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Seigniorage Revenue, Inflation Tax and Indian Economy: A Cointegration Analysis

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1. Introduction

There are two sources for governments to raise their revenues: The first source is the direct taxation put on output, and the second source is seigniorage. *Seigniorage* is also known as printing new money and 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). But, both sources of revenue cause deadweight social losses (Mankiw, 1987: 327-328), moreover inflation also brings some other social costs, such as reducing purchasing power of consumers, shoe leather costs, menu costs, variability in relative prices, imperfect indexation in the tax code and inconvenience. These costs are not very high for the moderate inflation commonly seen in industrial or developed countries (Foote, 2010: 58), but for developing countries, these costs can cause drastic social results.

Bailey [1956] points out that governments have been tempted to resort to open inflation as a method of financing a desired diversion of resources to the government sector of the economy, because of the apparently painless character of this method of diversion. He further points out that the argument against open inflation as a source of finance arises from the redistributive and disruptive aspects of inflation such as the hardship involved for people whose income and wealth are fixed in money terms and the misallocation of resources that may result from the heightened uncertainties concerning future relative and absolute prices. Bailey also points out that there is no evident numerical way to compare the costs of these disruptive and redistributive aspects and explains that inflationary finance has been employed at such tremendous costs because the costs in this form of finance are largely hidden as compared to other forms of taxation where the costs of administration and compliance are evident. Bailey,

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further, says that another aspect of open inflation is the 'welfare cost of open inflation', which in effect, is a tax on the holding of cash balance since a given rate of inflation is logically equivalent to an explicit tax on real cash balances. The mere anticipation of inflation leads individuals to reduce their stock of real cash balances until the marginal productivity of a dollar held in the form of real cash balances is balanced against the real rate of interest foregone plus the rate of inflation - the sum of the two being equal, when inflation is fully anticipated, to the money rate of interest. The real tax proceeds are equal to the stock of real balances people choose to hold after the inflation is announced multiplied by the rate of inflation [Marty, 1967].

On the other hand, 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. Seigniorage revenue creates inflation and this inflation cause financial losses. There should be positive correlation between printing money, namely seigniorage revenue, and inflation tax. According to optimal seigniorage theory, nominal interest rates and inflation are determined due to government's necessity to finance its budget deficit. If marginal cost of the tax is increasing with income, then a positive relationship will occur between inflation and nominal interest rates and taxes. The theory indicates that that nominal interest rates and inflation are individually random walks, but suggests that the nominal interest rates and inflation move together with tax rates. Mankiw tested this theory for the United States of America (USA) for the period 1952-1985, and provided some support for the theory (Mankiw, 1987: 327).

Many economists including Bailey (1956), Cagan (1956), Friedman (1971), Phelps (1973, 1972), Klein and Neumann (1990) and Marty (1967) analyse seigniorage revenue as a source of income to the government. In this point there are two different approaches trying to explain the relationship between seigniorage, nominal interest rates and inflation (Gürbüz et al, 2009: 55-56): The first approach belongs to monetarists. 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 a rise in stocks and reduction of private consumption. According to the second approach developed by Phelps (1973), seigniorage revenue is equal to the multiplication of nominal interest rates and real money balances. Then, Phelps suggests

that the income obtained by government depends on private sector's nominal interest rate's losses.

In this paper we investigate the relationship between real seigniorage revenue and inflation tax for Indian economy for the time period 1970-2015. The outline of the paper is as follows. Section two gives a brief introduction on Indian economy, inflation tax and seigniorage revenue, while section three introduces Mankiw's (1987) optimal seigniorage model. Section four estimates the empirical model and inference of econometric findings. The final section concludes the study.

2. Indian Economy, Inflation Tax and Seigniorage Revenue

We also make a chronological analysis between inflation (INF), inflation tax (INFTX) and seigniorage (SEIG) revenue of Indian economy between 1971 and 2015, presented in Figure 1. Indian economy lived a chronic high inflationary problem between 1970 and 1985. During this time period Indian economy has experienced an inflation rate between 0 to 28 per cent. After 1985 the inflation is sticky around 7- 13%. During 1973 to 1974 inflation rates reached about 27%. 1991 is a turning point in the Indian experience of inflation because of New Economic Policy 1990-91 of the Economy.

Definition of Inflation tax is obtained from Bailey (1956), i.e. multiplying annual change in consumer price index (CPI) with the previous year's monetary base ($\Delta CPI * M_0 (-1)/GDP$), while seigniorage revenue is calculated following Klein and Neumann (1990) and is equal to the change in monetary base ($\Delta M_0/GDP$). Both INFTX and SEIG is smoothed by gross domestic product (GDP), i.e. calculated as a share of GDP. The reference inflation used in this paper is the yearly change in CPI index. All the calculations based on the yearly data from 1970 to 2015 are obtained from electronic data service of the Reserve Bank of India (RBI). It is seen in figure 1 that Inflation tax curve is a rising from 1972 up to 2013. The inflation tax curve shows lower slope up to the year 1990-91 and shows very high slope during 2004 to 2014. Figure 1 also says that seigniorage revenue is volatile and stationary during the whole period of study. The respective differenced series are given in the appendix-A. From this Appendix –A, we know that all the differenced series are stationary.

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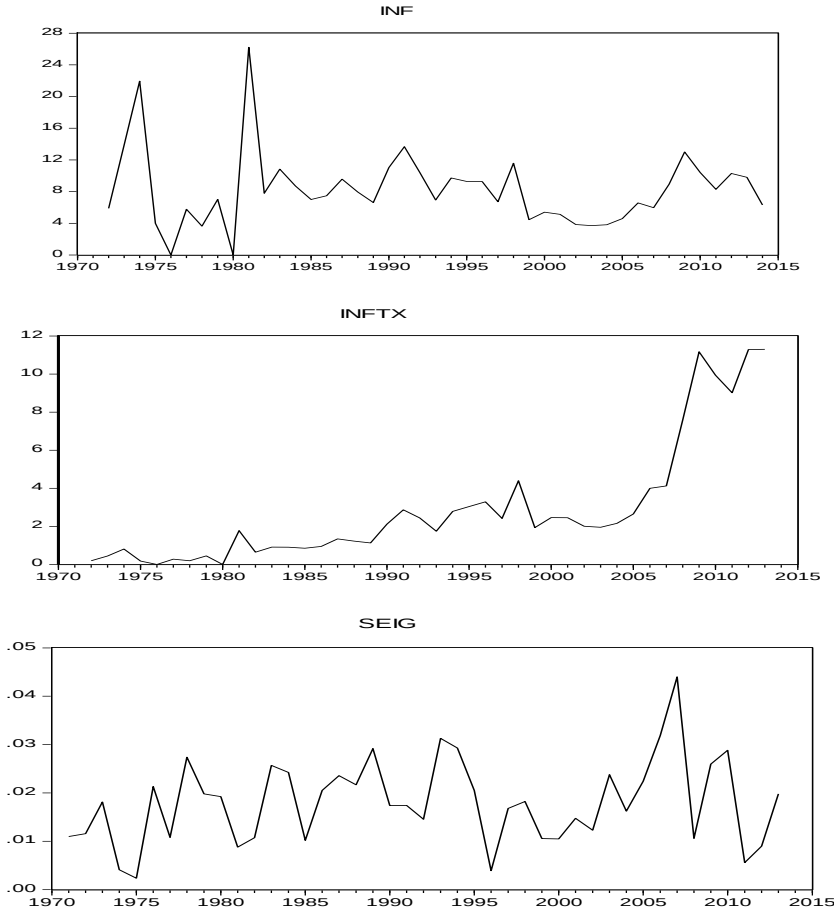
Figure 1: Inflation, inflation tax and seigniorage revenue as share of GDP



3. Mankiw's (1987) Optimal Seigniorage Model

Inflationary financing method of budget deficit is denoted by special terms: Inflation tax and seigniorage revenue. Seigniorage is defined as real revenue rose from monopoly power of government on printing money and demonstrated with $\Delta M/P$, rate of change in monetary base to the inflation (Klein and Neumann, 1990: 206). On the other hand inflation tax is a result of inflation and indicates the real capital losses of money holder, and defined as multiplication of inflation rate and real value of the

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(outside) quantity of Money: $\pi\left(\frac{M}{P}\right)$ (Phelps, 1973; Bailey, 1956). Here we should also mention "growth seigniorage" which is the result of increasing demand for money in developing countries, having positive real growth rates (Dornbusch and Fischer, 1987: 647).

Following Tobin (1956), Marty (1967) proposed to measure inflation tax with an alternative way by the rate of growth of money supply times real balances (Phelps, 1973: 68; Marty, 1967; 71). In this case real seigniorage revenue is equal to the multiplication of sum of inflation and growth rate and real money balances: $(\pi + g)\left(\frac{M}{P}\right)$ - where $\boldsymbol{g}$ is real growth rate. Phelps,(1972) equals inflation tax to the multiplication of nominal interest rates and real balances, $(\pi + r)\left(\frac{M}{P}\right)$ - where r is the real interest rate (Phelps,1972). This definition expresses that the income obtained by the government is then equivalent to the loss of the interest rate of the private sector (Gürbüz et al., 2009: 56). In this sense, seigniorage is a type of interest-free credit, paid by private sector due to holding liquid balance, transferred to the government.

The difference between seigniorage and inflation tax is due to the changes in real money demand, arising from the result of changes in the inflation rate, real income, and interest rates. This difference is usually known as a non-inflationary determinant of seigniorage, depending on the increase in the demand for money that is consistent with zero inflation rates (Rodrik, 1990: 12).

Given exogenous expenditure and an inter-temporal budget constraint, when government expenditure is financed by monetary and fiscal policy, nominal interest rates and inflation move together with tax rates put on output over the time (Mankiw, 1987: 327). According to Mankiw, if fiscal policy dominates monetary policy then government should imply monetary and fiscal policies, targeting minimize social costs depending on tax and seigniorage revenue.

Mankiw's approach can be summarized as follows within the framework of inter-temporal analysis. The optimal inter-temporal monetary and fiscal policy of a government should be examined under the following budget constraint in the present value (Mankiw, 1987: 328):

$$\int_0^\infty e^{-\rho s} G(t+s)ds + B(t) = \int_0^\infty e^{-\rho s} T(t+s)ds \qquad (1)$$

Where
G(t) = real expenditure at time t,

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T(t) = real revenue at time t,
B(t) = real government debt at time,
ρ = real discount rate (assumed constant over time).

Expenditure is taken to be exogenous, and future expenditure is a random variable. The government takes into consideration two different financing way financing budget deficits to minimize social losses: Tax on output and seigniorage. If level of output and tax rate on output is denoted by $Y(t)$ and $\tau(t)$ respectively, then revenue collected by government is $(t)\tau(t)$, and social losses caused by taxes will be equal to $f(\tau)Y$. Here, $f' > 0$ and $f'' > 0$. Suppose that *M*(*t*), *P*(*t*) and k in order show exogenous money supply, price level at time t and a constant respectively, then demand for money can be expressed within quantity equation as follows:

$$\frac{M(t)}{P(t)} = kY(t) \qquad (2)$$

Suppose that the inflation rate and the growth rate of output are shown by $\pi = \frac{\dot{P}}{P}$ and $g = \frac{\dot{Y}}{Y}$ in order. Then the real seigniorage revenue equals to:

$$\frac{\dot{M}}{P} = \frac{\dot{M}}{M}.\frac{M}{P} = (\pi + g)kY \qquad (3)$$

Adding the sum of the receipts from direct taxation and seigniorage, we find a formulation for total government revenue as below:

$$T = \tau Y = (\pi + g)kY \qquad (4)$$

Assume that $h(\pi)Y$ indicates social cost of inflation, where $h' > 0$ and $h'' > 0$. Examples to the direct and indirect costs of inflation are menu cost and inefficient functioning of markets respectively. To overcome these costs, the government targets to minimize the expected present value of the social costs under the budget constraint:

$$E_t \int_0^\infty e^{-\rho s} [f(\tau) + h(\pi)]Yds \qquad (5)$$

Subject to the budget constraint

$$\int_0^\infty e^{-\rho s} Gds + B(t) = \int_0^\infty e^{-\rho s} [\tau + \pi k + gk]Yds \qquad (6)$$

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For this purpose, the government has two choices: Inflation rate π and tax rate. Mankiw then examines the first- order condition of the equation (5) for an optimum as below:

$$E_t\{f'[\tau(t+s)]\} = f'[\tau(t)] \quad (7)$$

$$E_t\{h'[\pi(t+s)]\} = h'[\pi(t)] \quad (8)$$

$$h'[\pi(t)] = kf'[\tau(t)] \quad (9)$$

Under budget constraint the optimal monetary and fiscal policy satisfies these three equations.

The inter-temporal first-order conditions (7) and (8) in order equates marginal social cost of taxation today and in the future, and the marginal social cost of inflation today and in the future. While, the static first-order condition (9) equates the marginal social costs of raising revenues through direct taxation and through seigniorage. According to first-order condition of equation (9), an increase in the government revenue requirement increases the use of both direct taxation and seigniorage. This usage leads a parallel movement between level of taxation, inflation and nominal interest rates (Mankiw, 1987: 329-331). Mankiw test his optimal seigniorage theory for USA for a long time period covering 1952-1985. Findings are in the direction that there is a positive relationship between nominal interest rates and level of direct taxation. He has also obtained a log-run relationship between inflation rate and level of direct taxation.

4. Empirical Analysis

In this part, optimal seigniorage theory is tested for Indian Economy with yearly data for the period 1970 - 2015. The fundamental property of the optimal seigniorage theory is that inflation rate and nominal interest rates are determined by revenue requirement of the government. If we could collect reliable estimates for marginal social cost of inflation, marginal social cost of direct taxation and interest elasticity of money demand, then equation

(8) could be estimated to find out relationship between level of direct taxation, inflation and nominal interest rates at any point of time. Because we do not know these social costs, we prefer linear approximation to equation (8) for Indian economy, as Mankiw did for USA, with time series data (Mankiw, 1987: 332).

The aim of this study is to test the implication of optimal seigniorage theory that in the long run higher tax rates are associated with higher inflation rates and higher nominal interest rates. Namely, a cointegration relationship between nominal interest rates, inflation and taxes is examined. We will test whether there is a long-run equilibrium path for these variables considered for this study. If they move together there should be an equilibrium point which nominal interest rates, inflation and taxes are converging to.

Data used in this paper obtained from Handbook of statistics on Indian Economy. Definitions and some basic descriptive statistics of the variables we employed in the model are presented in table 3 with in level and in first differences. The choice of variables used in the model is based on previous studies in the related empirical literature. Table 1 indicates that maximum volatility happens in INT and INF variables, corresponding in order to the inflation and compound interest rates during the time period considered. The mean of first differences given in table 3 are very near but not equal to zero. Hence, these findings could be accepted as the evidence of linear deterministic trend in levels of series (Güloglu and Ivrendi, 2010).

Table 1. Descriptive statistics and definition of series in level

Variables	Definition	mean	sd	skewness	Min. value	Max. value	No. of obs
TAX	Ratio of total tax to the GDP	0.07	0.007	0.28	0.057	0.088	41
INF	Percentage change of CPI	8.32	4.87	1.53	0.000	26.23	41
INT	Nominal interest rates	9.76	2.18	0.05	5.71	13.75	41
DTAX	First difference of TAX	0.0003	0.005	-0.37	-0.01	0.009	41
DINF	First difference of INF	0.096	6.72	0.52	-18.4	26.23	41
DINT	First difference of INT	0.10	1.38	1.14	-2.27	4.99	41

Source: Author's estimation.

In the next section, we will firstly investigate stationarity and level of integration of time series we employ in the model. The determination of the degree of integration of series and the choice of appropriate Cointegration analysis I(1) or I(2) is important to make appropriate econometric analysis (Güloglu and Ivrendi, 2010: 9). There are also some potential problems of using non-stationary data. Granger and Newbold (1974)

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noted that non-stationary time series can cause spurious (non-sense) regression results.

Assume that we have a single equation as follow:

$$Y_t = \beta_1 + \beta_2 X_t + u_t \quad (9)$$

u_t ~I(1). If unit root tests on residuals indicates that u_t is stationary, then it is concluded that some linear combination of series Y_t and X_t is stationary, although Y_t and X_t are individually non-stationary. In other words, linear combinations eliminate stochastic trend in series X. In this case, established regression line is significant and Y_t and X_t is cointegrated. They move together in long run, and converge to an equilibrium path over the time (Engle and Granger, 1987: 251-276).

4.1 Unit Root Tests

Augmented Dickey Fuller (ADF) and Philips-Perron (P-P) unit root tests are employed to determine whether the variables are stationary. The unit root tests also turn out to be important in the determination of the degree of integration of series and the choice of appropriate cointegration analysis I(1) or I(2). ADF and P-P unit root tests results for the series are presented in table 2. The tables suggest that all of the series are I (1). Also this result can be seen from the graphs of series in first difference illustrated in figure 1 to figure 3. The graphical analysis of the differenced series indicates that the series are stationary with mean near zero.

As a result, we use I(1) of the variables to determine the number of cointegration vector by using Johansen analysis.

Table 2: Unit root test results

Variables		ADF		P-P	
		constant	constant and trend	constant	constant and trend
INF	level	-4.227*	-4.200*	-6.047*	-6.058*
	1st diff	-10.656*	-10.521*	-19.522*	-19.833*
TAX	level	-2.400	-20438	-2.508	-2.564
	1st diff	-5.965*	-5.897*	-5.949*	-5.887*
INT	level	-2.886	-2.906	-2.275	-2.211
	1st diff	-5.438*	-5.504*	-5.438*	-5.503*

Notes: Lag lengths are selected automatically according to Akaike Info Criterion and Shwarz criterion. The critical values of test statistics are tabulated in Fuller (1976) and MacKinnon (1996). ***: Test statistics are significant at 10 % level of significance. **: Test statistics are significant at 5%level of significance. *: Test statistics are significant at 1% level of significance.

4.2 Cointegration Analysis

In this part, we are examining whether the variables are cointegrated with each other. We know from Engle Granger (1987) that statitonary time series could make a linear combination converging to a long run equilibrium point over time. If one or more linear combination of individually non-stationary series is stationary then these series may be cointegrated. This means that these series cannot move too far away from each other (Dickey, Jansen and Thorton, 1991:58). The VAR- based cointegration relationship developed by Johansen (1995) should be estimated in order to capture the long term relationships between variables. For this purpose, we estimate a k-lag Vector Error Correction Model by Johansen Method.

Table 3. VAR lag order selection criteria

Lag	LR	FPE	AIC	SIC	HQC
0	Na	0.00480	3.1745	3.3091	3.2204
1	103.51	0.000259	0.2534	0.7921*	0.4371
2	17.713	0.000232	0.1268	1.0695	0.4483
3	20.413*	0.000174*	-0.1943*	1.1524	0.2649*
4	7.7724	0.000219	-0.0350	1.7157	0.5620
5	4.7882	0.000321	0.2283	2.3832	0.9632
6	8.5149	0.000375	0.1901	2.7490	1.0627
7	5.8018	0.000532	0.2360	3.1989	1.2465
8	6.9866	0.000679	-0.0108	3.3561	1.1374

Notes: * indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SIC: Schwarz information criterion. HQC: Hannan-Quinn information criterion.

But firstly, we determine lag length of unrestricted VAR model considering eight different lag selection criterions including likelihood Ratio (LR), Final Prediction Error Criterion (FPE), Akaike information criterion (AIC), Schwarz information criterion (SIC) and Hannan-Quinn information criterion (HQC). VAR lag order selection criteria results are shown in table 3. The maximum lag number selected is 8 and all the lag selection criterions suggest 3 lag orders.

In order to determine the cointegration rank, we employ Johansen Test method. There are two test statistics for the number of cointegrating vectors: The trace and maximum eigenvalue statistics. Table 4 presents the results of Johansen Cointegration Test using the maximum eigenvalue and the trace tests. The two tests indicate that there is one cointegrating relation. Hence, both trace and max-eigen statistics suggest that

there exists a unique cointegration relation (r=1) among three variables. Consequently, these two tests indicate that inflation, taxes and nominal interest rates are cointegrated.

Table 4 reports one cointegrating vector linking inflation, tax and nominal interest rates. But a cointegrating vector barely represents a long run relationship between endogenous variables. Because they are interpreted that there is one linear combination for which the variance is bounded (Dickey, Jansen and Thorton, 1991: 76).

Table 4. Johansen Cointegration test

Cointegration LR Test Based on Maximal Eigenvalue				
No of hypothesised CE(s)	Eigenvalues	Trace Statistics	95% critical	Prob**
None*	0.584857	44.13858	29.79707	0.0006
At most 1	0.266513	12.48978	15.49471	0.1349
At most 2	0.036317	1.331731	3.841466	0.2485
Cointegration LR Test Based on trace statistic				
No of hypothesised CE(s)	Eigenvalues	Max-Eigen Statistics	95% critical	Prob**
None*	0.584857	31.6488	21.13162	0.0012
At most 1	0.266513	11.15805	14.26460	0.1465
At most 2	0.036317	1.331731	3.841466	0.2485
Normalised cointegrating coefficients(standard errors in parenthesis)				
TAX	INF	INT		
1.0000	1.001129	-0.037176		
	(0.1934)	(0.10098)		

Maximum eigenvalue and Trace statistic indicates one cointegrated equation at 5% level of significance.
* indicates the statistic is significant at 5%.
** indicates MacKinnon-Haug-Michellis(1999) p-values.

Structural short and long-run relationships are indicated in VECM estimation. A VECM model with our variables is simply stated as follow:

$$d(INT_t) = \beta_0 + \beta_1 * d(INF_t) + \beta_2 * d(TAX_t) + \beta_3 * d(ECT_{t-1}) + \epsilon_t \quad (10)$$

Where; INT, INF and TAX are at the first differenced variables. β_0 is intercept, β_1 and β_2 are short run coefficient and ECT_{t-1} is the one period lag residual of below model:

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$$INT_t = \theta_0 + \theta_1 * INF_t + \theta_2 * TAX_t + \omega_t \quad (11)$$

ECT_{t-1} shows the adaptation rate to the long run equilibrium, and is also known as equilibrium error term of one period lag. ECT_{t-1} is an error correction term and leads variables INT, INF and TAX of the system to converge or to back to the long run equilibrium point. It corrects disequilibrium. Therefore, the sign of should be negative. The significant and negative coefficient shows what rate it corrects the previous period disequilibrium of the system. Hence, it means that there exists a long run equilibrium relationship among variables INT, TAX and INF stated in model (11).

VECM estimation result with two lagged is reported in Table 5. The coefficient of error correction term ECT_{t-1} of the model 1 has been -0.22 meaning that system corrects its previous period disequilibrium at a speed of approximately 22 per cent yearly. In other saying, almost 22% of deviation from long run equilibrium is smoothed in one year. Moreover the sign of ECT_{t-1} coefficient, significant and negative, as it is expected, indicates that there existed long run causality from INF and INT to TAX. Error correction term of the model-II and model-III is insignificant. This result indicates that in short run, inflation and nominal interest rates cause tax revenue as the per cent of GDP.

According to estimation result of cointegration equation (long-run relationship) on the top of table 5, there is a strong and significant long run relationship between nominal interest rates and inflation. It implies that an increase in inflation is associated with a 1.47 percentage decrease in the tax revenue as the per cent of GDP. Direction of the relationship is negative. The relationship between direct taxation and nominal interest rate is also significant but the coefficient on TAX appears very large. It implies that an increase in government revenue of 1 % of GNP is associated with a 330 % point decrease in the tax revenue as the per cent of GDP.

These results doesn't supports the optimal seigniorage theory suggesting that in the long run tax rates, inflation rates and nominal interest rates move together. Our findings are also not in line with study of Mankiw (1987) on American Economy. However, these estimation results are not consistent with the empirical study of Dogru (2013) testing optimal seigniorage theory for Turkish economy.

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Table 5: VECM estimation results

Cointegrating equation:
INT(-1) +1.475(2.88*) INF(-1) + 330.15(2.24*) TAX(-1) -44.25=0

	Model-I	Model-II	Model-III
Error Correction	D(TAX)	D(INT)	D(INF)
ECT(-1)	**-0.220142***	**-7.467407**	**-155.3407**
	(-2.66416)	**(-0.44252)**	**(-1.67614)**
D(TAX(-1))	**0.001785**	**54.83631**	**-138.490**
	(0.01134)	**(1.70619)**	**(-0.78459)**
D(TAX(-2))	**-0.427883***	**-76.00826**	**-280.5907**
	(-2.67048)	**(-2.3229)**	**(-1.56137)**
D(TAX(-3))	**-0.163048**	**-0.609141**	**354.3156**
	(-0.94185)	**(-0.01723)**	**(1.82483)**
D(INT(-1))	**0.002052****	**0.3461**	**1.366806**
	(2.09317)	**(1.72985)**	**(1.24330)**
D(INT(-2))	**0.002102***	**0.117649**	**0.511061**
	(2.76457)	**(0.75766)**	**(0.59927)**
D(INT(-3))	**0.000284**	**0.139685**	**0.119701**
	(0.38936)	**(0.93668)**	**(0.14615)**
D(INF(-1))	**0.000564****	**0.059523**	**-0.220362**
	(1.89533)	**(0.98031)**	**(-0.66082)**
D(INF(-2))	**4.70E-05**	**0.074455**	**0.005438**
	(0.21967)	**(1.70453)**	**(0.02267)**
D(INF(-3))	**-0.0002**	**0.022022**	**-0.02438**
	(-1.54897)	**(0.83332)**	**(-0.16798)**
R-squared	**0.4514**	**0.4281**	**0.5850**
Adj. R-squared	**0.2483**	**0.2163**	**0.4313**
Sum sq. resids.	**0.000447**	**18.6316**	**561.98**
S.E. equation	**0.004068**	**0.8307**	**4.5622**
F-Statistic	**2.2220**	**2.0215**	**3.8062**

Note: t-values are given in parenthesis. * and ** indicates rejection of null hypothesis at 1% and 5% .

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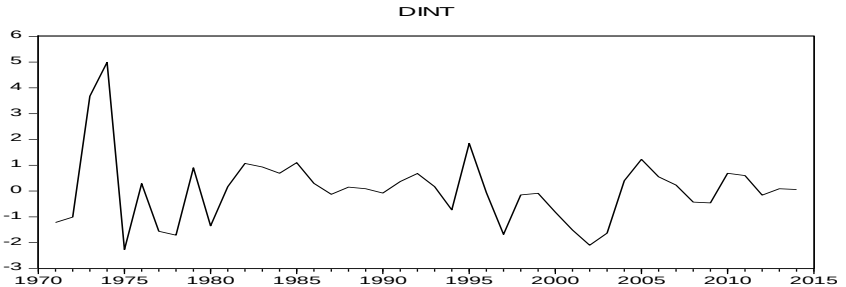
5. Conclusion

In this study, we tested Mankiw's (1987) optimal seigniorage theory for Indian economy using yearly time series data set for the period 1970-2015. This theory suggests that in the long run, there is a cointegration relation between tax rates, inflation rates and nominal interest rates. Econometric results of the study don't support the Mankiw's optimal seigniorage theory in India. Moreover, 22% of any deviation from long run equilibrium is smoothed in one year or in three years deviations converges to equilibrium point. Model suggests that one per cent increase in inflation and the nominal interest rates is associated with 1.45 per cent and 330 per cent decrease in tax revenue per GDP respectively.

Our findings are not in line with study of Mankiw (1987) on American economy. VEC model also suggest that there is short run causality from inflation and nominal interest rates to tax revenue.

Appendix- A: Time series plot of differences of TAX, INT and INF



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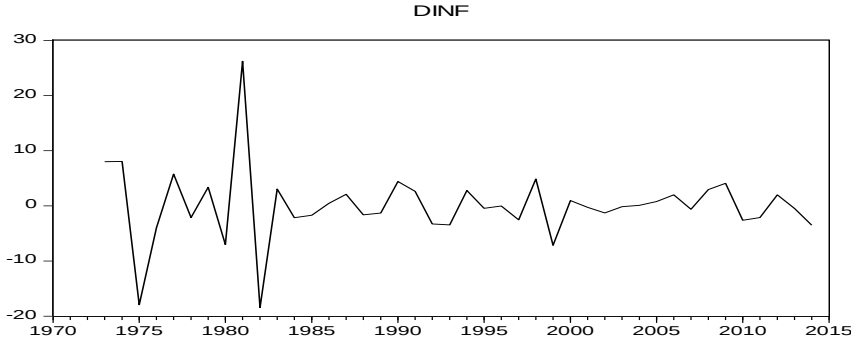

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