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# On the Welfare Cost of Inflation in a New Keynesian Model with a Cash-in-advance Constraint: The Case of Iran

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**Abstract**

The welfare cost of inflation in a new Keynesian model has been studied in this article. Nominal prices and wages are subjected to Rotenberg's adjustments in the benchmark model. In addition, this study uses the CIA model to compare the welfare cost of seigniorage tax and consumption tax. The model is calibrated for the Iranian economy and the results of the calibration are as following: In a steady state, a seigniorage tax imposes higher costs on social welfare rather than consumption taxes. We also find that the welfare cost of inflation increases linearly with the inflation rate and the welfare cost in a model without the government is higher than the model with government expenditures. Numerically, in the benchmark model, an annual inflation rate of 10% entails a welfare cost (relative to a -1.5% annual inflation rate, the Friedman Rule’s level of inflation rate) of 1.69% of a steady state consumption without a government. If we add the government to the model, this cost will be 1.28%. This amount will be only 0.5% if we use the RBC model. According to Ascra's measurement (2009), inflation tax increases welfare costs, but consumption tax decreases welfare costs.

**Keywords**: Inflation Tax, Monetary Policy, Welfare Cost.
**JEL Classification**: D58, D60, E40.

## 1. Introduction

How inflation tax affects resource allocation and welfare is an important debate in macroeconomics. Most studies postulate that inflation tax reduces welfare; regardless of whether money demand is derived from a cash-in-advance constraint, or transaction technology with money as an intermediate input, or it is derived from money in

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the utility function (e.g. Friedman, 1969; Kimbrough,1986; Prescott,1987; Cole & Stockman, 1992; Schreft, 1992; Gillman, 1993; Gomme, 1993; Correia & Teles, 1996; Dotsey & Ireland, 1996; Aiyagari, Braun & Eckstein, 1998; Wu & Zhang, 1998, 2000; Lucas, 2000; Erosa & Ventura, 2002). In most of these studies, the optimal rule for monetary policy is a deflation rate in which the nominal interest rate or cost of holding money reaches to zero as described by the Friedman rule. On the other hand, some studies emphasize on the positive rate of money growth for a positive nominal interest rate by considering extra factors. For example, Phelps (1973), Braun (1994), and Palivosand Yip (1995) believe that, inflation tax creates higher welfare than income tax as a means of public finance. Guidotti and Vegh (1993) concluded that optimal inflation tax would increase if transaction-cost technology has increasing returns to scale. Shi (1999) proposes an optimal money growth rate higher than Friedman rule by considering borrowing constraints. In Rebelo and Xie (1999), money is natural in the steady state, but it can change the production rate during the transition toward the steady state and the transitional effect can be taped by monetary policy to improve welfare if there is a production externality.

How much of the inflation cost is a central question in monetary economics? In the present paper, we determine the welfare cost of inflation, using a new Keynesian Dynamic Stochastic General Equilibrium (DSGE) model, because new Keynesian DSGE models have ‘become the high usage in discussions of fluctuations, policy and welfare’ since the mid-1990s, (Blanchard & Gali, 2007: 35). However, amazingly, few studies use this framework to study the welfare cost of inflation. There are two reasons for this: many new Keynesian DSGE models have supposed that the steady state (net) inflation rate is zero, and real wages are constant. Although these assumptions simplify wage-setting equations to Phillips curve-style relations, they also prevent the study of the effects of nominal rigidity on the welfare cost of long-run inflation. There are few studies such as Khan et al. (2003), and Schmitt-Grohe and Uribe (2005, 2006a, b, c, 2007) that do not consider these two assumptions. These studies focus instead on the optimal rate of inflation and monetary policies, but they do not consider the welfare costs of different rates of long-run inflation. However, Leong et al. (2011) is the only study, which focuses on the welfare cost of inflation in a new Keynesian framework. In this paper, we try to design a new Keynesian DSGE model, which is different from Leong et al. (2011) in its constraint, and wage rigidity. The model displays a representative household, which maximizes welfare, profit maximizing firms, and a government that conducts monetary policy, similar to Cooley and Hansen's (1989) Real Business Cycle (RBC) model. We introduce money into the model by a cash-in-advance (CIA) constraint, and two explanatory features of new Keynesian DSGE models into our model: monopolistic competition, and nominal rigidity. We assume that goods and labor markets are monopolistically competitive and nominal prices and wages are subjected to Rotenberg's (1982) staggered adjustments. The introduction of monopolistic competition and nominal rigidity might lead to welfare costs of inflation that are different from other models. For example, monopolistic competition can lead to a lower steady-state consumption, output, and welfare, making a given percentage change in a steady-state consumption to imply a larger welfare loss. In the present paper, similar to Cooley and Hansen (1989), we focus on the welfare cost of long-run inflation and calculate the welfare costs in relation to different levels of the inflation rate in the steady state. The rest of the paper is organized as follows. Section 2 reviews the related studies in the field. Then, we present the model in Section 3. Calibration issues are argued in Section 4. Sections 5 presents the benchmark result. Finally, Section 6 presents the conclusions.

## 2. Literature Review

There are many research studies in the literature on the welfare cost of inflation. The first researches on this topic is Bailey (1956) and Friedman (1969) that are the seminal works on the subject. According to Friedman (1969), non-negative inflation rate imposes welfare cost. Only a monetary policy, which brings the nominal interest rate equal to zero, can be considered as optimal. Friedman suggests that negative inflation equals to minus real interest rate.

Locus (2000), using a MIU approach, presents a measurement to estimate welfare cost of inflation by deviating from Friedman rule.

Based on U.S. statistical data, he reports an estimation 0.013 of aggregate consumption as welfare cost of inflation for 10 percent nominal interest rate.

Ho et al. (2007) suggested a measurement for comparing the welfare cost between a seigniorage tax and a consumption tax in a model with real balances and leisure in utility. They found that without a production externality, a seigniorage tax always had a higher welfare cost than a consumption tax in the long- run. With a production externality, a seigniorage tax not only had a smaller welfare cost than a consumption tax but also may have / lead to a welfare gain.

Lu et al. (2010), investigated welfare costs between seigniorage and consumption taxes in a neoclassical growth model with a cash-in-advance constraint. They compared equilibrium along transitional dynamic with steady-state paths and found that, because of lower consumption and leisure and thus higher welfare costs of consumption taxes during old periods, the welfare cost of consumption tax is larger than that of seigniorage tax.

Leong et al. (2011) estimated the welfare cost of inflation using Keynesian dynamic stochastic general equilibrium. They found that the welfare cost of inflation in a new Keynesian DSGE model is much higher than its peer in a Real Business Cycle model.

Izadkhasti et al. (2015), from sensitivity analysis in a steady state, found that when there is no externality of production, by increasing inflation tax rate, the ratio of consumption to GDP remains constant, but the labor, capital stock, and production will increase. With a decrease in the ratio of real money balances to GDP and leisure, the level of social welfare in a steady state also decreases. By considering production externality, steady state capital stock, production and welfare will increase.

Izadkhasti et al. (2015) investigated the net effects of switching from consumption tax to inflation tax on resource allocation and welfare that are crucially dependent on production externalities. With elastic labor supply, any raise in inflation tax will decrease leisure, but will increase the levels of real consumption, capital, and output.

Marzban et al. (2015) compared welfare loss from seigniorage tax and consumption tax. Seigniorage tax is in the form of higher money creation and transferring purchasing power from people to government. They found that consumption tax increases the level of expenditure and thus reduces economic welfare. They have evaluated welfare effects of seigniorage tax and consumption tax in an endogenous growth model. The results showed that, in the long-run, seigniorage tax has more welfare effects than consumption tax. Moreover, model calibration shows that seigniorage tax leads to more volatility in variables and welfare changes.

Shafiezade et al. (2016) used CIA approach to compare the welfare cost of seigniorage tax and consumption tax for Iran's economy /Iranian economy. They showed that, in the short run, the welfare cost of financing through seigniorage tax is less than consumption tax. However, in the long-run, seigniorage tax has more welfare cost effects than consumption tax.

In the economic literature, there are some studies focused on welfare cost of inflation tax. These studies have used both partial and general equilibrium approaches in new classical growth environment. The closest study to our paper is Leong et al. (2011), which shows that welfare cost of inflation tax is always increasing as the rate of inflation increase. The difference between our study and that of Leong et al. (2011) is that, in addition to Leong et al, we added consumption tax to the model. Moreover, we expanded the CIA constraint to get explicit relationship for consumption, output, labor and capital accumulation. We not only used Cooley and Hanson's (1989) measurement, but also employed Ascari' (2009) measurement for comparing two ways for government financing. According to the Literature Review, in the following we will explain theoretical model for evaluating macroeconomic policy by emphasizing/ with an emphasis on differences with traditional models.

## 3. Model

The model consists of a representative household, a representative final goods-producing firm, a continuum of intermediate goods-producing firms indexed by $i \in [0, 1]$ and a monetary authority. The representative household consumes, invests, and supplies labor to the intermediate goods-producing firms. A representative final goods-producing firm acting in a perfectly competitive market produces final output. The final goods-producing firm bundles the continuum of intermediate goods manufactured by monopolistic competitors and sells it to the household, who uses the final goods for consumption. The intermediate goods- producing firms are owned by the household and each of them produces a distinct, perishable intermediate goods, also indexed by i ∈ [0,1] during each period t = 0, 1, 2, …. The assumption of monopoly power of intermediate goods-producing firms allows introducing nominal rigidities in the form of quadratic nominal price adjustment costs. Finally, because we will focus on the welfare cost of steady-state inflation in the present paper, we assume that the government directly controls the steady-state inflation rate. Alternatively, we can think of the government as controlling the growth rate of money supply, $m_t = U_t(\frac{m_{t-1}}{\Pi_t})$. Because the real money balance is assumed a stationary variable, the steady state of $u_t$ will be the same as $\pi_t$, and so controlling $u_t$ is directly the same as controlling $\pi_t$ in the steady state.

**3.1 Households**

The representative household enters period t, holding $M_{t-1}$ in which $M$ is the real money balance, $B_{t-1}$ and $K_t$ units of money, one-period bonds and physical capital respectively. In addition to this endowment, the household receives a lump sum transfer $T_t$ from the monetary authority at the beginning of period t. The household receives $W_t h_t + r_t K_{t-1}$total nominal factor payments from supplying $h_t(i)$units of labor and $K_t(i)$units of capital to each intermediate goods producing firm i ∈ [0,1], letting $W_t$ and $r_t$ denote the nominal wage rate for labor and the nominal rental rate for capital, respectively. For all t = 0 ,1, 2,..., the household's choices of $h_t(i)$and $K_t(i)$must satisfy

$$h_t = \int_0^1 h_t(i)di \tag{1}$$

Where $h_t$ denotes total hours worked, and

$$K_t = \int_0^1 K_t(i)di \tag{2}$$

Finally, the household earns nominal dividends

$$D_t = \int_0^1 D_t(i)di \qquad (3)$$

The capital accumulation process is given by

$$K_t(i) = (1-\delta)K_{t-1}(i) + X_t(i) \qquad (4)$$

where $X_t$ is the investment. The budget constraint of the representative household is given by

$$\frac{m_{t-1}(i)}{\Pi_t} + \frac{I_{t-1}b_{t-1}(i)}{\Pi_t} + w_t h_t(i) + r_t k_{t-1}(i) + \tau_t(i) + (1-\delta)k_{t-1}(i) = (1+\tau_c)C_t(i) + m_t(i) + b_t(i) + k_t(i) \qquad (5)$$

$\forall t > 0$; where: $B_t$ denotes the nominal value of (risk free) bonds holdings which pay a one-period nominal (net) interest rate $I_t$, and $\tau_c$ is the tax on consumption and face on the cash-in-advance constraint

$$\frac{m_{t-1}(i)}{\Pi_t} + \frac{I_t b_{t-1}(i)}{\Pi_t} + \tau_t(\mathrm{i}) \geq (1+\tau_c)C_t(i) + b_t(i) \qquad (6)$$

By stating the problem in terms of the Lagrangian, the households choose $C_t$, $h_t$, $b$, $m_t$ and $K_t$ in order to maximize utility function:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\emptyset}(i)}{1-\emptyset} - \frac{h_t^{1+\eta}(i)}{1+\eta}\right)$$

where $E_t$ is the time t conditional expectations operator, $\beta \in (0,1)$ is the subjective discount factor, $\emptyset > 0$ and $\eta > 0$ are, respectively, the coefficient of risk aversion and the inverse of Frisch labour supply elasticity.

$$L = E_0 \sum_{t=0}^{\infty} \beta^t (\frac{C_t^{1-\emptyset}(i)}{1-\emptyset} - \frac{h_t^{1+\eta}(i)}{1+\eta}) + \sum_{t=0}^{\infty} E_0 \beta^t \lambda_t \Big(\frac{m_{t-1}(i)}{\Pi_t} + \frac{I_{t-1} b_{t-1}(i)}{\Pi_t} + w_t h_t(i) + r_t k_{t-1}(i) + \tau_t(i) + (1-\delta) k_{t-1}(i) - (1+\tau_c) C_t(i) - m_t(i) - b_t(i) - k_t(i)\Big) + \sum_{t=0}^{\infty} E_0 \beta^t \mu_t (\frac{m_{t-1}(i)}{\Pi_t} + \frac{I_t b_{t-1}(i)}{\Pi_t} - b_t(i) + \tau_t(i) - (1 + \tau_c) C_t(i)) \quad (7)$$

Where $\lambda_t$ and $\mu_t$ are the Lagrangian multipliers associated with the budget constraint and the cash-in-advance constraint, respectively. The maximization of the Lagrangian with respect to the control variables (after substituting for the Lagrangian multipliers) delivers the following optimality conditions:

$$\frac{h_t^{\eta}(i)}{C_t^{-\phi}(i)} = \frac{w_t}{(1+\tau_c) I_t} \quad (8)$$

$$1 = \beta E_t \left\{ (\frac{C_{t+1}(i)}{C_t(i)})^{-\phi} (\frac{I_t}{\Pi_t}) \right\} \quad (9)$$

$$1 = \beta E_t \left\{ (\frac{C_{t+1}(i)}{C_t(i)})^{-\phi} (\frac{I_t}{I_{t+1}} R_{t+1}) \right\} \quad (10)$$

Where $R_t = r_t + 1 - \delta$ represents the gross return on capital (net of depreciation).

**3.2 Firms**

The final $y_t$ goods is produced by a firm, acting in a perfectly competitive market, which compounds the intermediate goods $y_t(i)$ preposition to the constant returns to scale technology:

$$\left[\int_0^1 Y_{it}^{\frac{(\theta-1)}{\theta}} di\right]^{\frac{\theta}{\theta-1}} \geq Y_t \quad (11)$$

where $\theta > 1$ represents the elasticity of substitution between intermediate goods and $y_t(i)$. $P_t(i)$ shows the price of intermediate good i. The process of profit maximization leads to the following demand function for intermediate goods.

$$Y_{it} = \left[\frac{P_{it}}{P_t}\right]^{-\theta} Y_t \tag{12}$$

Where

$$\mathrm{P_t} = \left[\int_0^1 \mathrm{P_{it}^{(1-\theta)}di}\right]^{\frac{1}{(1-\theta)}} \tag{13}$$

Each intermediate good $i$ is produced by a single monopolistically competitive firm preposition to the constant returns to scale technology:

$$\mathrm{K_{it}^{\alpha}[e^{A_t}h_t]^{1-\alpha} \geq Y_{it}} \tag{14}$$

where $1 > \alpha > 0$ represents the elasticity of output with respect to capital. The technology shock $A_t$ follows the autoregressive process:

$$\mathrm{ln(A_t) = \rho_A \ln(A_{t-1}) + \varepsilon_{At}} \tag{15}$$

with$1 > \rho_z > 0$, $z > 0$ and $\varepsilon_{A_t} \sim N(0, \sigma_A^2)$.Although each firm, has a kind of market power, it is assumed that it acts as a price taker in the factor markets. The adjustment of its nominal price $P_t(i)$ is assumed costly, where the cost function is convex relative to the price adjustment. Following Rotemberg (1982), these costs are defined as:

$$\mathrm{PAC_{jt}} = \frac{\varphi_P}{2}\left[\frac{\mathrm{P_{jt}}}{\bar{\pi}\mathrm{P_{jt-1}}} - 1\right]^2 \mathrm{Y_t} \tag{16}$$

where $\varphi_p \geq 0$ denotes the size of price adjustment costs and π defines the gross steady state rate of inflation. According to these convex adjustment costs, the firm's optimization problem becomes dynamic. It chooses $h_t(i)$, $K_t(i)$, $Y_t(i)$, and $P_t(i)$ to maximize its total market value;

$$\max_{\{K_t(i),h_t(i),P_t(i)\}} E_0\left[\sum_{t=0}^{\infty}\beta^t\lambda_t(\frac{D_t(i)}{P_t})\right] \tag{17}$$

Subjected to the demand function for intermediate goods, where $\lambda_t$ measures the period t marginal utility to the representative household obtained by an additional unit of profits. The firm's profits distributed to the household as dividends are defined in real terms by:

$$\frac{D_t(i)}{P_t} = \left[\frac{P_t(i)}{P_t}\right] y_t(i) - w_t h_{it} - r_t K_{t-1}(i) - PAC_t(i) \tag{18}$$

Therefore, the Lagrangian for the firms' intertemporal optimization problem can be written as:

$$\begin{aligned} L = E_0\sum_{t=0}^{\infty}\beta^t\lambda_t(\left[\frac{P_t(i)}{P_t}\right] y_t(i) - w_t h_{it} - r_t K_{t-1}(i) - \frac{\varphi_p}{2}(\frac{P_t(i)}{\Pi P_{t-1}(i)})^2 Y_t) \\ + E_0\sum_{t=0}^{\infty}\beta^t\gamma_t((K_{t-1}(i)^{\alpha}(e^{A_t}h_t(i))^{1-\alpha} - \left[\frac{P_t(i)}{P_t}\right]^{-\theta} Y_t) \end{aligned} \tag{19}$$

Setting the partial derivatives of Lagrangian with respect to $h_t(i)$, $K_{t-1}(i)$, $P_t(i)$ equal to zero leads to the first order conditions:

$$\lambda_t w_t h_t(i) = (1-\alpha)\gamma_t Y_t(i) \tag{20}$$

$$\lambda_t R_t K_{t-1}(i) = \alpha\gamma_t Y_t(i) \tag{21}$$

$$\begin{aligned} \varphi_p\lambda_t\left(\frac{\Pi_t}{\Pi^{ss}}-1\right)\left(\frac{\Pi_t}{\Pi^{ss}}\right) \\ = (1-\theta)\lambda_t + \theta\gamma_t \\ + \beta\varphi_p E_t\left\{\lambda_{t+1}\left(\frac{\Pi_{t+1}}{\Pi^{ss}}-1\right)\left(\frac{\Pi_{t+1}}{\Pi^{ss}}\right)(\frac{Y_{t+1}}{Y_t})\right\} \end{aligned} \tag{22}$$

**3.3 Government**

In this model, the government operates as monetary and fiscal authority, and its revenues and outlays in period t are combined in the following flow budget constraint (expressed in real terms). Assume that consumption government spending is a fixed fraction $\Lambda$ :

$$\tau_c C_t + m_t - \frac{m_{t-1}}{\Pi_t} + b_t = g_t + \tau_t + \frac{I_{t-1}}{\Pi_t} b_{t-1} \qquad and\ g_t = \Lambda y_t \tag{23}$$

where $\tau_c$ is the rate of consumption tax, $b_t$ is the real bond, $g_t$ is government expenditure and $\tau_t$ lump sum transfer in each period, per capita real money supply is assumed to grow at the gross rate $U_t$.This implies:

$$m_t = U_t(\frac{m_{t-1}}{\Pi_t}) \tag{24}$$

To study the effects of a monetary surprise, the variable $U_t$ is assumed to evolve according to the law of motion:

$$ln(u_t) = (1 - \rho_u)\ln(u) + \rho_u \ln(u_{t-1}) + \varepsilon_{ut} \tag{25}$$

$\forall\, t \geq 0$; where: $\rho_u$ is the autoregressive coefficient (with $0 \leq \rho_u \leq 1$), $\varepsilon_{ut}$ and is a random variable serially uncorrelated and normally distributed, with zero mean and constant variance $\sigma^2{}_{\varepsilon u}$. With this specification, the average (net) growth rate of money supply chosen by the monetary authority is equal to $u$.

### 3.4 Symmetric Equilibrium

To close the model, we complete the following two steps. First, we consider a symmetric equilibrium where all intermediate goods-producing firms make identical decisions. This assumption implies$P_t(i) = P_t, Y_t(i) = Y_t,\ \ h_t(i) = h_t,\ \ C_t(i) = C_t \quad K_t(i) = K_t$, and $D_t(i) = D_t$ for t = 0,1,2... and all i ∈ [0,1].

### 3.5 Steady State

In steady state, equation (24) can be used to obtain:

$$U^{ss} = \Pi^{ss}$$

The result indicates that the steady state inflation rate is determined by the money growth rate chosen by the monetary authority. A direct implication of this is that the (steady state) real quantity of money (m) is constant. Given the households subjective discount rate $\beta$, the intertemporal condition (9) can be used to determine the long-run nominal interest rate:

$$1 = \beta\left(\frac{I^{ss}}{\Pi^{ss}}\right) \Rightarrow I^{ss} = (\frac{\Pi^{ss}}{\beta})$$

**3.6 Welfare Measure**

The welfare measure that we use to assess the welfare cost of steady-state inflation is the steady state of the utility of the representative household:

$$u = \frac{C_t^{1-\emptyset}}{1-\emptyset} - \frac{h_t^{1+\eta}}{1+\eta}$$

We will follow Cooley and Hansen (1989) and Ascari and Ropele (2009) for providing a better sense of the magnitude of the welfare cost. Cooley and Hansen (1989) estimated the change in steady-state consumption, denoted by$\Delta C^{\mathbf{welfare}}$, that would make the representative household as well off as under a steady-state net annual inflation rate of -1.5%:

$$\frac{(C_\pi + \Delta C^{welfare})^{1-\sigma}}{`1-\sigma} - \frac{h_\pi^{1+\eta}}{1+\eta} = \frac{(C^*)^{1-\sigma}}{1-\sigma} - \frac{(h^*)^{1+\eta}}{1+\eta}$$

where $C_\pi$and $h_\pi$ are, respectively, the steady-state consumption and labour hours associated with a steady-state inflation rate of$\pi$, while$C^*$ and $h^*$ are, respectively, the steady-state consumption and labour hours associated with a steady-state net annual inflation rate of -1.5%. We use the case of a -1.5% steady-state net annual inflation rate as the benchmark, because it is the Friedman Rule's level of inflation rate. Specifically, given the steady-state net annual real interest rate of 1.5% in our model, a -1.5% net annual inflation rate would yield a net annual nominal interest rate of 0%, thereby minimizing the distortion from the CIA constraint, which is the prescription suggested by the 'Friedman Rule'. The Friedman Rule's level of inflation rate is the optimal inflation rate in a model for which the CIA constraint is the only source of distortion. Ascari and Ropele (2009) use this equation for measuring welfare cost:

$$WC = \frac{1 - EXP[(1-\beta)(U-U^*)]}{\pi^* - \pi}$$

**3.7 Non-super Neutrality of Money**

Due to the derived equation in steady state, we can conclude that, by assuming price and wages rigidities, money is neutral. This result is in the opposite direction of classical viewpoints, which state that rigidities can create non-neutrality of money. Although in this model, money is neutral, but the growth rate of money affects real variables and thus we can conclude that the model in non-super neutral. Nevertheless, the notable point in this result is the direction of Non-super neutrality. In this study, growth of money and inflation have a negative effect on output; this result is against to dominant opinion in Keynesian template. We can check this result by following equations, which are derived from steady state relations:

$$Y^{ss}=\left(1-(\alpha\beta)\left(\frac{\theta-1}{\theta}\right)\delta\right)^{\frac{\phi}{-(\eta+\phi)}}(\alpha\beta)^{\frac{\alpha(\eta+1)}{(1-\alpha)}}(1-\alpha)^{\frac{1}{(\eta+\phi)}}(1+\tau_c)^{-\frac{1}{(\eta+\phi)}}\left(\frac{\theta-1}{\theta}\right)^{\frac{\eta\alpha+1}{(1-\alpha)(\eta+\phi)}}(\beta)^{\frac{1}{\eta+\phi}}(1+\pi^{ss})^{-\frac{1}{\eta+\phi}} \quad (27)$$

$$X^{ss}=\left(1-(\alpha\beta)\left(\frac{\theta-1}{\theta}\right)\delta\right)^{\frac{\eta}{(\eta+\phi)}}(\alpha\beta)^{\frac{\alpha(\eta+1)}{(1-\alpha)}}(1-\alpha)^{\frac{1}{(\eta+\phi)}}(1+\tau_c)^{-\frac{1}{(\eta+\phi)}}\left(\frac{\theta-1}{\theta}\right)^{\frac{\eta\alpha+1}{(1-\alpha)(\eta+\phi)}}(\beta)^{\frac{1}{\eta+\phi}}(1+\pi^{ss})^{-\frac{1}{\eta+\phi}} \quad (28)$$

$$C^{ss}=\left(1-(\alpha\beta)\left(\frac{\theta-1}{\theta}\right)\delta\right)^{\frac{\phi}{-(\eta+\phi)}}(\alpha\beta)^{\frac{\phi(1-\alpha)+\eta+\phi}{(1-\alpha)(\eta+\phi)}}(1-\alpha)^{\frac{1}{(\eta+\phi)}}(1+\tau_c)^{-\frac{1}{(\eta+\phi)}}\left(\frac{\theta-1}{\theta}\right)^{\frac{\phi(1-\alpha)+\eta+1}{(1-\alpha)(\eta+\phi)}}(\beta)^{\frac{1}{\eta+\phi}}(1+\pi^{ss})^{-\frac{1}{\eta+\phi}} \quad (29)$$

Tobin (1965), in his theory of monetary growth shows, that inflation can persuade individuals to hold more capital accumulation by decreasing the attractiveness of real money balances (Walsh, 2003). This effect of monetary policy is well known as Tobin Effect. According to the Tobin effect, expansionary monetary policy makes a moderate inflation, and thus individuals hold more capital assets. Nevertheless, contrary to Tobin effect, the Expansionary monetary policy, decrease consumption, capital accumulation and output.

The attractiveness of this Reverse effect inflation is due to that in a new Keynesian model, we have attained a result, which is agree to the Monetarist viewpoint.

To design the model for simulating Iran's economy, we need to know the values for the parameters of the model. By choosing the best values for model parameters, we form and solve the maximization problem for achieving the steady state values of variables of the model.

## 4. Calibration

We use the model for simulating Iran's economy. First, it is essential to quantify model parameters. According to data of the Iran's economy, we summarized these values in table 1.

**Table 1: Calibration of Structural Parameters**

| Parameter | Definition | Value | Source |
|---|---|---|---|
| $\beta$ | Discount factor | 0.985 | Jalali Naini, Naderian (2011) |
| $\eta$ | inverse of the wage elasticity of labor supply | 2.17 | Taei (2006) |
| $\delta$ | The depreciation rate of capital | 0.042 | Amini, Haji Mohammad (2005) |
| $\alpha$ | Share of capital in production | 0.412 | Shahmoradi,A(2008) |
| $\phi$ | inverse of the elasticity of inter-temporal substitution of consumption | 1.5 | Zangane (2009) |
| $\theta$ | elasticity of substitution between intermediate goods | 4.33 | Fakhr Hoseini |

We pout the numerical values, reported in Table 1, to relations derived in section 3. By replacing these parameters, we obtained numerical values for the model parameters in the steady state. These values are reported in table (2).

**Table 2: Optimal Values**

| variable | Optimal Value |
|---|---|
| $c$ | 0.39 |
| $K$ | 0.12 |
| $y$ | 0.40 |

**Source**: Researchers Computations

## 5. Benchmark Results

According to the model, we have calculated the welfare cost based on the different annual inflation rates. The results are comparable with the benchmark inflation rate of -5.41 which has no welfare cost. The results are reported in Table 3. Table 4 reports the results in when we add the governmental expenditures to the model.

**Table 3: Steady states and welfare costs of inflation for the benchmark model**

| | Annual inflation rate | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0% | 5% | 10% | 15% | 20% | 25% | 30% | 35% | 40% |
| C | 0.3934 | 0.388 | 0.383 | 0.378 | 0.374 | 0.370 | 0.366 | 0.362 | 0.358 |
| $\Delta C^{welfare}$ | 0.0008 | 0.0037 | 0.0065 | 0.0092 | 0.0118 | 0.0143 | 0.0183 | 0.0192 | 0.0215 |
| $\frac{\Delta C^{welfare}}{C}$ | 0.2186 | 0.9530 | 1.695 | 2.429 | 3.152 | 3.862 | 4.996 | 5.296 | 5.989 |

**Source**: Researchers Computations

**Table 4: Steady States and Welfare Costs of Inflation for the Benchmark Model with Government Expenditure**

| | Annual inflation rate | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0% | 5% | 10% | 15% | 20% | 25% | 30% | 35% | 40% |
| C | 0.3362 | 0.3318 | 0.3276 | 0.3237 | 0.3199 | 0.3164 | 0.3130 | 0.3098 | 0.3068 |
| $\Delta C^{\text{welfare}}$ | 0.0005 | 0.0024 | 0.0042 | 0.0060 | 0.0079 | 0.0096 | 0.0114 | 0.0131 | 0.0147 |
| $\frac{\Delta C^{\text{welfare}}}{C}$ | 0.1724 | 0.7233 | 1.28 | 1.85 | 2.46 | 3.03 | 3.64 | 4.22 | 4.79 |

**Source**: Researchers Computations

Like Cooley and Hansen (1989), we found that the higher rates of inflation reduce the steady-state level of consumption. While the welfare cost of moderate inflation is higher than that reported by Cooley and Hansen (1989) and Leong Teo and Yang (2011). For example, 10% (annual) inflation rate entails a welfare cost of 1.695% without considering government and 1.282% of steady-state consumption including government expenditures, relative to a -1.5% annual inflation rate, while this amount in Cooley and Hansen (1989) is 0.520% of steady-state consumption in and for Leong Teo and Yang(2011) is 0.506%.It is also substantial noting that, like Cooley and Hansen (1989) and Teo and Yang (2011), we find that a 0% inflation rate also entails a welfare cost of 0.8614% of steady-state consumption, relative to a -1.5% annual inflation rate.

**Table 5: Comparing the Effect on Welfare Costs between of Inflation Tax and Consumption Tax**

| Rate of growth | welfare costs(growth money) | welfare costs(growth consumption tax) |
|---|---|---|
| 0 | -66.9086 | -66.9086 |
| 0.05 | -15.6262 | -67.7139 |
| 0.10 | -8.9367 | -68.5149 |
| 0.15 | -6.3009 | -69.3101 |
| 0.20 | -4.8905 | -70.0975 |
| 0.25 | -4.0118 | -70.8766 |
| 0.30 | -3.4120 | -71.6464 |
| 0.35 | -2.9756 | -72.4065 |
| 0.40 | -2.6442 | -73.1565 |

### 5.1 Policy Implications

Policy implications are presented in two sections. The first section contains policies that can decrease the gap between target and current values of macroeconomic variables. By imposing policy shocks, we can check sensitive analysis of the model by different rates of monetary growth. We can see that the lower the rate of growth is the smaller the gap of optimal value will be. We calculated this gap in Table 2 for different growth rate of money. However, as shown in Table 6, in lower growth rate of money, the gap of optimal value is lower. Therefore, we suggest that monetary authority must decrease the growth rate of money. The Second section, the main goal of this paper, is selecting between inflation tax and consumption tax for financing government expenditure

According to the simulation that are provided in Tables 5, both inflation tax and consumption tax have distorted effects on output and capital accumulation. However, whereas inflation tax has more welfare cost, so if the government wants to choose between these two policies, we strongly recommend consumption tax.

**Table 6: The Gap between Optimal –Simulated Values for Different Rates of Money Growth**

| Variable | Gap in 0% | Gap in 10% | Gap in 20% | Gap in 30% |
|---|---|---|---|---|
| Y | -0.16% | -1.18% | -2.09% | -2.51% |
| C | -0.16% | -1.17% | -2.07% | -2.88% |
| K | -0.05% | -0.37% | -0.66% | -0.79% |
| H | -0.38% | -2.69% | -4.74% | -5.69% |

**Source**: Researchers Computations

## 6. Conclusion

In the present paper, we studied the welfare cost of inflation in a new Keynesian DSGE model. We added nominal rigidities to the model by assuming that prices and wages are subjected to Rotemberg (1982)-style adjustments. Our main findings are as follows: We found that the welfare cost of inflation increases linearly with inflation. By adding government expenditures to the model, the welfare cost of inflation increases slower than the model without considering government expenditures. For example, in the benchmark model, an annual inflation rate of 10% entails a welfare cost (relative to a -1.5% annual inflation rate, the Friedman Rule’s level of inflation rate) of 1.69% without government and 1.28% of steady-state consumption in a new Keynesian model. We also found that in the steady state, seigniorage tax rather than consumption taxes impose higher costs on society's welfare. Thus, we recommend consumption tax as policy for financing government expenditures. Furthermore, monetary authority must decrease the growth rate of money.to reduce the gap between the model result and Friedman rule.

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