

## The Welfare Cost of Inflation : Theory with an Application of Generalized Method of Moments ( GMM) to Iran

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### Abstract

This paper empirically investigates the welfare cost of inflation in a money in utility function (MIUF) model. In order to do this, as in modern monetary theory, dynamic optimizing framework of a representative agent is used. This optimization process yields a system of stochastic nonlinear Euler equations that show the agent's choices. The empirical analysis employs the generalized method of moments (GMM) technique to estimate the parameters of the system by using annual data for Iran, 1970- 2000. The structural parameters recovered from the estimation of the Euler equations of the model are statistically significant and economically meaningful. The results of this study confirm that the representative agent model fits the consumption and money data well. We find for low rate of inflation welfare cost markedly increases with increase in inflation but rapidly reaches an asymptote, that is the welfare cost of high inflation is 7 percent of GDP. The results show that the welfare loss due to an increase in the inflation from zero to 10 percent is equivalent to a decrease in real GDP over than 2 percent, more than twice as big as Lucas' (2000) estimate for U. S.

In this study, the implication of model about seigniorage is investigated too; our empirical finding in this regard indicates the stability of seigniorage to GDP ratio despite of wide fluctuation in the rate of inflation.

**Keywords:** Welfare Cost; Inflation; Dynamic Optimization; GMM.

### I- Introduction

A sound judgment regarding the desirability of price stability as the principal goal of monetary policy requires an accurate assessment of the consequences of sustained price inflation. Thus, the considerable efforts

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have been devoted to measuring the welfare cost of inflation and the estimate of the potential gains in welfare from the adoption of the monetary policies that reduce inflation rate are classic questions of monetary economics, addressed in a long line of research stemming from the contributions of Baily (1956) and Friedman (1969). Their traditional approach treats real money balance as a consumption good and inflation as a tax on real balances, and measures the welfare cost by computing the appropriate area under the money demand curve.

Analysis, most notably those of Fischer (1981) and Lucas' (1981,2000), Bali (2000) for USA, find the cost of inflation to be surprisingly low. Fischer computes the deadweight loss generated by an increase in inflation from zero to 10 percent as just 0.3 percent of GNP, using the monetary base as the definition of money. Lucas (1981) places the cost of a 10 percent inflation at 0.45 percent of GNP using  $M_1$  as the measure of money, moreover his recent research (2000) shows that the gain from reducing the annual inflation rate from 10 percent to zero is equivalent to an increase in real income of slightly less than one percent. Also, work by Bali find the welfare cost of a sustained 4 percent inflation is around 0.29 percent of GDP. Since these estimates appear small relative to the potential cost of a disinflation recession, they provide little support for the idea that price stability is an essential goal for monetary policy.

The inflation tax, however, may distort economic decisions along margins that Baily - Friedman approach ignores, because it is related to resorting to an ad hoc semilog demand for money. This paper, therefore, takes a dynamic general equilibrium model to assessing the welfare cost of inflation, utilizing annual data for the period 1970 - 2000, Iran. The main question is: from welfare perspective, how much losses are imposed to economy by inflation? Moreover, we investigate the implication of model about seigniorage. This study is different to the ones that are mentioned above in three aspects. First, we focus on the restrictions implied by the nonlinear Euler equations that characterize the First-order-condition of dynamic optimization by representative agent. Second, the parameters of model are estimated using the generalized method of moments (GMM). And third, the analysis and results below provide features of money



demand, of the behavior of welfare cost and seigniorage that differs from those derived from models that directly postulate a semilog demand for real money balances.

The remainder of this paper is organized as follows. Section 2 describes briefly the performance of inflation in Iran during the recent decades. Section 3 deduces the restrictions that are imposed on the data by a model that includes money in utility function and discusses some steady state implications of the model. Section 4 describes the estimation procedure. The empirical findings are presented in section 5. This section also uses the structural estimated parameters along with observable parameters and with a set of auxiliary assumptions about a hypothetical steady state to determine the models' quantities implications. Brief concluding remark is given in section 6.

## **2- Inflation Performance in Iran**

In recent decades Iran has been experiencing a variable and steadily increasing inflation. The performance of inflation in Iranian economy during 1960-2000 may be split in to two inflation regimes as follows :

\*1960-1972: relatively low and stable inflation.

\*1973-2000: higher and more variable inflation.

The GDP deflator and CPI inflation rates rose by an annual average rate of 14.4 and 13.9 percent, respectively, over the period. The inflation rates were in single figures from 1960 to 1972. After 1972, with the oil price and the quantity of oil exports increasing, the rates of inflation rose sharply and exhibited large fluctuations. The annual average rate of the GDP deflator and CPI inflations was 22.9 and 14.7 percent, respectively, during the period 1973-1978 . A spike for the GDP deflator inflation appeared in 1974 with a rate of 57.4 percent. Indeed, the oil value added is one of the main components of GDP and, through the definition of the GDP deflator, calculated using the ratio of nominal GDP over real GDP, has strongly affected the GDP deflator in 1974. The rates of inflation accelerated to an average of 17.0 and 18.9 percent , respectively, over the 1979-1988. This period was particularly rich of events that are sources of inflation pressure, since the revolution, second oil boom, the war with Iraq,

third oil crisis, and the economic embargo took place. Over the period of 1989-1993, when the economic reform programmed was implemented, the average rate of the GDP deflator was 24.9 while the CPI inflation was exactly the same as in the previous sub-period. The rates of inflation increased further over the period following the structural adjustment programmed. The GDP deflator and CPI inflation rates were 31.7 and 35.9 percent, respectively, over the period 1994-1996. The CPI inflation rate reached a peak of 49.5 percent in 1995. Also, during 1997-2000 inflation performance has been relatively stable; inflation rate remained in the range of moderate inflation (i.e. Low double digit)<sup>1</sup>.

### 3- The Model

Here, the model treats consumption and money demand behavior as jointly arising from a dynamic optimizing framework of a representative agent, as in modern monetary theory [see Imrohorglou (1994), Holman (1998) and Friedman and Verbetsy (2001)]. Like Sidrauski (1967) monetary model money is included directly in the utility function as an asset that provides liquidity services. Although many researchers have used a money-in-utility-function (MIUF) formulation for assets, the approach remains controversial. One alternative is to have money enter an asset-pricing model via a cash-in-advance (CIA) constraint<sup>1</sup>. The CIA approach is quite popular in the literature, particularly in international finance models<sup>2</sup>. Feenstra (1986) and I. Correia and P. Teles (1999) demonstrates that, in many cases, the CIA formulation is theoretically equivalent to the MIUF approach. Stockman (1989) points out that the CIA constraint captures only the transactions demand for money. The focus of the current paper is not to demonstrate that money mitigates transaction costs, but rather to explore the more general role of liquidity services in an agent's optimization problem. In addition to capturing transactions demand, placing

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1 – For a Detailed Review on Inflation in Iran See: Moradi (2000); Bahman-Oskooee (1995) and Jafari-samimi [(2000) &(1997)]

2- See M. Gillman (1993), M. Dotsey and P. Ireland (1996) and W. B. English (1999).

3- See R. Lucas (1982) and all of its Extensions in Literature.



real balances in the utility function allows for precautionary and store of value motives for holding money.

The economy consists of a continuum of infinitely lived identical individuals, with population growing at rate  $n$ . A representative household maximizes the expected discounted sum of utility over the infinite horizon by choosing consumption and real balances :

$$V_t = E_t \sum_{t=0}^{\infty} \beta^t u(c_t, z_t) \quad (1)$$

Where  $E_t$  denotes expectations conditional on available information at time  $t$ ,  $\beta \in (0,1)$  is a subjective discount factor,  $c_t$  denotes consumption services per capita,  $z_t$  denote real money balances per capita and  $u(\cdot)$  is a concave utility function that is increasing in both its arguments.

Each household's budget constraint, in per capita real units is given by,

$$c_t = \frac{z_t}{(1 + \pi_t)(1 + n_t)} + \frac{b_{t-1}(1 + i_{t-1})}{(1 + \pi_t)(1 + n_t)} + y_t - z_t - b_t \quad (2)$$

In equation (2)  $b_t$ ,  $z_t$  and  $c_t$  are respectively, the per capita values of one-period financial assets, money balances and consumption chosen by household for time  $t$ .  $n_t$ , and  $\pi_t$ , respectively, denote population growth and the rate of inflation from  $t-1$  to  $t$  and the nominal return on assets held from  $t-1$  to  $t$  is  $i_{t-1}$ .  $y_t$  is real per capita income from other sources.

Invoking the principle of optimality and the fundamental recursive relationship, the problem can be solved for any two periods  $\tau=t$  and  $\tau=t+1$  and the solution will hold for all  $t$  and  $t+1$ :

$$\max_{b_t, z_t} V = \left\{ u_t(c_t, z_t) + E_t \left[ \beta^{-1} u_{t+1}(c_{t+1}, z_{t+1}) \right] \right\} \quad (3)$$

s.t.

$$c_t = \frac{z_{t-1}}{(1+\pi_t)(1+n_t)} + \frac{b_{t-1}(1+i_{t-1})}{(1+\pi_t)(1+n_t)} + y_t - z_t - b_t$$

$$c_{t+1} = \frac{z_t}{(1+\pi_{t+1})(1+n_{t+1})} + \frac{b_t(1+i_t)}{(1+\pi_{t+1})(1+n_{t+1})} + y_{t+1} - z_{t+1} - b_{t+1}$$

Differentiating with respect to  $b_t$  and  $z_t$ , and rearranging yields the following two Euler equations:

$$E_t \left\{ \beta^{-1} \frac{\partial u_{t+1}/\partial c_{t+1}}{\partial u_t/\partial c_t} \left( \frac{(1+i_t)}{(1+\pi_{t+1})(1+n_{t+1})} \right) - 1 \right\} = 0 \quad (4)$$

$$E_t \left\{ \frac{\partial u_t/\partial z_t}{\partial u_t/\partial c_t} + \beta^{-1} \frac{\partial u_{t+1}/\partial c_{t+1}}{\partial u_t/\partial c_t} \left( \frac{1}{(1+\pi_{t+1})(1+n_{t+1})} \right) - 1 \right\} = 0 \quad (5)$$

The Euler equation (4) is the standard condition for optimally allocating consumption between periods  $t$  and  $t+1$ . It states that, along an optimal path, the marginal cost of reducing consumption in  $t$  by one unit is exactly equal to the expected, discounted, marginal benefit of investing the unit of consumption in bonds in  $t$  and consuming the proceeds in  $t+1$ . This equation, in alternative versions, has been the focus of numerous recent empirical studies of consumption [e.g., Hansen and Singleton (1982), Eckstein and Leiderman (1992), Holman (1998), Lopez (2000)]. Equation (4) equates the expected utility costs and benefits of reducing current-period consumption by one unit and allocating that unit to money holding and then to consumption in the next period. From an empirical perspective, both these equations can be used to drive the model's restrictions on the co-movements of consumption, money holdings, inflation, and assets' returns over time. Notice that in the special case in which the nominal return  $i_t$  is assumed to be known at the start of the period, equations (3) and (4) can be combined to yield

$$\frac{\partial u/\partial z_t}{\partial u/\partial c_t} = \frac{i}{1+i}$$

a nonstochastic relation between real money balances, consumption and the nominal interest rate. This equation can be viewed as a conventional demand for money in implicit form [see Lucas (1986)]. In our framework, however, equation (3) and (4) can not be combined to yield a nonstochastic relation.

In order to estimate the model and drive its implications for the welfare cost of inflation and seigniorage, like Eichenbaum, Hansen and Singleton (1998), Eckstein and Leiderman (1992), Imrohoglu (1994) holman (1998), Bali (2000), Lepz (2000) and Friedman and Verbetsky (2001) in recent empirical studies of the representative agent's dynamic optimization problem , we use the utility function

$$u(c_t, z_t) = \frac{1}{\theta} \left\{ \left( z_t^\gamma c_t^{1-\gamma} \right)^\theta - 1 \right\}, \quad (6)$$

Where  $\gamma$  is a preference parameter between zero and one? Also  $\theta$  is a preference parameter that is less than one. The parameter  $1 - \theta$  represents both the coefficient of relative risk aversion and the inverse of the elasticity of intertemporal substitution. When  $\theta$  is equal to zero, the utility function takes the logarithmic form  $u(c_t, z_t) = \gamma \log z_t + (1 - \gamma) \log c_t$ .

Using this specification we next turn to implication of the model for the welfare cost of inflation and seigniorage revenue-implication which are derived by comparing steady states of the model assuming different rates of inflation. We assume that per capita consumption and real money balances grow in steady state at a constant rate  $\phi > 0$ , that population grows at a constant rate  $n$ . Accordingly, equation (4) can be rearranged to yield a steady state demand for money:

$$z = \left( \frac{\gamma}{1-\gamma} \right) \left( \frac{c}{1 - \frac{\beta (1+\phi)^{\theta-1}}{(1+\pi)(1+n)}} \right). \quad (7)$$

Being derived from an optimizing model, steady state money demand is chosen to depend on explicit preference parameters. Assuming that the parameters in equation (7) are invariant with respect to steady state



change in the rate of inflation, we calculate from (7) the absolute value of the elasticity of money demand with respect to a steady state change in the inflation rate as,

$$\xi_z = \left| \frac{\partial z}{\partial \pi} \frac{\pi}{z} \right| = \left[ \beta(1 + \pi)(1 + n)(1 + \phi)^{\theta-1} - 1 \right]^{-1} \left( \frac{\pi}{1 + \pi} \right) \quad (8)$$

According to the model, the inflation elasticity of money demand depends on the underlying parameters and on the rate of inflation.

This study quantifies the welfare cost of deviating from a zero inflation policy by using Lucas' compensating variation approach; That is, the percentage decrease in consumption per capita,  $\omega_1$ , that would generate the same welfare loss as that from moving  $\pi = 0$  to a given  $\pi > 0$ ,

$$u[c(1 + \omega_1), z(\pi)] = u[c, z(0)] \quad (9)$$

Given the utility function, (6), by subsuming equation (7) in to the equation (9), we can drive the welfare cost:

$$W_1(\pi) = \psi \left\{ \left[ \left( 1 - \frac{\beta(1 + \phi)^{\theta-1}}{(1 + \pi)(1 + n)} \right) / \left( 1 - \frac{\beta(1 + \phi)^{\theta-1}}{(1 + n)} \right) \right]^{\gamma} - 1 \right\} \quad (10)$$

Here, welfare loss is expressed as a percentage of GDP and denoted by  $W_1$ .

In order to explore the present model's implications for seigniorage, notice that government's revenue from monetary base creation is given by,

$$s_t = \left( 1 - \frac{H_{t-1}}{H_t} \right) \cdot h_t \quad (11)$$

Where,  $s_t$  and  $h_t$  denote seigniorage and monetary base per capita units, respectively. In the steady state equilibrium considered here the gross



rate of change of the monetary base  $H_t/H_{t-1}$  is equal to  $(1+n)(1+\pi)(1+\phi)$ . Substituting for  $h_t$ , the derived demand for real monetary base from equation (7) and dividing by GDP per capita we get following expression for the ratio of seigniorage to GDP in steady state:

$$SR = \left[ 1 - \frac{1}{(1+\pi)(1+n)(1+\phi)} \right] \left[ \left( \frac{\gamma}{1-\gamma} \right) \psi k / \left( 1 - \frac{\beta(1+\phi)^{\theta-1}}{(1+\pi)(1+n)} \right) \right] \quad (12)$$

Where  $\psi$  is the ratio of consumption to GDP and  $k$  is the inverse of the money supply multiplier.

#### 4- Estimation Procedure

The generalized method of moments (GMM) technique as described in Hansen (1982) and Hansen and Singleton (1982) is used to estimate each pair of Euler equations. The two Euler equations are estimated as a system. The intuition behind the GMM procedure is relatively simple. Dynamic optimization problems yield a set of stochastic Euler equations that must be satisfied in equilibrium. The Euler equations state that the representative agent's expectations are orthogonal to all of the variable in his / her information set at the time predictions are made. For the purpose of estimation, we rearrange equations (4) and (5), taking in to account utility specification (6), and define the disturbances of the model as,

$$d_{1t+1} = \beta \left( \frac{z_{t+1}}{z_t} \right)^{\theta \gamma} \left( \frac{c_{t+1}}{c_t} \right)^{\theta(1-\gamma)-1} \frac{(1+i_t)}{(1+\pi_{t+1})(1+n_{t+1})} - 1 \quad (13)$$

$$d_{2t+1} = \left( \frac{\gamma}{1-\gamma} \right) \frac{c_t}{z_t} + \beta \left( \frac{z_{t+1}}{z_t} \right)^{\theta \gamma} \left( \frac{c_{t+1}}{c_t} \right)^{\theta(1-\gamma)-1} \frac{1}{(1+\pi_{t+1})(1+n_{t+1})} - 1 \quad (14)$$

This set of Euler equations will serve for estimating of the parameters by fitting Euler equations to time series. Based on these orthogonality conditions, we estimate the parameters vector,  $\Omega = (\beta, \theta, \gamma)$ , by applying Hansen's (1982) generalized method of moments (GMM) to annually data for Iran covering the period 1970-2000. The method involves choosing instrumental variables that belong to the information set and invoking the orthogonality conditions embodied in the Euler equations, eqs. (13) and (14),

$$E_t[d_{t+1}(\Omega_0) \otimes I_t] = 0 \quad (15)$$

Where, the true vector of parameters,  $\Omega_0$ , should satisfy orthogonality conditions between disturbances,  $d_{t+1} = (d_{1\ t+1}, d_{2\ t+1})$ , and a set of instrumental variables,  $I_t$ . We can use these moment restrictions to estimate the parameters with nonlinear optimization methods. The sample moment corresponding to the expected value in eq. (15) is:

$$g_T(\Omega) = \frac{1}{T} \sum_{t=0}^T d_{t+1}(\Omega) \otimes I_t \quad (16)$$

If eq. (15) holds and the number of parameters is equal to the number equations in eq. (16) then the GMM estimates are the values of the unknown parameters that simultaneously set each equation in eq. (16) equal to zero. However, in most cases the number of equations is greater than the number of parameters, and the GMM estimator selects parameter estimates so that the sample correlations between the instruments and the disturbances are as close to zero as possible by minimizing the following quadratic form:

$$\min_{\Omega} : S = g_T'(\Omega) W_T g_T(\Omega) \quad (17)$$

Where,  $g_T(\Omega) = \frac{1}{T} \sum_{t=0}^T d_{t+1}(\Omega) \otimes I_t$  and  $W_T$  is consistent estimate of the covariance matrix of  $g_T$  that is a symmetric positive definite



weighting matrix. Hansen (1982) has shown that the minimized value  $s$  multiplied by  $T$  (the number of observations) denoted by  $J$ , has a  $\chi^2$  distribution with  $N_1N_2 - N_3$  degrees of freedom,  $N_1, N_2$  and  $N_3$  representing the number of instruments, the number of equations and the number of parameters, respectively.

## 5- Empirical Findings

The parameters vector,  $\Omega$ , are estimated with two-equations system, eqs. (13) and (14), using the generalized method of moments to annually data for Iran, 1970-2000. In this study, the aggregate time series used are as follow. Consumption is measured by total private consumption spending from the national accounts. Money is defined as the standard  $M_1$  or alternatively as the monetary base. All nominal variables are deflated by the GDP deflator and per capita measures are obtained by dividing aggregates by the existing population. The nominal one-period return on bonds is proxies by the yield on short-run bank deposit. Two proxies are used to measure inflation, GDP deflator and consumer price index (CPI).

In estimating the model, we used the following vector of instruments:

$$I_t = \left\{ \frac{c_{t+1}}{c_t}, \frac{c_t}{c_{t-1}}, \frac{z_{t+1}}{z_t}, \frac{z_t}{z_{t+1}}, \frac{1+i_t}{(1+n_{t+1})(1+\pi_{t+1})}, \frac{1}{(1+n_t)(1+\pi_{t+1})} \right\}.$$

With these six instruments and two equations, there are twelve orthogonality condition. Since the number of orthogonality exceeds the number of parameters, there are over identifying restrictions, and we can test the validity of these restrictions using the  $J_T$ -statistics reported on the table 1. The  $J_T$ -statistics is the minimized value of objective function times the number of observations. Under the null hypothesis that the model is correctly specified and over identification are satisfied, the  $J_T$ -statistics is asymptotically  $\chi^2$  distribution with degrees of freedom equal to the number of over identifying restrictions [Hansen (1982)]. In this case, the critical  $\chi^2_9$  is 16.92 at 5 percent significance level. So we can not reject the null hypothesis and assume that the model is correctly specified. In other word, the  $J$ -test of over identifying restrictions easily indicates nonrejection of the MIUF model and the instrument sets employed in the

GMM procedure at the 5 percent significance level across all applied data. The estimation results of parameters vector are displayed in table 1.

**Table 1: GMM estimate for parameters of Euler equations**

parameter	CM	DM	CH	DH
$\beta$	0.99 (0.0071)	1.073 (0.0226)	0.99 (0.0071)	0.81 (0.0279)
$\theta$	-1.305 (0.0393)	-1.393 (0.0823)	-1.143 (0.0373)	-2.48 (0.1717)
$\gamma$	0.04 (0.012)	0.044 (.0011)	0.0369 (0.0009)	0.0401 (0.0007)
J	7.56	7.74	6.49	4.59
$\varepsilon$	0.433	0.418	0.467	0.287

\* The data definitions are as follows. CM: CPI and  $M_1$  per capita, DM: GDP deflator and  $M_1$  per capita, CH: CPI and monetary base per capita, DH: GDP deflator and monetary base per capita.

\*\* Standard errors are shown in parentheses.

All structural parameters are statistically significant and economically meaningful. The estimated discount rate,  $\beta$ , is significantly greater than zero at the 1 percent level, the only exception being DM case. The results provide some support for the view that real balances provide liquidity services that directly contribute to utility. In other word, money services seem to provide statistically significant transactions cost-reducing, precautionary and store-of-value services. The estimated share of expenditures devoted to money  $\gamma$  is significantly greater than zero at the 1 percent level and lies between 0.037 and 0.044. All estimated values for  $\theta$  are negative and range from a low of -2.48 to a high of -1.143, that imply concave utility. The estimates of  $\theta$  point to a high risk



aversion coefficient and to a low intertemporal elasticity of substitution. That is, the latter ranges from 0.287 to 0.467.

Based on the parameter estimates obtained in this section and based on eq. (10) and (12), we made some estimates from the welfare cost of inflation and from seigniorage revenue as a percentage of GDP for Iran. For these calculations, we use the following parameters values:

**Table 2: The value of parameters**

$\beta$	$\gamma$	$\theta$	$\psi$	$\phi$	$n$
0.99	0.04	-1.305	0.6	0.013	0.0273

Where the parameters values for  $\beta$ ,  $\gamma$ ,  $\theta$  are chosen from the estimates and the values for  $\psi$ ,  $\phi$ ,  $n$  correspond to the annually sample means of the share of consumption in GDP, the rate of change of real GDP per capita and population growth rate, respectively. Table 3, reports the results for the welfare cost of inflation, seigniorage as a percentage of GDP and for the inflation rate elasticity of money demand. The second column of table 3 displays the welfare cost, as percents of GDP, associated with increasing inflation from zero to a positive rate. We use eq.(10) to compute the decrease in per capita consumption (expressed as percent of GDP) that would generate the same welfare loss as that from increasing inflation from zero to a given rate in the table. From table 3 we see that a shift from zero inflation to an annual rate of inflation of 10 percent results in a loss in utility equivalent to 2.04 percent of GDP. This is more than double to the Lucas'(2000) estimate for united states. Moreover, our estimates for the welfare loss due to an increase in the inflation rate from 10 percent to 20 percent are equivalent to about 1 percent of GDP. As evident from table 3, for low rate of inflation welfare cost markedly increase with increase in inflation, but then welfare cost reaches an asymptote, 7 percent of GDP.

**Table 3: Welfare cost of inflation, money demand elasticity and seigniorage ratio**

$\pi$	$W_i$	$\xi$	$SR$
0	0	0	1.40
3	0.85	0.78	1.69
5	1.26	0.83	1.81
8	1.77	0.84	1.91
10	2.04	0.84	1.97
12	2.28	0.83	2.00
15	2.59	0.82	2.05
18	2.85	0.81	2.09
20	3.01	0.80	2.10
25	3.34	0.77	2.14
30	3.62	0.74	2.16
40	4.04	0.70	2.20
50	4.37	0.65	2.23
70	4.83	0.58	2.25
100	5.27	0.49	2.28
$\infty$	6.93	0	2.33

The third column of table 3 reports seigniorage as a percent of GDP. There are two features of these seigniorage calculations. First, as can be seen in table 3, the ratio of seigniorage to GDP is an increasing function of the rate of inflation. That is, government can raise more revenue by increasing monetary base growth and inflation. This finding does not support the notion that inflation rates in Iran exceeded the revenue-maximizing rate. Second, although the gains to government from increasing inflation from zero to 10 percent per year are of about 2 percent, the gains from further increasing inflation are of a small order of magnitude. For example, shifting from a annually rate of inflation of 10 percent to 25 percent generally results in an increase in revenue of only 0.17



percent of GDP. As shown in the table seigniorage rapidly reaches an asymptote, 2.33 percent of GDP. So our empirical finding shows, stability of seigniorage ratio despite of wide fluctuations in the rate of inflation. The calculated values for seigniorage under mild and high inflation correspond nearly with 2 percent of GDP.

Table 3 also reports values of the inflation rate elasticity of money demand. Notice that this elasticity first increases with the rate of inflation, reaches a maximum and then decreases with further increases in inflation.

## 6- Conclusions

This study quantifies the welfare loss of deviating from a zero inflation policy. To do this, we have presented estimates from parameters of a model that treats consumption and money demand behavior as jointly arising from a single optimizing framework of a representative agent, as in the modern monetary theory. The first-order-conditions for optimization yield a system of equation that is used to estimate parameters vector by using GMM technique based on data for Iran, 1970-2000.

All estimated parameters are statistically significant and economically meaningful and we have shown that the representative agent model is consistent with the data. The results lend some support to the view that real balances provide valued services that significantly contribute to the agent utility flow. Additionally, the MIUF can not be rejected and the estimated share of money is approximately 0.04 in all cases examined.

Here, we found that while inflation fluctuated, the ratio of seigniorage remained in 2 percent of GDP. The results on seigniorage rates shows that seigniorage rate is an increasing function of inflation rate, but it reaches an asymptote. It does not have the shape of the Laffer curve. Although changes in inflation were not accompanied by marked fluctuation in seigniorage, they had a strong impact on welfare in steady state. Based on the model's estimated parameters the steady state welfare cost of 10 percent inflation is 2 percent of GDP and the welfare cost of 50 percent (the rate of inflation in 1995 in Iran) is about 4.37 percent of GDP.

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