compute $\{B_{t+1}, M_{t+1}, C_t, Tr_t\}_{t=0}^{T_1-1}$.

6. Compute the sequence of public surpluses, $\left\{M_{t+1} - \frac{M_t}{1+e_t} - G - \tau_t^0\right\}_{t=0}^{T_1-1}$ and update the guess for equilibrium sequence of transfers;

$$\{\tau_t^1\}_{t=0}^{T_1-1} = \left\{\chi\tau_t^0 + (1-\chi)\Big(M_{t+1} - \frac{M_t}{1+e_t} - G\Big)\right\}_{t=0}^{T_1-1} \tag{20}$$

   for $0 < \chi < 1$.[6]

[6] I set $\chi = 0.75$.

7. If $\max\left\{|\tau^0_{T_1-1} - \tau^{2.25\%}|, sup||\Gamma_{T_1-1} - \Gamma^{2.25\%}||\right\} < 10^{-4}$, go to the next step. Otherwise, increase T_1 and go back to step 2.

8. If $\max\left\{\left|\{\tau^1_t - \tau^0_t\}_{t=0}^{T_1-1}\right|, \left|\{M_{t+1} - \frac{M_t}{1+e_t} - G - \tau^0_t\}_{t=0}^{T_1-1}\right|\right\} < 10^{-4}$, the transition equilibrium is solved for. Otherwise, set $\{\tau^0_t\}_{t=0}^{T_1-1} = \{\tau^1_t\}_{t=0}^{T_1-1}$ and go back to step 3.

Economy 2

The solution algorithm of Economy 2 is similar to the one described above. The main difference is that now I search for an equilibrium sequence of government spending, $\{G^1_t - G^0_t\}_{t=0}^{T_1-1}$, for a given constant stream of transfers, τ. Naturally, steps 6 and 8 have to be modified to update the candidate spending vector and perform the convergence test.

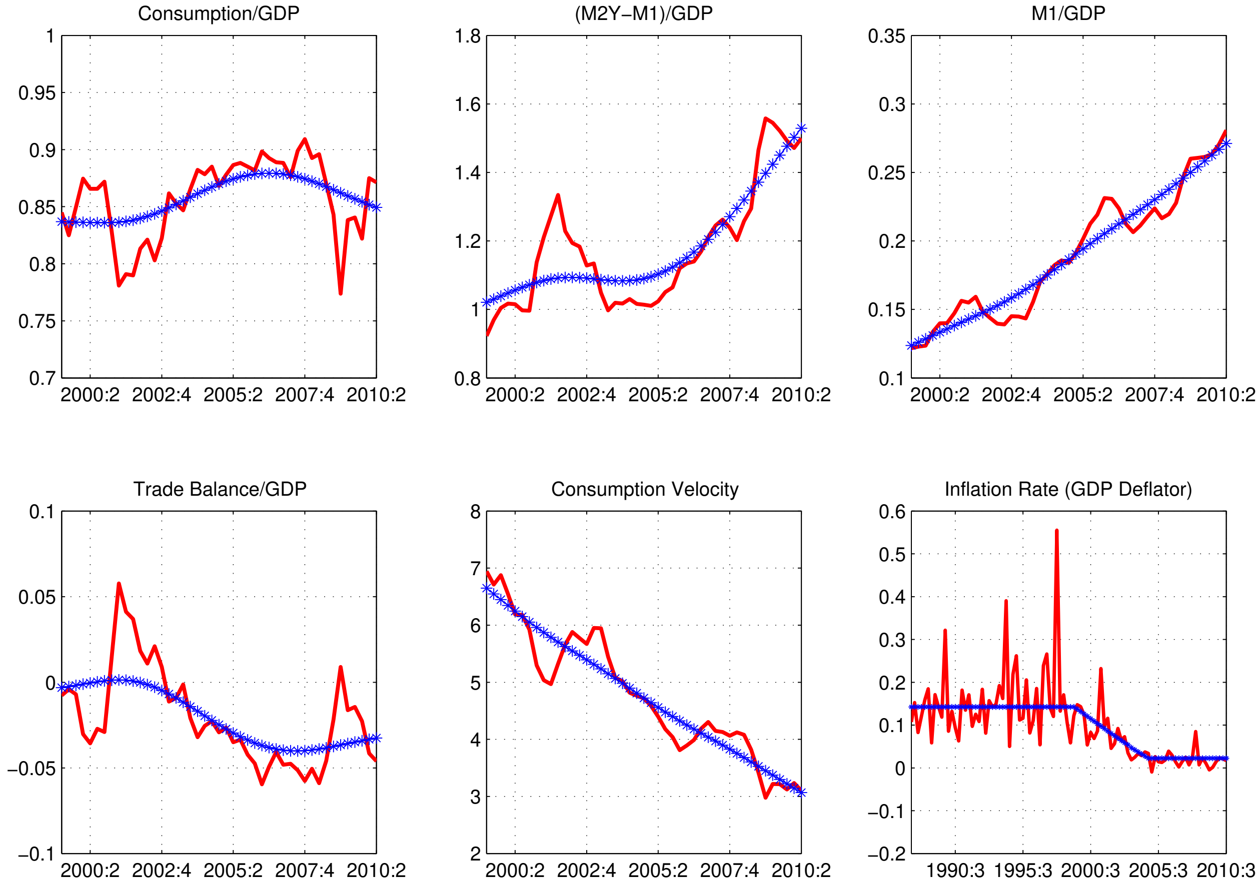

Figure 1: Macroeconomic Dynamics of Disinflation in Turkey

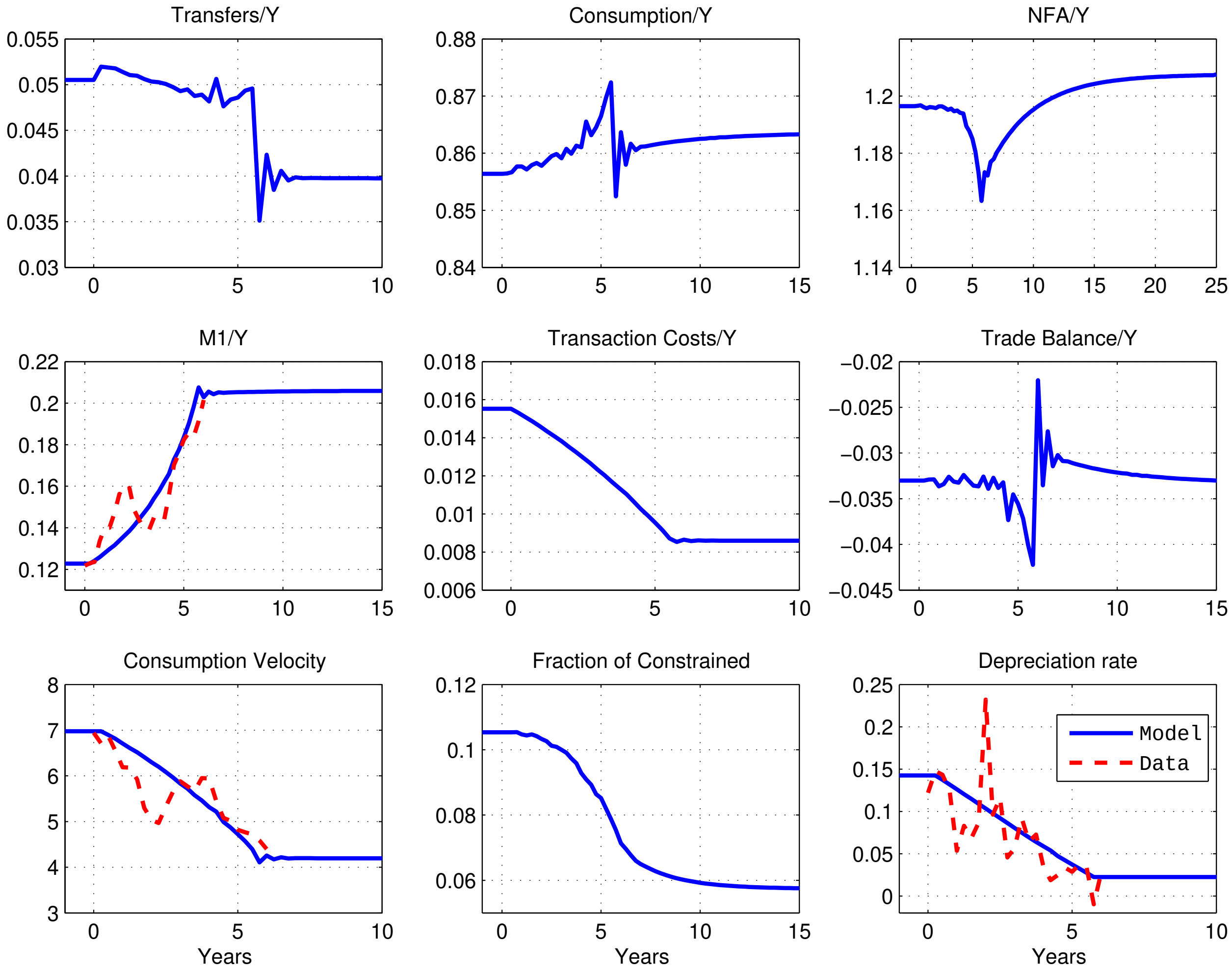

Figure 2: Macroeconomic Dynamics of Disinflation (Uniform Transfers)

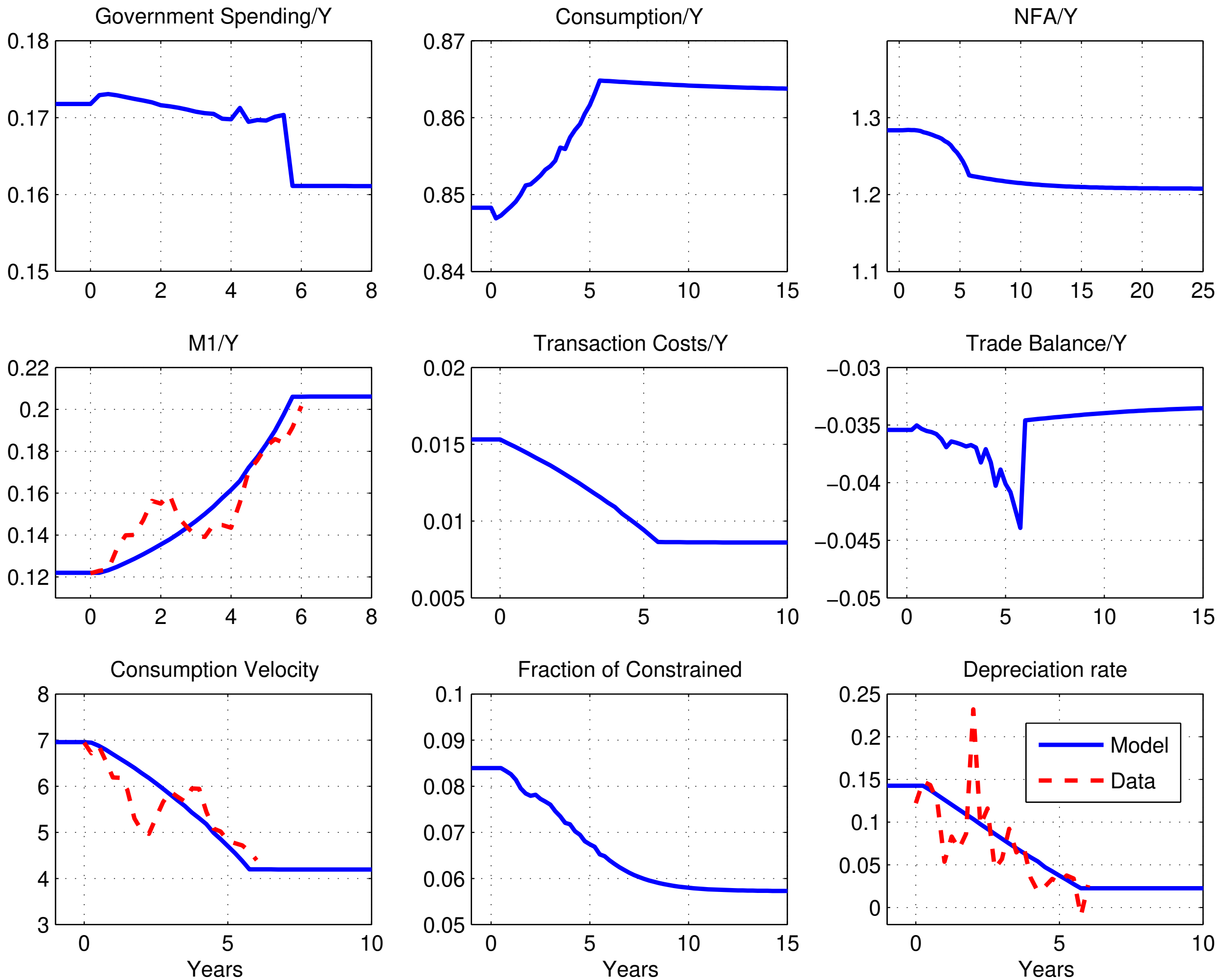

Figure 3: Macroeconomic Dynamics of Disinflation (Endogenous Spending)

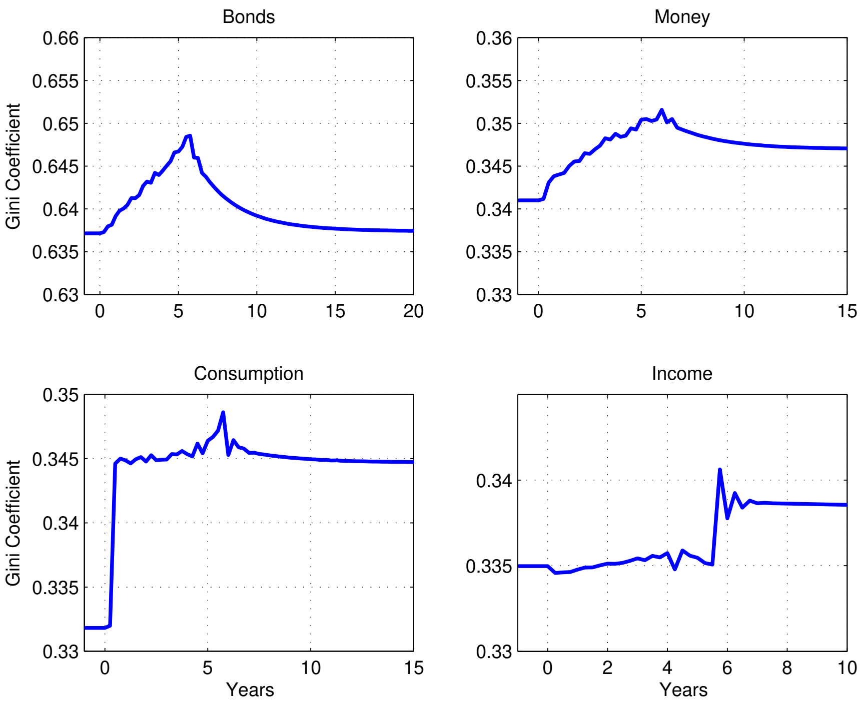

Figure 4: Disinflation and Inequality (Uniform Transfers)

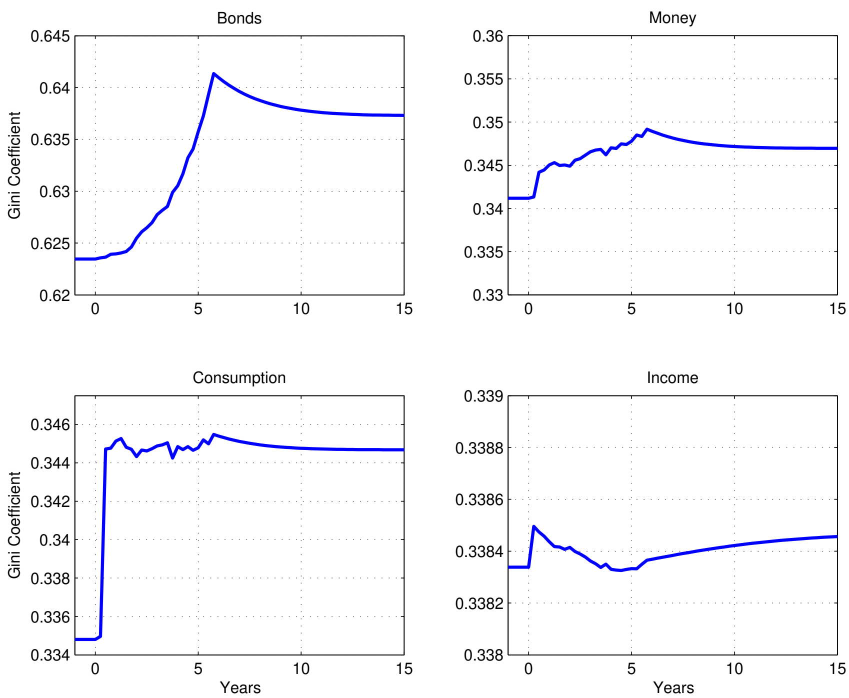

Figure 5: Disinflation and Inequality (Endogenous Spending)

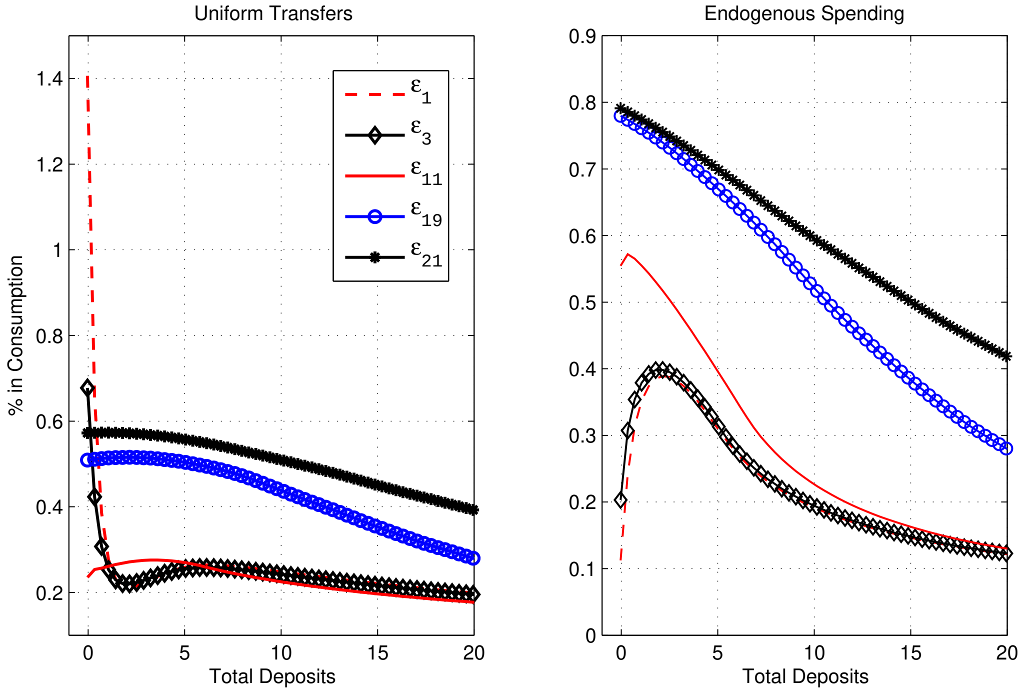

Figure 6: Disaggregated Welfare Gains From Disinflation

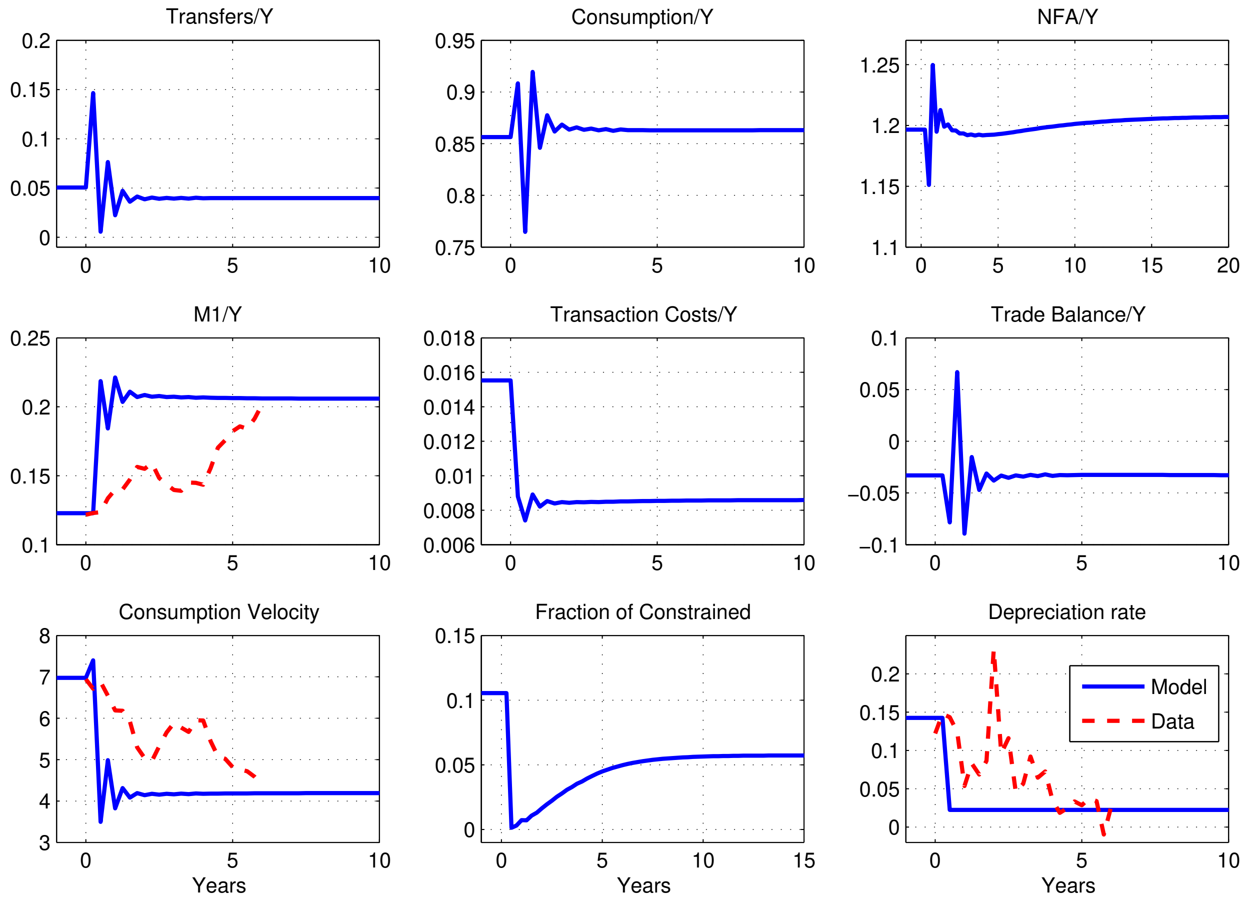

Figure 7: Macroeconomic Dynamics of Sudden Disinflation (Uniform Transfers)

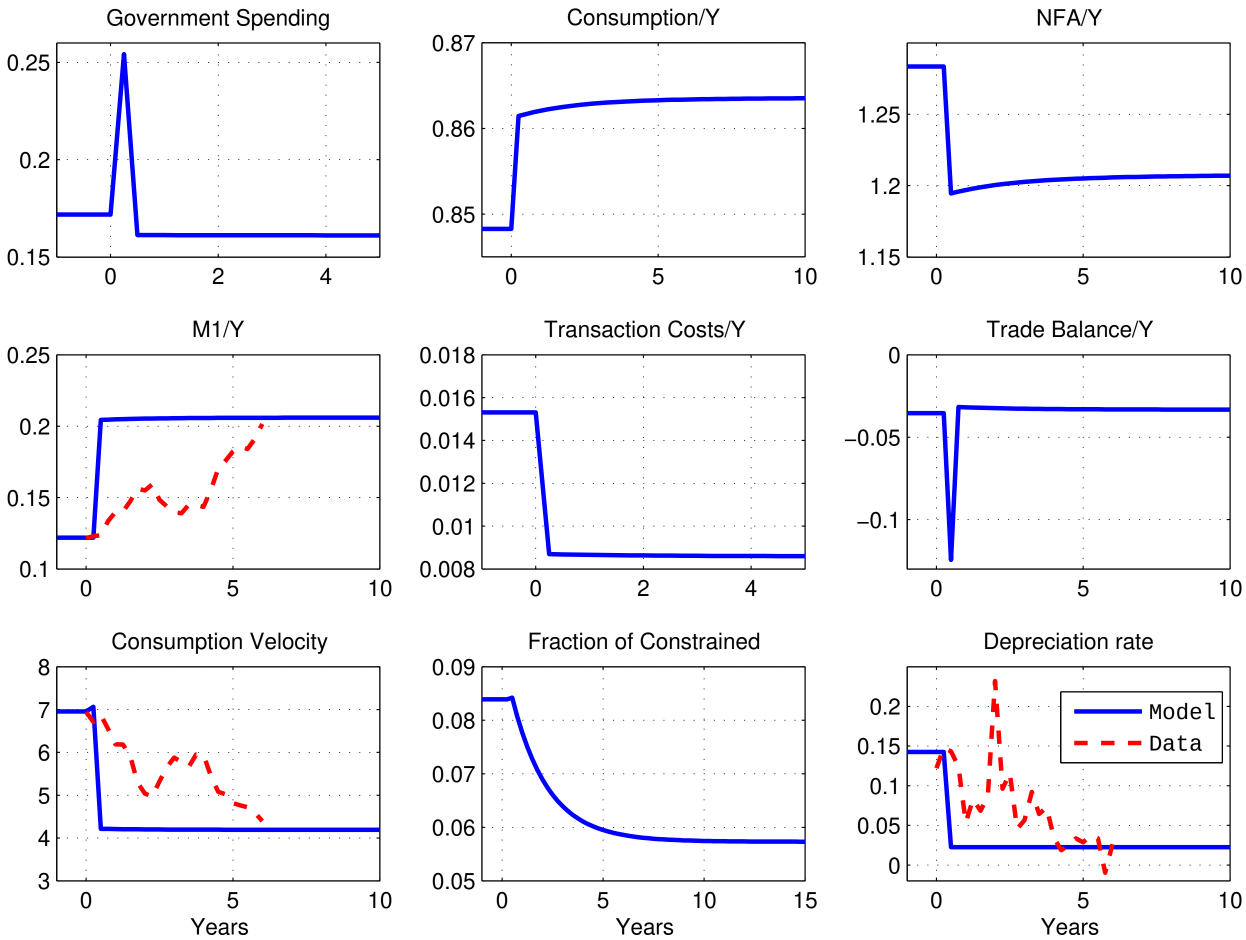

Figure 8: Macroeconomic Dynamics of Sudden Disinflation (Endogenous Spending)

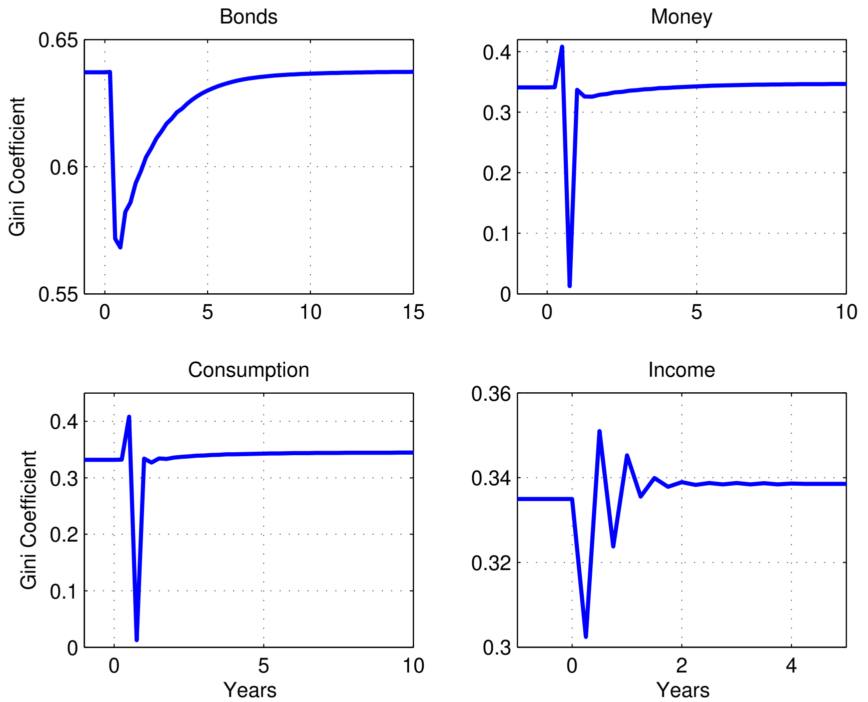

Figure 9: Sudden Disinflation and Inequality (Uniform Transfers)

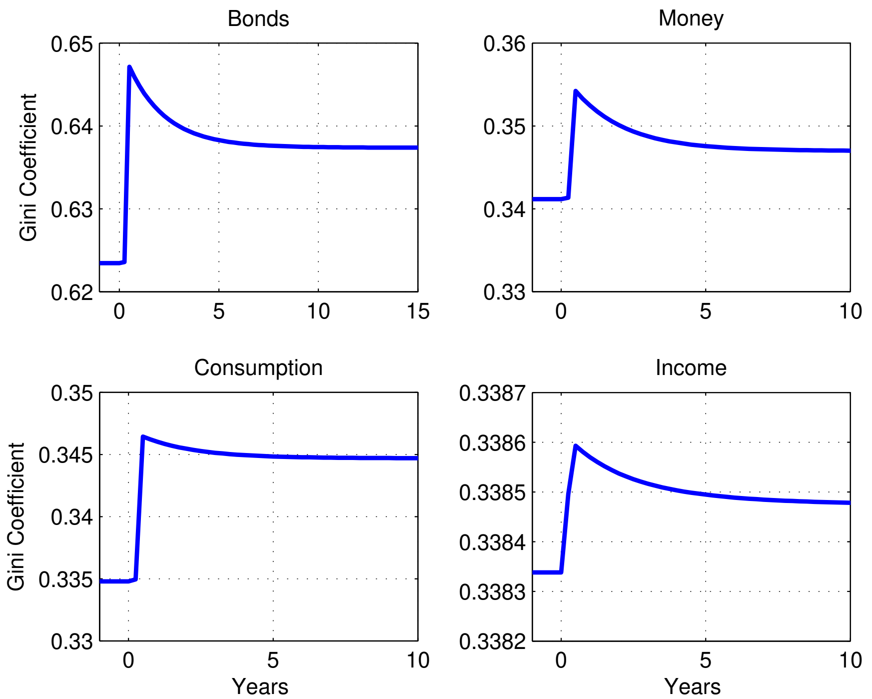

Figure 10: Sudden Disinflation and Inequality (Endogenous Spending)

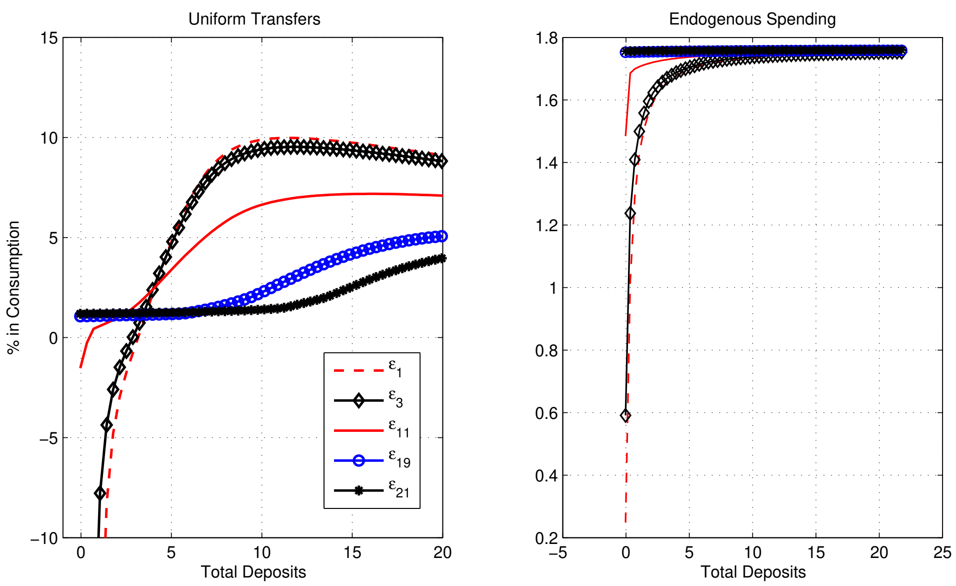

Figure 11: Disaggregated Welfare Gains from Sudden Disinflation