# Inflation-based fiscal consolidation: a DSGE approach

Busato, Francesco and Albanese, Marina and Varlese, Monica

16 July 2022

# Inflation-based fiscal consolidation: a DSGE approach*

Francesco Busato† Marina Albanese‡ Monica Varlese§

July, 2022

**Abstract**

This paper investigates under which conditions a permanent increase in inflation target might entail public debt reduction, in a Two Agents New Keynesian model with sticky prices and distortionary taxation. In light of that, this paper contributes to the more recent lively debate among economists and policymakers regarding whether an increase in inflation could contribute to a public debt reduction without damaging macroeconomic stability.

Real and welfare effects caused by changes in the inflation target from 2% to 5% are discussed. Overall, results show that an increase in inflation affects the economy positively in the short run but negatively in the long term. Consistently, higher inflation worsens households' welfare.

Moreover, a sensitivity analysis of the model's key parameters is carried out. Quite interestingly, it emerges that fiscal consolidation through an increase in inflation is far from obvious. A more sluggish inflation adjustment path influences households' expectations, entailing debt-to-GDP ratio increases rather than decreases.

Body Math *JEL Classification System: D6, E31, E44, E58, H63*

*Keywords: Inflation, Public debt-to-GDP ratio, Monetary policy, Welfare effects*

* I certify that I have the right to deposit the contribution with MPRA

†University of Naples Parthenope. Department of Economics and Legal Studies. Email: francesco.busato@uniparthenope.it

‡University of Naples Federico II. Department of Political Science. Email: albanese@unina.it

§University of Naples Parthenope. Department of Economics and Legal Studies. Email: monica.varlese@studenti.uniparthenope.it

# 1 Introduction

Nowadays, public debt across all countries is on an unsustainable path getting the attention of theoretical and empirical studies. The Covid-19 pandemic led to a significant contraction in the world economy. Governments' responses, including expansionary fiscal policies, have contributed to sharp increases in public debt levels across the globe (**de Soyres et al, 2022**). Specifically, US public debt to Gross Domestic Product ratio (public debt-to-GDP, hereafter) achieved values around 125% on Jan. 31, 2022 (Figure 1).

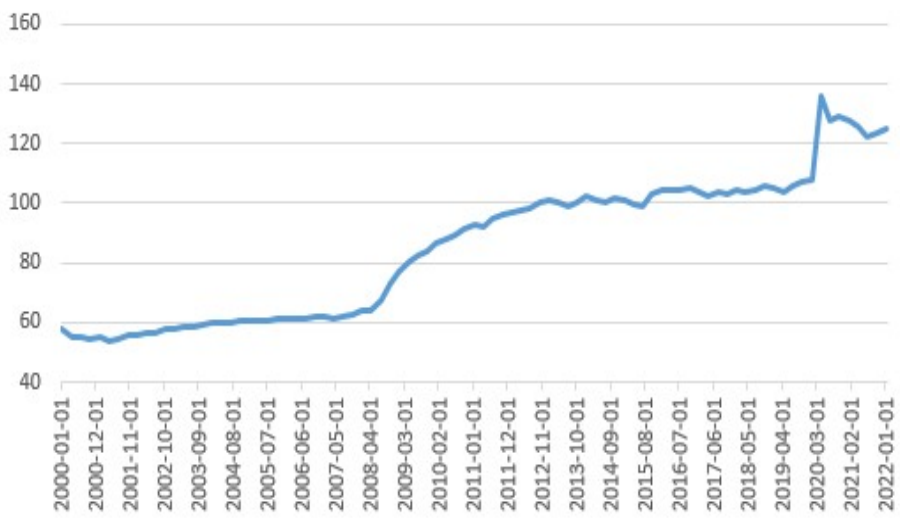


Figure 1: **Total Public Debt as Percent of Gross Domestic Product for the United States.** Source: Our elaboration from Fred data

At the same time, the average value of annual inflation increased to 5% in 2021 but it reached 40-year high of 8.6% in May 2022 (**Rockeman, 2022**). As consequence, Federal Open Market Committee (FOMC) tightened U.S. monetary policy to bring inflation down to its target value of 2%. However, the main issue lies in the fact that the problem of inflation seems deeper than the temporary increase in commodity prices caused by the war in Ukraine (**Tepper, 2022**). In this regard, most economists and policymakers seem concerned inflation might raise permanently (**Beckmann et al., 2021**; **Blanchard, 2021**; **Summers, 2021**)[1].

In that context, the question regarding whether an increase in inflation could contribute to a public debt reduction without damaging macroeconomic stability, go back to being relevant.

A growing body of theoretical literature has analyzed the link between inflation and

[1]The main reason why inflation is higher lies in a transitory rise of commodity prices. However, permanent changes in the labor market caused by the Covid-19 pandemic, might contribute to keeping inflation high for a long time.


Figure 2: **Inflation, consumer prices for the United States.** Source: Our elaboration from Fred data

public debt in the context of Dynamic Stochastic General Equilibrium models. **Krause and Moyen (2016)** investigate how the interaction of inflation expectations and debt maturity influences the real public debt dynamic after an increase in inflation target. To do that, they first simulate a positive debt shock and then trace the evolution of its real value after a contemporaneous increase in inflation. Their results show that real public debt reduces only if the change in the inflation target is very persistent. Similarly, **Cardani et al (2020)** assess e desirability of adjusting the inflation target during the debt consolidation period, adopting a Ramsey optimal approach. They find that a permanent reduction in public debt is more pronounced when monetary policy is constrained to implement a pure inflation targeting strategy.

**Bhattarai et al (2014)** modeling passive monetary and active fiscal policy regimes find that inflation target reduction entails public debt value raises. This, in turn, causes a positive wealth effect, and inflation starts to increase. Contextually, fiscal authority raises taxes to finance higher public debt, partially offsetting the positive wealth effect. Similarly, **Leeper et al (2017)** consider alternative monetary-fiscal regimes: either active monetary policy coupled with passive fiscal policy (regime M) or active fiscal policy together with passive monetary policy (regime F). One of their results is that the real value of debt cannot fall through lower bond prices and revaluation occurs through higher future inflation. **Kliem et al (2016)** study the impact of the interaction between fiscal and monetary policy on the low-frequency relationship between the fiscal stance and inflation using cross-country data from 1965 to 1999. They demonstrate that changes in monetary–fiscal policy interaction and following variations caused by structural shocks can well account for changes in the low-frequency relationship between the fiscal burden and inflation.

**Bianchi and Melosi (2019)**, simulate a mix of active monetary and fiscal policies non-coordinated to investigate how policymakers can stimulate an increase in inflation and economic activity by separating the problem of long-run debt sustainability from short-run fiscal stimulus. Similarly, **Bianchi et al (2020)** estimate a TANK model with partially unfunded debt simulate a rich set of shocks. Authors find that unfunded transfers lead to a fall in the real interest rate, as the government and central banks coordinate to increase inflation stabilizing the increase in transfers.

On the other hand, empirical literature has analyzed the relationship between public debt and inflation using different estimation techniques.

**Taghavi (2000)** study the link between public debt, growth, and inflation in Germany, Italy, France, and the United Kingdom, using vector auto regression (VAR) estimation technique. They show that debt appeared to be inflationary in the long term but the inflation dynamic is not clear in the short term. **Reinhart and Rogoff (2010)** study the systemic relationship between high public debt levels, growth, and inflation in a sample that includes both advanced economies and emerging market countries. They find that high public debt levels coincide with higher inflation episodes, for emerging market economies. The opposite is for advanced economies. Similarly, **Lopes da Veiga et al (2016)** study the relationship between public debt to GDP ratio, economic growth, and inflation by considering different African economies. They find that increasing rates of inflation entails high levels of public debt. Differently, **Akitoby et al (2014)** study the impact of inflation on fiscal deficit in advanced economies. They suggest that an increase in inflation could help reduce the public debt to GDP. Eventually, **Hilscher et al (2022)** investigating how inflation modifies the burden of debt for the US economy, find that an increase in inflation could reduce the real value of debt by only a few percentage points of GDP.

However, as far as we know, literature on the link between inflation and public debt neglects the potential role that a permanent increase in inflation might have to contribute to debt consolidation. This is what we do in this paper to assess different impacts that an exogenous increase in inflation target might be in the short and long-term. We think this question is even more important today given the high values of inflation and public debt that more and more worry economists and policymakers.

This paper addresses two questions: under which conditions increase in inflation might help to reduce public debt-to GDP ratio? what are the real and welfare effects of inflation-based fiscal consolidation? To answer these questions, we simulate a permanent increase in inflation target in a Two Agents New Keynesian (TANK) model à la **(Leeper et al., 2017)** with monopolistic competition in goods, sticky-price, and distortionary taxation. While assessing pure effects of inflation raises on public debt, we assume that government cannot implement any fiscal policy.

In this regard, differently from **Krause and Moyen (2016)** where fiscal rule implies a

minimal reaction of the tax rate following debt shock, we carry out a growth cycle analysis in a deterministic environment focusing on the potentially key role of inflation as a deflator. Moreover, unlike **Cardani et al (2020)**, we don't envisage an exogenous debt reduction path but the potential fiscal consolidation endogenously follows inflation raises.

Our results show that an increase in inflation entails a reduction in public debt-to-GDP ratio since that positively affects the output both in the short and the long run. However, high inflation target reduces households' disposable income since permanent increase in interest rate causes lower wages and higher cost of borrowing. As result, the aggregate demand falls down.

Welfare analysis confirms real results: savers and hand-to-mouth households benefit from high inflation only in the short term. On the opposite, a permanent increase in inflation is welfare costly for households in the long run.

Moreover, while carrying out sensitivity analysis, this paper provides another key contribution: an increase in inflation does not always help public debt-to-GDP reduction. Indeed, if inflation adjustment is more sluggish might negatively affect markets' stability in terms of confidence in growth. As consequence, debt-to-GDP ratio might increase.

In light of that, while contributing current debate underlying of which there is the presumption that inflation is always effective in reducing public debt, this paper suggests that actual inflation rate level could generate consequences opposite to those desired.

Now proceeds to the following sections: Section 2 describes the model. Sections 3 and 4 report the experiment and the calibration of the model. Short- and long-run results are explained in Section 5. In the same section, we also carry out a welfare analysis while a sensitivity analysis is presented in Section 6. Eventually, Section 7 concludes.

## 2 The Model

The model we use is a Two Agents New Keynesian (TANK) model à la **Leeper et al., (2017)** with monopolistic competition in goods, sticky price and distortionary taxation. The economy includes households, firms, the government and the central bank. There are two different type of households: savers who can save, and hand-to-mouth households who can consume their income period by period. Firms convert household labor and capital into the final good and prices are sticky 'a la **Calvo (1983)** with indexation. The government issues new long-term bonds and levies taxes from households, to finances government expenditures and expiring long-term debt. Eventually, monetary authority follows a Taylor rule in setting the nominal interest rate.

## 2.1 Households

There is a continuum of households, of which a fraction $\mu$ are hand-to-mouth while the remaining fraction $1-\mu$ are savers. The former are indexed by $H$ and savers are indexed by $S$.

### 2.1.1 Savers

Savers consume private and public goods and supply labor services. Their utility function is the following:

$$\max E_0 {}_{t=0}^{\infty} \beta_S^t \left[ \log C_{S,t} - \frac{(N_{S,t})^{1+\eta}}{1+\eta} \right],$$

where $\beta_S^t$ is the discount factor; $C_{S,t}$ denotes a composite consumption given by the sum of private ($C_{S,t}^*$)and public ($G_t$) consumption, namely $C_{S,t} = C_{S,t}^* + \alpha_G G_t$; finally, $N_{S,t}$ represents the working hours.

Their budget constraint is:

$$P_t C_{S,t}(1+\tau^C) + P_t^B B_t + \frac{B_{S,t}}{R_{S,t}} = (1+\rho P_t^B) B_{t-1} + B_{S,t-1} + (1-\tau^N) w_{S,t} N_{S,t} + (1-\tau^K) r_t^k K_{S,t}, \tag{1}$$

where $B_S$ are one-period bonds promising a nominal payoff $B_S$ at time t + 1 that can be purchased at the present discounted value $R_{S,t}^{-1} B_{S,t}$; $B_t$ are long-term government bond that can be purchased at price $P_t^B$ , with a maturity decaying at a constant rate $\rho \in [0,1]$ and duration $(1-\beta\rho)^{-1}$. Nominal consumption is taxed at the rate $\tau^C$; capital and labor incomes are subject to a tax rate $\tau^K$ and $\tau^N$, respectively.

The capital stock, $K_{S,t}$, own by savers, evolves according to the following law of motion:

$$K_{S,t+1} = I_{S,t} + (1-\delta) K_{S,t} \tag{2}$$

The first order conditions to the problem are the following:

$$\frac{1}{C_{S,t}} = \lambda_{S,t} P_t (1+\tau^C) \tag{3}$$

$$(N_{S,t})^\eta = \lambda_{S,t} (1-\tau^N) w_{S,t} \tag{4}$$

$$\lambda_{S,t} = \beta_S \lambda_{S,t+1} \left[ (1-\tau^K) r_{t+1}^k + (1-\delta) \right] \tag{5}$$

$$\lambda_{S,t} \frac{1}{R_{S,t}} = \beta_S \lambda_{S,t+1} \tag{6}$$

$$\lambda_{S,t} P_t^B = \beta_S \lambda_{S,t+1}(1 + \rho P_{t+1}^B) \tag{7}$$

where the first three equations represent the first order conditions respect to consumption, working hours and capital. The last two equations are the inter-temporal condition for short- and long- term bonds, respectively.

### 2.1.2 Hand-to-Mouth

As well, hand-to-mouth households maximize the same utility function as savers:

$$\max E_0 {}_{t=0}^{\infty} \beta_H^t \left[ \log C_{H,t} - \frac{(N_{H,t})^{1+\eta}}{1+\eta} \right],$$

where $\beta_H^t = \beta_S^t$ is the discount factor. They consume their after-tax income, period by period and are subject to the following budget constraint:

$$P_t C_{H,t}(1 + \tau^C) = (1 - \tau^N) w_{H,t} N_{H,t},$$

The first order conditions to the problem are the following:

$$\frac{1}{C_{H,t}} = \lambda_{H,t} P_t (1 + \tau^C) \tag{8}$$

$$(N_{H,t})^\eta = \lambda_{H,t}(1 - \tau^N) w_{H,t} \tag{9}$$

where the first equation represents the first condition respect to the consumption, while the second is the labor supply condition.

## 2.2 Firms

The final goods firms operate under perfect competition and flexible prices. They aggregate intermediate goods according to the following production function:

$$Y_t = \left[ \int_0^1 Y_t(z)^{(\varepsilon-1)/\varepsilon} dz \right]^{\varepsilon/(\varepsilon-1)},$$

where $\varepsilon > 1$ represents the elasticity of substitution between intermediate goods. The final good firm chooses $Y_t(z)$ to minimize its costs, resulting in demand of intermediate good $z$:

$$Y_t(z) = \left( \frac{P_t(z)}{P_t} \right)^{-\varepsilon} Y_t.$$

The price index is then given by:

$$P_t = \left[ \int_0^1 P_t(z)^{1-\varepsilon} dz \right]^{1/(\varepsilon-1)}.$$

### 2.3 Intermediate goods producers

We assume that intermediate firms compete monopolistically producing goods according to the following technology:

$$Y_t(z) = (K_t)^{\xi} \left( {N_{S,t}}^{\alpha} {N_{H,t}}^{(1-\alpha)} \right)^{1-\xi} \tag{10}$$

where $\xi, \alpha \in [0, 1]$.

They choose capital and labor services to maximize their expected profits. The first-order conditions of the maximization problem are the following:

$$w_{S,t} = mc_t \left[ \alpha(1-\xi) \right] \frac{Y_t(z)}{N_{S,t}} \tag{11}$$

$$w_{H,t} = mc_t \left[ (1-\alpha)(1-\xi) \right] \frac{Y_t(z)}{N_{H,t}} \tag{12}$$

$$r_t^k = mc_t \xi \frac{Y_t(z)}{K_t} \tag{13}$$

where $mc_t$ denotes the marginal cost. Equations 11-12 describe the demand for savers' and hand-to-mouth households' labor services, while equation 13 denotes capital demand.

### 2.4 Price setting equations

The price-setting problem for the intermediate good producers follows the standard Calvo-Yun setting. In each period an intermediate firms sells its good at price $P_t(z)$ and faces a constant probability, $1 - \theta \in [0, 1]$, of being able to choose the sale price.

The optimal price $P_t^*(z)$ is chosen in order to maximize the discounted value of expected future profits. The firms' maximization problem is the following:

$$\max_{P_t^*(z)} E_t \sum_{s=0}^{\infty} (\theta\beta_S)^s \frac{P_t}{\lambda_t} \frac{\lambda_{t+s}}{P_{t+s}} \left( P_t^*(z) \prod_{k=1}^{s} \pi_{t+k-1}^{\chi} - P_{t+s} mc_{t+s} \right) Y_{t+s}^*(z) = 0$$

subject to:

$$Y_{t+s}^*(z) = \left( \frac{P_t^*(z) \prod_{k=1}^{s} \pi_{t+k-1}^{\chi}}{P_{t+s}} \right)^{-\varepsilon} Y_{t+s}^d$$

where $mc_t$ is the marginal cost, or the inverse of the markup $X_t$. $\frac{\lambda_{t+s}}{\lambda_t}$ denotes the

stochastic discount factor of savers[2], who own the firms, and $Y_t^d$ represents the aggregate demand.

The first order condition respect to $P_t^*(z)$ is:

$$E_t \sum_{s=0}^{\infty} (\theta\beta_S)^s \frac{\lambda_{t+s}}{\lambda_t} \left( \frac{\prod_{k=1}^{s} \pi_{t+k-1}^{\chi}}{\prod_{k=1}^{s} \pi_{t+k}} \right)^{-\varepsilon} Y_{t+s}^d \left( \frac{P_t^*(z)}{P_t} \right)^{-\varepsilon-1}$$
$$\left[ \left( \frac{P_t^*(z)}{P_t} \right) \left( \frac{\prod_{k=1}^{s} \pi_{t+k-1}^{\chi}}{\prod_{k=1}^{s} \pi_{t+k}} \right) + \frac{\varepsilon}{1-\varepsilon} mc_{t+s} \right]$$

where the term $\frac{\varepsilon}{1-\varepsilon}$ indicates the mark up in the absence of price stickiness.

By writing this first-order condition recursively, we can define:

$$x_t^1 = \left( \frac{P_t^*(z)}{P_t} \right)^{-\varepsilon-1} E_t \sum_{s=0}^{\infty} (\theta\beta_S)^s \frac{\lambda_{t+s}}{\lambda_t} \left( \frac{\prod_{k=1}^{s} \pi_{t+k-1}^{\chi}}{\prod_{k=1}^{s} \pi_{t+k}} \right)^{-\varepsilon} Y_{t+s}^d mc_{t+s}$$

$$x_t^2 = \left( \frac{P_t^*(z)}{P_t} \right)^{-\varepsilon} E_t \sum_{s=0}^{\infty} (\theta\beta_S)^s \frac{\lambda_{t+s}}{\lambda_t} \left( \frac{\prod_{k=1}^{s} \pi_{t+k-1}^{\chi}}{\prod_{k=1}^{s} \pi_{t+k}} \right)^{1-\varepsilon} Y_{t+s}^d.$$

By expressing recursively:

$$x_t^1 = Y_t^d mc_t P_t^*(z)^{-\varepsilon-1} + E_t \left[ (\theta\beta_S) \frac{\lambda_{t+1}}{\lambda_t} \left( \frac{P_t^*(z)}{P_{t+1}^*(z)} \right)^{-\varepsilon-1} \left( \frac{\pi_t^{\chi}}{\pi_{t+1}} \right)^{-\varepsilon} x_{t+1}^1 \right] \tag{14}$$

$$x_t^2 = Y_t^d P_t^*(z)^{-\varepsilon} + E_t \left[ (\theta\beta_S) \frac{\lambda_{t+1}}{\lambda_t} \left( \frac{P_t^*(z)}{P_{t+1}^*(z)} \right)^{-\varepsilon} \left( \frac{\pi_t^{\chi}}{\pi_{t+1}} \right)^{1-\varepsilon} x_{t+1}^2 \right]. \tag{15}$$

It is possible to rewrite the price setting equation as follows:

$$x_t^1 = \frac{\varepsilon - 1}{\varepsilon} x_t^2. \tag{16}$$

## 2.5 Aggregation

The market clearing condition for the goods is:

$$Y_t = Y_t^d * \tilde{s}_t \tag{17}$$

where $s_t$ denotes the price dispersion in the Calvo model as follows

$$\tilde{s}_t = (1-\theta) P_t^*(z)^{(-\varepsilon)} + \theta \left( \frac{\pi_t}{\pi_{t-1}^{\chi}} \right)^{\varepsilon} \tilde{s}_{t-1}; \tag{18}$$

$P_t^*$ represents the aggregate price level that satisfies the following equation:

[2] Where $\lambda_t$ is equal to $\frac{1}{C_{S,t}}$.

$$1 = \theta \pi_t^{(\varepsilon-1)} \left(\pi_{t-1}^{\chi}\right)^{(1-\varepsilon)} + (1-\theta) P_t^*(z)^{(1-\varepsilon)}. \tag{19}$$

$Y_t^d$ represents the aggregate demand:

$$Y_t^d = C_t + I_t + G_t, \tag{20}$$

where $C_t$ is the aggregate consumption as follows:

$$C_t = \mu C_{H,t} + (1-\mu) C_{S,t}.$$

$K_t$ and $I_t$ denote aggregate capital and investment:

$$K_t = (1-\mu) K_{S,t}, \tag{21}$$

$$I_t = (1-\mu) I_{S,t}. \tag{22}$$

## 2.6 Fiscal sector

Government issues new long-term debt obligations and collects taxes to finances government expenditures and expiring long-term debt. While assuming that short-term bonds are in zero net supply, fiscal authority' nominal budget constraint can be described as follows:

$$(1+\rho P_t^B) B_{t-1} + P_t G_t = P_t^B B_t + (\tau^N) w_{S,t} N_{S,t} + (\tau^N) w_{H,t} N_{H,t} + \tau^K r_t^k K_{S,t} + \tau^C P_t C_t \tag{23}$$

where

$$B_t = b_t Y_t, \tag{24}$$

and

$$G_t = g_t Y_t. \tag{25}$$

## 2.7 Monetary Policy

We assume that the Central Bank sets the nominal interest rate according to the a standard Taylor rule:

$$\frac{R_t}{R^*} = \left(\frac{\pi_t}{\pi^*}\right)^{\phi_\pi^R} \left(\frac{Y_t}{Y^*}\right)^{\phi_y^R}, \tag{26}$$

where $R^*$represents the target nominal interest rate; $\pi^*$and $y^*$ denote the steady state inflation rate and output, respectively.

# 3 Experiment

The experiment we carry out consists of a permanent positive monetary policy shock. Specifically, in a deterministic environment, we simulate a transition dynamic from one initial steady state where inflation target is calibrated at 2% to a new steady state where inflation target is set to 5%[3]. The low-inflation steady state denotes the implicit target of the Federal Reserve and of other main central banks. Instead, the high-inflation steady state represents the value that US inflation reached in June 2021.

To investigate the pure effects of inflation increases on public debt, we assume that the government does not balance its budget constraint through a fiscal policy of taxes raise or public spending reduction. However, we define a Taylor-type rule that relates public debt-to-GDP ratio and the inflation target, as follows:

$$\frac{b_t}{b} = \left(\frac{\pi_t}{\pi}\right)^{-\phi_b} \tag{27}$$

where $\phi_b$ is a policy' parameter measuring the public debt-to-GDP ratio response to inflation gap.

# 4 Calibration

This Section summarizes parameter values. Table 1 shows their description and details. While calibrating structural parameters, we rely largely on the estimates by **Leeper et al. (2017)** which are consistent with the US data.

As for the households, the parameter representing the discount factor is set equal to 0.99 both for savers and for hand-to-mouth households; the inverse Frish elasticity $\eta$ is set to 1.77 and the parameter denoting the substitutability between private and government consumption $\alpha_G$ is calibrated at -0.24, following **Leeper et al (2017)**. The parameter representing hand-to-mouth households' share is set at 0.11, in line with **Kaplan et al (2014)**. The rate of capital depreciation is set to 0.025 consistently with standard literature. Eventually, in calibrating the decay rate of the maturity of long-term government bonds at 0.9593, we follow **Bianchi et al (2020)**.

As for the firms, parameters denoting elasticity of production function are set to 0.33. The price elasticity of demand $\varepsilon$, is calibrated at 6 as in **Cantore and Freund (2021)**.

[3]The TANK model is numerically solved in Dynare, using perfect foresight. Dynare is a software platform for running a wide class of economic models including Dynamic Stochastic General Equilibrium (DSGE) models. See https://www.dynare.org/ for details.

The Calvo price parameter $\theta$ is equal to 0.920 as in **Leeper et al. (2017)** while the price indexation $\chi$ to 0.66, as in **Smets and Wouters (2007)**.

With regards to monetary policy, we calibrate first and second steady-state values of inflation at 2% and 5%, respectively.

The parameters denoting the response of nominal interest rate to inflation $\phi_\pi^R$ and output $\phi_y^R$ are set to 1.5 and 0.5 respectively, in line with the classical Taylor rule specification.

With respect to fiscal sector, we follow **Leeper et al. (2017)** in setting tax rates on capital, labor and consumption to 0.218, 0.186 and 0.023, respectively and in setting the public spending to GDP ratio to 0.11. Eventually, we calibrate parameter governing the response of public debt-to-GDP ratio to inflation rate $\phi_b$, at 1.3.

Table 1: **Parameters' Values**

| Parameter | Value | Description |
|---|---|---|
| Households | | |
| $\beta_S = \beta_H$ | 0.99 | Discount factor |
| $\eta$ | 1.77 | Parameter associated with labor elasticity |
| $\delta$ | 0.025 | Capital depreciation rate |
| $\rho$ | 0.959 | Maturity of long-term bonds |
| $\alpha_G$ | $-0.240$ | Sustainability of public consumption |
| $\mu$ | 0.11 | Share of hand-to-mouth households |
| Firms | | |
| $\alpha = \xi$ | 0.33 | Elasticity in production function |
| $\varepsilon$ | 6 | Price elasticity of demand |
| $\theta$ | 0.920 | Calvo price |
| $\chi$ | 0.66 | Price indexation |
| Monetary Policy | | |
| $\pi^*_{old}$ | 2% | Inflation (old target) |
| $\pi^*_{new}$ | 5% | Inflation (new target) |
| $\phi_\pi^R$ | 1.5 | Inflation stabilization |
| $\phi_y^R$ | 0.5 | Output stabilization |
| Fiscal sector | | |
| $\tau^C$ | 0.023 | Tax rate on consumption |
| $\tau^N$ | 0.186 | Tax rate on labor |
| $\tau^K$ | 0.218 | Tax rate on capital |
| $g$ | 0.11 | Public spending to GDP ratio |
| $\phi_b$ | 1.5 | Policy parameter for inflation response |

# 5 Results

This Section discusses the short- and long-run effects of a permanent increase in the inflation target on the main macroeconomic variables. The aim is to study the impact of inflation rises on the economy and under which conditions it's possible that hyperinflation could help to reduce public debt.

## 5.1 Short-run results

This subsection investigates the short-run effects of a permanent increase in inflation target which gradually raises towards the new and high steady-state level. Figure 3-4 show transition dynamics of the main macroeconomic variables.

The increase in inflation positively affects nominal GDP entailing output increases in the short–run. On the other hand, the effect of inflation exerts upward pressure on nominal interest rates. The reason lies in the fact that savers demand higher returns to compensate for the erosion of their capital caused by higher inflation. Consequently, nominal interest rates increase meaning that government has to incur higher interest expenditure. This, in turn, leads to a greater deficit.

At the same time, asset prices decrease up to the fifth quarter, moving inversely with the nominal interest rates. This is the reason why savers invest more both in Short- and Long-term bonds.

These results imply that public debt increases. However, since output grows up faster than public debt, the debt-to-GDP ratio falls down.

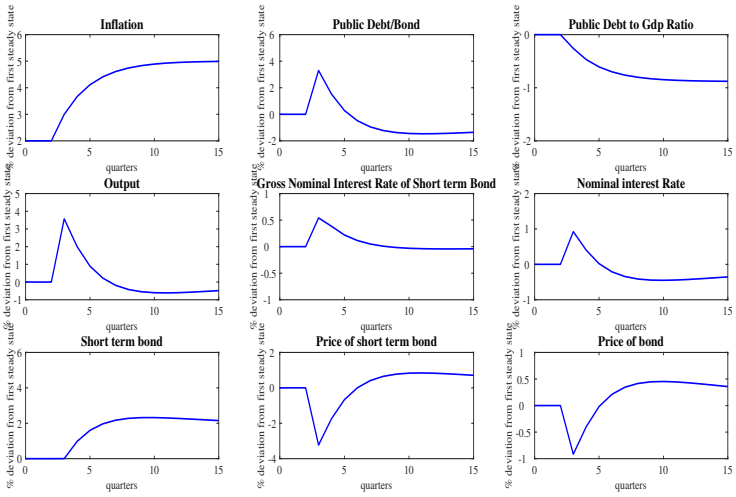


Figure 3: **Short run effects of inflation-based fiscal consolidation experiment**

As well, the permanent increase in inflation causes nominal wages to rise. As a consequence, households works and consume more. In other words, a gain of income due to wages and worked hours increase, involves a rise in households' consumption in the short run. However, while hand-to-mouth households consume all their income, savers invest their savings into financial market as well. This is the reason why hand-to-mouth households' consumption increases more than savers' consumption. This, in turn, causes investments to raise, contributing to aggregate demand growth.

On the other hand, firms demand more capital thanks to the increase in rental rate.

This, in turn, causes investments raise, contributing aggregate demand growth up.

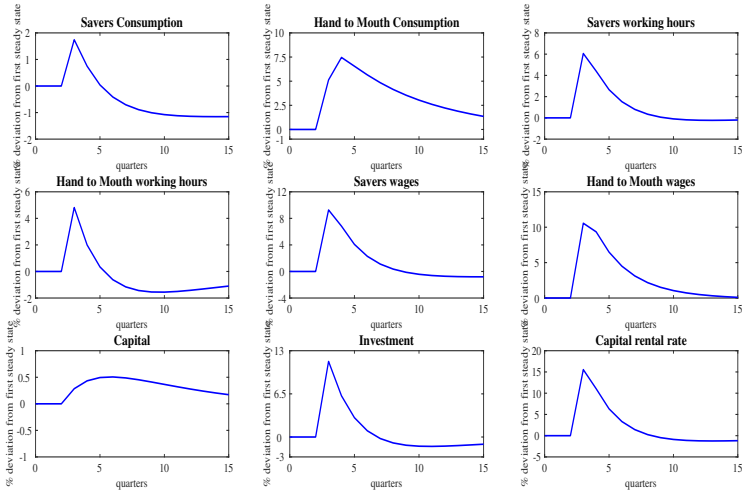


Figure 4: **Short run effects of inflation-based fiscal consolidation experiment**

In that context, the aggressive increase in inflation determines a fall in the debt-to-GDP ratio, providing a positive contribution to growth.

## 5.2 Long-run results

Table 2 shows the steady-state percentage variations of the key macroeconomic variables, once inflation target reaches 5%. Nominal interest rates reduce in the medium and long-run, before returning to the previous steady-state value (namely, the long-run variation is equal to zero) while prices move inversely with them.

On the other hand, real interest rate permanently increases. This is the reason why nominal wages reduce. As result, households work more and consume less.

Moreover, since a higher interest rate raises the cost of borrowing, savers invest less in bonds (namely, public debt decreases) while firms cut back on investment entailing a reduction in capital. The long-run positive variations in working hours more than compensate for the negative variation in capital. Indeed, output increases in the long run.

Reducing public debt releases resources involving high public consumption in the long run. However, the positive variation in public spending is not sufficient to compensate for public consumption and investment reduction. This implies that the aggregate demand falls down.

Since the effect of inflation on nominal interest rates vanish, while the effect on the GDP growth rate persists, the debt-to-GDP ratio reduction is confirmed in the long run as well.

Table 2: **Steady state percentage variations after consolidation**

| Variables | Values |
|---|---|
| Inflation | $0,7274$ |
| Public debt | $-0,6617$ |
| Public debt-to- GDP ratio | $-0,8815$ |
| Output | $0,2216$ |
| Short-term bonds | $-2,3078$ |
| Savers' consumption | $-1,0570$ |
| Hand-to-mouth' consumption | $-1,0564$ |
| Government' consumption | $0,2219$ |
| Aggregate demand | $-0,7626$ |
| Savers' working hours | $0,3619$ |
| Hand-to-mouth' working hours | $0,3617$ |
| Savers' wages | $-0,4221$ |
| Hand-to-mouth' wages | $-0,4221$ |
| Capital | $-0,0617$ |
| Investment | $-0,0619$ |
| Real interest rate | $0,7663$ |

### 5.3 Welfare analysis

While analyzing welfare effects of inflation-based fiscal consolidation experiment, we compute the Welfare-based Ratio ($WR^i$, hereafter), following **Ascari and Ropele (2012a)**. For this purpose, we compute the Consumption Equivalent Measure (CEM) namely a constant fraction of consumption that households should give up to reach the value function that they obtain if inflation reaches 5%.

The initial value functions for savers $V^S_{old}$ and hand-to-mouth households $V^H_{old}$ when $\pi^*$ is equal to 2% (experiment was not implemented), are respectively given by:

$$V^S_{old} = \frac{1}{1-\beta^S}\left[\ln C_{S,old} - \frac{(N_{S,old})^{1+\eta}}{1+\eta}\right] \tag{28}$$

$$V^H_{old} = \frac{1}{1-\beta^H}\left[\ln C_{H,old} - \frac{(N_{H,old})^{1+\eta}}{1+\eta}\right] \tag{29}$$

Since we know from the numerical solution of the model the values functions of when experiment is actually implemented ($V^S_0$ and $V^H_0$,respectively), we can compute CEM solving the following equations:

$$V^S_0 = \frac{1}{1-\beta^S}\left[\ln C_{S,old}(\Psi_S) - \frac{(N_{S,old})^{1+\eta}}{1+\eta}\right] \tag{30}$$

$$V^H_0 = \frac{1}{1-\beta^H}\left[\ln C_{H,old}(\Psi_H) - \frac{(N_{H,old})^{1+\eta}}{1+\eta}\right]. \tag{31}$$

Thus, the consumption equivalent measures for savers $\Psi_S$ and hand-to-mouth households $\Psi_H$, are respectively equal to:

$$(\Psi_S) = \exp\left[\left(1-\beta^S\right)\left(V_0^S - V_{old}^S\right)\right] - 1, \tag{32}$$

$$(\Psi_H) = \exp\left[\left(1-\beta^H\right)\left(V_0^H - V_{old}^H\right)\right] - 1. \tag{33}$$

Eventually, we compute the welfare ratios as follows:

$$WR^S = \frac{\Psi_S}{\pi^*_{old} - \pi^*_{new}} \tag{34}$$

$$WR^H = \frac{\Psi_H}{\pi^*_{old} - \pi^*_{new}}. \tag{35}$$

As for the long-run, the consumption equivalent units are respectively:

$$(\Psi_{S,\infty}) = \exp\left[\left(1-\beta^S\right)\left(V_{new}^S - V_{old}^S\right)\right] - 1, \tag{36}$$

$$(\Psi_{H,\infty}) = \exp\left[\left(1-\beta^H\right)\left(V_{new}^H - V_{old}^H\right)\right] - 1. \tag{37}$$

where $V_{new}^S$ and $V_{new}^H$ denote the value functions in the new steady state. The long-run welfare based sacrifice ratios are given by:

$$WR_\infty^S = \frac{\Psi_{S,\infty}}{\pi^*_{old} - \pi^*_{new}} \tag{38}$$

$$WR_\infty^H = \frac{\Psi_{H,\infty}}{\pi^*_{old} - \pi^*_{new}}. \tag{39}$$

Finally, the short-run welfare-based sacrifice ratio is given by the difference between total and long-run WR. Negative welfare ratio values mean welfare gains and vice versa.

Table 3 summarizes our welfare results: for both types of households, inflation increases is welfare improving in the short run while is welfare costly in the long run.

Table 3: **Welfare Ratios, Percentage Variations**

| | Savers | Hand to Mouth |
|---|---|---|
| Short-run WR | $-0,0340$ | $-0,31328$ |
| Long-run WR | $0,7957$ | $0,4269$ |
| Total WR | $0,7617$ | $0,1136$ |

As for the short-run, savers and hand-to-mouth households consume more and work

less since their income raises. The increase in consumption and the lower labor disutility positively affect households' utility function. As result, welfare improves. The reason lies in the fact that households initially benefit from the increase in inflation thanks to the temporary price reduction caused by positive effects on the nominal interest rates. Moreover, consistently with short-run results, the increase in inflation causes wages to raise up to third quarters entailing households' disposable income improving.

On the opposite, savers and hand-to-mouth households consume less and work more, in the long run. Indeed, their wages reduce given the higher real interest rate entailing a loss of income. As result, an increase in inflation is welfare costly in the long run for both types of agents. However, savers suffer more than hand-to-mouth households because they as firms' owners are worried about price rigidities. In other words, they prefer a situation of low inflation. Moreover, their income reduces more given the high cost of borrowing caused by interest rate rises. Total WRs confirm these results.

## 6 Sensitivity analysis

In our TANK model, the increase in inflation comes with a sizeable economic recovery causing a reduction in public debt-to-GDP ratio as well. Nominal interest rate increases on impact and then undershoot its steady-state level.

What is the main economic mechanism behind these results? In other words, are the short-tun results in Section 5 always verified?

To answer this question we carry out a sensitivity analysis restricting its attention to $\chi$ and $\phi_b$ parameters.

Figure 5 investigates the sensitivity of our results to the degree of price indexation to past inflation, increasing its value to 0.75. The denominator effect of nominal GDP growth is fully confirmed. However, higher inflation indexation makes its adjustment more sluggish. As a result, the nominal interest rate adapts more slowly to inflation as well, affecting households' inflation expectations.

Especially, savers who are forward-looking agents, expect that prices will increase so they invest more in long-term bonds in the short run. On the other hand, since long-term bonds are not inflation-indexed, only the most recently issued bonds reflect the new higher level of inflation. This means that inflation erodes the part of the public debt which has not yet been renewed, i.e. which does not reflect new and higher inflation value.

As a result, public debt rise more than in the figure 3. Since output growth up less than bonds, public debt-to-GDP ratio increases in the short run[4].

[4]This means that equation 27 defines the relationship between the public debt-to-GDP ratio and inflation but does not qualitatively drive the results explained in section 5.

On the opposite, a lower degree of price indexation increases the speed of inflation transition dynamic towards its higher steady state. As a result, short-run effects are qualitatively the same but larger than those in Section 5.

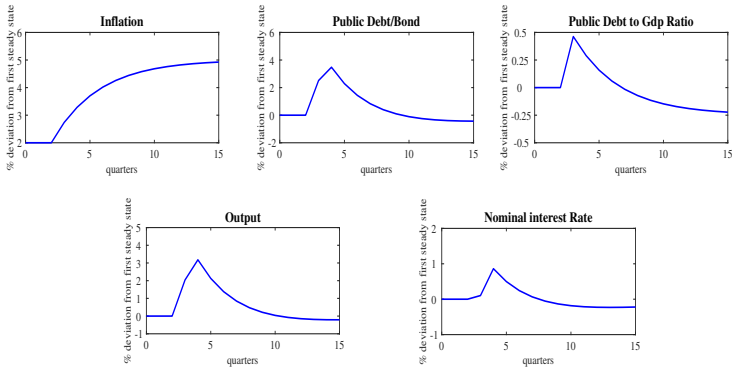


Figure 5: **Sensitivity analysis on degree of inflation indexation**

Another step of our sensitivity analysis is to test how the model reacts to different values of the parameter governing the response of public debt-to-GDP ratio to inflation gap $\phi_b$. Figure 6 shows that by increasing $\phi_b$ (for example a value of 1.7) public debt-to-GDP ratio reduces slower than when it is equal to 1.3 (as in the benchmark model). As result, the main macroeconomic variables' paths are more inertial than in Section 5. On the opposite, a lower value of $\phi_b$ makes the process of inflation-based consolidation faster. However, transition dynamics are qualitatively the same as the benchmark model. The same is true with $\phi_b = 0$ as well.

This suggests that equation 27 only influences the speed of short-run adjustments but does not quantitatively affect results meaning that the only parameter able to influence the relationship between public debt-to-GDP ratio and inflation is the degree of price indexations. In other words, if an inflation-based fiscal consolidation is possible or not, only depends on the speed of inflation adjustment.

# 7 Conclusion

This paper investigates the real and welfare effects of a permanent increase in inflation rates both in the short- and long-run. The aim is to assess under which conditions inflation acts as a deflator, namely contributes to a permanent reduction in the public debt-to-GDP ratio. Today more than ever this question appears relevant since unsustainable values of inflation

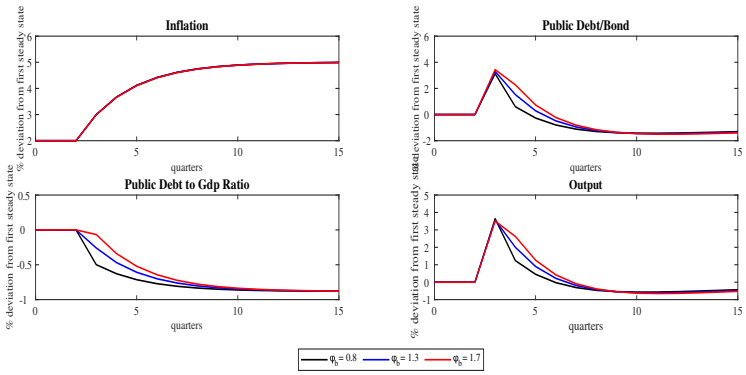


Figure 6: **Sensitivity analysis on parameter governing the response of public debt-to-GDP ratio to inflation gap.**

and public debt are affecting economies all over the world.

To capture the pure role of inflation as a potential deflator of public debt, we assume that the government does not implement any fiscal policy to contribute to the consolidation plan. The experiment consists of permanent increases in the targeted inflation rate from 2 to 5 percent. The speed with which the public debt-to-GDP ratio responds to variations in inflation rate depends on the parameter $\phi_b$ in the equation 27. While the speed with which the inflation rate reaches the higher value of 5% is determined by the inflation indexation parameter.

Results envisage that fiscal consolidation through an increase in inflation is far from obvious. Overall, inflation raises positively affects the government's budget constraint and households' welfare. However, a more sluggish inflation adjustment path influences households' expectations, entailing debt-to-GDP ratio increases in the short term.

While analyzing long-term effects, we envisage that debt consolidation always occurs but since real interest rate raises household's disposable income reduces. As a result, an increase in inflation is welfare costly for savers and hand-to-mouth households in the long run.

In terms of policy message this paper suggests that given the potentially negative effects on public debt caused by higher inflation, today more than ever, it would be needed more tighten monetary policy namely disinflationary policy. Moreover, a fiscal policy aimed at reducing the government's deficit would be needed.

To our knowledge, this paper is the first attempt to study the effects of permanent inflation target increases in a deterministic model where fiscal policy remains passive. However,

it would be interesting to investigate how real and welfare effects change when fiscal authorities actively react. Moreover, it would be interesting to consider in the analysis different monetary policy rules including a countercyclical Taylor rule where nominal interest rate responds to public debt as well. Eventually, this paper neglects wage-setting mechanisms that may influence the effectiveness of inflation raise. We leave these extensions for future research.

## References


[1] Akitoby, B., Binder, A., & Komatsuzaki, T. (2017). Inflation and public debt reversals in the G7 countries. Journal of Banking and Financial Economics, (1 (7)), 28-50.

[2] Ascari, G., & Ropele, T. (2012a). Disinflation in a DSGE perspective: Sacrifice ratio or welfare gain ratio?. Journal of Economic Dynamics and Control, 36(2), 169-182.

[3] Beckmann, J., Gern, K. J., Hauber, P., Jannsen, N., & Stolzenburg, U. (2021). Rising Inflation–Transitory or Cause for Concern. Publication for the committee on Economic and Monetary Affairs, Policy Department for Economic, Scientific and Quality of Life Policies, European Parliament, Luxembourg, September. Via Internet (22.9. 2021): https://www. europarl. europa. eu/thinktank/de/document. html.

[4] Bhattarai, S., Lee, J. W., & Park, W. Y. (2014). Inflation dynamics: The role of public debt and policy regimes. Journal of Monetary Economics, 67, 93-108.

[5] Bianchi, F., & Melosi, L. (2019). The dire effects of the lack of monetary and fiscal coordination. Journal of Monetary Economics, 104, 1-22.

[6] Bianchi, F., Faccini, R., & Melosi, L. (2020). Monetary and fiscal policies in times of large debt: Unity is strength (No. w27112). National Bureau of Economic Research.

[7] Blanchard, O. (2021). In defense of concerns over the $1.9 trillion relief plan. Peterson Institute for International Economics, February, 18, 2021.

[8] Calvo, G. A. (1983). Staggered prices in a utility-maximizing framework. Journal of monetary Economics, 12(3), 383-398.

[9] Cantore, C., & Freund, L. B. (2021). Workers, capitalists, and the government: fiscal policy and income (re) distribution. Journal of monetary economics, 119, 58-74.

[10] Cardani, R., Menna, L., & Tirelli, P. (2020). The optimal policy mix to achieve public debt consolidation. Macroeconomic Dynamics, 24(1), 113-129.

[11] de Soyres, C., Kawai, R., & Wang, M. (2022). Public Debt and Real GDP: Revisiting the Impact. INternational Monetary Found, WP. 76.

[12] Hilscher, J., Raviv, A., & Reis, R. (2022). Inflating away the public debt? An empirical assessment. The Review of Financial Studies, 35(3), 1553-1595..

[13] Kaplan, G., Violante, G. L., & Weidner, J. (2014). The wealthy hand-to-mouth (No. w20073). National Bureau of Economic Research.

[14] Kliem, M., Kriwoluzky, A., & Sarferaz, S. (2016). Monetary–fiscal policy interaction and fiscal inflation: A tale of three countries. European Economic Review, 88, 158-184.

[15] Krause, M. U., & Moyen, S. (2016). Public debt and changing inflation targets. American Economic Journal: Macroeconomics, 8(4), 142-76.

[16] Leeper, E. M., Traum, N., & Walker, T. B. (2017). Clearing up the fiscal multiplier morass. American Economic Review, 107(8), 2409-54.

[17] Lopes da Veiga, J. A., Ferreira-Lopes, A., & Sequeira, T. N. (2016). Public Debt, Economic Growth and Inflation in African Economies. South African Journal of Economics, 84(2), 294-322.

[18] Reinhart, C. M., & Rogoff, K. S. (2010). Growth in a Time of Debt. American economic review, 100(2), 573-78.

[19] Rockeman O., (2022). US Inflation Quickens to 40-Year High, Pressuring Fed and Biden. Available online at https://www.bloomberg.com/news/articles/2022-06-10/us-inflation-unexpectedly-accelerates-to-40-year-high-of-8-6

[20] Smets, F., & Wouters, R. (2007). Shocks and frictions in US business cycles: A Bayesian DSGE approach. American economic review, 97(3), 586-606.

[21] Summers L. H. (2021). Opinion: The inflation risk is real. Washington Post, 24 May 2021. Available online at https://www.washingtonpost.com/opinions/2021/05/24/ináation-risk-is-real/

[22] Taghavi, M. (2000). Debt, Growth and Inflation in Large European Economies: A Vector Autoregression Analysis. Journal of Evolutionary Economics, 10, 159–173.

[23] Tepper T. (2022). Why Is Inflation So High? Available at https://www.forbes.com/advisor/investing/why-is-inflation-rising-right-now/