Inflation and Inflation Tax in Iran: A Threshold Regression 'Laffer Curve' Model

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Abstract: The purpose of this paper is examining the Laffer curve for inflation tax. To do so we have used Hansen (1996, 2000), threshold regression model to study whether a non-linear relationship between inflation Tax and inflation based on two regimes of inflation (low and high inflation regimes). Our findings support a standard Laffer curve shape in Iran with a threshold inflation rate of 15.24 percentage points. In other words, only at inflation below this rate inflation tax will increase as a result of higher inflation.

Key words: *Seigniorage, Inflation tax, Threshold Regression, Laffer curve*

1. Introduction

The governments of developing countries usually spend more than they collect in revenues. The resulting deficits can be financed in three different ways: by borrowing from non-bank public, by borrowing from the rest of the world, or by borrowing from the banking system, including the Central Bank. The first source is relatively limited in developing countries because their capital markets are poor or there is no such market at all, or because this method of financing is not being accepted by people in these countries who usually think that government borrowing means government bankruptcy.

Since 1980s many developing countries have come to rely on foreign borrowing to help finance their increasing public sector deficits¹. When external funding began to decrease as a result of debt crisis and so on, governments were forced to reduce their fiscal deficits or to finance them from the banking system. Some countries were able to reduce their fiscal deficits, but many were not. Cutting expenditures, especially those to which people had become accustomed was difficult from a social and political point of view, and raising additional revenues was not always feasible². Therefore, most governments shifted their financial requirements to the banking system.

The important point which this paper concentrates on is that government makes a profit from issuing money because the cost of producing modern money (largely bank notes) is less than the face value. This profit on new money is called seigniorage which is typically a source of government revenue in developing countries. The purpose of this paper is to evaluate whether a non-linear relationship between inflation Tax and inflation based on two regimes of inflation (low and high inflation). To do so we have applied the Laffer curve for inflation tax and uses Hansen (1996, 2000) threshold regression model.

The remainder of this paper proceeds as follows: section 2 provides the meaning and the concepts of the government revenue from money creation. In section 3 the analytical and theoretical framework on the relationship between seigniorage and inflation will be discussed. Model specification represented in section 4.

¹- This indicates a major problem in developing countries because the loan is usually in foreign currency, whereas revenues are in the domestic currency (unless the government owns an important export activity, such as oil productions).

²- They lacked adequate instruments of taxation, and most of their external debt had been contracted at floating rates, so that the rise in real interest rates sharply increased the cost of servicing the debt.

The empirical analysis which is based on estimation of threshold value of inflation will be shown in section 5. The concluding section brings out the major implications of the paper.

2. Review of Literature

Several studies have tried to consider seigniorage in recent years. JafariSamimi (1997-98) examined the relationship between inflation and seigniorage in a sample of different developing countries via estimation of Laffer curve for the period 1965-1990. He concluded that although the typically inverted U-shaped Laffer curve is acceptable for developing countries, the government revenue from printing money arises from inflation tax only, which is a high costly method of financing government budget deficit. Tahsin (2003) has investigated the predictions of the theory of optimal seigniorage in developing countries over the period 1970-1999. He represented that the tax smoothing hypothesis, tested on forty selected developing countries, is rejected. However, the hypothesis that economies with high levels of expenditures and taxation also have high levels of inflation tax, tested on the forty selected developing countries and on a larger sample (up to 112 developing countries) could not be rejected. Korap (2006) has investigated the courses of inflation tax and seigniorage revenue for policy makers of the Turkish economy. For this purpose, he first constructed ex-ante seigniorage revenue maximizing inflation model, and then calculated annual inflation tax and seigniorage revenues for the post-1980 period Turkish economy. Following these theoretical issues, his empirical model has 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 (through deficit and seigniorage respectively) deform the GLC (Growth Laffer Curve). They found that when accounting for public investment, there exists a GLC between taxes and economic growth. Second, there is a 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. Combes et. al (2010) studied the potential substitution effect between seigniorage and deforestation revenues on a panel of developing countries. The results of their study have exhibited that there is a non-negligible substitution effect between seigniorage and deforestation revenues, which is, as suggested by the theoretical model, even stronger if the endogenous character of seigniorage is taken into account. As a consequence, disinflation policies as recommended by the IMF, may hasten deforestation.

3. Seigniorage and Inflation

Inflation erodes the value of all assets that are measured in nominal terms. Therefore we can consider inflation resulting from money creation as a tax on cash balances³. In a stationary economy with constant real income, the real government revenue from money creation or the tax (seigniorage) in equilibrium is equal to the rate of price times the real stock of money (due to additional demand for money as a result of inflation

³- To understand how the tax works, it is useful to begin with equation of exchanges (money supply *velocity = price * output). A government running a deficit covers by borrowing from the Central Bank. The money supply, via the usual credit multiplier, rises proportionately. From the equation of exchange, the price level rises in proportion to that, assuming economic activity and velocity constant. Therefore, though printing money, people view the government imposing a “tax” equal to the product of the rate of inflation (i.e. tax rate) and the money supply or monetary base (i.e. tax base). People, or to be precise asset holders, “pay” the tax by losing purchasing power on their money holdings. A government which has issued money “collects” the tax as income.

which is called “inflation tax”). This product in turn will be equal to the real value of the new money printed. In other words, we can write⁴:

$$R = \frac{dM}{p} = \pi \left(\frac{M}{p} \right) = \pi m \quad (1)$$

Where R is the real government revenue from money creation, $\frac{dM}{p}$ the real value of the new money printed, π the inflation rate (i.e. tax rate) and $m = \left(\frac{M}{p} \right)$ the real stock of money (i.e. tax base). It can be shown that the government revenue from money creation (i.e. R) is a maximum at the rate of inflation at which the elasticity of demand for money balances with respect to the rate of inflation is equal to unity⁵.

It should be mentioned, however, that the analysis of the government revenue from money creation (seigniorage) is typically treated in the framework of a steady state growing economy, where real income can no longer be fixed. For such an economy there are two sources of government revenue from money creation. The first part includes - as mentioned earlier - the “inflation tax” on holding of the stock of real money balances by the public which is due to additional demand for money as a result of inflation⁶. The second part is due to the people’s rising demand for real money balances as a result of an increase in their incomes to keep up with the growth of the economy - even if inflation rate is zero. Hence we have to add another term to equation (1).

Following Cagan (1956), Friedman (1971) and others⁷, thus, a government’s real revenues from money creation (seigniorage) as a percentage of GDP⁸, (i.e. R), can be written as the sum of two terms as shown by equation (2).

$$\frac{dy}{dx} R = \frac{dM}{py} = mg + m\pi \quad (2)$$

Where M is the equity of high powered money (or monetary base), π the rate of inflation, m the ratio of real money base to GDP, and g the rate of growth of real GDP. The first term in equation (2) arising from economic growth - induced increase in money demand (mg), and the second arising from inflationary money creation ($m\pi$) or the inflation tax.

From a mathematical point of view, we can write equation (2) in the following form:

⁴ - See (Friedman, 1953 & 1971); (Bailey 1956); (Cagan, 1956); (Johnson, 1969)

⁵ - To show this we can simply take the first derivative of R with respect to π from equation (1) and set it equal to zero. We have:

$$\frac{dR}{d\pi} = 0 \quad \text{or} \quad m + \pi \frac{dm}{d\pi} = 0$$

dividing both sides of the above equation by m we can write:

$$-1 = \frac{dm}{d\pi} \frac{\pi}{m}$$

⁶ - This part has been shown in Equations (1).

⁷ - As a theory of inflationary finance, the Cagan-Chicago tradition has emphasized that governments use inflation as a rational means of collecting revenue for deficit finance. This approach has led to models of optional inflation. Cagan (1956) introduced the notion of a revenue-maximizing rate of inflation and showed that most countries undergoing hyperinflations were inflating at well beyond revenue-maximizing rate. This approach was extended by others. For example see Friedman (1971), Barro (1972, 1983), Bruno & Fischer (1990) and Melnick & Sokoler (1984).

⁸ - The ratio of the change in high-powered money (i.e. the change in “reserve money” to nominal GDP) explains the command over resources, as a ratio to GDP that government obtained each year by creating high-powered money.

$$\frac{dy}{dx}R = \frac{dM}{py} = B0 + f(\pi) \quad (3)$$

Where $B0$ indicates the first part of the government revenue from money creation due to the growth of the economy- even if inflation is zero (i.e. $\frac{dy}{dx}R = mg = B0$ where $\pi = 0$), and $f(\pi)$ is the second part of government revenue from money creation (i.e. $m\pi$ or the inflation tax) which is a function of inflation rate. It might be thought that the seigniorage argument is related only to countries which have high inflation, but of course that is not the case⁹. It is shown in equation (2) and (3) that the revenue from money creation consists of two components.

Model Specification: We have used the following model based on JafariSamimi (1994):

$$\text{Inflation Tax} = F(\text{Inflation}) + \varepsilon_t \quad (4)$$

The non-linear model based on threshold regression as following:

$$\text{Inflation Tax} = F(\text{Inflation})A[\text{Inflation} \leq \gamma] + F(\text{Inflation})A[\text{Inflation} > \gamma] + \varepsilon_t \quad (5)$$

$$A[\text{Inflation} > \gamma] = \begin{cases} 1 & \text{if Inflation} > \gamma \\ 0 & \text{if Inflation} \leq \gamma \end{cases}$$

The threshold value γ can be found by estimating the regression (5) through finding the minimum Error Sum of Squared. In this paper we set "Inflation Rate" as the threshold variable. We can also apply the statistic coming from the threshold variable. For instance, we adopt the heteroskedasticity-consistent Lagrange multiplier (LM) of Hansen (1996), to test the null hypothesis of the linear assumption. Once the estimator can be found, we then start with the statistical test, but the test procedure of Regression (5) is different from the traditional test. Under the null hypothesis of no threshold effect, the threshold parameters will be unidentified. This will cause the traditional test statistic in a large sample distribution to not belong to the χ^2 distribution, but rather to a non-standard and non-similar distribution which is affected by nuisance parameters. This will cause the critical value of the distribution to not be estimated through simulation. In order to overcome the difficulty, Hansen (1996), uses a statistic of his own large sample distribution function to transfer and calculate the asymptotic p-value of a large sample. Under the null hypothesis, the distribution of the p-value statistic is uniform, and this kind of transformation can be calculated through bootstrap. In Eq. (5) H_0 refers to the regression equation that goes back to the linear model as Eq. (4) shows. This means that there exists no threshold effect. Conversely, it means that there exist different effects between the two regimes. Let S_0 and S_1 be the residual sum of squares under the null hypothesis and the alternative of Eq. (2), respectively. As such, the F-test is based on:

$$F = \frac{S_0 - S_1(\hat{\gamma})}{\hat{\sigma}^2} \quad (6)$$

4. Results

This paper uses Hansen (1996, 2000), threshold regression model to study whether a non-linear relationship between inflation Tax and inflation based on two regimes of inflation (low and high inflation). As Table 1 shows, we adopt Hansen (1996, 2000), advice to use the bootstrapping model. While the threshold variable is "inflation rate", we find that F-statistic is (13.26), which is significant at 1% level. The threshold value is 15.24%, and this means that one threshold exists. After making sure that the threshold effect exists, we analyze the linear and non-linear models.

Table 1: Threshold Tests

Threshold Variables	Inflation
p value of F test	0.00
Threshold Regime (%)	16.1

⁹ - see for example Phelps (1973) and Fischer (1983) on *optimal inflation in a theory of public finance*.

Source: Researcher calculations

Table 2: Inflation Tax and Inflation

<i>Variables</i>	<i>Linear Model</i>		<i>Non-Linear Model</i>			
Threshold value (%)		p-value	≤15.24	p-value	>15.24	p-value
Interception	15.63	0.0	-59.02	0.0	61.98	0.0
Inflation	544.62	0.0	1296.8	0.0	-716.2	0.0
R2	0.71		0.78			

Source: Researcher calculations

As table 2 indicates, in linear model, inflation has a significantly positive effect on inflation tax. In the non-linear model, when “inflation rate” is the threshold variable, in low inflation regime (inflation rate is less than 15.24), The inflation rate has a significantly positive impact on inflation tax. By contrast, when inflation rate is in high regime (inflation rate is larger than 15.24), the inflation rate has a significantly negative impact on inflation tax. So the inflation rate has a threshold value that it has a different effect on inflation tax based on two regimes of inflation rate. So, government makes a profit from issuing money because the cost of producing modern money (largely bank notes) is less than the face value. The inflation rate of 15.24% is a threshold inflation rate in Iran that this rate maximizes inflation tax for government. We have concluded that the inverted U-shaped Laffer Curve is acceptable for Iran economy. In the present time in Iran, inflation rate is higher than 15.24%, therefore, government should control inflation and decrease inflation rate for increasing inflation tax.

5. Conclusion

In recent years most governments in developing countries shifted their financial requirements to the banking system. As a result, governments make revenue from issuing money. This revenue is called seigniorage and in general consists of two parts, namely the rising demand for money to keep up with the growth of economy and the “inflation” tax.

This paper uses Hansen (1996, 2000) threshold regression model to study whether a non-linear relationship between inflation Tax and inflation based on two regimes of inflation (low and high inflation regimes). Empirical results indicate the Laffer curve in inflation tax exists in Iran. The threshold inflation rate is 15.24%. Therefore, in low inflation regime (inflation rate is less than 15.24), The inflation rate has a significantly positive impact on inflation tax. By contrast, when inflation rate is in high regime (inflation rate is larger than 15.24), the inflation rate has a significantly negative impact on inflation tax. The inflation rate of 15.24% is a threshold inflation rate in Iran that this rate maximizes inflation tax for government. We have concluded that the inverted U-shaped Laffer Curve is acceptable for Iran economy. In the present time in Iran, inflation rate is higher than 15.24%, therefore, government should control inflation and decrease inflation rate for increasing inflation tax.

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