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# Central Bank Independence, Government Political Orientation and Optimum Government Expenditure Financing

Hakan Berument\*

Department of Economics  
Bilkent University  
06533 Ankara  
Turkey

Phone: + 90 312 266 2529

Fax: + 90 312 266 5140

Email:berument@bilkent.edu.tr

A. Özlem Önder

Department of Economics  
Ege University  
35040 İzmir  
Turkey

Phone: + 90 232 373 2960

Fax: + 90 232 373 4194

Email:ondero@bornova.ege.edu.tr

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## Abstract

This paper extends the government optimum expenditure financing model by incorporating the effects of both the government's political orientation and the central bank's independence. For the panel data of fourteen OECD countries for the period from 1974 to 1997, this paper shows first that countries with higher levels of central bank independence generate less seigniorage revenue, and second that governments which are controlled by left-wing parties create more seigniorage revenue to finance their spending.

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## Abstract

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## 1. Introduction

This paper incorporates the effects of a government's political orientation and the central bank's independence into Mankiw's (1987) government optimum expenditure financing model. For the panel data of fourteen OECD countries from 1974 to 1997, the paper finds that the choice between taxation and seigniorage to finance government spending is influenced by two additional factors: central bank independence (hereafter CBI) and the political orientation of governments (right- or left-wing governments). Empirical evidence suggests that seigniorage revenue creation is lower for those countries that have more independent central banks or whose governments are right-wing. Alesina (1988, 1989), Grilli and Tabellini (1991), Cukierman, Webb and Neyapti (1992) and Berument (1998) find that countries with more independent central banks are associated with lower levels of inflation. Alesina & Sachs (1988), Chappell & Keech (1988) and Berument (1994) find that right-wing governments are associated with lower levels of inflation (or money creation) than left-wing governments. This study considers these two factors and tests whether they successfully explain governmental monetary policy determination within the governments' optimum financing model.

A government's monetary policy might be set along with its tax policies to generate revenue in order to finance spending. Mankiw argues that since both of these resources create inefficiencies in an economy, governments make use of these revenues together to finance spending. Mankiw (1987) and Poterba & Rotemberg (1990) find a positive relationship between tax and seigniorage revenues for the U.S. after World War II. However, Poterba & Rotemberg (1990) could not find the same positive relationship between a proxy of seigniorage revenue and tax revenue for France,

Germany and the U.K. They note that changing a government's objective function and institutional factors may affect the tax-seigniorage trade off. This paper considers the government's changing orientation and different degrees of central bank independence as additional factors and explores whether the relationship between tax and seigniorage revenue is influenced by these two factors.

When governments set up their monetary policies, they might also have other concerns, such as achieving higher growth levels or influencing interest rates. Considering the first of these other motives, Fischer (1977), Barro (1977 and 1978) and Barro & Gordon (1983) argue that governments may use their monetary policies to influence the output and (/or) the unemployment rate. Regarding the second concern, Cukierman (1990) argues that central banks (hereafter CBs) have incentive to decrease interest rates by increasing money supply in order to secure the stability of the financial systems. This paper also considers these two alternative motives in the discussion of the empirical evidence for the implications of the optimum expenditure financing model. Taking these two motives into account does not, however, change the basic conclusion of the paper.

The models on the optimum financing literature use inflation as a proxy for government seigniorage revenue (e.g., Mankiw, 1987, Grilli, 1989, Poterba & Rotemberg, 1990, and Trehan & Walsh, 1990). However, seigniorage revenue is not the only factor that affects the inflation rate. As done in Berument (1994 and 1998), section 2 derives the implications of the optimum financing model when a government's policy variables are the tax rate and the monetary base growth rate, not the tax rate and the inflation rate as some of the existing literature on the optimum financing model assumes. Furthermore, the effects of the orientation of the government and the CBI are incorporated.<sup>1</sup> Section 3 introduces the data, Section 4 covers the empirical evidence, and the last section offers concluding comments.

## 2. The Theoretical Model

It is assumed that the monetary and fiscal branches of the government determine the government's monetary and tax policies simultaneously. Tax and seigniorage revenue are ultimately used to finance government spending. Both the fiscal and the monetary branches like to minimize the present value of the burden of these two revenues. However, the monetary authority (the central bank) is more concerned with the loss generated by the seigniorage revenue than the fiscal authority is.<sup>2</sup> Therefore, we assume that generating the same amount of seigniorage revenue will be more difficult if a CB is more independent. Hence, we can write the government's objective function as

$$W_t = \sum_{s=0}^{\infty} (1+r)^{-s} \left[ \theta_{t+s}^{1+\alpha} - \kappa(cbi) \left( \frac{M_{t+s-1}}{M_{t+s}} \right)^{1-\beta} \right] \quad (1)$$

where  $W_t$  is the present value of the loss generated by taxation and seigniorage revenue,  $\theta_t$  is the tax rate and  $M_t$  is the monetary base (hereafter money) at time  $t$ ,  $r$  is the fixed real interest rate,  $cbi$  is the CBI index and  $\kappa(cbi)$  is the relative weight government assigns to seigniorage revenue creation at any given level of taxation in the objective function. Here,  $\theta_t^{1+\alpha}$  measures the loss created by taxation and  $-\left(\frac{M_{t-1}}{M_t}\right)^{1-\beta}$  measures the loss generated by the seigniorage revenue at time  $t$ . Moreover,  $\alpha$  and  $\beta$  are non-negative constants, and hence, the deadweight loss function for each type of government,  $W_t$ , is a convex function of both the tax rate and money growth in order to satisfy the second order conditions. It is assumed that  $\kappa(cbi)$  is an increasing function of CBI<sup>3</sup>, so it will be more difficult for the government to increase the money growth in countries which are associated with more independent CBs, *ceteris paribus*.

It is important to note that we also allow that different types of administrations (type D and type R) assign different weights to the creation of seigniorage revenue for a given level of taxation and central bank independence.<sup>4</sup> Hence, the objective functions for both types of administration

can be written as

$$W_t^i = \sum_{s=0}^{\infty} (1+r)^{-s} \left[ \theta_{t+s}^{1+\alpha} - \kappa^i(cbi) \left( \frac{M_{t+s-1}}{M_{t+s}} \right)^{1-\beta} \right] \quad i = D, R. \quad (2)$$

As in the similar model of Alesina and Sachs (1988), it is assumed that Party R is more sensitive to money growth than Party D; hence,  $\kappa^R(cbi)$  is greater than  $\kappa^D(cbi)$  at the given level of CBI,  $cbi$ . Therefore, the objective function as stated in equation 2 allows that any type of administration derives loss from both the seigniorage revenue and taxes. The seigniorage loss is higher for a given level of taxation if the government is type R rather than type D, and if the central bank is more independent.

Here, we assume that the CB is sensitive to the creation of seigniorage revenue for both types of administrations at different degrees for each level of the central bank independence index. In other words, under complete central bank independence, the orientation of government affects the seigniorage revenue creation differently. There are two reasons for this: first, Cukierman(1992) recognizes that there is no completely independent central bank that is insensitive to political pressure from the government. Second, allowing the possibility that  $\kappa^D(cbi)$  and  $\kappa^R(cbi)$  converge under complete central bank independence requires imposing some arbitrary non-linear functional forms of  $\kappa(\cdot)$ . The results of this paper could be sensitive to functional form selection.

The intertemporal budget constraint the government faces when it chooses to minimize its loss function requires that the government debt be equal to the debt and its interest payments from the previous period plus government spending minus government tax and seigniorage revenues. Here, the seigniorage revenue is written as

$$\frac{M_t - M_{t-1}}{P_t} = \left( 1 - \frac{M_{t-1}}{M_t} \right) m_t \quad (3)$$

where  $m_t$  is real money holdings and  $P_t$  is the price level at time  $t$ . Therefore, the government

intertemporal budget constraint is written as

$$b_t = (1 + r)b_{t-1} + G_t - \theta_t y_t - \left(1 - \frac{M_{t-1}}{M_t}\right) m_t \quad (4)$$

where  $b_t$  is government debt,  $G_t$  is real government spending, and  $y_t$  is real income at time  $t$ .

Governments set the tax rate,  $\theta_t$  and the inverse of the monetary base growth,  $\frac{M_{t-1}}{M_t}$  to minimize their objective function, Equation 2, subject to their intertemporal budget constraint, Equation 4.

The Hamiltonian equation can be written as

$$H = \sum_{s=0}^{\infty} (1 + r)^{-s} \left[ \theta_{t+s}^{1+\alpha} - \kappa^i (cbi) \left( \frac{M_{t+s-1}}{M_{t+s}} \right)^{1-\beta} \right] - \lambda_t \left( r b_{t-1} + G_t - \theta_t y_t - \left(1 - \frac{M_{t-1}}{M_t}\right) m_t \right) \quad i = D, R. \quad (5)$$

The first order conditions require that the marginal loss of taxation and seigniorage must be equal to each other. For both types of administrations the marginal loss of taxation is

$$\frac{(1 + \alpha)\theta^\alpha}{(1 + \varepsilon_\theta)y_t} \quad (6)$$

Here,  $\varepsilon_\theta$  is the constant elasticity of real income with respect to the tax rate. Poterba and Rotemberg suggest including  $\varepsilon_\theta$  to incorporate the feedback effects of taxation into real income. The marginal loss of money growth for each type of administration is equal to

$$\frac{(1 - \beta)\kappa^i (cbi) (M_{t-1}/M_t)^{-\beta}}{m_t (1 - \varepsilon_\mu)} \quad i = D, R. \quad (7)$$

where the constant elasticity of real money holdings with respect to the change in money growth,  $\varepsilon_\mu$ , is also incorporated in order to account for the effect of money growth on real money holdings because money growth, which causes inflation, affects the opportunity cost of holding money. It is important to note that higher CBI causes the marginal loss of the money growth rate to be higher for both parties. However, the marginal deadweight loss due to money growth is different for each party. For each type of administrations, the first order conditions will give the following after equating the logarithms of Equations 6 and 7 for each type of government:

$$\ln \frac{M_t}{M_{t-1}} = \frac{1}{\beta} \ln \frac{(1 + \alpha)(1 - \varepsilon_\mu)}{(1 - \beta)(1 + \varepsilon_\theta)} + \frac{\alpha}{\beta} \ln \theta_t + \frac{1}{\beta} \ln \frac{m_t}{y_t} - \frac{1}{\beta} \ln \kappa^i (cbi) \quad i = D, R. \quad (8)$$

The equations are combined with a dummy variable  $D_t$  for both types of administration.  $D_t$  will have a value of one if the government is type  $D$ , and zero otherwise. Furthermore, it is assumed that  $\kappa^i(cbi) = e^{\delta^i cbi}$ , where  $\delta^R$  is greater than  $\delta^D$ , because it is assumed that type  $R$  governments are more sensitive to money growth than type  $D$  governments. Hence, the following equation can be written

$$\ln \frac{M_t}{M_{t-1}} = \frac{1}{\beta} \ln \frac{(1+\alpha)(1-\varepsilon_\mu)}{(1-\beta)(1+\varepsilon_\theta)} + \frac{\alpha}{\beta} \ln \theta_t + \frac{1}{\beta} \ln \frac{m_t}{y_t} - \frac{1}{\beta} \delta^R cbi + \frac{1}{\beta} (\delta^R cbi - \delta^D cbi) D_t \quad (9)$$

Mankiw (1987) notes that government preferences towards tax and seigniorage creation might change over time and the cost of tax collecting is time variant. This paper investigates whether a substantial part of the seigniorage revenue creation can be explained by the optimum financing model under different institutional and political factors rather than by an exact relationship between tax and seigniorage revenue creation. Hence, to explain the behavior of seigniorage revenue under these two institutional factors, a simple error term is included. The following equation will be estimated.

$$\ln \frac{M_t}{M_{t-1}} = \gamma_0 + \gamma_1 \ln \theta_t + \gamma_2 \ln \frac{m_t}{y_t} + \gamma_3 cbi + \gamma_4 (D_t * cbi) + \varepsilon_t \quad (10)$$

Here,  $\gamma_0 = \frac{1}{\beta} \ln \frac{(1+\alpha)(1-\varepsilon_\mu)}{(1-\beta)(1+\varepsilon_\theta)}$ ,  $\gamma_1 = \frac{\alpha}{\beta}$ ,  $\gamma_2 = \frac{1}{\beta}$ ,  $\gamma_3 = \frac{-\delta^R}{\beta}$ , and  $\gamma_4 = \frac{-\delta^D + \delta^R}{\beta}$ . The testable implications of the model are that  $\gamma_1$ ,  $\gamma_2$  and  $\gamma_4$  are positive, and  $\gamma_3$  is negative. The optimum financing model suggests that there is a positive relationship between tax and seigniorage revenues. Equation 10 also suggests that less seigniorage revenue will be created if the CB is more independent. Moreover, this specification, which includes the interactive term between  $D_t$  and  $cbi$ , allows us to test whether the creation of the seigniorage revenue is lower for the type D administrations, compared to type R administrations, for any given level of the central bank independence index. Note that both  $\theta_t$  and  $\frac{M_t}{M_{t-1}}$  are in logarithmic terms. Hence, higher CBI not only causes the level of  $\frac{M_t}{M_{t-1}}$  to be lower

but also causes a proportion of spending to be financed with less seigniorage revenue.

### **3. Data**

The data set includes annual observations from fourteen developed OECD countries for the period from 1974 to 1997. Observations from developed countries, rather than from developing or less developed countries, are used because the optimum financing model implicitly assumes that governments can increase their tax revenues along with their seigniorage revenues if they wish to do so. On the other hand, developing countries may have difficulties in raising their tax revenues due to a less developed tax collection infrastructure. The data set includes observations from Australia, Austria, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, Norway, the United Kingdom, and the United States.

Sources for data are as follows. The consumer price index (hereafter CPI), monetary base, GDP are from the International Monetary Fund-International Financial Statistics tape. Central government spending and receipts<sup>5</sup> are from OECD National Accounts, Income and Outlay Transactions of General Government. The data for the type of regime is from Alesina (1989), and extended by Lane, McKay and Newton (1997).

The following are the descriptions of the variables that are used for the empirical test of the testable models. Money growth rate is the first logarithmic difference of the monetary base. The inflation rate is measured as the first logarithmic difference of the CPI. The logarithm of the tax rate is the logarithm of the central government's receipt-GDP ratio. The first logarithmic difference of the monetary base is then used as a proxy for the seigniorage revenue. A direct way of measuring the seigniorage revenue is suggested by Klein & Neumann (1990). However, measuring the seigniorage revenue creation by using the method they suggest depends on legal, institutional and operational details of the monetary base creation, which cannot be compared across countries, as these two

authors mention. Because this study needs a proxy of seigniorage revenue that can be compared across countries, a new variable is not calculated but instead monetary base growth and inflation are used as a measure of seigniorage revenue.

Since it is very difficult to measure the CB's actual independence, a central bank's independence is measured as the legal independence of the central bank from its own government. Various central banks' legal independence indexes have been calculated. The Cukierman, Webb and Neyapti (1992) (hereafter CWN) index is the most comprehensive and detailed one. Although we use the CWN index for the regression analysis, for completeness the next section reports the summary of the estimates when the Bade & Parkin (1985) and Grilli *et al.* (1991) indexes are used.<sup>6</sup>

In their index, CWN consider sixteen different variables to construct the CB's legal independence. They assign the variables values from zero to one, and then take the mean of those variables as the CB's independence index. First, CWN consider policy formulation: who formulates monetary policy, how the CB carries out government directives, and how a conflict between the CB and government is resolved. The role that the CB plays in the formulation of the government budget is the final criterion examined in this category. Second, they study the appointment procedure for the bank. In this category, they consider the term of office, appointment and dismissal procedures, and the possibility of the governor holding a different office. Moreover, they incorporate the role of the price stability objective as stated in their charters to set up the CB's independence index. Finally, they analyze the CB's role regarding lending. Limitations on advances and saucerized lending, types of limits, the amount of control the CB has on terms of lending, and problems of lending in primary markets are some of the criteria considered in this category. Then the length of maturity of loans, restrictions on interest rates, and the extent of the CB's circle of potential borrowers are analyzed to determine these factors' contribution to the bank's independence index. Appendix B also discusses other CBI indexes that are used later in the paper.

#### 4. The Empirical Evidence

This section considers empirical evidence for two models. Equation 10 will be estimated in order to test the implication of the first model. The empirical evidence when the seigniorage revenue is proxied by the inflation rate will be also presented as a second model. The second model's derivation appears in Appendix A.

To estimate these models, the Parks (1967) method is used. The method performs generalized least squares across countries and calculates the estimates by considering any autocorrelation for each country, for any variance difference across countries, and for any cross-country correlation. The method also constrains the estimated coefficients for each country such that each variable has the same estimated coefficient across countries. Constraining the estimated coefficients is necessary because the CBI index is prepared as a constant number for the entire period for each country. If the coefficients are not constrained, the estimates of the coefficients will not be obtained due to the perfect multicollinearity problem.

|                           |
|---------------------------|
| Insert Table 1 about here |
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Table 1 reports the results for the two models. Before estimating the model, the time trend is included in the regression analysis.<sup>7</sup> Both the money growth rate (or inflation) and tax rates are persistent variables. Performing a single regression analysis for Equation 10 may capture the time trend they share. The first row of the table is for the money growth rate-tax rate relationship (first model) suggested by Equation 10. Estimates for the inflation-tax rate relationship (second model) that Poterba and Rotemberg suggest are reported in the second row. The estimated coefficient for the logarithm of the tax rate is positive for inflation-tax rate relationship and negative for the money growth rate-tax rate relationship. This result suggests that there is a positive relationship between tax and seigniorage revenues that the optimum financing model suggests when inflation rate is used

as a proxy for seigniorage revenue and the coefficient for the model is statistically significant at the 5% level.<sup>8</sup> However, we could not find supporting evidence for the optimum financing model for the money growth rate- tax rate relationship. The estimated coefficients for the CBI index are negative and significant; when countries have relatively more independent CBs, then they create less seigniorage revenue to finance their spending, *ceteris paribus*. As the theory suggests, the interactive dummies have a positive and statistically significant coefficient for the inflation-tax rate regression and a positive coefficient for money growth rate-tax rate regression. This suggests that the creation of the seigniorage revenue is lower for the type D administration, compared to type R administrations, at any given level of the central bank independence index. Hence, the creation of seigniorage revenue is not only lower for the countries associated with more independent central banks, but it is also higher if the administration is type D rather than type R. Lastly, coefficients on the logarithms of the money-income ratios are positive and significant as suggested by Equation 10. There is a feedback effect from the creation of seigniorage and tax revenues to real money holdings and the national output, *respectively*. The sums of squared residuals (*SSRs*) are also reported in the last column. In summary, only one implication of the optimum financing model – which suggests a positive relationship between money growth rate-tax rate – is rejected for the first specification. The implications of the hypotheses are all supported for the second model at least at the 5% level.

One might consider the possibility that the positive relationship between seigniorage revenue and the tax rate is proxying a relationship other than that suggested by the optimum financing model. To test for this possibility, this study performs regression analyses after taking into account other possible influences. First, business cycles may influence government financing. Therefore, a proxy for business cycles is included in the regression analysis on an ad hoc basis to control for the business cycle effect. Second, CBs might be responding to the interest rate or the government deficit. Fiscal authority does not have complete control over the interest rate; changes in government deficit

or in government spending at a given level of taxes may also affect interest rates. Higher levels of government spending will increase the interest rate, and in order to decrease it the interest rate sensitive CB may increase the money supply. To incorporate this possibility, government spending is also included in the analysis. Hence, both the deviation of the real GDP from the trend expressed as a ratio of trend-real GDP,  $v_t$ , and the logarithm of the government spending-GDP ratio,  $lng_t$ , are included in the regression analysis.

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Table 2 reports the results after including two additional variables,  $v_t$  and  $lng_t$ , in the models. The results from Table 2 are weaker than the results from Table 1. For the money growth rate-tax rate relationship, the estimated coefficient for the tax rate becomes positive but insignificant and the coefficient for the central bank independence index is insignificant. The coefficient for the partisan effect is negative but insignificant. The second model is more robust relative to the first one. All of the coefficients have the same sign as those in Table 1. Furthermore, their level of significance is similar to their level in Table 1, except the coefficient for the tax rate and monetary base-GDP ratio, which are insignificant. Thus, the implications of the theory are not rejected for either of the models. The estimated coefficients for government spending do not support the implication of deficit financing or the interest rate smoothing hypothesis for the first model. The estimated coefficient for  $lng_t$  is negative and insignificant for the money growth-tax rate relationship. On the other hand, in the second model, the estimated coefficient  $lng_t$  is positive and significant. The results appearing the literature are mixed as well. Evans (1988 and 1989) shows that government spending or deficit does not affect the interest rate for the U.S.. The estimated coefficients for the deviation of output from trend, however, are statistically insignificant for both the money growth rate-tax rate and the inflation-tax rate relationships. This may suggest that governments may not be persistently using their monetary policies to influence output level.

It is also necessary to consider that estimates reported in Tables 1 and 2 might be suffering from simultaneity biasedness. The theory presented in Section 2 assumes that governments determine their tax and seigniorage revenues simultaneously. Furthermore, the first order conditions also imply that the marginal deadweight loss of taxation (or money growth) must be the same across time. Hence, both the tax rate and the money growth rate are martingale and therefore, both are also endogenous variables, as is the logarithm of the money-income ratio because the tax rate and the money growth rate affect real income and real money holdings, *respectively*. Therefore, the instrumental variables (hereafter IV) are used to reestimate the models. The instruments are the lagged value of the logarithm of tax rate, the lagged value of the deviation of real GDP from the trend – expressed as a ratio of trend-real GDP, the lagged value of the logarithm of government spending-GDP ratio and a time trend. In order to perform the IV technique, the ordinary least squares method is used for both the first and second stage regressions.

Insert Table 3 about here

These results are reported in Table 3. The estimated coefficients for the money-income ratio are positive and those for the CBI indexes are negative, as the theory suggests, for both relationships. The interactive dummy is positive for the second model as the theory suggests. The coefficient of the tax rate is not significant for the money growth rate-tax rate relationship. The coefficients of the money-income ratio and the interactive dummy for government commitment are not significant for the inflation-tax rate relationship. Hence, the supporting evidence is diminished when the IV technique is used, although the implications of the theory are not rejected.

Insert Table 4 about here

Table 4 reports the results when the IV technique is used to test the implications of the optimum financing hypothesis after considering the governments' other possible motives. The estimates

reported in Table 2 did not change their signs for CBI and its interactive dummies for both of the models; however, none of the coefficients are significant for the money growth rate-tax rate relationship. The estimated coefficients for the tax rate and money-income ratio become negative for the inflation-tax rate relationship but they are not significant. Furthermore, the estimated coefficient for the  $lng_t$  is positive and significant, just as in Table 2. However, the coefficient for  $v_t$  is positive and significant for the inflation-tax rate relationship.

A possible reason for the diminished supporting evidence when the IV technique is used is that there is a simultaneity bias problem for the regression analysis, which uses the Parks method. However, the reason might alternatively be that the IV method gives less efficient estimates than the Parks method.

It can be concluded that the estimated coefficients for the tax rates and interactive dummies are positive and the coefficients for the CBI are always negative, as the theory suggests for the inflation-tax rate relationship. The supporting evidence weakens under alternative hypotheses and also when the IV technique is used. This result is especially valid for the money growth rate- tax rate relationship.

#### *4.1. Results when other indexes are used*

This subsection presents a summary of the evidence on the optimum financing model when three other indexes are used in addition to the CWN index for central bank independence. The estimated coefficients for the regression analysis, when all the indexes are used, are reported in Appendix C. An additional index has been taken from Bade & Parkin (1985) (hereafter BP), and the political and economic independence indexes are taken from Grilli *et al.* (1991) (hereafter GMT.P and GMT.E *respectively.*)

|                           |
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| Insert Table 5 about here |
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Table 5 reports the results for both the money growth rate- tax rate relationship and the inflation-tax rate relationship for all four CBI indexes. The BP index is not available for Austria, Finland and Ireland and the GMT.P and GMT.E indexes are not available for Finland and Norway; thus, these countries are excluded from the sample when the corresponding indexes are used. To save space, estimated coefficients for the constant term and the time trend are not reported. Furthermore, if an estimated coefficient has the sign the model suggests and is significant at the 5% (10%) level, then ++ (+) is reported. If the implication of the hypothesis is rejected at the 5% (10%) level, then -- (-) is reported for the corresponding variable. Lastly, 0 is reported when a variable is excluded from the regression.

Insert Table 6 about here

Table 5 shows that none of the implications of the hypotheses are rejected except the coefficient of the tax rate for the money growth rate-tax rate relationship and the coefficient of the independence index when GMT.E index is used for the inflation-tax rate relationship. When the CWN and the BP indexes are used, both types of relationships support the implications of the hypotheses more strongly than when the GMT.P and GMT.E indexes are used. Furthermore, the implications of the hypotheses are supported better by the inflation-tax rate relationship than by the money growth rate-tax rate relationship. Table 6 reports the same analysis when the IV technique is used. Even though none of the implications of the hypotheses are rejected, the supporting evidence diminishes.<sup>9</sup>

Insert Table 7 about here

In sum, the hypotheses are mostly supported when the Parks estimation procedure is used, and the supporting evidence decreases when the IV technique is used. Lastly, when GMT.E's and GMT.P's independence indexes are used, the hypotheses are supported least. The most supporting

evidence is observed when the BP index is used.

## **5. Conclusion**

The aim of this paper is to incorporate the effects of central bank independence and the political orientation of governments in the tax-seigniorage revenue trade-off, which governments face to finance their spending. The hypotheses tested in this paper are as follows: first, governments raise both their tax and seigniorage revenues together to finance spending; second, governments that are associated with more independent central banks create less seigniorage revenue; and third, the creation of seigniorage revenue is higher under left-wing governments at each given level of central bank independence.

The existing literature on the optimum financing uses inflation as a proxy for the government's seigniorage revenue. The inflation rate might be affected by various factors other than the seigniorage revenue. The empirical results are found to be sensitive to different proxies of seigniorage revenue. When the seigniorage revenue is proxied by the monetary base growth rate, weaker supporting evidence is observed. The hypotheses of the paper are supported best when the CWN's and the BP's central bank independence indexes are used and when the seigniorage revenue is proxied by the inflation rate for fourteen OECD countries for the sample from 1974 to 1997. The supporting evidence decreases under alternative hypotheses and also when the IV technique is used.

These results are on a parallel with the relevant literature on CBI (e.g., Cukierman, 1992, Alesina and Summers, 1993, and Berument, 1998), which suggests that more CBI leads to less inflation. Moreover, the paper successfully demonstrates that the CBI and the political orientation of a government do influence the tax-seigniorage trade-off that governments face.

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## Notes

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1. In Appendix A, the implication of the optimum financing model is derived when the government's policy variables are the inflation and tax rates.

2. Both the monetary authority and the fiscal authority are subject to different political incentives and institutional constraints; therefore, they may differ on how to value the loss generated from tax and seigniorage revenues.

3. A similar approach is also used by Tabellini (1986) to incorporate CBI into governments' objective functions.

4. Partisan theory assumes that parties represent their constituencies. It is reasonable to assume that these constituencies have fixed preferences for the tax rate and the money growth rate over the party's time horizon. Therefore, it is considered (like in Alesina & Sachs, 1988, and Cukierman *et al.* 1992) that once party D (or R) is elected, it will minimize its objective function for an infinite horizon.

5. Government receipt figures for the US were obtained from the Department of Commerce, Bureau of Economic Research because the figures were not available from the International Monetary Fund-International Financial Statistics for the sample period this paper considers.

6. CBI indexes are calculated over different periods of time for several countries. These rankings are calculated as a constant number for the entire period that is considered for each country.

7. Mankiw and P&R also include the time trend in their models before testing.

8. The level of significance is 5% unless otherwise noted.

9. The regression analyses are also performed after controlling for the government's possible other concerns. The results are parallel to the ones reported in Tables 5 and 6. All of the estimates for

the testable implications of the hypotheses and robustness tests are reported in Appendix C.

# Tables

Table 1: The Empirical Evidence on the Optimum Financing Model: 1974-1997.<sup>a</sup>

| <i>Dep.Var.</i>          | <i>Constant</i> | <i>time</i> | $\ln\theta_t$ | $\ln\frac{m_t}{y_t}$ | $\ln\frac{m_{t-1}}{y_t}$ | <i>cbi</i> | $D_t cbi$ | <i>SSR</i> |
|--------------------------|-----------------|-------------|---------------|----------------------|--------------------------|------------|-----------|------------|
| $\ln\frac{M_t}{M_{t-1}}$ | 0.2014          | -0.0021     | -0.0114       | 0.0387               |                          | -0.0004    | 8.91E-6   | 3.2168     |
|                          | 8.826           | -4.342      | -2.092        | 5.029                |                          | -3.176     | 0.078     |            |
| $\ln\frac{P_t}{P_{t-1}}$ | 0.1371          | -0.0044     | 0.0194        |                      | 0.0008                   | -0.0003    | 0.0001    | 0.2253     |
|                          | 16.038          | -17.766     | 9.498         |                      | 2.361                    | -4.821     | 4.108     |            |

Note:  $\ln\theta_t$  = Logarithm of the tax rate;  $\ln\frac{m_t}{y_t}$  = Logarithm of the real monetary base-real GDP ratio;  $\ln\frac{m_{t-1}}{y_t}$  = Logarithm of the lag value of the real monetary base-real GDP ratio; *cbi* = Central bank independence index;  $D_t$  = Dummy variable for the left-wing governments.

<sup>a</sup> t-values are reported under the corresponding estimated coefficients.

Table 2: Robustness Tests: 1974-1997.<sup>a</sup>

| <i>Dep.Var.</i>          | <i>Constant</i> | <i>time</i> | $\ln\theta_t$ | $\ln\frac{m_t}{y_t}$ | $\ln\frac{m_{t-1}}{y_t}$ | <i>cbi</i> | $D_t cbi$ | $\ln g_t$ | $v_t$     | <i>SSR</i> |
|--------------------------|-----------------|-------------|---------------|----------------------|--------------------------|------------|-----------|-----------|-----------|------------|
| $\ln\frac{M_t}{M_{t-1}}$ | 0.2136          | -0.0024     | 0.01721       | 0.0488               |                          | -1.90E-5   | -6.16E-5  | -0.0300   | -4.09E-12 | 3.0122     |
|                          | 9.620           | -5.423      | 0.765         | 5.371                |                          | -0.111     | -0.489    | -1.105    | -1.462    |            |
| $\ln\frac{P_t}{P_{t-1}}$ | 0.1410          | -0.0044     | 0.0039        |                      | 0.0004                   | -0.0004    | 0.0002    | 0.0160    | 1.1E-12   | 0.2240     |
|                          | 13.261          | -17.816     | 0.543         |                      | 1.137                    | -4.694     | 4.410     | 1.949     | 1.159     |            |

Note:  $\ln g_t$  = Logarithm of government spending-GDP ratio;  $v_t$  = Deviation of real GDP from trend expressed as a ratio of trend- real GDP.

<sup>a</sup> t-values are reported under the corresponding estimated coefficients.

Table 3: The Empirical Evidence on The Optimum Financing Model – IV Results: 1974-1997.<sup>a b</sup>

| <i>Dep.Var.</i>                 | <i>Constant</i> | <i>time</i> | <i>lnθ<sub>t</sub></i> | <i>ln</i> $\frac{m_t}{y_t}$ | <i>ln</i> $\frac{m_{t-1}}{y_t}$ | <i>cbi</i> | <i>D<sub>t</sub>cbi</i> | <i>SSR</i> |
|---------------------------------|-----------------|-------------|------------------------|-----------------------------|---------------------------------|------------|-------------------------|------------|
| <i>ln</i> $\frac{M_t}{M_{t-1}}$ | 0.1211          | -0.0028     | - 0.0076               | 0.0026                      |                                 | -0.0003    | -4.50E-5                | 3.3180     |
|                                 | 2.111           | -2.735      | -0.381                 | 0.168                       |                                 | -0.742     | -0.117                  |            |
| <i>ln</i> $\frac{P_t}{P_{t-1}}$ | 0.1548          | -0.0050     | 0.0196                 |                             | 0.0004                          | -0.0004    | 0.0001                  | 0.2177     |
|                                 | 11.699          | -18.241     | 3.288                  |                             | 0.532                           | -2.451     | 1.231                   |            |

<sup>a</sup> t-ratios are reported under the corresponding estimated coefficients.

<sup>b</sup> Instruments are the lagged value of the logarithm of tax rate, the lagged value of the deviation of real GDP from trend expressed as a ratio of trend-real GDP, the logarithm of the lagged government spending-GDP ratio, the time trend.

Table 4: Robustness Tests – IV Results: 1974-1997.<sup>a b</sup>

| <i>Dep.Var.</i>          | <i>Constant</i> | <i>time</i> | $\ln\theta_t$ | $\ln\frac{m_t}{y_t}$ | $\ln\frac{m_{t-1}}{y_t}$ | <i>cbi</i> | $D_t cbi$ | $\ln g_t$ | $v_t$     | <i>SSR</i> |
|--------------------------|-----------------|-------------|---------------|----------------------|--------------------------|------------|-----------|-----------|-----------|------------|
| $\ln\frac{M_t}{M_{t-1}}$ | 0.1171          | -0.0030     | -0.0635       | -0.0029              |                          | -1.08E-5   | -0.0001   | 0.0074    | -3.38E-13 | 3.0626     |
|                          | 1.936           | -3.140      | -0.946        | -0.151               |                          | -0.018     | -0.299    | 0.955     | -0.038    |            |
| $\ln\frac{P_t}{P_{t-1}}$ | 0.1776          | -0.005      | -0.0204       |                      | -0.0006                  | -0.0006    | 0.0002    | 0.0443    | 4.94E-12  | 0.3461     |
|                          | 11.624          | -18.213     | -1.199        |                      | -0.847                   | -3.427     | 2.028     | 2.424     | 2.080     |            |

<sup>a</sup> t-ratios are reported under the corresponding estimated coefficients.

<sup>b</sup> Instruments are the lagged value of the logarithm of the tax rate, the lagged value of the deviation of real GDP from trend expressed as a ratio of trend-real GDP, the logarithm of the lagged government spending-GDP ratio, the time trend.

Table 5: The Empirical Evidence on the Optimum Financing Model with Other Indexes: 1974-1997.

| <i>Index</i> | <i>Dep.Var.</i>          | $\ln\theta_t$ | $\ln\frac{m_t}{y_t}$ | $\ln\frac{m_{t-1}}{y_t}$ | <i>cbi</i> | $D_t cbi$ |
|--------------|--------------------------|---------------|----------------------|--------------------------|------------|-----------|
| CWN          | $\ln\frac{M_t}{M_{t-1}}$ | --            | ++                   | 0                        | ++         |           |
|              | $\ln\frac{P_t}{P_{t-1}}$ | ++            | 0                    | ++                       | ++         | ++        |
| BP           | $\ln\frac{M_t}{M_{t-1}}$ | -             | ++                   | 0                        | ++         |           |
|              | $\ln\frac{P_t}{P_{t-1}}$ | ++            | 0                    | ++                       | ++         | ++        |
| GMT.P        | $\ln\frac{M_t}{M_{t-1}}$ | --            | ++                   | 0                        |            |           |
|              | $\ln\frac{P_t}{P_{t-1}}$ | ++            | 0                    | ++                       |            | ++        |
| GMT.E        | $\ln\frac{M_t}{M_{t-1}}$ | --            | ++                   | 0                        |            |           |
|              | $\ln\frac{P_t}{P_{t-1}}$ |               | 0                    | --                       | ++         | ++        |

Table 6: The Empirical Evidence on the Optimum Financing Model with Other Indexes - IV

Results: 1974-1997.

| <i>Index</i> | <i>Dep.Var.</i>          | $\ln\theta_t$ | $\ln\frac{m_t}{y_t}$ | $\ln\frac{m_{t-1}}{y_t}$ | <i>cbi</i> | $D_t cbi$ |
|--------------|--------------------------|---------------|----------------------|--------------------------|------------|-----------|
| CWN          | $\ln\frac{M_t}{M_{t-1}}$ |               |                      | 0                        |            |           |
|              | $\ln\frac{P_t}{P_{t-1}}$ | ++            | 0                    |                          | ++         |           |
| BP           | $\ln\frac{M_t}{M_{t-1}}$ |               |                      | 0                        | ++         |           |
|              | $\ln\frac{P_t}{P_{t-1}}$ | ++            | 0                    | +                        | ++         | ++        |
| GMT.P        | $\ln\frac{M_t}{M_{t-1}}$ |               |                      | 0                        |            |           |
|              | $\ln\frac{P_t}{P_{t-1}}$ | ++            | 0                    |                          |            | +         |
| GMT.E        | $\ln\frac{M_t}{M_{t-1}}$ |               |                      | 0                        |            |           |
|              | $\ln\frac{P_t}{P_{t-1}}$ |               | 0                    |                          | ++         | +         |

Table 7: Correlation Among Various Central Banks' Independence Indexes<sup>a</sup>

|       | CWN          | BP                | GMT.P             | GMT.E             |
|-------|--------------|-------------------|-------------------|-------------------|
| CWN   | 1.000<br>0.0 | 0.67821<br>0.0153 | 0.79581<br>0.0020 | 0.56165<br>0.0574 |
| BP    |              | 1.000<br>0.0      | 0.44281<br>0.2000 | 0.45702<br>0.1842 |
| GMT.P |              |                   | 1.000<br>0.0      | 0.64897<br>0.0224 |
| GMT.E |              |                   |                   | 1.000<br>0.0      |

<sup>a</sup> Standard errors are reported under the correlations.

## Appendix A: The Derivation of the Inflation-Tax Rate Relationship.

Depending upon the orientation of a government, its objective function is the following:

$$W_t^i = E_t \sum_{s=0}^{\infty} (1+r)^{-s} \left[ \theta_{t+s}^{1+\alpha} - \kappa^i(cbi) \left( \frac{P_{t+s-1}}{P_{t+s}} \right)^{1-\beta} \right] \quad i = D, R. \quad (11)$$

where  $\theta_t$  is the tax rate and  $P_t$  is the price level at time  $t$ .  $r$  is the fixed real interest rate,  $cbi$  is the CBI, while  $\alpha$  and  $\beta$  are constants.  $\kappa^D(cbi)$  and  $\kappa^R(cbi)$  are the relative weights of the inflation rate at the given level of tax rate which the parties assign at each level of CBI. It is also assumed that  $\kappa^R(cbi)$  is greater than  $\kappa^D(cbi)$  at the given level of  $cbi$  for party D and party R *respectively*. Furthermore, both  $\kappa(cbi)$ s are an increasing function of CBI. The government's seigniorage revenue is the real change in monetary base and can be written as

$$\frac{M_t - M_{t-1}}{P_t} = m_t - \frac{P_{t-1}}{P_t} m_{t-1} \quad (12)$$

where  $M_t$  is the monetary base and  $m_t$  is the real monetary base at time  $t$ . Therefore, the government's intertemporal budget constraint can be written as

$$b_t = (1+r)b_{t-1} + G_t - \theta_t y_t - \left( m_t - \frac{P_{t-1}}{P_t} m_{t-1} \right) \quad (13)$$

Here,  $b_t$  is real government debt,  $G_t$  is real government spending and  $y_t$  is real income at time  $t$ .

For both parties, the marginal cost of taxation is

$$\frac{(1+\alpha)\theta^\alpha}{(1+\varepsilon_\theta)y_t} \quad (14)$$

The marginal cost of money growth for type  $D$  and  $R$  administrations is equal to

$$\frac{(1-\beta)\kappa^i(cbi)(P_{t-1}/P_t)^{-\beta}}{m_{t-1}(1-\eta)} \quad i = D, R. \quad (15)$$

Here,  $\varepsilon_\theta$  and  $\eta$  are respectively the constant elasticity of real income with respect to the tax rate and the constant elasticity of real money holdings with respect to the money growth. For party D,

the first order conditions will lead to

$$\ln \frac{P_t}{P_{t-1}} = \frac{1}{\beta} \ln \frac{(1+\alpha)(1-\eta)}{(1-\beta)(1+\varepsilon_\theta)} + \frac{\alpha}{\beta} \ln \theta_t + \frac{1}{\beta} \ln \frac{m_{t-1}}{y_t} - \frac{1}{\beta} \ln \kappa^D(cbi) \quad (16)$$

For party R, the first order conditions will give the following:

$$\ln \frac{P_t}{P_{t-1}} = \frac{1}{\beta} \ln \frac{(1+\alpha)(1-\eta)}{(1-\beta)(1+\varepsilon_\theta)} + \frac{\alpha}{\beta} \ln \theta_t + \frac{1}{\beta} \ln \frac{m_{t-1}}{y_t} - \frac{1}{\beta} \ln \kappa^R(cbi) \quad (17)$$

The last two equations can be combined with a dummy variable  $D_t$ , which will have zero value at time  $t$  if the government is type R, and a value of one if the government is type D. Furthermore, it is assumed that  $\kappa^i(cbi) = e^{\delta^i cbi}$ ,  $i = D, R$ . Therefore, the following equations will be estimated to test the hypotheses:

$$\ln \frac{P_t}{P_{t-1}} = \gamma_0 + \gamma_1 \ln \theta_t + \gamma_2 \ln \frac{m_{t-1}}{y_t} + \gamma_3 cbi + \gamma_4 (D_t * cbi) \quad (18)$$

Here,  $\gamma_0 = \frac{1}{\beta} \ln \frac{(1+\alpha)(1-\eta)}{(1-\beta)(1+\varepsilon_\theta)}$ ,  $\gamma_1 = \frac{\alpha}{\beta}$ ,  $\gamma_2 = \frac{1}{\beta}$ ,  $\gamma_3 = \frac{-\delta^R}{\beta}$ , and  $\gamma_4 = \frac{-\delta^D + \delta^R}{\beta}$ . The estimated coefficients for  $\gamma_1, \gamma_2$ , and  $\gamma_4$  will be positive, and  $\gamma_3$  are expected to be negative.

## Appendix B. A Discussion About Other CBI Indexes

Legal independence of central banks is measured in one of two ways in the literature: either by their political or by their economic independence. For example, BP report the political independence index for the period 1973-1985. They look at the institutional and formal relationship between the central bank and the government. Countries are categorized in four classes; the first class is the most independent, and the fourth is the least. Specifically, BP examine who appoints the central banker and how often; the presence of government officers on the board of the bank; and whether there are any requirements for government approval of specific policies. Here, they assume that if the government has less power to appoint or dismiss members of the board or the CB has wider authority to set monetary policy, and the CB has more power to resist the will of

the government, then the CB has a higher level of legal independence. BP's index, however, does not include the effect of the role of the CB on the budget process.

GMT construct their rankings for both political and economic independence of CBs by considering the 1950-1989 period. Their study considers political independence as the capacity to choose the final goal of monetary policy: e.g., inflation or economic activity. GMT assume that the economic independence of the CB lies in the bank's ability to choose the instruments with which to pursue its goals. GMT also assume that if the CB has more legal power to stop lending money to the public, the CB has more economic independence. They consider eight criteria, assign values of zero or one to each and add these numbers to construct the political independence rankings. First, they consider the CB to be more independent if appointments are not under the government's control. Second, they consider whether the term for which the governor is appointed is more or less than five years. Third, they check whether all the members of the board are appointed by the government and fourth, whether the board is appointed for more than five years. They also look at whether there is mandatory participation of a government representative on the board or government approval of monetary policy formulation is required. Statutory requirements that the CB pursue monetary stability among its goals are checked; more specifically, the authors assume that those CBs with single objectives, e.g., price stability, are more independent than CBs with multiple objectives. Lastly, they check whether the CB's position is legally strong, i.e., how the resolution procedure works if there is a conflict with the government.

To observe the economic independence of CBs, GMT consider whether the government has an automatic right to get credit from the bank; whether the CB charges a market interest rate to the government; the nature of credit: temporary or permanent; the amount of credit which may be borrowed: limited or unlimited; whether the CB participates in the primary market of public debt; whether the discount rate is set by the CB; and whether banking supervision is entrusted solely to

the CB or if it is entrusted to both the CB and another organization.

Overall, BP and GMT.P use similar political variables to construct their respective rankings. GMT.E uses economic variables to construct the rankings. CWN combine these sets of political and economic information together to construct their rankings. The following table presents the correlations among these different CB independence indexes. Standard errors are reported beneath each correlation.

There are positive correlations among the indexes. BP have weak correlations with both GMT indexes. The strongest correlation is between GMT.P and CWN, perhaps because CWN also includes some measures which are in GMT.P. The weakest correlation is between GMT.P and BP, which is surprising because the indices use similar measures to construct the rankings.

## Appendix C: Tables

Here, the estimates of the testable implications of models and robustness tests are reported when both the Parks procedure and the IV technique are used for three CBI indexes: BP, GMT.P and GMT.E.

Table 8: The Empirical Evidence on the Optimum Financing Model with Other Indexes: 1974-1997.<sup>a</sup>

| <i>Index</i> | <i>Dep.Var.</i>          | <i>Constant</i> | <i>time</i> | $\ln\theta_t$ | $\ln\frac{m_t}{y_t}$ | $\ln\frac{m_{t-1}}{y_t}$ | <i>cbi</i> | $D_t cbi$ | <i>SSR</i> |
|--------------|--------------------------|-----------------|-------------|---------------|----------------------|--------------------------|------------|-----------|------------|
| BP           | $\ln\frac{M_t}{M_{t-1}}$ | 0.2296          | -0.0019     | -0.0135       | 0.0467               |                          | -0.0138    | 0.00133   | 2.2841     |
|              |                          | 8.135           | -3.831      | -2.112        | 5.047                |                          | -3.352     | 0.539     |            |
|              | $\ln\frac{P_t}{P_{t-1}}$ | 0.1331          | -0.0041     | 0.0122        |                      | 0.0013                   | -0.0151    | 0.0036    | 0.13477    |
|              |                          | 16.959          | -14.733     | 4.002         |                      | 3.020                    | -8.740     | 4.319     |            |
| GMT.P        | $\ln\frac{M_t}{M_{t-1}}$ | 0.1823          | -0.0017     | -0.0178       | 0.0453               |                          | -0.0004    | 0.0007    | 2.4877     |
|              |                          | 7.404           | -3.482      | -2.950        | 5.245                |                          | -0.198     | 0.528     |            |
|              | $\ln\frac{P_t}{P_{t-1}}$ | 0.1189          | -0.0045     | 0.0239        |                      | 0.0013                   | 0.0012     | 0.0027    | 0.0037     |
|              |                          | 18.514          | -16.703     | 10.074        |                      | 4.314                    | 1.310      | 5.581     |            |
| GMT.E        | $\ln\frac{M_t}{M_{t-1}}$ | 0.1778          | -0.0017     | -0.0186       | 0.0404               |                          | -0.0014    | 0.0005    | 2.4838     |
|              |                          | 7.556           | -3.554      | -3.029        | 3.628                |                          | -0.589     | 0.515     |            |
|              | $\ln\frac{P_t}{P_{t-1}}$ | 0.1864          | -0.0042     | 0.0014        |                      | -0.0017                  | -0.0088    | 0.0009    | 0.1915     |
|              |                          | 16.896          | -16.110     | 0.617         |                      | -3.982                   | -9.627     | 3.372     |            |

<sup>a</sup> t-ratios are reported under the corresponding estimated coefficients.

Table 9: Robustness Tests with Other Indexes: 1974-1997.<sup>a</sup>

| <i>Index</i> | <i>Dep.Var.</i>          | <i>Constant</i> | <i>time</i> | $\ln\theta_t$ | $\ln\frac{m_t}{y_t}$ | $\ln\frac{m_{t-1}}{y_t}$ | <i>cbi</i> | $D_tcbi$ | $\ln g_t$ | $v_t$     | <i>SSR</i> |
|--------------|--------------------------|-----------------|-------------|---------------|----------------------|--------------------------|------------|----------|-----------|-----------|------------|
| BP           | $\ln\frac{M_t}{M_{t-1}}$ | 0.2395          | -0.0023     | 0.0119        | 0.0522               |                          | -0.0054    | 0.0014   | -0.021    | -3.43E-12 | 2.0951     |
|              |                          | 8.418           | -5.111      | 0.499         | 5.204                |                          | -1.019     | 0.541    | -0.703    | -1.147    |            |
|              | $\ln\frac{P_t}{P_{t-1}}$ | 0.1247          | -0.0043     | 0.0412        |                      | 0.0016                   | -0.0184    | 0.0039   | -0.0404   | 4.03E-12  | 0.1283     |
|              |                          | 15.857          | -15.299     | 4.898         |                      | 3.840                    | -11.239    | 4.533    | -3.761    | 3.457     |            |
| GMT.P        | $\ln\frac{M_t}{M_{t-1}}$ | 0.2007          | -0.0022     | 0.0145        | 0.0507               |                          | 0.0047     | -0.0005  | -0.0276   | -5.13E-12 | 2.2692     |
|              |                          | 8.517           | -5.366      | 0.569         | 5.635                |                          | 2.286      | -0.357   | -0.927    | -1.788    |            |
|              | $\ln\frac{P_t}{P_{t-1}}$ | 0.1239          | -0.0044     | -0.0057       |                      | 0.0008                   | 0.0010     | 0.0026   | 0.0324    | -8.66E-13 | 0.2086     |
|              |                          | 17.488          | -16.463     | -0.729        |                      | 2.579                    | 1.092      | 5.013    | 3.581     | -0.789    |            |
| GMT.E        | $\ln\frac{M_t}{M_{t-1}}$ | 0.2179          | -0.0021     | 0.0043        | 0.0567               |                          | 0.0022     | 0.0003   | -0.0156   | -4.49E-12 | 2.2693     |
|              |                          | 8.287           | -4.805      | 0.161         | 4.302                |                          | 0.625      | 0.344    | -0.481    | -1.532    |            |
|              | $\ln\frac{P_t}{P_{t-1}}$ | 0.1921          | -0.0042     | 0.0086        |                      | -0.0020                  | -0.0099    | 0.0009   | -0.0117   | 1.45E-12  | 0.1901     |
|              |                          | 16.769          | -15.796     | 1.089         |                      | -4.374                   | -9.741     | 3.422    | -1.181    | 1.550     |            |

<sup>a</sup> t-ratios are reported under the corresponding estimated coefficients.

Table 10: The Empirical Evidence on the Optimum Financing Model with Other Indexes – IV  
 Results: 1974-1997.<sup>a b</sup>

| <i>Index</i> | <i>Dep.Var.</i>          | <i>Constant</i>  | <i>time</i>        | $\ln\theta_t$     | $\ln\frac{m_t}{y_t}$ | $\ln\frac{m_{t-1}}{y_t}$ | <i>cbi</i>        | $D_t cbi$         | <i>SSR</i> |
|--------------|--------------------------|------------------|--------------------|-------------------|----------------------|--------------------------|-------------------|-------------------|------------|
| BP           | $\ln\frac{M_t}{M_{t-1}}$ | 0.1469<br>2.345  | -0.0024<br>-2.153  | -0.0149<br>-0.712 | 0.0102<br>0.546      |                          | -0.0155<br>-2.060 | -0.0046<br>-0.733 | 2.3286     |
|              | $\ln\frac{P_t}{P_{t-1}}$ | 0.1417<br>11.112 | -0.0047<br>-17.193 | 0.0114<br>1.977   |                      | 0.0012<br>1.774          | -0.0147<br>-5.973 | 0.0046<br>2.039   | 0.1277     |
| GMT.P        | $\ln\frac{M_t}{M_{t-1}}$ | 0.1278<br>2.233  | -0.0024<br>-2.166  | -0.0098<br>-0.492 | 0.0150<br>0.886      |                          | 0.0001<br>0.032   | -0.0011<br>-0.259 | 2.5142     |
|              | $\ln\frac{P_t}{P_{t-1}}$ | 0.1345<br>10.779 | -0.0051<br>-16.434 | 0.0233<br>3.563   |                      | 0.0009<br>1.361          | 9.53E-5<br>0.052  | 0.0029<br>1.870   | 0.2014     |
| GMT.E        | $\ln\frac{M_t}{M_{t-1}}$ | 0.1134<br>2.126  | -0.0026<br>-2.415  | -0.0167<br>-0.799 | -0.0013<br>-0.064    |                          | -0.0062<br>-1.296 | -0.0011<br>-0.384 | 2.4784     |
|              | $\ln\frac{P_t}{P_{t-1}}$ | 0.1520<br>9.115  | -0.0050<br>-17.166 | 0.0084<br>1.403   |                      | -0.0783<br>-1.261        | -0.0078<br>-4.947 | 0.0002<br>1.751   | 0.1847     |

<sup>a</sup> t-ratios are reported under the corresponding estimated coefficients.

<sup>b</sup> Instruments are the lagged value of the logarithm of tax rate, the lagged value of the deviation of real GDP from trend expressed as a ratio of trend-real GDP, the logarithm of the lagged government spending-GDP ratio, the time trend.

Table 11: Robustness Tests with Other Indexes – IV Results: 1974-1997.<sup>a b</sup>

| <i>Index</i> | <i>Dep.Var.</i>          | <i>Constant</i> | <i>time</i> | $\ln\theta_t$ | $\ln\frac{m_t}{y_t}$ | $\ln\frac{m_{t-1}}{y_t}$ | <i>cbi</i> | $D_t cbi$ | $\ln g_t$ | $v_t$     | <i>SSR</i> |
|--------------|--------------------------|-----------------|-------------|---------------|----------------------|--------------------------|------------|-----------|-----------|-----------|------------|
| BP           | $\ln\frac{M_t}{M_{t-1}}$ | 0.1552          | -0.0030     | -0.0383       | 0.0110               |                          | -0.0118    | -0.0028   | 0.0359    | 2.09E-12  | 2.1418     |
|              |                          | 2.207           | -2.579      | -0.531        | 0.476                |                          | -1.010     | -0.296    | 0.415     | 0.238     |            |
|              | $\ln\frac{P_t}{P_{t-1}}$ | 0.1329          | -0.0048     | 0.036         |                      | 0.0016                   | -0.0180    | 0.0055    | -0.0340   | 6.24E-12  | 0.1226     |
|              |                          | 8.751           | -17.718     | 1.882         |                      | 2.100                    | -6.908     | 2.415     | -1.519    | 3.091     |            |
| GMT.P        | $\ln\frac{M_t}{M_{t-1}}$ | 0.1405          | -0.0029     | -0.0331       | 0.0176               |                          | 0.0085     | -0.0055   | 0.0408    | -4.73E-12 | 2.3103     |
|              |                          | 2.240           | -2.589      | -0.454        | 0.853                |                          | 1.310      | -0.983    | 0.493     | -0.554    |            |
|              | $\ln\frac{P_t}{P_{t-1}}$ | 0.1477          | -0.0005     | -0.0266       |                      | 0.0001                   | -0.0010    | 0.0036    | 0.0503    | 3.07E-12  | 0.1990     |
|              |                          | 10.970          | -15.630     | -1.098        |                      | 0.199                    | -0.517     | 2.199     | 2.299     | 1.239     |            |
| GMT.E        | $\ln\frac{M_t}{M_{t-1}}$ | 0.1302          | -0.0031     | -0.0196       | -0.0023              |                          | -0.0058    | -0.0007   | 0.0087    | 1.12E-12  | 3.8171     |
|              |                          | 2.089           | -2.746      | -0.256        | 0.095                |                          | -0.858     | -0.221    | 0.098     | 0.133     |            |
|              | $\ln\frac{P_t}{P_{t-1}}$ | 0.2121          | -0.0050     | 0.0018        |                      | -0.0025                  | -0.0108    | 0.00173   | -0.0071   | 5.13E-12  | 0.1797     |
|              |                          | 12.173          | -16.737     | 0.089         |                      | -2.855                   | -5.713     | 1.917     | -0.298    | 2.270     |            |

<sup>a</sup> t-ratios are reported under the corresponding estimated coefficients.

<sup>b</sup> Instruments are the lagged value of the logarithm of tax rate, the lagged value of the deviation of real GDP from trend expressed as a ratio of trend-real GDP, the logarithm of the lagged government spending-GDP ratio, the time trend.