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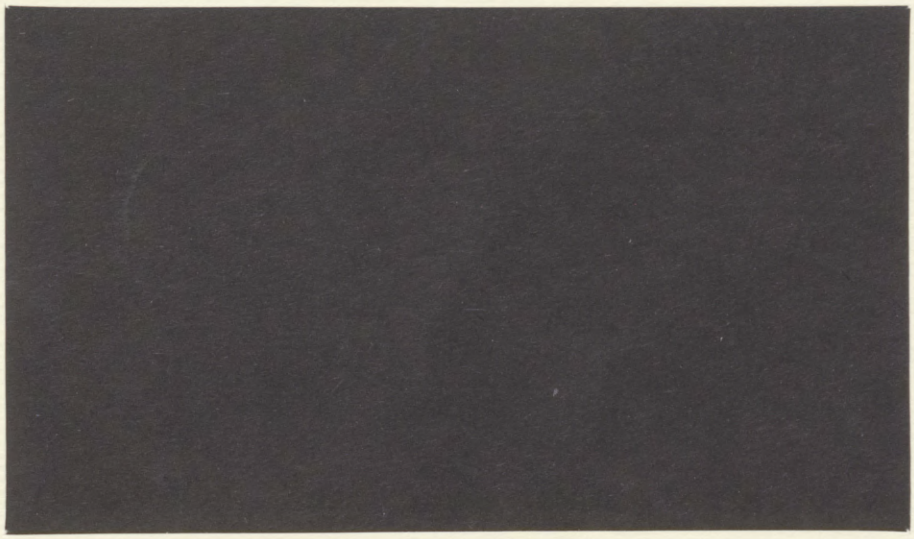

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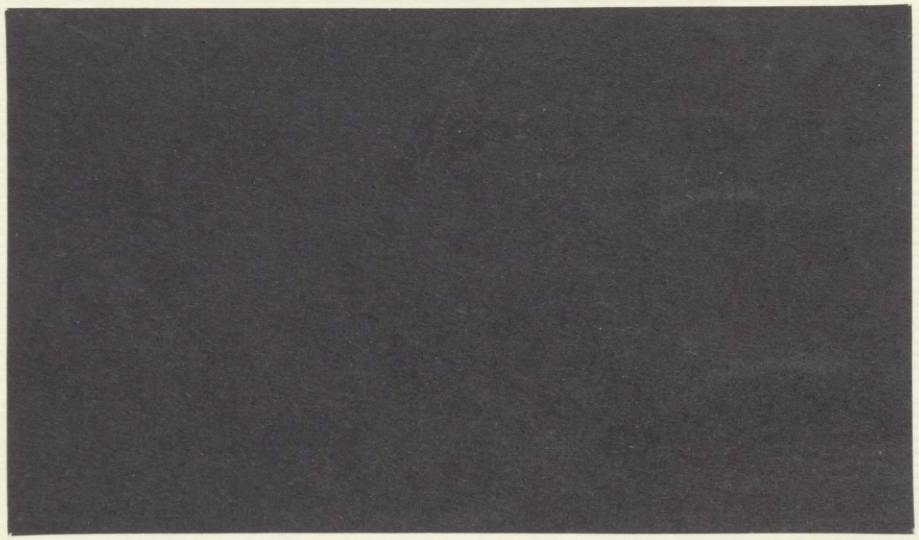

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SEIGNIORAGE AND INFLATION: THE CASE OF ARGENTINA*

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ABSTRACT

This paper studies the relation between seigniorage and inflation in Argentina for the period 1979-1989. We estimate a money demand function and derive the Laffer curve for several sub-periods with different monetary/exchange rate regimes. We find that for most of the period the Argentine economy remained on the "efficient" side of the Laffer curve. The long-run revenue maximizing rate of inflation has been around 20% per month for the "tablita" (1979-1981) and post-Austral (1985-1988) periods and around 30% per month for the pre-Austral period (1982-1985). The long-run maximum level of seigniorage has been above 6% of GDP. Our results imply that the hyperinflation experienced by Argentina in 1989 can be interpreted as an unstable phenomenon that resulted from the need to collect a level of seigniorage that exceeded the maximum warranted by the demand for money.

I. Introduction

Very high inflations are usually explained by the need to raise revenue from money creation (i.e. seigniorage) to finance the budget deficit. The literature on inflationary finance (as presented for example in Friedman (1971), Sargent and Wallace (1973) and Bruno and Fischer (1990) among others) provides the analytical underpinnings to study this issue. The models in this literature give rise to a Laffer curve between inflation and seigniorage, and show that in general there are two steady state equilibria.

There are essentially three alternative explanations of very high inflations within this approach. A first explanation considers that the economy is on the "efficient" part of the Laffer curve and hence that increases in inflation are associated with larger seigniorage (this is implicit in the analysis presented in Sargent and Wallace (1973)). The second explanation argues that the economy might be stuck at an equilibrium that lies on the "wrong" side of the Laffer curve (e.g. Bruno and Fischer (1990)); fiscal deficits in this case are not the sole explanation for inflation. From a fiscal perspective, the government can increase the revenue from seigniorage by reducing the rate of inflation. The common feature of these two views is that they consider high inflation as a stable long-run equilibrium. The third explanation sees high inflation as an unstable phenomenon (e.g. Kiguel (1989)), whose main cause are attempts to raise seigniorage in excess of the maximum warranted by the demand for money. According to this approach, once the economy reaches this point inflation accelerates, eventually reaching hyperinflation levels. Discerning which of these explanations is the most relevant to explain the actual behavior of a particular economy depends on whether the inflation elasticity of the demand for money is smaller or greater than unity, and on whether the long-run fiscal deficit is greater or smaller than the maximum long-run revenue from money creation.

The purpose of this paper is to use the recent Argentine experience to discuss the relevance of these alternative views. The main question addressed by the paper is whether the rate of inflation was beyond the revenue maximizing rate. Argentina is a natural candidate to look at this issue (especially in the last fifteen years) because inflation has been persistently high (in excess of 100 percent per year) and seigniorage appears to have been an important force underlying these developments (see figure 1). This is illustrated further in Table 1, which shows the overall deficits of the non-financial public sector and the way these deficits were financed, as well as seigniorage and inflation for the period 1978-87.[1] Deficits were very large for most years, and seigniorage played an important role in financing them.

[INSERT FIGURE 1]

In addition, this paper extends the existing empirical literature on money demand in Argentina, by taking into account the changes in the monetary/exchange rate regime that took place during these years. In this respect it differs from other recent studies such as Melnick (1988), Fernandez and Mantel (1989), and Rodriguez (1991). We take into account two criteria to distinguish the periods: first, the nature of the exchange rate-monetary arrangement (i.e. whether the exchange rate is fixed or flexible), and second the relevant opportunity cost of holding money (i.e. inflation, interest rates or the rate of depreciation of the exchange rate), depending on whether or not there were controls on interest rates and/or foreign exchange transactions.

The remainder of the paper will be organized as follows. The next section briefly discusses the main features of the various regimes that we study. Section III presents the estimation of money demand for the various periods, and summarizes the main features. We conclude in section IV with the implications for the debate on the relationship between seigniorage and

inflation. We include an appendix showing the methodology for computing the inflation tax when only discrete time data are available.

II. Monetary Regimes in our Sample

There are basically two main monetary/exchange rate regimes between 1979 and 1989. The first one, from January 1979 till January 1981 (in what follows called the "tablita" period), was characterized by a preannounced path of the exchange rate (the famous tablita), a high degree of international capital mobility, and market determined interest rates. Money supply was essentially endogenous (as in the Mundell-Fleming model), while domestic interest rates were determined by the interest rate parity condition.[2] The domestic interest rate clearly represented the opportunity of holding money during this time.

The second period, from February/March 1981 till the end of 1989, was characterized by higher (though varying in degree and type) restrictions on capital flows, hence giving the authorities more control of the money supply. Interest rates and prices (or inflation) had a more important role in clearing the money market (since the money supply was to a large extent a policy variable).

The change in monetary regime was not accompanied by any significant changes in other policy areas. In particular, there is no evidence of any important change in fiscal policy regarding the size of the public sector, or efforts to restraint the government's access to central bank financing. By and large, the whole period was characterized by lax fiscal deficits and no serious, persistent attempt to deal with the problem.

It is useful to divide this second period in four, to account for changes in financial arrangements. In what follows we describe the duration and main features of each sub-period:

(i) Between February 1981 and June 1982, the situation was characterized by large financial instability, as a result of continuous changes in regulations regarding interest rates, and foreign exchange markets.

(ii) The period between July 1982 and March 1985 (the pre-Austral period) was more stable (regarding financial institutions), although there was widespread macroeconomic instability. There were controls on interest rates and there was a parallel market for foreign exchange (the dual market).

(iii) The period between April 1985 and December 1988 (the post-Austral period) had essentially the main characteristics as the previous one, except for the liberalization of interest rates included in the financial reform of March 1985. This period includes the Austral plan (of June 1985), a major attempt to bring down inflation.

(iv) The period from 1989 onwards was one of hyperinflation, and extreme macroeconomic instability.

We estimate Cagan's money demand function with monthly data. The estimation concentrates on three periods: the "tablita", the pre Austral and the Austral. We decided to drop the period between February 1981 and June 1982 due to the small number of observations, and to the biases introduced by the frequent changes in regimes that took place during this short interval. Simple econometric tests[3], indicate that it is not appropriate to include this transition in either the Tablita or the pre-Austral periods. We also excluded the hyperinflation because it marks a structural brake in the time-series properties of the real stock of money and interest rates.

III. Empirical Evidence[4]

A. The "Tablita" period: January 1979-January 1981

The "Tablita" period is ideal for econometric purposes, as the nominal interest rate, the independent variable in the regression, can be taken as exogenously determined by the interest rate parity condition and the pre-announcement of the future exchange rate. Whereas the quantity of money, the dependent variable, was endogenized by the exchange rate regime and, thus, determined by demand conditions.

The money demand was estimated under the assumptions of partial adjustment and market clearing[5].

(1) $m_t = a_0 + a_1 i_t + u_t$

(2) $m_t = (1-\alpha)m_{t-1} + \alpha a_1 i_t + u_t$

where m_t = ln of the real stock of M1; and i_t = 30 day deposit interest rate in Buenos Aires.

Interest rate parity implies that

(3) $i_t = i_t^* + (e^*_{t+1} - e_t) + \theta_t$

where i^* = international interest rate; e_t = ln of the nominal dollar/peso exchange rate and a superscript * indicates expectation.

If the deviations from interest rate parity, θ_t, are independent of the money market shocks, u_t, (1) and (2) can be estimated by a simple OLS regression. However, since the interest rate shocks and the money market shocks are likely to be correlated we also estimated (1) and (2) through instrumental variables.[6]

The results from estimating (1) and (2) for the "tablita" period are presented in table I. We observe that the assumptions regarding the correlation of interest rates and money market disturbances as well as the speed of adjustment of the money market do not significantly affect the estimated values of the money demand's structural parameters. The level of interest rates that maximizes the steady state inflation tax ranges from a low estimate of 17.2% (σ=3.27) per month in the seasonal moving average partial adjustment model with instrumental variables, to a high estimate of 22.2% (σ=3.61) in the instrumental variables market clearing model with a dummy variable for December.

B. <u>The pre and post Austral Periods</u>

The second estimation is done for the pre and post Austral periods. As we already mentioned, the money supply process was independent of intervention in the foreign exchange market. Nevertheless, the financing of the fiscal deficit was an important source of monetary expansion, thus maintaining some endogeneity in the money supply process.

This link between money supply and fiscal deficits, and the endogeneity of the opportunity cost of holding money (either interest rates of inflation) create problems of identification, and a simultaneity bias when an equation such as (1) is estimated. Fortunately, we found that the logarithm of the real stock of M1 and the opportunity cost of holding money were co-integrated variables, allowing us to overcome the problems of identification and consistency. As a result we were able to estimate the long-run relationship between money and its opportunity cost that should hold in steady state[7].

Let the deviations from equilibrium in the money market be given by

$$(1') \quad u_t = m_t - m_t^d = m_t - a_0 - a_1 x_{t+1}$$

where x_{t+1} = expected opportunity cost of holding money in period t+1.

If $\{m_t\}$ and $\{x_{t+1}\}$ are integrated processes and form a co-integrated system, then there is a unique[8] co-integrating vector that yields stationary errors, u_t, and it necessarily has to be the one corresponding to the money demand's structural parameters if the money market is stable. Any other linear combination between $\{m_t\}$ and $\{x_{t+1}\}$, such as one arising from the money supply process, will be non-stationary. This solves the identification problem.

Consistent estimators of the co-integrating vector can be obtained from a standard OLS regression. However, this estimates will have a small sample bias of order $O(T^{-1})$ (Stock, 1987). The possible sources of bias are (i) the endogeneity of the expected opportunity cost of holding money, and (ii) the errors in variables problem that arises during the pre-Austral period because x_{t+1} is unobservable and (iii) the omission of a transaction variable in (1'). Stock and Watson (1989) propose an estimation procedure that reduces the small sample bias and yields a Gaussian maximum likelihood estimator of the unknown

parameters of the co-integrating vector. This estimator is based on the regression

$$m_t = a_0 + a_1 x_{t+1} + \sum_{j=-k}^{k} (x_{t+1+j} - x_{t+j}) + \xi_t \qquad (4)$$

For the pre-Austral period we chose the regulated deposit interest rate and the rate of inflation as proxies for the opportunity cost of holding money. The tests for unit roots and the co-integrating regressions are reported in table II. We rejected the null hypothesis that money, inflation and regulated interest rates were driftless random walks at the 1%, 5% and 10% significant level respectively, but we could not reject the hypothesis of a random walk with drift for any of the three variables. The second differences of the three variables are unambiguously stationary processes. The null hypothesis of no co-integration is rejected in seven of the eight regressions. Finally, we observe that the estimates of the revenue maximizing rate of inflation are close to 30% in the Stock-Watson dynamic regressions.

After April 1985 we have a better measure of x_{t+1} given by market deposit interest rates. The tests for unit roots do not reject the hypothesis of a unit root in the process for $\{m_t\}$ but they <u>do</u> reject the hypothesis of a unit root for interest rates. Nevertheless, we estimated the money demand's parameters from (4). We did so because even though these estimators are no longer superconsistent, the magnitude of the bias of the estimates should be small if the covariance between the regressors and the errors are small, relative to the variance of the interest rate. As a way of checking the reliability of our estimates we estimated an error correction model with the residuals of (4). As a result of this exercise we obtained reasonable estimates of a_0 and a_1. The estimates from (4) and from the reverse regressions of (1) and (4) imply a revenue maximizing rate of inflation of 21% per month. The lagged residual from (4) had a coefficient significantly different from zero in a VAR model of the first differences of m_t on lagged differences of money and interest rates, indicating that our estimates of the money market's deviations from equilibrium are reasonable.

There are two interesting findings in the results presented in this section. A first, striking fact is the similarity between the estimates for the post-Austral period and those obtained for the "tablita" regime is striking. This is surprising in view of the significant changes in the institutional setting in the two periods. These two episodes had in common the fact that interest rates were essentially market determined, and that the central bank used the exchange rate as a nominal anchor for disinflation. There were many differences as well --in the Tablitas the exchange rate was preannounced, while in the post-Austral period it was fixed at times but there were unscheduled devaluations. However, these common elements can account for the similarity in results. Second, the period of interest rate controls yielded a higher revenue maximizing rate of inflation. This not only indicates that financial repression can be used as a way to raise the revenue from money creation in the short run, more importantly, it points out that the type of financial innovations stressed in Calvo and Leiderman (1992) and other works are indeed important to fully understand seigniorage and inflation.

IV. Conclusions

We started the paper with questions regarding the interpretation of high inflation in countries such as Argentina. Much of these questions can be addressed with the help of figure 2, which shows the Laffer curves derived from the estimation for the Tablita and Pre-Austral periods, and the actual size of the inflation tax during the period[9]. The figure shows that for most of the period the economy has remained on the "efficient" side of the Laffer curve, and hence that increases in inflation have been, by and large, associated with increases in the inflation tax. The revenue maximizing inflation rates are high, around 20% per month for the Tablitas and the post-Austral period and 30% per month for the pre-Austral period, as was the actual revenue (around 7 percent of GDP). The rates for the post-Austral are higher than indicated by Fernandez and Mantel (1989) and Rodriguez (1991) (which are close to 20%), mainly because their methodology did not consider different periods.

[INSERT FIGURE 2]

The Laffer curve also provides useful insights regarding the dynamics of inflation during the period under study. The numbers presented in table 1 indicate that between 1978 and 1981, Argentina was experiencing high inflation by world standards (around 7% per month), but there was no risk of hyperinflation. Seigniorage was large, but it could be financed in a stable fashion (i.e. corresponds to a point on the Laffer curve). In contrast, for the period 1982-84 seigniorage exceeded 7%, which is above the levels that can be sustained by a stable rate of inflation. This means that in all likelihood the economy was on an explosive hyperinflationary path (of the type described in Kiguel (1989)). This is supported by the fact that inflation doubled in 1983, and again in 1984. The Austral plan in 1985 was a clear attempt to avoid a full blown hyperinflation and to bring back seigniorage (and inflation) to sustainable levels. When seigniorage became excessive for the second time in 1989 (it reached around 9% of GDP), the government was not able to control a full blown hyperinflation.

REFERENCES

Blejer, Mario I., (1982) "Interest Rate Differentials and Exchange Risk", I.M.F. Staff papers, Vol 29, No.2 June, pp. 270-79.

Bruno, Michael and Stanley Fischer (1990). "Seigniorage, Operating Rules and the High Inflation Trap," Quarterly Journal of Economics, Vol. 105, May, No. 421 pp.353-74.

Calvo, Guillermo A. and Leonardo Leiderman (1992). "Optimal Inflation Tax Under Precommitment: Theory and Evidence," The American Economic Review, Vol. 82, No.1, March, pp. 179-194.

Engle, Robert E. and C. W. J. Granger (1987). "Co-Integration and Error Correction: Representation, Estimation, and Testing," Econometrica, Vol. 55, No. 2, March, pp. 251-76.

Fernandez, Roque B. and Rolf R. Mantel. "Fiscal Lags and the Problem of Stabilization: Argentina's Austral Plan," in Latin American Debt and Adjustment, Philip L. Brock, Michael B. Connolly and Claudio Gonzalez-Vega, editors, New York: Praeger, pp. 65-79.

Friedman, Milton. (1971), "Government Revenue from Inflation", Journal of Political Economy, vol 79, pp 846-856.

Kiguel, Miguel A. (1989), "Budget Deficits, Stability and the Monetary Dynamics of Hyperinflation", Journal of Money Credit and Banking, Vol. 21, No. 2 May, pp.148-57.

Rafi Melnick (1988), "The Demand for Money in Argentina 1978-1987: Before and After the Austral Program," Discussion Paper # 168, Boston University, August 1988.

Rodriguez, Carlos A. (1991). "The Macroeconomics of Public Sector Deficits, the Case of Argentina," PRE Working Paper Series, NO. 632, Washington DC: The World Bank.

Sargent, Thomas and Neil Wallace (1973). "Rational Expectations and the Dynamics of Hyperinflation," International Economic Review, Vol. 14, No. 2, June, 328-50.

Stock, James H. (1987), "Asymptotic Properties of Least Squares Estimators of Co-Integrating Vectors", Econometrica, vol 55, No 5: 1035-1056.

Stock, James H. and Mark Watson (1989), "A Simple MLE of Cointegrating Vectors in Higher Order Integrated Systems", Technical Working Paper No 83, N.B.E.R., December.

The World Bank, Argentina: reforms for price stability and growth, Washington, D.C., 1990.

APPENDIX: Measuring the Inflation Tax with Discrete Time Data.

The inflation tax, the capital losses that inflation imposes on money holders, is a continuous time process and it should be measured with continuous time data. The unavailability of the latter requires to find an approximation based only on discrete time data. Let p_t be the end of period prices, $\bar{p}_t$ the average price level for period t, M_t the end of period nominal stock of money and m_t the end of period real stock of money.

Proposition: The best approximation to the inflation tax is:

$$T = \frac{M_t - M_{t-1}}{\bar{P}_t} - \left(\frac{M_t}{P_t} - \frac{M_{t-1}}{P_{t-1}}\right) \tag{1}$$

The alternative measure of the inflation tax $T' = m_{t-1}\,\pi_t$ is incorrect.

<u>Proof</u>: Define the set $A = \{\, t : M_t$ and P_t are continuous from the right$\}$. The instantaneous inflation tax is given by

$$\begin{aligned} T = m_t\,\pi_t &\equiv \frac{\dot{M}_t}{P_t} - \dot{m}_t \qquad \textit{for all } t \in A \\ &\equiv \lim_{\delta \to 0}\left(\frac{M_{t+\delta} - M_{t-\delta}}{P_{t-\delta}} - (m_{t+\delta} - m_{t-\delta})\,\frac{P_{t+\delta}}{P_{t-\delta}}\right) \qquad \textit{for all } t \notin A \end{aligned} \tag{2}$$

Defining A over a time interval of length one, the total inflation tax over that interval becomes

$$\begin{aligned} T = \int_A \frac{\dot{M}_t}{P_t}\,dt + \sum_{t \notin A} \lim_{\delta \to 0} \frac{M_{t+\delta} - M_{t-\delta}}{P_{t-\delta}} - (m_t - m_{t-1}) - \\ - \sum_{t \notin A} \lim_{\delta \to 0} (m_{t+\delta} - m_{t-\delta})\left(\frac{P_{t+\delta}}{P_{t-\delta}} - 1\right) \end{aligned} \tag{3}$$

The first two terms in (3) represent the total seigniorage levied by the central bank over the period, the third one represents the changes in real money balances and the last term is of second order and will be assumed to be negligible. Thus, the aggregation problem for measuring the inflation tax is the same one that arises in measuring seigniorage. This problem has

been studied by Bresciani-Turroni (1937). Let the total seigniorage collected over the period be

$$G = \int_A g_t \, dt + \sum_{t \in A} g_t \tag{4}$$

$$\text{where } g_t = \begin{cases} \dfrac{\dot{M}_t}{P_t} & \text{for all } t \in A \\ \lim\limits_{\delta \to 0} \dfrac{M_{t+\delta} - M_{t-\delta}}{P_{t-\delta}} & \text{for all } t \notin A \end{cases}$$

The time aggregation problem can then be restated as that of finding a time averaged price such that

$$\overline{P_t} = \frac{M_t - M_{t-1}}{G} = \frac{\int_A P_t g_t \, dt + \sum_{t \in A} P_t g_t}{G} \tag{4'}$$

Assuming that the level of seigniorage is constant over each period the price defined by (4') is the arithmetic mean of the instantaneous prices. Under this assumption (3) is equal to (1). ∎

The alternative measure given by

$$T' = m_{t-1} \pi_t \equiv \frac{M_t - M_{t-1}}{P_{t-1}} - (m_t - m_{t-1})(1 + \pi_t)$$

is incorrect and for high rates of inflation may result in a considerable overestimation. The two sources of bias are the second order term $(m_t - m_{t-1})\pi_t$ and the implicit assumption that all the seigniorage is collected at beginning of period prices. ∎

TABLE I: Financing of the fiscal deficit.

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Fiscal Deficit	6.5	6.5	7.5	13.3	15.1	16.1	12.6	6.1	4.3	7.4
Net Borrowing	5.5	6.9	3.9	8.0	7.8	-0.6	6.5	3.8	4.3	7.4
Domestic	3.6	5.1	2.0	3.7	6.5	-1.1	6.9	2.9	0.3	3.2
Foreign	1.9	1.8	1.9	4.3	1.3	0.5	-0.4	0.9	4	4.2
Central Bank Credit	1.0	-0.4	3.6	5.3	7.3	16.7	6.1	2.3	0.0	0.0
Seigniorage	6.9	5.68	4.76	3.52	7.83	8.61	7.12	6.51	3.46	4.03
Inflation (annual)	175.5	159.5	100.8	104.5	164.8	343.8	626.7	672.2	90.1	131.3

NOTES:

a. All the figures are % of GDP, except for the rate of inflation that is % per year.

b. Source: World Bank (1990) and IFS.

c. Domestic borrowing excludes Central Bank loans to the treasury.

TABLE II: TABLITA (79:01-81:01)

I. Market Clearing Model: $m_t = a_0 + a_1 i_t + \mu_t$

	a_0	a_1	F	R^2	DW	$E[1/a_1]$
SMA(12)	10.58 (61)	-.049 (-4.41)	26.0	0.70	1.69	21.1 (3.78)
SMA(12) TSLS	10.62 (49)	-.056 (-5.11)	15.5	0.58	1.69	18.4 (3.48)
DEC/MA(1) TSLS	10.55 (72)	-.046 (-6.0)	28.8	0.80	1.95	22.2 (3.61)

II. Partial Adjustment Model: $m_t = (1-\gamma)m_{t-1} + \gamma a_0 + \gamma a_1 i_t + \mu_t$

	$(1-\gamma)$	γa_0	γa_1	a_0	a_1	F	R^2	h	$E[1/a_1]$
SMA(12)	0.28 (2.2)	7.63 (5.6)	-.039 (-4.1)	10.61 (47)	-.054 (-4.65)	21.3	0.75	1.06	19.4 (3.98)
SMA(12) TSLS	0.21 (1.5)	8.40 (5.6)	-.048 (-4.3)	10.64 (45)	-.060 (-5.06)	18.3	0.72	0.20	17.2 (3.27)
DEC TSLS	0.39 (4.2)	6.51 (6.6)	-.030 (-4.1)	10.56 (56)	-.049 (-5.17)	49.7	0.88	0.40	21.1 (4.08)

Notes:

a. t-statistics are in parenthesis except for $E(1/a_1)$ where the standard deviation is reported.

b. t-statistics for the structural parameters of the partial adjustment model are based on the variance of the asymptotic distribution.

c. SMA(12): Seasonal moving average
Dec (Dummy) = 1 in December, 0 otherwise.

d. The first regression for each model reports the standard OLS estimation.

e. TSLS estimates I. and II. with instrumental variables using lagged interest rates and current and lagged rates of devaluation as instruments for i_t.

f. In model I. the TSLS with a Dec dummy is corrected for an MA(1) error process.

g. Data source: DATAFIEL

TABLE III: PRE-AUSTRAL (82:07-85:03)

UNIT ROOT TESTS	PHILLIPS-PERRON TESTS			DICKEY FULLER TESTS			
	t	Φ_3	Φ_2	DF	ADF(1)	ADF(2)	ADF(3)
MONEY	-1.70	1.38	10.70***	-0.82	-0.71	-0.22	0.27
INFLATION	-2.16	5.19	5.44*	-0.71	-1.13	0.06	-0.30
INTEREST RATE	-2.29	2.93	4.91*	-0.79	-0.99	-0.62	-0.66

COINTEGRATING REGRESSIONS

$$m_t = a_0 + a_1 x_{t+1} + u_t$$
$$x_{t+1} = -a_0/a_1 - 1/a_1 m_t + u_t'$$

I. Regulated Interest Rate

	a_0	a_1	R^2	DW	DF	PP(1)	ADF(1)	PP(2)	ADF(2)	PP(3)	ADF(3)
OLS	10.34	-0.039	0.75	0.95	-2.89*	-2.80*	-3.33**	-2.83*	-2.77**	-2.92*	-2.26
	(134)	(-7.8)									
SW	10.42	-0.035	0.93	2.05	-4.61***	-4.86***	-3.91***	-5.06***	-2.64	-5.08***	-2.35
	(166)	(-8.3)									
	$-a_0/a_1$	$-1/a_1$									
OLS	204	-19.4	0.75	0.81	-2.84*	-2.98*	-3.30**	-2.83*	-2.87*	-2.67*	-2.90*
	(10.1)	(-8.21)									
SW	271	-26.1	0.81	1.17	-2.67*	-2.78*	-3.55**	-2.64*	-2.35	-2.58	-2.91*
	(9.35)	(-9.21)									

II. Inflation Rate

OLS	10.29	-0.024	0.43	0.79	-3.03**	-2.89**	-3.83**	-2.91*	-2.70*	-3.07**	-1.47
	(102)	(-3.7)									
SW	10.41	-0.034	0.77	0.58	-2.27	-2.24	-2.93*	-2.22	-2.23	-2.27	-1.58
	(97)	(-5.4)									
	$-a_0/a_1$	$-1/a_1$									
OLS	195	-17.99	0.43	0.82	-2.92*	-3.60**	-4.11***	-3.40**	-2.56	-2.93*	-1.82
	(4.91)	(-4.44)									
SW	330	-31.64	0.85	1.08	-3.34**	-3.66**	-4.37***	-3.28**	-1.99	-3.11**	-2.57
	(10.6)	(-10.01)									

Notes:

a. t-statistics between brackets. The standard errors are consistently estimated with the method proposed in Newey and West (1987).

b. The Phillips-Perron tests for unit roots where performed with a truncation lag of 3.

c. *, ** and *** denote 10%, 5% and 1% significance levels for the rejection of Ho.

d. The Stock-Watson regressions where computed with k=6.

e. See note e in Table III

f. Data source: Datafiel

TABLE IV: POST-AUSTRAL (85:03-88:12)

UNIT ROOT TESTS	PHILLIPS-PERRON TESTS					DICKEY FULLER TESTS			
	t	Φ_3	Φ_2	t'	Φ_1	DF	ADF(1)	ADF(2)	ADF(3)
MONEY	-2.44	3.86	2.75	-1.88	1.81	-1.99	-2.53	-2.61	-1.91
INTEREST RATE	-2.67	4.64	3.21	-2.49	2.29	-2.59	-3.73**	-4.41***	-2.51

REGRESSIONS Market Interest Rate

$$m_t = a_0 + a_1 i_t + u_t$$
$$i_t = -a_0/a_1 - 1/a_1 m_t + u_t'$$

	a_0	a_1	R^2	DW	DF	PP(1)	ADF(1)	PP(2)	ADF(2)	PP(3)	ADF(3)
OLS	10.19	-.031	.65	0.68	-2.92*	-2.87*	-3.14**	-2.88*	-2.66*	-2.89*	-2.55
	(149)	(-8)									
SW	10.36	-.047	.92	1.64	-5.06***	-4.98***	-4.01***	-5.01***	-3.7***	-5.14***	-4.28***
	(423)	(-30)									
	$-a_0/a_1$	$-1/a_1$									
OLS	215	-20.75	.65	0.84	-3.74***	-3.95***	-5.23***	-3.74***	-3.95***	-3.56**	-3.55**
	(4.7)	(-4.6)									
SW	98	-19.08	.93	1.86	-5.57***	-5.58***	-3.42**	-5.64***	-3.09**	-5.67***	-3.40**
	(16)	(-15)									

ERROR CORRECTION MODEL

$$m_t - m_{t-1} = \underset{(-2.7)^{***}}{-.086}\, u_{t-1} + \sum_{j=1}^{4} \delta_j (1-L) m_{t-j} + \sum_{j=1}^{4} \eta_j (1-L) i_{t-j} + \xi_t$$

$R^2 = 0.49$
DW = 2.06
Q(18) = 14.9

Notes:

a. t-statistics between brackets. The standard errors are consistently estimated with the method proposed in Newey and West (1987).

b. The Phillips-Perron tests for unit roots where performed with a truncation lag of 4.

c. *, ** and *** denote 10%,5% and 1% significance levels for the rejection of H_0.

d. The Stock-Watson regressions where computed with k=4.

e.

Statistic	Null Hypothesis (H_0)	
Φ_3	$\beta=0,\ \alpha=1,\ \mu=\mu$	in $y_t = \mu + \beta(t-\frac{1}{2}T) + \alpha\, y_{t-1} + \epsilon_t$
Φ_2	$\beta=0,\ \alpha=1,\ \mu=0$	in $y_t = \mu + \beta(t-\frac{1}{2}T) + \alpha\, y_{t-1} + \epsilon_t$
t	$\alpha=1$	in $y_t = \mu + \beta(t-\frac{1}{2}T) + \alpha\, y_{t-1} + \epsilon_t$
Φ_1	$\mu=0,\ \alpha=1$	in $y_t = \mu + \alpha\, y_{t-1} + \epsilon_t$
DF, t'	$\alpha=1$	in $y_t = \mu + \alpha\, y_{t-1} + \epsilon_t$
ADF(k), PP(k)	$\alpha=1$	in $y_t = \mu + \alpha\, y_{t-1} + \sum_{j=1}^{k} \delta_j (1-L) y_{t-j} + \omega_t$

f. Data source: DATAFIEL

1. We were not able to compile consistent fiscal numbers till 1989. A casual comparison with other series (that do not cover the full period) suggest that the fiscal situation deteriorated in 1988 (the year before the hyperinflation) and even more in 1989.

2. Blejer (1982) shows that domestic interest rates were in fact determined by international interest rates and the preannounced rate of devaluation (implying that the rule was indeed credible).

3. Chow tests reject the null hypothesis of no structural bias in the money demand function's parameters when we extend the "tablita" period to June 1982. If we assume instantaneous market clearing in the money market the null hypothesis of no change in the parameters is rejected when we extend the sample period only until march 1981

4. All the data used in this section was obtained from DATAFIEL.

5. We also estimated (1) and (2) including a transactions variable and found that the coefficient of the transaction variable in the money demand regressions was not significantly different from zero. Furthermore, the estimates of a_1 were not sensitive to the inclusion of a transactions variable in the regression. The transactions variables that we tried were the log of GDP (assuming that GDP is constant within each quarter) and a monthly series for GDP that we constructed from data on industrial production, energy consumption, etc. for which we had monthly data.

6. The set of instruments we used were lagged values of the interest rate and current and lagged values of the rate of devaluation (a predetermined policy variable).

7. Dickey-Fuller and Augmented Dickey-Fuller tests reject the hypothesis that log y_t is an I(1) process.

	DF	ADF(1)	ADF(2)	ADF(3)	ADF(4)	ADF(4*)
log y_t	-3.95***	-2.19	-2.61	-1.57	-2.92*	-3.52**

ADF(4*) is an Augmented Dickey-Fuller test that includes only the fourth lagged difference of log y_t in the DF regression. This implies that we do not

need to include log y_t in order to estimate a co-integrating vector between m_t and x_{t+1}.

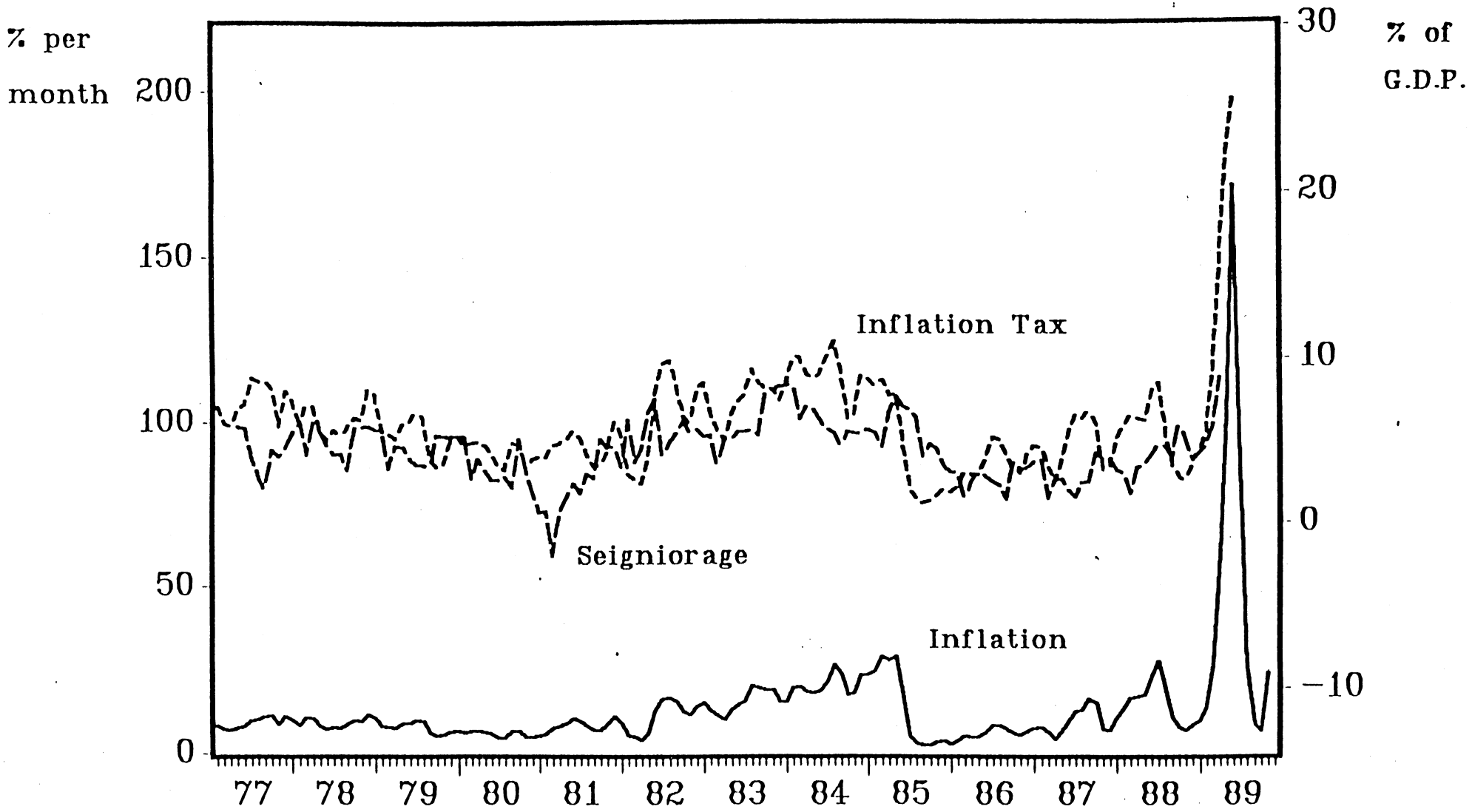
8. If the co-integrated system has more than two I(1) variables, say money, interest rates and output, then the co-integrating vector will no longer be unique. However, if that were the case u_t in (1)' will not be stationary. If a stationary transactions variable enters the demand for money equation (1)' still has a unique co-integrating vector that can be consistently estimated.

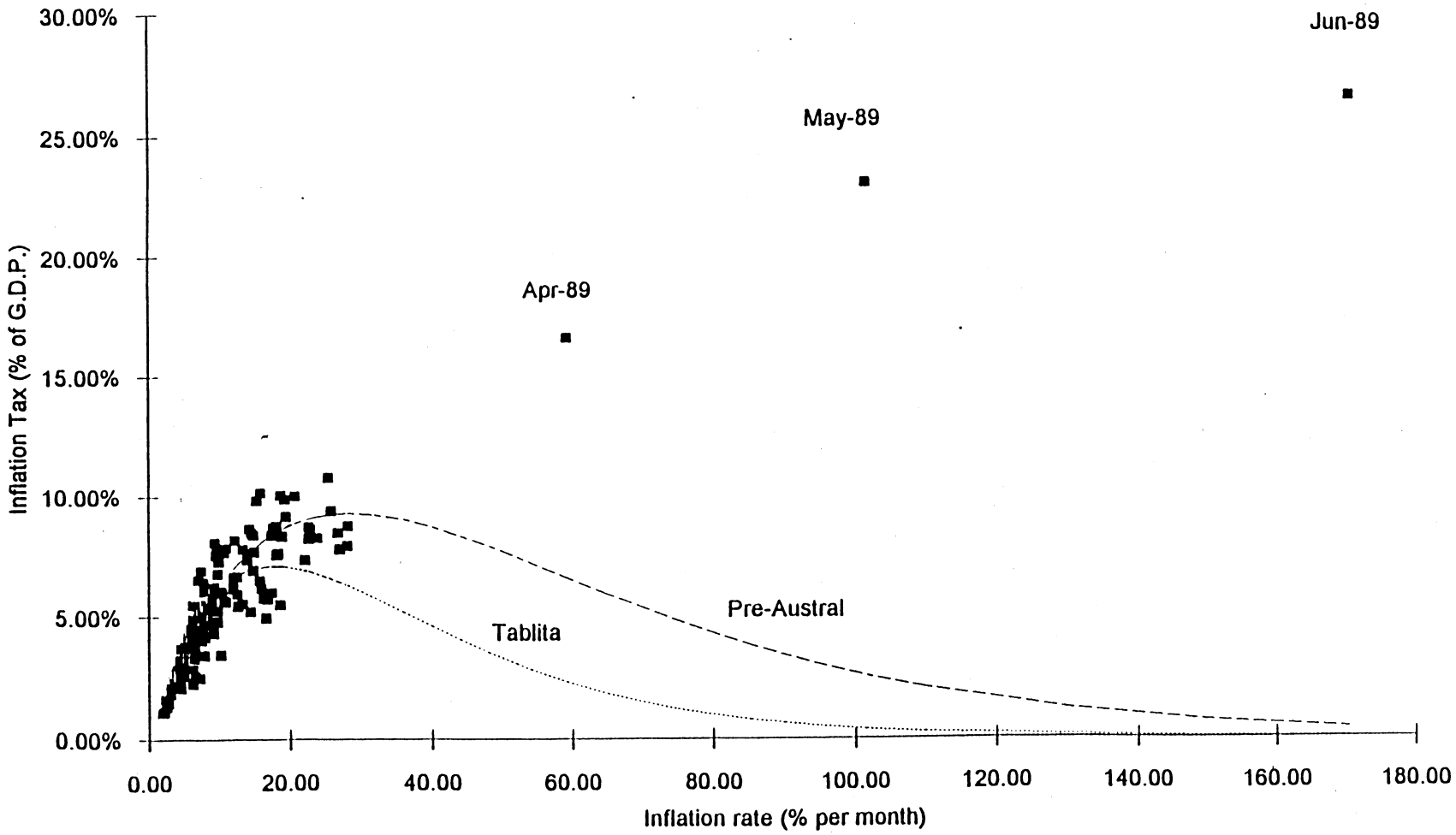
9. The Laffer curves were constructed using the money demand functions reported in tables I and II. For the "Tablita" period the Laffer curve is Inflation Tax = $\left[e^{(10.62 - 0.056\,\pi)}\pi \right] / GNP$, and for the Pre-Austral period it is Inflation Tax = $\left[e^{(10.42 - 0.035\,\pi)}\pi \right] / GNP$. The methodology for computing the inflation tax is described in the appendix.

CAPTIONS

Figure 1: Inflation, Inflation Tax and Seigniorage

Figure 2: The Laffer Curve and the Inflation tax


% per month
200
150
100
50
0
30
20
10
0
−10
% of G.D.P.
Inflation Tax
Seigniorage
Inflation
77
78
79
80
81
82
83
84
85
86
87
88
89


30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Inflation Tax (% of G.D.P.)
Jun-89
May-89
Apr-89
Pre-Austral
Tablita
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
Inflation rate (% per month)

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