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# Estimation of Seigniorage Laffer curve in IRAN: A Fuzzy C-Means Clustering Framework

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## Abstract

*There are two sources for governments to raise their revenues. The first is the direct taxation levied on output, and the second is seigniorage. Seigniorage is also known as printing new money and is defined as the value of real resources acquired by the government through its power of sovereignty on its monopoly of printing money. The purpose of this paper is to examine the Laffer curve for Seigniorage in the economy of Iran through data-set collected from the statistical books of the central bank of Iran related to the time period 1979-2010. For this purpose, we use a methodology that is based on the Fuzzy C-Means algorithm that is widely used in the context of pattern recognition, and the Takagi-Sugeno approach which is proper for modeling fuzzy systems. This methodology is exceptionally flexible and provides a computationally tractable method of*

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*dealing with non-linear models in high dimensions. Our findings support a standard Laffer curve shape in Iran. In other words, it will be concluded through empirical results that there is a nonlinear relationship between seigniorage and inflation for the economy of Iran in the time period studied in this paper.*

***Keywords**: Seigniorage, Takagi-Sugeno approach, Fuzzy systems, Bootstrap, Iran*

***JEL Classification:** E43, E52, E62*

# 1. Introduction

Seigniorage is also known as printing new money and is defined as the value of real resources acquired by the government through its power of sovereignty on its monopoly of printing money (Begg, Fischer and Dornbusch, 1994). Money creation is one potential source of revenue for a government, which is a relatively inexpensive way of raising funds. Excessive reliance on seigniorage results in higher inflation and sometimes in hyperinflation. Inflation is just like a tax (Mankiw, 1987). As a tax, it has the benefit of being source of revenue for the government and it has the cost of altering the behavior of private sector. These costs are not very high for the moderate inflation commonly seen in industrial or developed countries (Foote, 2010: pp. 58), but for developing countries, these costs can cause drastic social results. The existence of benefit as well as cost side makes it imperative for policymakers to optimize when they set the size of seigniorage. In developed economies, governments tend to resort little to seigniorage and rely on taxation and bond sale, or borrowing instead of financing their expenditures through seigniorage (Fischer, 1982); but it may be more important for countries such as Iran which do not rely on bonds or have less well-developed tax systems.

After liberalization of the financial markets by the 1980's, borrowing from the international financial markets has become the most common way of financing deficits for developing countries (Samimi et al., 2012: pp. 82-83). But when these countries lose their credibility as a result of debt crises, governments were forced to borrow from the central bank and commercial banking system. This requirement has forced central banks to print money. For a developing country, domestic borrowing possibilities, to a great extent, may increase inflation. In this case it is a question whether the governments could collect maximum seigniorage revenue thanks to its monopoly on printing money (Korap, 2006: 5).

Inflation tax is also one of the drastic results of high inflation. Inflation tax is a term which refers to the reduction in the real value of financial stocks in the hands of the people due to the effects of inflation. In other words, inflation tax has a welfare cost effect (Cooley and Hansen, 1989: 742). The real financial loss can be expressed as loss of purchasing power of money holder. Seignoirage revenue creates inflation and this inflation cause financial losses. The theory of optimal taxation states that in the presence of tax evasion and tax collection costs, it is optimal for governments to rely on inflation tax. Hence, according to the optimal theory, we can expect the developing countries to rely on inflation tax, when tax collection cost is high and the tax evasion exists. However, there is a limit in increasing inflation rate. Since, inflation tax revenues plotted against inflation indicates a Laffer curve relationship, after revenue maximizing inflation level, increase in inflation will result in decline in inflation tax revenues.

There should be positive correlation between printing money, namely seigniorage revenue, and inflation tax. According to the monetarist theory, an increase in the monetary base will increase monetary inflation. The rise in inflation reduces real money balances through a rising in the nominal interest rates. This affects the readjustment of cash between economic agents, and leads to a rise in stocks and reduction of private consumption (Dogru 2013). Due to the poorly developed domestic financial markets and the restrictions on foreign borrowing in Iran, the government could not finance the budget deficit through sources other than monetization. Financing budget deficit through borrowing from the central bank will increase money supply. The evidence related to the economy of Iran after 1973, shows that the actual rate of inflation generally has exceeded the corresponding rates that would maximize seigniorage. This means that the government could have obtained extra seigniorage with a lower rate of inflation.

Several studies have tried to consider seigniorage in recent years. Korap (2006) have investigated the courses of inflation tax and seigniorage revenue for policy makers of the Turkish economy. For this purpose, he first

constructed the ex-ante seigniorage revenue maximizing inflation model, and then calculated annual inflation tax and seigniorage revenues for the post-1980 period in Turkish economy. Following these theoretical issues, his empirical model have constructed upon the Turkish economy, and his ex-post estimation results revealed that inside the period considered, the Turkish economy lies on the correct or efficient side of the seigniorage maximizing Laffer curve. Ehrhart et al. (2009) developed a growth model with public investment as the engine of perpetual growth, and looked for the effect of deficit, tax and money financing on economic growth on a sample of developing countries. They studied in particular the way fiscal and monetary policies deform the GLC (Growth Laffer Curve). They found that when accounting for public investment, there exists a GLC between taxes and economic growth. Second, this GLC depends on both fiscal deficits and seigniorage. On the one hand, a lower deficit-to-GDP-ratio or a higher money-growth rate reduces the GLC-maximizing tax rate. This may explain why governments have difficulties in defining a fiscal policy that perfectly matches the optimal tax rate. On the other hand, a higher deficit ratio always moves the GLC downwards, while the effect of seigniorage is subject to nonlinearities. By using a regression model Jafari Samimi (2012) has proved relation between inflation and seigniorage revenue in a quadratic equation for the period 1974-2007 in Iran.

Since money creation is associated with inflation, it is important to examine the relationship between inflation and seigniorage whether a Laffer curve relationship exists between seigniorage revenue and the rate of inflation. Then, in this paper we investigate the Laffer curve relationship between seigniorage revenue and inflation rate for the economy of Iran by using time series data-set for the time period 1979-2010.

The paper is structured as follows: Section two begins with a brief overview of seigniorage revenue that shows how it fits into a broader picture

of government finance. Section three presents data and methodology. Section four focuses on the empirical analysis of seigniorage and inflation rate, and eventually the last section; section five, is a conclusion deduced from the whole subjects and approaches discussed in the paper.

## 2. Literature Review

One way that governments can obtain goods and services is to print money that is used to purchase resources from the private sector. However, to understand the revenue implications of inflation (and the government's revenue needs); one must start with the government's budget constraint. Consider the following identity for the fiscal branch of a government (Carl E Walsh 2010, pp. 136 to 139):

$$G_t + i_{t-1}B_{i-1}^T = T_t + (B_t^T - B_{t-1}^T) + RCB_t \quad (1)$$

The left side consists of government expenditures on goods, services, and transfers $G_t$, plus interest payments on the outstanding debt $i_{t-1}B_{i-1}^T$, and the right side consists of tax revenue $T_t$, plus new issues of interest-bearing debt $B_t^T - B_{t-1}^T$, plus any direct receipts from the central bank $RCB_t$.

The monetary authority, or central bank, also has a budget identity that links changes in its assets and liabilities. This takes the form:

$$(B_t^M - B_{t-1}^M) + RCB_t = i_{t-1}B_{i-1}^M + (H_t - H_{t-1}) \quad (2)$$

Where $B_t^M - B_{t-1}^M$ is equal to the central bank's purchases of government debt, $i_{t-1}B_{i-1}^M$ is the central bank's receipt of interest payments from the Treasury, and $H_t - H_{t-1}$ is the change in the central bank's own liabilities. These liabilities are called *high-powered money*, or sometimes *the monetary base*. By letting $B = B^T - B^M$ be the stock of government interest-bearing debt held by the public, the budget identities of the Treasury and the

central bank can be combined to produce the consolidated government sector budget identity:

$$G_t + i_{t-1}B_{i-1}^T = T_t + (B_t - B_{t-1}) + (H_t - H_{t-1}) \quad (3)$$

According to (3), the value of government purchases $G_t$, plus its payment of interest on outstanding privately held debt $i_{t-1}B_{t-1}$, must be funded by revenue that can be obtained from one of three alternative sources. First, $T_t$ represents revenues generated by taxes (other than inflation). Second, the government can obtain funds by borrowing from the private sector. This borrowing is equal to the change in the debt held by the private sector, $B_t - B_{t-1}$. Finally, the government can print currency to pay for its expenditures, and this is represented by the change in the outstanding stock of non-interest-bearing debt, $H_t - H_{t-1}$. Equation (3) can be divided by the price level $P_t$ to obtain:

$$\frac{G_t}{P_t} + i_{t-1}\left(\frac{B_{i-1}^T}{P_t}\right) = \frac{T_t}{P_t} + \frac{(B_t - B_{t-1})}{P_t} + \frac{(H_t - H_{t-1})}{P_t} \quad (4)$$

Or:

$$\frac{B_{t-1}}{P_t} = \left(\frac{B_{t-1}}{P_{t-1}}\right)\left(\frac{P_{t-1}}{P_t}\right) = b_{t-1}\left(\frac{1}{1+\pi_t}\right)$$

Where $b_{t-1} = \frac{B_{t-1}}{P_{t-1}}$ represents real debt and $\pi_t$ is the inflution rate.With the convention that lowercase letters denote variables deflated by the price level, the government's budget identity is:

$$g_t + \bar{r}_{t-1}b_{t-1} = t_t + (b_t + b_{t-1}) + h_t - \frac{h_{t-1}}{(1+\pi_t)} \quad (5)$$

Where $\bar{r}_{t-1} = \left[\frac{1+i_{t-1}}{1+\pi_t}\right] - 1$ is the ex post real return from $t-1$ to $t$.To highlight the respective roles of anticipated and unanticipated inflation, let

$r_t$ be the exante real rate of return and let $\pi_t^e$ be the expected rate of inflation; then $1 + i_{t-1} = (1 + r_{t-1})(1 + \pi_t^e)$. Adding $(r_{t-1} - \bar{r}_{t-1})b_{t-1} = (\pi_t - \pi_t^e)(1 + r_{t-1})b_{t-1}/(1 + \pi_t)$ to both sides of (5), and rearranging, the budget constraint becomes:

$$g_t + r_{t-1}b_{t-1} = t_t + (b_t + b_{t-1}) + \frac{(\pi_t - \pi_t^e)}{(1 + \pi_t)} \\ (1 + r_{t-1})b_{t-1} + \left[h_t - \left(\frac{1}{1 + \pi_t}\right)h_{t-1}\right] \quad (6)$$

The third term on the right side of this expression, involving $(\pi_t - \pi_t^e)b_{t-1}$ represents the revenue generated when unanticipated inflation reduces the real value of the government's outstanding interest-bearing nominal debt. To the extent that inflation is anticipated, this term will be zero; $\pi_t^e$ will be reflected in the nominal interest rate that the government must pay. Inflation by itself does not reduce the burden of the government's interest-bearing debt; only unexpected inflation has such an effect. The last bracketed term in (6) represents seigniorage, the revenue from money creation. Seigniorage can be written as:

$$s_t \equiv \frac{H_t - H_{t-1}}{P_t} = (h_t - h_{t-1}) + \left(\frac{\pi_t}{1+\pi_t}\right)h_{t-1} \quad (7)$$

Then seigniorage arises from two sources. First, $h_t - h_{t-1}$is equal to the change in real high-powered money holdings. Since the government is the monopoly issuer of high-powered money, an increase in the amount of high-powered money that the private sector is willing to hold allows the government to obtain real resources in return. In a steady state (7) shows that seigniorage will equal:

$$\left(\frac{\pi}{1+\pi}\right)h = \left(\frac{\theta}{1+\theta}\right) \quad (8)$$

Therefore, for small values of the rate of inflation, s (seigniorage) can be thought of as the product of a tax rate of $\pi$, the rate of inflation, and a tax base of h, the real stock of base money. Since base money does not pay

interest, its real value is depreciated by inflation whether or not inflation is anticipated. One should consider the government's budget constraint expressed in terms of the total liabilities of the government. Using (6), (7), and $d = b + h$, the budget constraint can be rewritten as:

$$g_t + r_{t-1}d_{t-1} = t_t + (d_t + d_{t-1}) + \frac{(\pi_t - \pi_t^e)}{(1+\pi_t)}$$
$$(1 + r_{t-1})d_{t-1} + \left[\left(\frac{i_{t-1}}{1+\pi_t}\right)h_{t-1}\right] \quad (9)$$

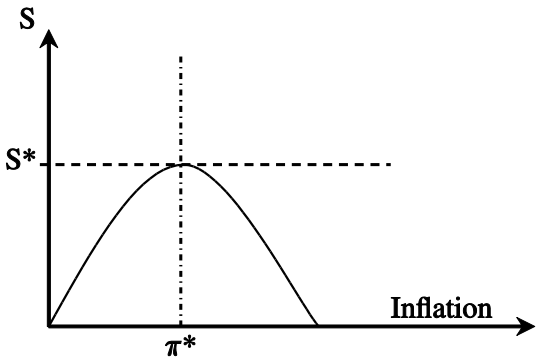
Seigniorage, defined as the last term in (9.1), becomes:

$$\bar{s} = \left(\frac{i}{1+\pi}\right)h \quad (10)$$

Then, the various forms of the government's budget identity suggest various alternative measures of the revenue from money creation. In this paper seigniorage revenue is calculated following Klein and Neumann (1990) and is equal to the change in monetary base $\frac{\Delta H}{GNP}$ that seigniorage here is smoothed by gross domestic product (GDP).

**Laffer curve:** The Laffer curve is a theoretical representation of the relationship between government revenue raised by taxation and all possible rates of taxation. As taxes increase from low levels, tax revenue collected by the government also increases. It also shows that tax rates increasing after a certain point (T*) would cause people not to work as hard or not at all, thereby reducing tax revenue. Eventually, if tax rates reach 100% (the far right of the curve), then all people would choose not to work because everything they earn would go to the government. The budget identity of the public sector states that the excess of public sector outlays over revenues is financed by printing money, some economists regarded seigniorage as a form of inflation tax.

Figure 1. Laffer curve




As inflation rate increases to $\pi^*$ in figure 1, the response of velocity to the inflation rate also gives rise to what terms the 'seigniorage Laffer curve', in which the revenue from the inflation tax (seigniorage) first rises, then falls with increases in the rate of inflation.

In this article, this curve is estimated directly instead of the usual approach which is a byproduct of demand for money empirical estimates.

## 3. Methodology

An important part of economical investigations has been recently related to stable specification of empirical models especially in monetary. One of the most important reasons for instability is alteration affected by sociopolitical events such as revolution, sanction, etc. and also economic political decisions. These reasons lead to fundamental changes in economy and cause complexity of economic models. This is the event known as Lucas critique in economic and is about the changes in fundamental and structural equations and parameters in economy during the time. After Lucas critique, different studies verified instability of parameters through different models such as Regime Switching Regression. These models have different parameters in different regimes. Therefore they are nonlinear models even if they have been assessed through linear approaches.

It should be noted that the sociopolitical and cultural shocks are not measurable precisely. They could be assessed accordingly through Fuzzy approaches, when we intend to assess their effects on variables in economy. Fuzzy approaches are used when we deal with vagueness and uncertainty as a result of non- specificity and confusion in evidences and measures.

For this purpose, we use a methodology that is based on the Fuzzy c-Means algorithm (Takagi and Sugeno, 985). These tools have been applied widely in many disciplines since the seminal contributions of Zadeh (1965, 1987) and his colleagues. These applications are numerous in such areas as computer science, system analysis, and electrical and electronic engineering. Josef *et al*. (1992) used this broad approach in the context of modeling with panel data. Lindstrm (1998) used fuzzy logic in a rather different way to model fixed investment in Sweden on the basis of the level and variability in the real interest rate. Giles and Stroomer (2004) have presented a new filter to extract the cyclical component from an economic time-series by using c-Means clustering.

Takagi-Sugeno fuzzy system which is used base on fuzzy clustering in this paper includes three steps:

First, the sample data are partitioned into a number of "fuzzy clusters". Second, a regression model is fitted separately over each cluster. Finally, the fitted models for each cluster are combined in a weighted average fashion, the weights being the "degrees of membership" that associate each of the original sample points with each of the fuzzy cluster. Because these weights vary continuously through the sample, even if linear models are fitted to each cluster, the weighted average model can capture very complex non-linearities with ease (Giles and Stroomer, 2004).

We use a fuzzy clustering approach by the membership function $\mu_A(p): P \rightarrow [0,1]$, which defines a degree of membership of $p \in P$ in a fuzzy set A. Giles and Draeseke (2003). Let $p_k$ be the k'th. Data-point (k=1,

2,…, n). Let $v_i$ be the center of the I'th. Cluster (i=1, 2,…, c). Let $d_{ik} = \|x_k - v_i\|$ be the distance between $x_k$ and $v_i$; and let $u_{ik}$ be the "degree of membership" of data-point "k" in cluster "I", where: $\sum_{i=1}^{c} u_{ik} = 1$. The objective is to partition the data-points into "c" clusters, and simultaneously locate those clusters and determine the associated "degree of membership", so as to minimize the function:

$$j(u, v) = \sum_{i=1}^{c} \sum_{k=1}^{n} (u_{ik})^m (d_{ik})^2$$

Noting the relationship between the $d_{ik}$'s and the $v_i$'s above, the membership values and the center of the fuzzy clusters are obtained iteratively as:

$$u_{ik} = 1 \Big/ \{ \sum_{j=1}^{c} [(dik)^2 / (d_{jk})^2]^{1/(m-1)} \}.$$

$$v_t = [\sum_{k=1}^{n} (u_{ik})^m x_k] / [\sum_{k=1}^{n} (u_{ik})^m; \qquad i = 1,2,...,c$$

To see how this methodology can be incorporated into an econometric framework, consider a simple regression model with a dependent variable, *S*, and a single regressor, *P*. then, we assume that there is a single input variable. So the fuzzy relationship is of the form:

$$s = f(p) + \varepsilon \tag{11}$$

Where $\varepsilon$ is a random disturbance term. There is no need to make any distributional assumptions about the latter. Note that this modeling strategy is essentially a semi-parametric. The identification and estimation of the fuzzy model then proceeds according to the following steps:

1. One would partition the sample into fuzzy clusters by applying the FCM algorithm (fuzzy c-means) to the *P* data. This generates the membership values for each p-value with respect to each cluster, and implicitly it also defines a corresponding partition for s.

2. Form a model by using data taken from each fuzzy cluster. Then if the chosen estimation procedure is least squares:

$$s_{ij} = \beta_{i0} + \beta_{i1} p_{ij} + \varepsilon \; ; \; j = 1, 2, \dots, n_i \quad , i = 1, 2, \dots, c \tag{12}$$

Where c is equal to number of clusters. It should also be noted that in fact any relevant estimation technique could be used at this stage.

3. The step 2 generates c sets of parameter estimations that are combined by using the membership values as the weights, to model the conditional mean of the dependent variable as follows:

$$\hat{s}_k = [\sum_{i=1}^{c} (b_{i0} + b_{i1} p_k) u_{ik}] / [\sum_{i=1}^{c} u_{ik}] \; ; \; k = 1, \dots, n \tag{13}$$

Where $u_{ik}$ is the degree of membership of the k[th] value of $p$ in the i[th] Fuzzy cluster, and $b_{im}$is the least squares estimator of $\beta_{im}$ obtained using the i'th, fuzzy partition of the sample.

The fuzzy predictor of the conditional mean p is a weighted average of linear predictors based on the fuzzy partitions of explanatory variables, with a membership value varying continuously through the sample observations. The effect of this condition is that the non-linear system can be effectively modeled. This approach is very similar to the inclusion of dummy variables in an econometric variable. By allowing interaction of dummy-variables and independent variables, we also specify local sub-models. While the number and location of the sub-periods is determined endogenously by the data in the fuzzy approach, they have been imposed exogenously after visual data inspection in our econometric model. However, this is not a fundamental

difference because the number and location of the sub-periods could also be determined automatically by using econometric techniques.

In addition, it can be seen that the separate modeling over each fuzzy cluster involves the use of fuzzy logic of the form "*If* the input data are likely to lie in this region, *then* this is likely to be the predictor of the output variable", etc. The derivative of the conditional means with respect to the input variable also has this weighted average structure, and the same potential for non-linearity.

Under very mild conditions on the input data and the random error term, fitting the sub-models over each fuzzy cluster yields a weakly consistent predictor of the conditional mean of the output variable. The partitioning of the sample into fuzzy clusters, and the determination of the associated membership functions, involves using only the explanatory variable data in a non-stochastic manner. If the explanatory variables are exogenous then so will be the membership values that are used to construct the weighted averages of the least squares predictors in Step 3 above. Then, the fuzzy predictor of the conditional mean of $y$ at Step 3 will be weakly consistent (David E. A. Giles, 2001).

Alternatively, all of the confidence intervals can be computed using the bootstrapping method. This has the merit of generating results that are specific to our particular sample size and sample values, and this is the approach that we have adopted in our application here, for fuzzy modeling. Our bootstrap algorithm can be summarized as follows:

1. Estimate the model (12) for each fuzzy cluster.
2. Sample with replacement from the vector of residuals for the cluster at hand. This will produce a new vector of residuals over that cluster.

3. Calculate new$y_i's$ over the cluster at hand using the independent variables for that cluster, the set of parameter estimates and the residuals produced in step 2.
4. Use the new $y_i's$ with the independent data to estimate a new $\beta_i$ for each current cluster.
5. Go back to step 2 above and repeat (say) 100 times.
6. Finally, we calculate a percentile confidence interval to these 100-repetitions of coefficients.

## 4. Empirical Results

Data-set are gathered from Iran Central bank data-set yearly during 1979-2010. Consumer Price Index(CPI) is used to calculate inflation and Klein and Neumann (1990) is used to calculate seigniorage revenue and is equal to the change in monetary base $\frac{\Delta H}{GNP}$ that seigniorage here is smoothed by gross domestic product (GDP). Then seigniorage revenue is equal $\frac{\Delta H}{GDP}$. We apply our fuzzy analysis to the model with two fuzzy clusters, and $m = 2$:

$$S_t = \beta_1 + \beta_2 p_t + \varepsilon_t$$

Where $S_t$ is seigniorage revenue and $p_t$ is inflation rate. The estimation results appear in Table 1. The membership functions associated with the fuzzy clustering of the inflation rate data appear in Figure 2.

## Table 1: Fuzzy Regression Results and Bootstrap Confidence Interval (%95), Mean of Tax Revenue of Government

| Fuzzy Cluster | Ranked observation | Slope | Intercept | Mean of tax revenue of government | $R^2$ |
|---|---|---|---|---|---|
| **1** | 1979-1980,1982-1985,1989-1991,1997-2007,2009-2010 | -0.0001480 [-0.0001482-0.0001473] | 0.0660852 [0.0660813 ,0.660867] | 65147.4 | 0.89 |
| **2** | 1981,1986-1988,1992-1996,1999 | 0.00057860 [0.0005296 ,0.0006261]* | 0.0223842 [0.0215177, 0.0230568]* | 27653.8 | 0.67 |

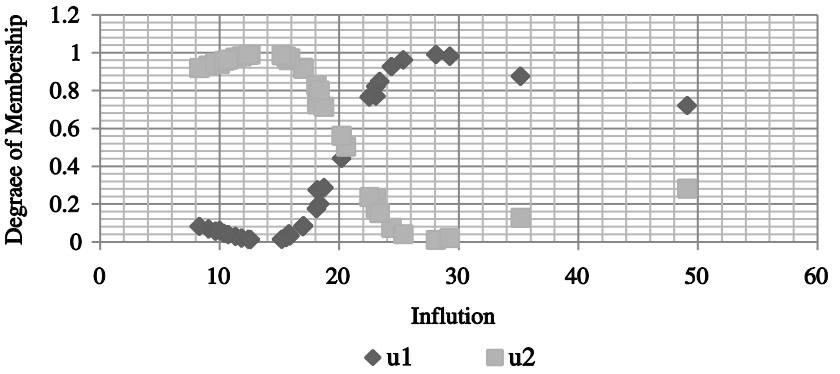
**RMS ERROR-00.0202073**

**Diagnostic Tests**

| Fuzzy Cluster | Test | Estimation | P.V |
|---|---|---|---|
| **1** | **ARCH** | 0.159 | 0.923 |
| | **White** | 0.493 | 0.903 |
| | **D.W** | 1.90 | ……. |
| **2** | **ARCH** | 1.109 | 0.277 |
| | **White** | -0.69 | 0.496 |
| | **D.W** | 1.70 | …… |

*Source:* Results of research, estimated by Matlab software

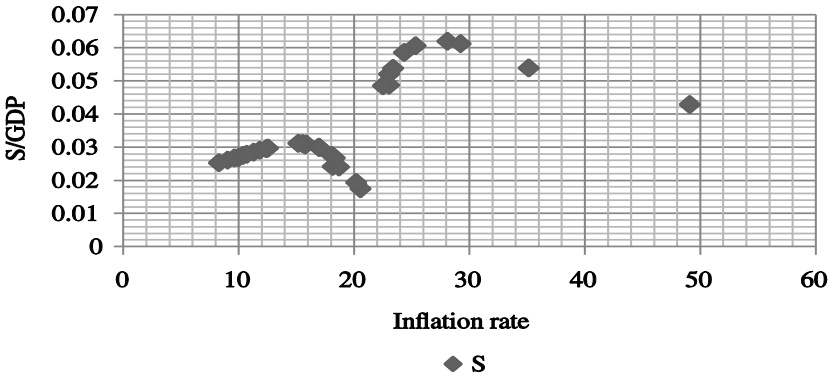
**Figure 2: Membership Function**




With regards to Table 1, all coefficients are hardly meaningful for two fuzzy clusters.

Figure 3 shows the inflation rate Laffer curve in comparison with the proportion of seigniorage revenue to GDP. This curve includes two Laffer curves. The curve located on the left is related to first cluster and the opposite belongs to second cluster.

**Figure 3: Inflation Rate Laffer curve in Contrast With the Proportion of Seigniorage Revenue**



As to left and right curves in Figure 3, with increase of inflation rate, government's seigniorage revenues begin to reduce accurately from the points fifteen percent (15%) and twenty eight percent on the curves. for each two curves, from the inflation rates of 15 and 28 percent correspondingly, economy will be placed in the imprecise side of Laffer curve. In other word, if government decides to raise the proportion of seigniorage revenues, higher inflation rate will be compelled to economy. Concerning the curves, it will be derived that having three percent (3%) increase in portion of seigniorage revenue to GDP, will be led to at least fifteen percent increase (15%) in inflation. Therefore the results reveal a linear relation between inflation rate and seigniorage revenues in Iran economy in the period 1979-2010.

Jafari Samimi reported the amount 15.24 by using the regression models for the economy of Iran in the period 1947-2007, which is according to the maximum placed in left on Laffer curve in Figure 3. The researcher in another study by using threshold regression has reported that the inflation rate which causes government to earn the maximum seigniorage revenue is included in range 22-27 in Iran. The results placed in the left side on Laffer curve in Figure 3 are also included in this range.

Regarding Table 1, the government's mean of tax revenue in first cluster belonged to the left curve in figure 1, is roughly 65147.4 (Milliard Rials) and it is approximately 27653.8 (billion Rials) for second cluster belonged to right curve in figure 3. Therefore, it could be concluded that for the years in second cluster given in table 1 (right curve in figure 3), the government's mean of tax revenues were lower and consequently government has chosen higher inflation level in order to afford its costs and also to gain more seigniorage revenue. On the other hand, there is an inefficient tax system and collection costs are high, there is no advanced financial market and the proportion of oil revenue in the government revenue is very high and volatile. Moreover, it should be pointed out that the oil price and the amount of oil exports of Iran are exogenously determined in the world market and OPEC respectively. Consequently, the government uses Seigniorage to

smooth its spending, which demonstrates the link between fiscal and monetary. We have shown this link on diagram in Figure 4. Concerning to the diagram, when the rate oil revenues/GDP has decreased; government's seigniorage revenues/GDP has increased.

**Figure 4. Oil revenues/GDP in contrast with government's seignorage /GDP**

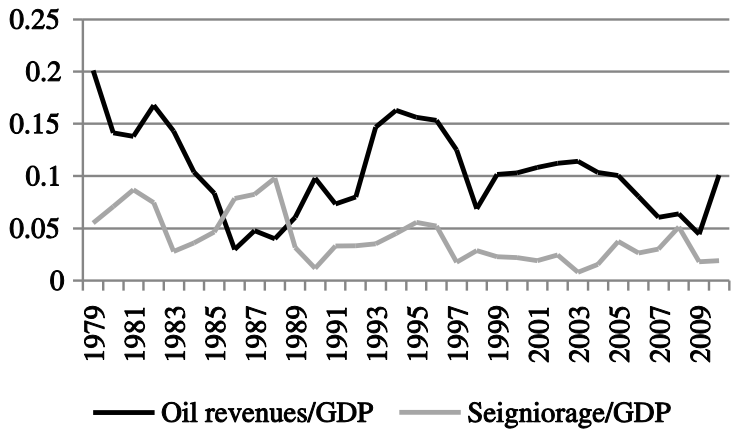
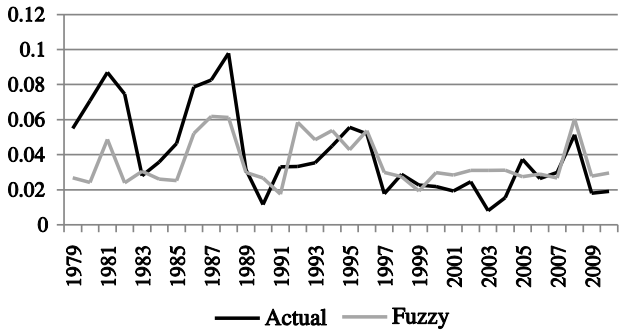


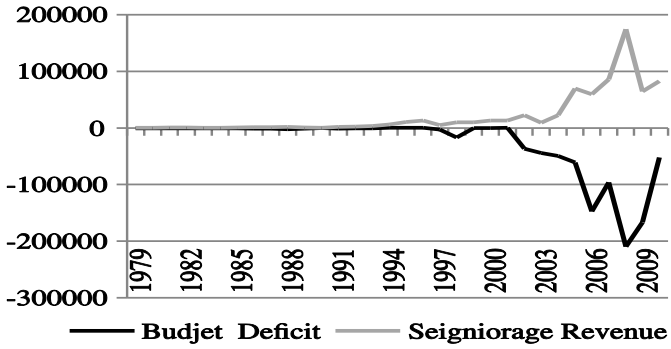

Figure 5 presents the real values for proportion of government's seigniorage revenue to GDP in contrast with simulated values obtained through fuzzy approach which its RMS ERROR criterion is described in Table 1.

**Figures 5: Actual Values of Proportion Seigniorae in Contrast With Simulated Values Obtained through Fuzzy Approach**




With relation to Figure 6 which presents budget deficit, compared to government's seigniorage revenue, it's clear that with increase in deficit budget, there will be an increase in seigniorage revenue.

**Figure 6: Budget Deficit in Contrast With Government's Seignorate Revenue**



## 5. Conclusion

Developing economies often rely heavily on financing the deficit by printing new money–also called seigniorage. But revenues acquired through seigniorage coerce inflation to the economy. Inflation is just like a tax as it generates revenues for the government – though distorts private sector behavior.

This paper is intended to search for the state of existing evidences which reveal a nonlinear relationship between seigniorage and inflation for Iran economy by using data-set pertaining to the time period 1979-2010. In fact, the Laffer curve is a theoretical representation of a nonlinear relationship between government seigniorage revenue and inflation rate. In this article, this curve is estimated directly instead of the usual approach which is a byproduct of demand for money empirical estimates.

For this purpose, we have used a methodology that is based on the Fuzzy c-Means algorithm. This approach is very similar to the inclusion of dummy variables in an econometric model. Therefore, we've obtained two Laffer curves through this approach to different years in the period 1979-2010. In other word, it has been proved that if government decides to raise the proportion of seigniorage revenues, higher inflation rate will be compelled to economy.

It could generally be inferred that we always need to determine the part where the government's seigniorage revenue is placed in the Laffer curve. If the seigniorage revenue is located on the right side, government with improvement in its performance could have the same revenue level with lower inflation rate. Consequently, government should arrange its costs and revenues in the way that prevent deficit and if deficit is inevitable, the money printing should be kept in balance and in case of excessive money creation, inflation will be resonated.

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