The Backing of Government Debt and the Price Level*

R. Castro, C. Resende, and F. J. Ruge-Murcia

Département de sciences économiques and C.I.R.E.Q., Université de Montréal

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Abstract

This paper studies the interdependence between fiscal and monetary policies, and their joint role in the determination of the price level. The fiscal authority has a long-run commitment to finance a given proportion, say $\delta$, of the outstanding government debt. The remaining debt is backed by seigniorage revenue. The parameter $\delta$ characterizes the interdependence between fiscal and monetary authorities. It is shown that in a standard monetary economy, this policy rule implies that the price level depends not only on the money stock, but also on the proportion of debt that is backed with money. Empirical estimates of $\delta$ are obtained for OECD countries using data on nominal consumption, monetary base, and debt. Results indicate that debt plays only a minor role in the determination of the price level in these economies. Estimates of $\delta$ correlate well with institutional measures of central bank independence.

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1 Introduction

This paper studies the interdependence between fiscal and monetary policies, and their joint role in the determination of the aggregate price level. In general, fiscal and monetary policies are linked through the consolidated government budget constraint. A combination of taxes, new debt issue, and seigniorage revenue must finance government expenditures in every period. Or, expressed in terms of the intertemporal budget constraint, outstanding debt must be backed by a combination of the present discounted value of current and future seigniorage revenues and primary surpluses.

More precisely, this paper examines the proposition that how debt is backed affects the manner in which the aggregate price level is determined. The theoretical analysis is carried out in a standard competitive monetary economy. The government is characterized by a long-run fiscal policy rule whereby a given fraction of outstanding debt, say $\delta$, is backed by the present discounted value of current and future primary surpluses. The remaining debt is backed by seigniorage revenue. The parameter $\delta$ summarizes the degree of interdependence between fiscal and monetary authorities. It is a structural parameter, determined by the way a given institutional setup shapes the interaction between these two authorities. We show that, in a standard monetary economy, this policy rule implies that the price level depends not only on the money stock, but also on the proportion of debt that is backed with money.\footnote{There is, of course, a large literature that studies the relation between fiscal variables and inflation. Among others, Sargent (1986) documents the role of budget deficits in the European hyperinflations of the 1920's; Ruge-Murcia (1995) examines the relation between government spending and inflation in Israel in the 1980's; and Fischer, Sahay, and Vegh (2002) use post-war data to show the relation between fiscal balance and inflation in high inflation countries.}

We draw on earlier research by Aiyagari and Gertler (1985) and extend their work in at least three directions. First, we derive results using only the long-run fiscal policy rule without having to specify a particular period-by-
period rule. This long-run rule is compatible with the time-stationary rule in Aiyagari and Gertler, but also with other (perhaps not time-stationary) period-by-period rules. Second, we characterize the determination of the price level at all times, rather than only at the steady state. Finally, we propose a simple empirical strategy to construct an estimate of the $\delta$ parameter.

In order to understand the importance of the empirical analysis, note that in this model there is a continuum of fiscal regimes indexed by $\delta$. There are two polar cases. First, in the case where $\delta = 1$, the fiscal authority backs fully all government debt. Fiscal policy accommodates monetary policy in the following sense: whenever the monetary authority sells government bonds in the open market, the fiscal authority increases current or future taxes (and/or reduces current or future expenditures) to back the principal and interest payments on the newly issued debt. The monetary authority never responds to the increase in the stock of government debt associated with a budget deficit. Sargent (1982) and Aiyagari and Gertler (1985) refer to this case as a Ricardian regime.

Second, in the case where $\delta = 0$, it is the monetary authority that completely backs all government debt. The monetary authority accommodates the fiscal authority whenever a budget deficit is financed with debt. This accommodation takes the form of an increase in current or future seigniorage revenues to back the principal and interest payments on the newly issued debt. The fiscal authority is insensitive to monetary policy in the sense that neither taxes nor expenditure react (today or in the future) to changes in stock of outstanding government debt. Sargent, and Aiyagari and Gertler refer to this case as a polar Non-Ricardian regime.

Aiyagari and Gertler rightly argue that one cannot distinguish between Ricardian and Non-Ricardian regimes on the basis of long-run correlations between nominal interest rates and money growth. The reason is that there exists monetary policy rules for which the Non-Ricardian regimes ($0 \leq \delta < 1$) generate the same correlation as the Ricardian regime ($\delta = 1$). However,
we show that under certain conditions, the long-run dynamics of money, debt, and private consumption allow the direct estimation of $\delta$ and standard statistical inference can be used to draw conclusions regarding the regime that better describes policy in a given economy. The estimation strategy is based on standard results in unit-root econometrics that were not well developed at the time Aiyagari and Gertler wrote their contribution.

Using data from a sample of developed economies, we construct country-specific estimates of $\delta$. Although we find some heterogeneity, the null hypothesis that $\delta$ equals 1 cannot be rejected at standard levels for most countries in the sample. Hence, it would appear that a Ricardian regime is a reasonable approximation for these countries. This finding implies that (i) the fiscal authority backs all outstanding debt, (ii) debt plays only a minor role in the determination of the price level, and (iii) the Quantity Theory of Money holds (as a long-run proposition).

We also explore some empirical implications of our estimates of $\delta$. First, we contrast them with alternative measures of central bank independence proposed in the literature [see for example Alesina and Summers (1993) and Cukierman (1992)]. Although $\delta$ can be interpreted as a measure of central bank independence, we should not expect it to be perfect correlated with those measures. The reason is that $\delta$ reflects a broader notion of the interaction between fiscal and monetary authorities, whereas the usual central bank independence indexes (CBI) are based on narrow legal features. We do find, however, a broad agreement between $\delta$ and standard measures of central bank independence. Second, we examine whether countries with a more independent monetary authority have a larger proportion of government debt backed by the fiscal authority and, as a consequence, rely on lower levels of seigniorage. We do find a negative relation between $\delta$ and seigniorage revenue in the data, consistently with our model’s prediction. Third, as a consistency check, we test the following implication of our finding that most countries in the sample follow Ricardian fiscal regimes. With $\delta = 1$, the government debt
should help forecast future primary surpluses, while it should not be helpful in forecasting future seigniorage. An impulse-response analysis suggests that this implication of our model is also consistent with the data.

Our work is related to, but conceptually different from, the literature on the Fiscal Theory of the Price Level (FTPL) [see, for example, Woodford (1995) and Cochrane (1998, 2001)]. Under the FTPL, the price level is determined by the intertemporal budget constraint as the quotient between the nominal value of the interest bearing debt and the present value of the surplus (that might include seignorage revenues). The underlying assumption is that the government’s actions are not fully constrained by budgetary issues. Consequently, the intertemporal budget constraint holds as an equilibrium condition (rather than as a constraint), and thus only for equilibrium prices. Any shock to the primary surplus that is independent of the current level of debt must impact the price level, regardless of how committed the monetary authority is to price stability. Our model, on the other hand, assumes that the intertemporal budget constraint is always satisfied for any arbitrary sequence of prices (in and off equilibrium). Because of this conceptual difference, our econometric results should not be directly used to test the plausibility of the FTPL.2

The paper is organized as follows. Section 2 presents the theoretical model. Section 3 outlines the estimation strategy and reports empirical results. Section 4 concludes.

2Although Cochrane’s (1998) suggests that the FTPL cannot be falsified empirically because only equilibrium prices are observable.
2 The Model

2.1 Private Sector

The economy is populated by identical, infinitely-lived consumers with perfect foresight. The objective of the representative consumer is:

$$\max_{\{c_t, n_t, m_t, b_t, k_t\}} \sum_{t=0}^{\infty} \beta^t u (c_t, m_t/p_t, 1 - n_t)$$

(1)

where $\beta \in (0, 1)$ is the subjective discount factor and $u$ is strictly increasing in all arguments, strictly concave, twice continuously differentiable, and satisfies the Inada conditions.

In each period, consumers choose consumption ($c_t$) and labor ($n_t$), and decide next period holdings of capital ($k_t$), money ($m_t$) and nominal one-period government debt ($b_t$). The time endowment is normalized to one. The population size is constant and normalized to one. The variable $p_t$ is the aggregate price level. Capital and labor services are rented each period to a representative competitive firm that produces output according to a standard neoclassical production function.

The inclusion of real balances ($m_t/p_t$) as an argument of the utility function reflects the convenience of using money in carrying out transactions. Feenstra (1986) shows the equivalence between including real balances in the utility function, assuming liquidity costs that appear in the budget constraint, and introducing a cash-in-advance constraint. In this sense, the approach followed here to motivate money demand is not restrictive. Since our model is concerned with the composition of government liabilities, we follow Woodford (1995) in interpreting $m_t$ as the consumer’s holdings of the monetary base.

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3The assumption of perfect foresight is not crucial for the theoretical results, but it is analytically convenient. Aiyagari and Gertler (1985) allow uncertainty but focus on a steady state with constant asset prices. Leeper (1991) permits shocks to the fiscal and monetary policy rules, but output, consumption, and government expenditure are deterministic.
Because it is analytically very tractable and it allows us to exploit the linearity of the government’s budget constraint, we assume that the instantaneous utility function is logarithmic and separable:

\[ u(c_t, m_t/p_t, l_t) = \ln(c_t) + \gamma \ln(m_t/p_t) + \theta \ln(1 - n_t), \]

where \( \gamma \) and \( \theta \) are positive constants, measuring the relative importance of real money holdings and leisure in utility.

The consumer’s optimization problem is subject to a no-Ponzi-game condition and to the sequence of budget constraints (expressed in real terms):

\[ c_t + m_t/p_t + b_t/p_t + k_t = w_t n_t + r_t k_{t-1} + m_{t-1}/\pi_t p_{t-1} + i_{t-1} b_{t-1}/\pi_t p_{t-1} - \tau_t, \quad (2) \]

for all \( t \), where \( \tau_t \) is a lump-sum tax, \( \pi_t = p_t/p_{t-1} \) is the gross inflation rate, and \( i_{t-1} \) is the gross nominal interest rate on government debt, set in period \( t - 1 \) and paid in period \( t \). The wage rate is denoted by \( w_t \) and the gross return on capital between periods \( t - 1 \) and \( t \) is denoted by \( r_t \). In equilibrium, the absence of arbitrage profits will require \( r_t \) to equal the real gross interest rate \( i_{t-1}/\pi_t \).

The first-order necessary conditions of the representative consumer’s problem imply:

\[ 1/c_t = \beta(i_t/\pi_{t+1})(1/c_{t+1}), \quad (3) \]

\[ m_t/p_t = \gamma c_t i_t/(i_t - 1), \quad (4) \]

where \( R_t^{(j)} = \prod_{h=1}^{j} r_{t+h} \) is the \( j \)-periods-ahead market discount factor. Equation (3) is the Euler equation for consumption and equation (4) defines money demand as a function of the return on money and consumption. These two conditions alone turn out to provide the key implication of our model concerning the determination of the price level. In particular, the production side of the economy plays no role.
2.2 Government

In every period, the government spends an exogenous amount of resources \( G_t \). Government expenditures may be financed by levying lump-sum taxes \( \tau_t \),\(^4\) by issuing money \( M_t \) and by increasing public debt \( B_t \). The government is subject to a no-Ponzi-game condition and to a dynamic budget constraint (expressed in real terms):

\[
G_t + (i_{t-1} - 1) \frac{B_{t-1}}{p_t} = \tau_t + \frac{(M_t - M_{t-1})}{p_t} + \frac{(B_t - B_{t-1})}{p_t}. \tag{5}
\]

Forward iteration on (5) and the government’s no-Ponzi condition imply an intertemporal budget constraint:

\[
i_{t-1} \frac{B_{t-1}}{p_t} = \sum_{j=0}^{\infty} \frac{\tau_{t+j}}{R_t^{(j)}} + \sum_{j=0}^{\infty} \frac{M_{t+j} - M_{t+j-1}}{p_{t+j}R_t^{(j)}} - \sum_{j=0}^{\infty} \frac{G_{t+j}}{R_t^{(j)}}
= T_t + S_t - G_t,
\]

where \( T_t \), \( S_t \) and \( G_t \) are the present value of tax receipts, seigniorage revenue, and government expenditure, respectively. Without loss of generality, we assume that the government’s present value budget constraint holds in equality.\(^5\)

The government is assumed to follow a “long-run” fiscal policy rule whereby it commits itself to raise large enough primary surpluses (in present value terms) to back a constant fraction of the currently outstanding debt. More formally:

**Definition (δ-backing fiscal policy)** Given a sequence of prices \( \{i_{t+j-1}, p_{t+j}\}_{j=0}^{\infty} \) and an initial stock of nominal debt \( B_{t-1} \), a δ-backing fiscal

\(^4\)Our analysis would go through if the government levied distortionary taxes on capital and labor income. As emphasized in the previous section, this would have no bearing on the key restriction imposed by our model.

\(^5\)We impose a no-Ponzi condition on total government’s liabilities. Under the assumption that the government does not waste revenues, this amounts to \( \lim_{j \to \infty} (M_{t+j} + B_{t+j}) / p_{t+j}R_t^{(j)} = 0 \).
policy is a sequence \( \{G_{t+j}, \tau_{t+j}, B_{t+j}\}_{j=0}^{\infty} \) such that, for all \( t \):

\[
T_t - G_t = \delta i_{t-1} \frac{B_{t-1}}{p_t},
\]

where \( \delta \in [0, 1] \).

Put simply, this fiscal policy rule means that a constant fraction (\( \delta \)) of the outstanding government debt (including interest payments) is backed by the present discounted value of current and future primary surpluses. Since the government’s intertemporal budget constraint is always satisfied, it follows that:

\[
S_t = (1 - \delta)i_{t-1} \frac{B_{t-1}}{p_t}.
\]

Hence, the policy (6) also implies that a fraction \((1 - \delta)\) of the currently outstanding debt is backed by the present discounted value of current and future seigniorage revenue.

The set of possible fiscal regimes is indexed by the fraction \( \delta \) of the outstanding debt that is backed by the primary surplus. Because \( \delta \in [0, 1] \), this set is a continuum limited by the following two polar cases.

(i) In the case where \( \delta = 1 \), the fiscal authority backs fully all outstanding debt. It commits itself to adjust the stream of future primary surpluses in order to match the current value of the government’s bond obligations. There is complete accommodation of the fiscal policy to any open market sale by the monetary authority. Whenever the monetary authority sells government bonds in the open market, the fiscal authority increases current or future taxes (and/or reduces current or future expenditures) to back the principal and interest payments on the newly issued debt. On the other hand, the monetary authority never responds to the increase in the stock of government debt associated with a budget deficit. Sargent (1982) and Aiyagari and Gertler (1985) refer to this case as a Ricardian regime. Because of the apparent leading role played by the monetary authority, Leeper (1991) refers to this case as one of active monetary/passive fiscal policy.
(ii) In the case where \( \delta = 0 \), all outstanding debt is backed by the monetary authority in the form of current and future seigniorage revenues. The monetary authority fully accommodates the fiscal authority whenever a budget deficit is financed with debt. This accommodation takes the form of an increase in current or future seigniorage revenues to back the principal and interest payments on the newly issued debt. The fiscal authority is insensitive to monetary policy in the sense that neither taxes nor expenditure react (now or in the future) to changes in stock of outstanding government debt. Sargent, and Aiyagari and Gertler refer to this case as a polar Non-Ricardian regime. Leeper refers to it as one of passive monetary/active fiscal policy.

The long-run rule (6) is consistent with multiple period-by-period fiscal policy rules. As an example, consider the following simple version of the rule used by Aiyagari and Gertler (1985):

\[
p_t(\tau_t - G_t) = \delta [(i_{t-1} - 1) B_{t-1} - (B_t - B_{t-1})] .
\]

Under (8), the nominal primary surplus is adjusted in every period (increasing \( \tau_t \) or reducing \( G_t \)) in the exact amount needed to finance a fixed fraction \( \delta \) of the interest on the outstanding debt \( (B_{t-1}) \) net of an adjustment for debt growth. To see that this stationary policy satisfies (6), simply iterate forward on (8) and use the government’s no-Ponzi-game condition. In principle, there might be other period-by-period policy rules (perhaps not time-stationary) that are consistent with the rule (6). An advantage of our approach is that we are able to determine the price level and construct empirical estimates of \( \delta \) using the long-run policy rule (6) without having to assume that a particular policy like (8) is satisfied in every period, for every country in the sample.

The parameter \( \delta \) characterizes the degree of interdependence between fiscal and monetary authorities. This parameter should not be interpreted narrowly, as capturing a publicly announced policy commitment, or a commitment formally written in a country’s budget, constitution, or central bank
organic law. Instead, δ should also capture the informal interaction of the fiscal and monetary authorities given a stable institutional setup. We think this broader interpretation of δ is important. In fact, This interpretation is reinforced by the observation that the price level is derived here using a long-run fiscal policy rule without any reference to particular period-by-period fiscal or monetary policy rules.

2.3 Equilibrium

The competitive equilibrium for this economy may be defined in an entirely standard way. Specifically, it corresponds to a price system, allocations for the representative consumer and the representative firm, and a government policy, such that (i) the representative consumer and the representative firm optimize given the government policy and the price system, (ii) the government policy is budget-feasible given the price system, and (iii) markets clear.

To derive the key implication for the determination of the price level, we need to concentrate only on the clearing of the money market:6

$$M_t = m_t.$$  

(9)

Money supply is determined by the combination of the fiscal rule and the government’s intertemporal budget constraint [eq (7)], while money demand is given by the consumer’s intratemporal condition relating money and consumption [eq (4)]. From equation (7), money supply can be written after some manipulations as:

$$\frac{M_t}{p_t} = \frac{i_t}{i_t - 1} \left[ (1 - \delta) i_{t-1} \frac{B_{t-1}}{p_t} + \frac{M_{t-1}}{p_t} - \sum_{j=1}^{\infty} \frac{M_{t+j}}{p_{t+j} R^{(j)}_t} \frac{i_{t+j} - 1}{i_{t+j}} \right].$$  

(10)

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6Even though this is not essential for our analysis, note that in our model the price level is determined by the clearing of the money market alone. This is a consequence of money being neutral.
Imposing the equilibrium condition (9) on (10) and using money demand [eq. (4)] we obtain:

$$\gamma c_t = (1 - \delta) i_{t-1} \frac{B_t}{p_t} + \frac{M_{t-1}}{p_t} - \sum_{j=1}^{\infty} \frac{m_{t+j}}{p_{t+j} R_t^{(j)}} i_{t+j} - 1.$$

Exploiting the recursive nature of the Euler equation to find an expression for $$P_\infty \sum_{j=1}^{\infty} \frac{m_{t+j}}{p_{t+j} R_t^{(j)}} [(i_{t+j} - 1)/i_{t+j}]$$ in terms of current consumption, and after some algebra, it is possible to write the price level as a function of consumption and of the beginning-of-period stocks of money and debt:

$$p_t = \frac{(1 - \beta)(M_{t-1} + (1 - \delta) i_{t-1} B_{t-1})}{\gamma c_t}. \tag{11}$$

Aiyagari and Gertler obtain an expression for the price level similar to the one above, but assuming a specific period-by-period rule and focusing on a stationary solution with constant asset prices. Alternatively, one can use the fact that $$M_{t-1} + (1 - \delta) i_{t-1} B_{t-1} = M_t + (1 - \delta) B_t,$$ to write the price level in terms of the end-of-period stocks of money and debt:

$$p_t = \frac{(1 - \beta)[M_t + (1 - \delta) B_t]}{\gamma c_t}. \tag{12}$$

Regardless of the whether one focuses on either (11) or (12), this model implies that the price level depends not only on the money stock, but also on

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The proof goes as follows. Write equation (7) as:

$$(M_t - M_{t-1})/p_t - (1 - \delta)i_{t-1}B_{t-1}/p_t = -\sum_{j=1}^{\infty} \left( (M_{t+j} - M_{t+j-1})/p_{t+j} R_t^{(j)} \right),$$

$$= -(1/r_{t+1}) \sum_{j=0}^{\infty} \left( (M_{t+1+j} - M_{t+j})/p_{t+1+j} R_t^{(j)} \right),$$

$$= -(1 - \delta)i_{t}B_{t}/p_{t+1}r_{t+1},$$

$$= -(1 - \delta)B_{t}/p_{t},$$

where the last line follows from multiplying and dividing the right-hand side by $$p_t,$$ and using the definitions of gross inflation and gross real interest rates.

[11]
the proportion of the outstanding debt that is backed by money. In this sense, the proportion of the outstanding debt that is backed by money behaves like money itself.

In order to develop further the reader’s intuition, consider a long run situation where all real variables are constant, output \((y)\) and consumption \((c)\), in particular By dividing and multiplying the right-hand side of (12) by \(y\), we obtain:

\[
p_t = \frac{M_t}{y} + \frac{(1 - \delta)B_t}{y},
\]

where \(V \equiv (1 - \beta)y/(\gamma c)\) can be interpreted as a measure of velocity of a broad monetary aggregate, given by the sum of money and “monetized debt” (the proportion of debt that is backed by seigniorage), \(M_t + (1 - \delta)B\). Note that only for the particular case when \(\delta = 1\), can the constant \(V\) be interpreted as money-velocity, and the quantity theory of money holds. More generally, for any \(\delta \in [0, 1)\), the stock of debt plays a role in the determination of the price level. This point was made before by Aiyagari and Gertler.

A difference between this model and price determination under the Fiscal Theory of the Price Level is that in the latter, debt affects the price level even if it is never monetized. In this model, only the proportion of debt that is monetized (now or in the future) affects the price level. Furthermore, the influence of debt on the price level increases linearly with \((1 - \delta)\), that is, with the proportion of debt that is financed by current or future seigniorage revenues. When \(\delta = 1\), Ricardian Equivalence holds. For a given path of government expenditure, savings in the form of government debt will be used to pay future lump-sum taxes. Consequently, debt has no effect on the current demand for goods or money. Instead, when \(\delta \in [0, 1)\), a proportion of debt does not require future lump-sum tax increases but requires instead an increase in current and/or future seigniorage revenue. Anticipating future inflation, forward-looking agents reduce their current demand for money and
bid the price level up. Since individual behavior is distorted by the inflation tax, the Ricardian Equivalence will not hold in this case.

3 Empirical Analysis

3.1 Econometric Strategy

This section describes a simple econometric strategy to obtain estimates of the parameter that measures the degree of interdependence between fiscal and monetary policies, $\delta$. The strategy exploits standard results in unit-root econometrics. Rewrite equation (12) as:

$$M_t = \frac{\gamma}{(1 - \beta)} C_t - (1 - \delta) B_t,$$

(13)

where $C_t \equiv p_t c_t$ denotes nominal private consumption. Consider the empirical counterpart to this relation:

$$M_t = \alpha + \rho_1 C_t + \rho_2 B_t + e_t,$$

(14)

where $\alpha$ is an intercept, $\rho_j$ for $j = 1, 2$ are constant coefficients, and $e_t$ is a disturbance term that captures specification error. In terms of the structural parameters of the model, $\rho_1 = \gamma/(1 - \beta)$, and $\rho_2 = - (1 - \delta)$. Notice that although not all structural parameters could be identified from the Ordinary Least Squares (OLS) projection of $M_t$ on $C_t$ and $B_t$, $\delta$ could be identified from the coefficient on the stock of debt. In principle, because all three variables are endogenous in this model, the OLS regression would yield biased and inconsistent estimates if the variables were covariance-stationary. However, if $M_t, C_t,$ and $B_t$ are $I(1)$ variables (integrated of order one), and equation (14) is a cointegrating relationship, then the same regression would yield superconsistent parameter estimates [see Phillips and Durlauf (1986)].

\[\text{In principle, the reduced-form (14) can be written with either } M_t, C_t, \text{ or } B_t \text{ on the left-hand side. In adopting the formulation above, we are normalizing the coefficient of } M_t \text{ in the cointegrating vector to unity. Provided } M_t \text{ belongs to the cointegrating relation,}\]
Our approach is not the only one that could deliver estimates of the parameter $\delta$. We can think of at least two other strategies. First, one could consider estimating $\delta$ directly from the fiscal rule (6). An advantage of this strategy is that it would deliver a “theory-free” estimate without the need to model the consumer’s behavior or make assumptions about functional forms. However, this strategy requires the computation of the present discounted values $T_t$ and $G_t$ that involve infinite future values for taxes and government expenditure. Since we only have access to a finite number of observations, the implementation of this approach would necessarily involve truncation and the loss of many degrees of freedom. Second, one could follow the literature and construct inferences about government behavior on the basis of particular period-by-period rules [see, for example, Bohn (1998)]. This strategy would overcome the problem created by the computation of infinite summations. However, it seems unlikely that the same period-by-period rule describes government behavior in a cross-section of countries with different institutional arrangements. Instead, the approach here makes the hypothesis of similar consumer’s preferences across countries (at least in terms of functional form if not of preference parameters) but avoids imposing a common institutional design for governments in different countries.

3.2 Data

The empirical analysis is based on annual, per-capita data on nominal monetary base, nominal government debt, and nominal private consumption from 14 industrialized countries. All series come from the International Financial Statistics (IFS) database compiled by the International Monetary Fund. The only exceptions are government debt for the United States and Canada.

The data on monetary base corresponds to series 14 (Reserve Money) in the IFS (or by the sum of series 14a, 14c and 14d). For Canada, government results are robust to this normalization. The reason we choose to write the reduced-form in this manner is that its estimation delivers $\delta$ directly without the need to use, for example, the Delta method to compute its standard error.
debt corresponds to the series D469409 (Net Federal Government Debt) in the CANSIM database of Statistics Canada. For the United States, government debt is the series Gross Federal Debt Held by the Public from the U.S. Department of Commerce and available from the web site of the Federal Reserve Bank of St. Louis (www.stls.frb.org). For all other countries, government debt corresponds to the series 88a (Government Debt on National Currency) or, when this was not available, the series 88b (Government Domestic Debt) in the IFS. Finally, private consumption and population correspond, respectively, to the series 96F (Household Consumption Expenditures or Private Consumption) and 99Z.ZF in the IFS.

The countries in the sample were not randomly selected. Instead, we included in the sample all member countries of the Organization for Economic Cooperation and Development (OECD) for which reasonably long time series of the variables were available. The countries in the sample (with the sample period in parenthesis) are: Austria (1970 to 1997), Belgium (1953 to 1997), Canada (1948 to 1999), Finland (1950 to 1997), France (1950 to 1997), Germany (1950 to 1990), Italy (1962 to 1998), the Netherlands (1951 to 1998), Norway (1971 to 1997), Spain (1962 to 1998), Sweden (1950 to 1999), Switzerland (1960 to 1999), United Kingdom (1970 to 1997) and United States (1951 to 1999). In addition to data availability, the sample period for some countries was limited by substantial institutional changes. In particular, sample for Germany ends before reunification and the samples for member countries of the European Monetary Union end before the introduction of the Euro in January 1999.

3.3 Results

The econometric strategy outlined above to estimate the structural parameters of the model is valid only if \( M_t, C_t \), and \( B_t \) are I(1) variables and the OLS regression (14) is not spurious (that is, if (14) forms a cointegrating relation). Unit root and cointegration tests are used to assess both conditions.

[15]
Table 1 report results of Augmented Dickey-Fuller (ADF) unit-root tests. The estimated alternative is a covariance-stationary autoregression with both a constant and a deterministic trend. For all ADF tests, the level of augmentation, (i.e., the number of lagged first differences included in the OLS regression) was based on the Modified Information Criterion (MIC) proposed by Ng and Perron (2001). In all cases, the null hypothesis of a unit root with drift cannot be rejected against the alternative of a deterministic trend at the 5 percent significance level. The only exceptions are the per-capita nominal government debts of Norway and Italy. However, in the case of Norway the hypothesis cannot be rejected at the 1 percent level, and in both cases the hypothesis cannot be rejected when we apply recursive t-tests to select the level of augmentation.

The null hypothesis of no cointegration is tested using the residual-based method proposed by Engle and Granger (1987) and Phillips and Ouliaris (1990). Gonzalo and Lee (1998) show that this test is more robust than Johansen’s trace test to certain departures from unit root behavior like long memory and stochastic unit roots. The residual-based test requires running OLS on the relation of interest and then testing the hypothesis that the regression residuals have a unit root. Nonstationarity of the residuals constitutes evidence against cointegration.

Results for this test are reported in the last column of Table 1. The null hypothesis is rejected at the 5 percent level for Austria, Canada, Spain and Sweden, and at the 10 percent level for Belgium, Finland and the United States. For France, Italy, Norway and the United Kingdom, the null cannot be rejected at the 10 percent level but the result is marginal in that the p-values are reasonably close the 0.10. Without ambiguity, the null cannot be rejected for the Netherlands and Switzerland. Because, $M_t$, $B_t$, and $C_t$ were found to be $I(1)$ for both countries, the absence of cointegration is interpreted

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9In order to assess the robustness of the results to the lag-selection method, we also applied recursive t-tests with similar conclusions to the ones reported. Two exceptions are noted below.
as a rejection of the theoretical model for these two countries.

The above results are important because they allow us to describe empirically the money market equilibrium as a cointegrating relation. This means that even if the individual series can be represented as nonstationary processes, the behavioral rules and resource constraints of the model economy imply that a precise combination of these variables should be stationary. Hence, a simple Least Squares regression yields a superconsistent estimate of the parameter that characterizes the interdependence between fiscal and monetary policies. Because not all conditions outlined above are met for all countries in the sample, the analysis that follows focuses only on 12 of the 14 countries in the original sample, namely Austria, Belgium, Canada, Finland, France, Germany, Italy, Norway, Spain, Sweden, the United Kingdom, and the United States.

The estimation of the cointegrating vector provides us with estimates of the structural parameters of the model. A number of methods to estimate cointegrating vectors have been proposed in the literature. A nonexhaustive list includes OLS [Engle and Granger (1987)], nonlinear least squares [Stock (1987)], canonical correlations [Bossaerts (1988)], three-step-estimation [Engle and Yoo (1989)], maximum likelihood in a fully specified Vector Error Correction model [Johansen (1991)], and dynamic ordinary least squares (DOLS) [Stock and Watson (1993)]. Gonzalo (1994) uses Monte Carlo experiments to compare different estimation methods and concludes that in finite samples the maximum likelihood method has the smallest variance among the estimators considered. However, this approach has the disadvantage that it delivers only the basis of the cointegrating vectors rather than the cointegrating relations themselves. Phillips (1991) stresses that if researchers want to make structural interpretations on the separate cointegrating relations,

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**Footnote:**

Elliot (1998) shows that even if the model variables have roots near but not exactly equal to one, the point estimates of the cointegrating vector are consistent. However, hypothesis tests regarding the coefficients that do not have an exact unit root can be subject to size distortions.
this logically requires the use of restrictions from economic theory.

With the above considerations in mind, we employ the DOLS method proposed by Stock and Watson (1993) that is asymptotically equivalent to maximum likelihood [see Gonzalo (1994, p. 204)] but exploits the functional relationship predicted by the model. This approach involves running the OLS regression:

$$\begin{align*}
M_t &= \alpha + \rho_1 C_t + \rho_2 B_t + \sum_{s=-k}^{k} \xi_{1,s} \Delta C_{t-s} + \sum_{s=-k}^{k} \xi_{3,s} \Delta B_{t-s} + e_t,
\end{align*}$$ (15)

where $\xi_{j,s}$ for $j = 1, 2$ and $s = -k, -k + 1, \ldots, k - 1, k$ are constant coefficients. Recall that in terms of the structural parameters of the model, $\rho_1 = \gamma/(1 - \beta)$ and $\rho_2 = -(1 - \delta)$. The appropriate number of leads and lags was selected by the sequential application of recursive $F$-tests.\footnote{Results using the Bayesian Information Criteria (BIC) are similar to the ones reported and are available from the corresponding author upon request.}

Table 2 presents estimates of the structural parameters and their rescaled standard errors. Standard errors are rescaled to take into account the serial correlation of the residuals that remains after adding the $k$ leads and lags [see, Hayashi (2000, pp. 654-657)].\footnote{All regressions include an intercept term (not reported). The theoretical model predicts that the intercept should be zero [see eq. (13)]. However, for most countries in the sample, the intercept was found to be statistically different from zero. Strictly speaking, this constitutes a rejection of the theory. A more constructive interpretation of this result is that the theoretical relation holds up to a constant term.}

In all cases the coefficient on nominal consumption, $\rho_1 = \gamma/(1 - \beta)$ is positive and (except for Italy and Norway) statistically different from zero. The weight of real balances in the utility function ($\gamma$) and the subjective discount rate ($\beta$) are not separately identified. However, if one assumes that $\beta = 0.96$ (that is, the steady-state real interest is approximately 4 percent per year) then one could compute an estimate of $\gamma$ as $\hat{\gamma} = \hat{\rho}_1(1 - 0.96)$. This estimate is reported in Column 5.

An estimate of $\delta$ can be trivially identified from the reduced-form parameter $\rho_2 = -(1 - \delta)$. This estimate is reported in Column 3. Notice that
in all cases, this parameter is positive, statistically different from zero, but (except for Austria and Belgium) not statistically different from one at the 5 percent level. Recall that $\delta$ is the proportion of current government debt that is backed by the present discounted value of current and future primary surpluses. Hence the finding that $\delta$ is close to 1 means that outstanding debt in developed economies is essentially backed by the fiscal authority. Backing takes the form of a commitment to adjust the stream of future primary surpluses to match the current value of its bond obligations. In the long-run, there is complete accommodation of the fiscal policy to the open market operations by the monetary authority in the sense that (for example) when the monetary authority sells government bonds in the open market, the fiscal authority increases current or future taxes (and/or reduces current or future expenditures) to back the principal and interest payments on the newly issued debt.

This finding suggests that the interdependence between fiscal and monetary authorities in developed economies is well described by what Sargent (1982) and Aiyagari and Gertler (1985) refer to as a Ricardian regime or, in the language of Leeper (1991), an active monetary/passive fiscal policy regime. In this regime, the fiscal authority backs all outstanding debt, debt plays only a minor role in the determination of the price level, and the Quantity Theory of Money holds as a long-run proposition.

### 3.4 Additional Empirical Implications

We now examine some additional empirical implications of our estimates.

First, we compare $\hat{\delta}$ with alternative measures of central bank independence and seigniorage revenue computed by other researchers. The comparison with indexes of central bank independence is motivated by interpreting $\delta$ as a value determined by interaction of the fiscal and monetary authorities in a given institutional setup. We view the institutional setup as capturing not only the formal legal characteristics of the central bank’s organic law,
but also the informal policy decision-making practice. In contrast to alternative measures of central bank independence proposed in the literature, our measure therefore captures not only formal but also informal, or behavioral, elements.

The comparison with seigniorage is motivated by the our model’s prediction that reliance on seigniorage should be greater in economies where the fiscal authority is committed to finance a smaller fraction of the outstanding debt. This comparison is not meant to capture a causal relationship, but it is plausible that countries that back a larger proportion of their government debt with seigniorage, would feature larger average seigniorage revenues as a proportion of Gross Domestic Product and government spending.\(^\text{13}\)

Second, we derive the joint implications of \(\hat{\delta}\) and the long-run policy rule regarding the response of the primary surplus and seigniorage to innovations in government debt. We then use a Vector Autoregression to examine whether these implications are broadly consistent with the data.

Figures 1 through 3 plot the relation between \(\hat{\delta}\) and measures of central bank independence. The measure in Figure 1 is the index computed by Alesina and Summers (1993) as the arithmetic average of the indexes constructed by Bade and Parkin (1982) and by Grilli, Masciandaro, and Tabellini (1991). The measure in Figure 2 is the index constructed by Cukierman (1992). All these indexes measure central bank independence by focusing primarily on legal characteristics like the terms of office of the central bank director(s), restrictions on public sector borrowing from the central bank, conflict resolution between the central bank and the executive branch etc. The measure in Figure 3 is (one minus) the central bank governor’s turnover rates. Cukierman proposes this variable as a possible measure of actual, as opposed to legal, central bank independence.

In all three figures, we observe a positive relation between our empirical measure of interdependence between fiscal and monetary policies (\(\hat{\delta}\)) and the

\(^{13}\text{Strictly, this statement is true only for a given level of the public debt.}\)
indexes of central bank independence. In general, the larger the independence
of the monetary authority, the larger the proportion of government debt
that is backed by the fiscal authority. This relationship can be quantified
by means of correlation coefficients and OLS regressions. The correlations
between \( \hat{\delta} \) and the indexes in Figures 1 through 3 are, respectively, 0.45, 0.23,
and 0.06. The weakest relationship is that between \( \hat{\delta} \) and (one minus) the
turnover rates. However, Cukierman (p. 385) cautions that the governor’s
turnover rate might not be an effective proxy for central bank independence
in developed countries.

Results from regressions of \( \hat{\delta} \) on each index of central bank independence
are reported in Table 3. First, consider results in Columns 1, 3, and 5, where
the regressors are an intercept term and the independence index. In all cases,
the coefficient on the index is positive but not statistically different from zero
at standard levels, and the \( R^2 \)’s are generally low. Second, consider results
in Columns 2, 4, and 6, where the set of regressors is expanded to include the
independence index squared. In all cases, the coefficients on the index (index
squared) are positive (negative), and the \( R^2 \)’s are considerably larger than in
the linear projections. In the first and third regressions, the coefficients are
statistically different from zero at the 5 percent level. These results indicate
a nonlinear, concave relation between \( \hat{\delta} \) and central bank independence.

Consider now the relation between \( \hat{\delta} \) and seigniorage revenue as a propor-
tion of GDP and of government expenditures. These relations are plotted in
Figures 4 and 5, respectively. The seigniorage measures are the annual aver-
ages between 1971 and 1990 reported by Click (1998, p. 155). In both cases
there is a negative (possibly nonlinear) relation between \( \hat{\delta} \) and seigniorage.
The correlation coefficients are, respectively, \(-0.61\) and \(-0.53\).

Although these results are suggestive, they must be interpreted with cau-
tion for two reasons. First, the number of countries in the sample is relatively
small and, consequently, outliers can have a large effect on the computed
correlations. For example, when one excludes the United States from the
sample, the correlations between $\hat{\delta}$ and the legal-based indexes drop to 0.05 (Alesina and Summers) and −0.02 (Cukierman). The correlation between $\hat{\delta}$ and (one minus) the turnover rates rises to 0.18. Second, a $F$-test of the restriction that $\delta$ is the same in all countries in the sample yields a statistic of 0.003. Comparing this statistic with the 5 percent critical value of the $F$ distribution with (11,259) degrees of freedom indicates that the restriction cannot be rejected. This means that the interaction between fiscal and monetary authorities in the sample countries is relatively similar, perhaps because institutional differences across these countries are comparatively small.

The assumed long-run policy rule in conjunction with the finding that (in general) $\hat{\delta}$ is approximately equal to one imply that innovations in government debt should provoke positive long-run response in the primary surplus, but leave seigniorage revenues relatively unaffected. In order to assess this implication we construct a parsimonious Vector Autoregression of order 1 in government debt, primary surplus, and seigniorage as percent of GDP for each country in the sample. The data on the primary surplus was also taken from the IFS database of the International Monetary Fund. The responses of the primary surplus and seigniorage following a one-standard-deviation innovation in government debt are plotted in Figures 6 to 17. The dotted lines are asymptotic 95 percent confidence intervals. Two main results are apparent from these Figures. First, after a negative (in all cases, except Norway) and usually statistically different from zero initial response, the primary surplus increases (usually, monotonically) over time and becomes positive after 5 to 10 years following the debt shock. In most cases, this positive response becomes statistically different from zero at some point in the 10 to 20 year horizon. This result is consistent with view that the fiscal authority increases future taxes and/or reduces future expenditures to back newly issued debt. Exceptions are Austria, France, and Germany, where the point estimate of

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14 For the United States, the primary surplus is available only since 1959. Consequently, the US sample for this VAR is slightly shorter than the one used to obtain previous empirical results.
the impulse response is still negative (though not statistically significant) after 20 years, and Norway, for which the response is always positive but never statistically different from zero. In related research, Bohn (1998) finds for the United States that an increase in government debt by $100 leads to an increase in the primary surplus by $5.40 in the following year.

Finally, the seigniorage response to a debt innovation is usually of an order of magnitude smaller than the primary surplus response, and not statistically different from zero. Hence, by an large, debt innovations leave seigniorage revenue unaffected, as implied by our model.

4 Conclusions

This paper uses a simple infinite-horizon monetary economy to study how fiscal and monetary policy interact to determine the aggregate price level. The government behavior is summarized by a long-run fiscal policy rule, where a fraction of the outstanding debt is backed by the present discounted value of current and future primary surpluses. The remaining debt is backed by the present discounted value of current and future seigniorage revenue. Economies may thus be indexed by the fraction of the debt backed by the fiscal authority. Only in the polar Ricardian regime, when the debt is fully backed by fiscal policy, the price level is determined by the stock of money alone. More generally, the proportion of debt backed by money behaves like money itself for the purpose of determining the price level.

Simple unit root econometrics techniques can be employed to identify the parameter that indexes the policy regimes from the long-run dynamics of nominal money stock, consumption, and government debt. Results from OECD economies suggest that a Ricardian, regime where the fiscal authority backs all outstanding debt, debt plays only a minor role in the determination of the price level, and the Quantity Theory of Money holds (as a long-run proposition) is a reasonable approximation for most devel-
oped countries. Consistency checks based on impulse-response analysis are roughly in agreement with the main empirical results. Finally, we find that our measure of monetary policy independence is positively correlated with standard institutional measures of central bank independence.
### Table 1. Unit Root and Cointegration Tests Results

<table>
<thead>
<tr>
<th>Country</th>
<th>ADF Unit Root Test $M_t$</th>
<th>ADF Unit Root Test $B_t$</th>
<th>ADF Unit Root Test $C_t$</th>
<th>Residual-Based Cointegration Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>−2.20</td>
<td>−1.53</td>
<td>−1.25</td>
<td>−5.52*</td>
</tr>
<tr>
<td>Belgium</td>
<td>−1.45</td>
<td>−1.45</td>
<td>−2.67</td>
<td>−3.56†</td>
</tr>
<tr>
<td>Canada</td>
<td>−0.59</td>
<td>−1.68</td>
<td>−1.93</td>
<td>−4.82*</td>
</tr>
<tr>
<td>Finland</td>
<td>−2.15</td>
<td>1.21</td>
<td>−2.22</td>
<td>−3.71†</td>
</tr>
<tr>
<td>France</td>
<td>−3.16</td>
<td>−2.15</td>
<td>−2.37</td>
<td>−3.41</td>
</tr>
<tr>
<td>Germany</td>
<td>−2.40</td>
<td>−2.24</td>
<td>−1.53</td>
<td>−4.50*</td>
</tr>
<tr>
<td>Italy</td>
<td>−0.54</td>
<td>−4.73*</td>
<td>−2.38</td>
<td>−3.30</td>
</tr>
<tr>
<td>Netherlands</td>
<td>−1.82</td>
<td>−1.85</td>
<td>−1.79</td>
<td>−2.09</td>
</tr>
<tr>
<td>Norway</td>
<td>−0.07</td>
<td>−3.66*</td>
<td>−2.45</td>
<td>−3.18</td>
</tr>
<tr>
<td>Spain</td>
<td>−1.77</td>
<td>0.20</td>
<td>−1.66</td>
<td>−3.82*</td>
</tr>
<tr>
<td>Sweden</td>
<td>−2.13</td>
<td>−1.88</td>
<td>−1.11</td>
<td>−4.96*</td>
</tr>
<tr>
<td>Switzerland</td>
<td>−1.49</td>
<td>−1.64</td>
<td>−2.99</td>
<td>−2.07</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>−1.10</td>
<td>−3.29†</td>
<td>−1.68</td>
<td>−3.02</td>
</tr>
<tr>
<td>United States</td>
<td>2.28</td>
<td>−2.64</td>
<td>−0.24</td>
<td>−3.76†</td>
</tr>
</tbody>
</table>

*Notes*: The superscripts * and † denote the rejection of the null hypothesis at the 5 percent and 10 percent significance levels, respectively.
Table 2. Estimates of Structural Parameters

<table>
<thead>
<tr>
<th>Country</th>
<th>$\hat{\rho}_1$ Estimate</th>
<th>s.e.</th>
<th>$\delta$ Estimate</th>
<th>s.e.</th>
<th>$\hat{\gamma}$</th>
<th>$1 - \hat{\delta}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>0.197*</td>
<td>0.012</td>
<td>0.944*</td>
<td>0.011</td>
<td>4.93*</td>
<td>0.056*</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.145*</td>
<td>0.061</td>
<td>0.959*</td>
<td>0.019</td>
<td>3.63*</td>
<td>0.041*</td>
</tr>
<tr>
<td>Canada</td>
<td>0.128*</td>
<td>0.059</td>
<td>0.956*</td>
<td>0.043</td>
<td>3.20*</td>
<td>0.044</td>
</tr>
<tr>
<td>Finland</td>
<td>0.292*</td>
<td>0.101</td>
<td>0.997*</td>
<td>0.338</td>
<td>7.30*</td>
<td>0.003</td>
</tr>
<tr>
<td>France</td>
<td>0.163*</td>
<td>0.020</td>
<td>0.939*</td>
<td>0.048</td>
<td>4.08*</td>
<td>0.061</td>
</tr>
<tr>
<td>Germany</td>
<td>0.179*</td>
<td>0.031</td>
<td>0.928*</td>
<td>0.060</td>
<td>4.48*</td>
<td>0.072</td>
</tr>
<tr>
<td>Italy</td>
<td>0.360</td>
<td>0.283</td>
<td>0.903*</td>
<td>0.106</td>
<td>9.00</td>
<td>0.097</td>
</tr>
<tr>
<td>Norway</td>
<td>0.089</td>
<td>0.101</td>
<td>0.946*</td>
<td>0.298</td>
<td>2.23*</td>
<td>0.054</td>
</tr>
<tr>
<td>Spain</td>
<td>0.467</td>
<td>0.652</td>
<td>0.905*</td>
<td>0.536</td>
<td>11.68*</td>
<td>0.095</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.268*</td>
<td>0.064</td>
<td>0.952*</td>
<td>0.062</td>
<td>6.70*</td>
<td>0.048</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.046*</td>
<td>0.008</td>
<td>0.994*</td>
<td>0.019</td>
<td>1.15*</td>
<td>0.006</td>
</tr>
<tr>
<td>United States</td>
<td>0.033</td>
<td>0.046</td>
<td>1.073*</td>
<td>0.049</td>
<td>0.83*</td>
<td>−0.073</td>
</tr>
</tbody>
</table>

Notes: s.e. is the (rescaled) standard error. The superscript * denotes the rejection of the null hypothesis that the true coefficient is zero at the 5 percent significance level. The estimate of $\gamma$ is obtained assuming that $\beta = 0.96$. 

[26]
Table 3. Relation between $\hat{\delta}$ and Central Bank Independence

<table>
<thead>
<tr>
<th>Measure of Independence</th>
<th>Intercept</th>
<th>Alesina and Summers’</th>
<th>Cukierman’s</th>
<th>One minus Turnover Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.89*</td>
<td>0.48*</td>
<td>0.94*</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.20)</td>
<td>(0.03)</td>
<td>(0.09)</td>
</tr>
<tr>
<td>Index</td>
<td>0.03</td>
<td>0.35*</td>
<td>0.06</td>
<td>0.83</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.15)</td>
<td>(0.09)</td>
<td>(0.49)</td>
</tr>
<tr>
<td>Index²</td>
<td>-</td>
<td>-0.06*</td>
<td>-</td>
<td>-0.96</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.54)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$r^2$</td>
<td>0.21</td>
<td>0.52</td>
<td>0.05</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Notes: the figures in parenthesis are robust standard errors. The superscript * denotes the rejection of the null hypothesis that the true coefficient is zero at the 5 percent significance level.
References


Fig. 1: Relation between Delta Central Bank Independence (I)

Index by Alesina and Summers (1993)
Fig. 2: Relation between Delta and Central Bank Independence (II)
Fig. 3: Relation between Delta and Central Bank Independence (III)
Fig. 4: Relation between Delta and Seigniorage (I)
Fig. 5: Relation between Delta and Seigniorage (II)
Fig. 6: Response to a Debt Innovation. Austria

Primary Surplus

Seigniorage
Fig. 7: Response to a Debt Innovation. Belgium

Primary Surplus

Seigniorage
Fig. 8: Response to a Debt Innovation. Canada

Primary Surplus

Seigniorage
Fig. 9: Response to a Debt Innovation. Finland

Primary Surplus

Seigniorage
Fig. 10: Response to a Debt Innovation. France

Primary Surplus

Seigniorage
Fig. 11: Response to a Debt Innovation. Germany
Fig. 12: Response to a Debt Innovation. Italy
Fig. 13: Response to a Debt Innovation. Norway
Fig. 14: Response to a Debt Innovation. Spain
Fig. 15: Response to a Debt Innovation. Sweden
Fig. 16: Response to a Debt Innovation. U.K.
Fig. 17: Response to a Debt Innovation. U.S.