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## Seigniorage and Inflation: The Case of Argentina

VERY HIGH INFLATIONS are usually explained by the need to raise revenue from money creation (that is, 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 (for example, 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 (for example, Kiguel 1989), whose main cause is the attempt to raise seigniorage in excess of the maximum warranted by the demand for money. According

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TABLE 1  
FISCAL DEFICITS, SEIGNIORAGE, AND INFLATION

	1979/80	1982/84	1986/87
Fiscal Deficit	7.0	14.6	5.9
Net Borrowing	5.4	4.6	5.9
Seigniorage	5.2	7.8	3.7
Inflation (annual average)	128.3	340.4	109.7

NOTES: a. All the figures are percent of GDP, except for the rate of inflation that is percent per year.  
 b. Fiscal deficit = domestic borrowing + Central Bank loans to the treasury.  
 c. Source: World Bank (1990), IFS, and DATAFIEL.

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. This is illustrated in Table 1, which shows the overall deficits of the nonfinancial public sector and the way these deficits were financed, as well as seigniorage and inflation for the periods 1979–80, 1982–84, and 1986–1987.<sup>1</sup> Deficits were very large for most years, and seigniorage played an important role in financing them.

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 (that is, whether the exchange rate is fixed or flexible), and second, the relevant opportunity cost of holding money (that is, 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 2 presents the estimation of money demand for the various periods, and summarizes the main features. We conclude in section 3 with the implications for the debate on the rela-

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.

tionship between seigniorage and inflation. An appendix showing the methodology for computing the inflation tax when only discrete time data are available can be obtained from the authors.

## 1. MONETARY REGIMES IN OUR SAMPLE

There are basically two main monetary/exchange rate regimes between 1979 and 1989. The first one, from January 1979 until 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.<sup>2</sup> The domestic interest rate clearly represented the opportunity of holding money during this time.

The second period, from February/March 1981 until 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 restrain 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 into four subperiods to account for changes in financial arrangements. In what follows we describe the duration and main features of each subperiod:

(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 onward was one of hyperinflation and extreme macroeconomic instability.

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).

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,<sup>3</sup> 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.

## 2. EMPIRICAL EVIDENCE<sup>4</sup>

### 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 preannouncement 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.<sup>5</sup>

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

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

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

Interest rate parity implies that

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

where  $i_t^* =$  the international interest rate;  $e_t = \ln$  of the nominal dollar/peso exchange rate, and a superscript  $e$  indicates expectation.

If the deviations from interest rate parity,  $\theta_t$ , are independent of the money market shocks,  $u_t$ , (1) and (2) can be estimated by a simple OLS regression. However, since

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 were 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.

the interest rate shocks and the money market shocks are likely to be correlated we also estimated (1) and (2) through instrumental variables.<sup>6</sup>

The results from estimating (1) and (2) for the tablita period are presented in Table 2. 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 percent ( $\sigma = 3.27$ ) per month in the seasonal moving average partial adjustment model with instrumental variables, to a high estimate of 22.2 percent ( $\sigma = 3.61$ ) in the instrumental variables market clearing model with a dummy variable for December.<sup>7</sup>

### B. The Pre- and Post-Austral Periods

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 or 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 cointegrated 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.

Let the deviations from equilibrium in the money market be given by<sup>8</sup>

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

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 cointegrated system, then there is a unique<sup>9</sup> cointegrating vector that yields stationary errors,  $u_t$ . If the money

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. The results from the estimation of the partial adjustment model are reported in Kiguel and Neumeyer (1989).

8. 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 cointegrating vector between  $m_t$  and  $x_{t+1}$ .

9. If the cointegrated system has more than two I(1) variables, say money, interest rates, and output, then the cointegrating 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 cointegrating vector that can be consistently estimated.

market is stable, it necessarily has to be the one corresponding to the money demand's structural parameters. Any other linear combination between  $\{m_t\}$  and  $\{x_{t+1}\}$ , such as one arising from the money supply process, will be nonstationary. This solves the identification problem.

Consistent estimators of the cointegrating 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, (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 cointegrating vector. This estimator is based on the regression

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

For the pre-Austral period we chose the rate of inflation as a proxy for the opportunity cost of holding money.<sup>10</sup> The tests for unit roots and the cointegrating regressions are reported in Table 2. Dickey-Fuller tests do not reject the hypothesis that real money balances and inflation are random walks with drift. The second differences of these variables are unambiguously stationary processes. The null hypothesis of no cointegration is rejected in three of the four regressions. Finally, we observe that the estimates of the revenue-maximizing rate of inflation are close to 30 percent 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 *do* 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 is 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). The estimates from (4) and from the reverse regressions of (1) and (4) imply a revenue-maximizing rate of inflation of 21 percent 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

10. Interest rates were determined by the central bank and set at levels that were often negative in real terms. In Kiguel and Neumeier (1989) we report the results of estimating (4) using the regulated interest rate as a proxy for the opportunity cost of holding money.

TABLE 2

## I. MONEY DEMAND REGRESSIONS

	$a. \text{ Tablita period (79:01-81:01) } m_t = a_0 + a_1 i_{t+1} + u_t$									
	$a_0$	$a_1$	$F$	$R^2$	DW	$E[1/a_1]$				
OLS	10.58 (61)	-0.049 (-4.41)	26.0	0.70	1.69	21.1 (3.78)				
TSLs/SMA(12)	10.62 (49)	-0.056 (-5.11)	15.5	0.58	1.69	18.4 (3.48)				
TSLs/DEC/MA(1)	10.55 (72)	-0.046 (-6.0)	28.8	0.80	1.95	22.2 (3.61)				
	$b. \text{ Pre-Austral Period (82:07-85:03) } m_t = a_0 + a_1 \pi_{t+1} + u_t \text{ and } \pi_{t+1} = -a_0/a_1 - 1/a_1 m_t + u'_t$									
	$a_0$	$a_1$	$R^2$	DW	DF	ADF(1)	ADF(2)	ADF(3)		
OLS	10.29 (102)	-0.024 (-3.7)	0.43	0.79	-3.03**	-3.83**	-2.70*	-1.47		
SW	10.41 (97)	-0.034 (-5.4)	0.77	0.58	-2.27	-2.93*	-2.23	-1.58		
OLS	$-a_0/a_1$ 195 (4.91)	$-1/a_1$ -17.99 (-4.44)	0.43	0.82	-2.92*	-4.11***	-2.56	-1.82		
SW	330 (10.6)	-31.64 (-10.01)	0.85	1.08	-3.34**	-4.37***	-1.99	-2.57		

continued



TABLE 2 (continued)

I. MONEY DEMAND REGRESSIONS									
c. Post-Austral Period (85:03-88:12) $m_t = a_0 + a_1 i_{t+1} + u_t$ and $i_{t+1} = -a_0/a_1 - 1/a_1 m_t + u'_t$									
	$a_0$	$a_1$	$R^2$	DW	DF	ADF(1)	ADF(2)	ADF(3)	
OLS	10.19 (149)	-.031 (-8)	.65	0.68	-2.92*	-3.14**	-2.66*	-2.55	
SW	10.36 (423)	-.047 (-30)	.92	1.64	-5.06***	-4.01***	-3.7***	-4.28***	
OLS	215 (4.7)	$-1/a_1$ -20.75 (-4.6)	.65	0.84	-3.74***	-5.23***	-3.95***	-3.55**	
SW	98 (16)	-19.08 (-15)	.93	1.86	-5.57***	-3.42**	-3.09**	-3.40**	
Error Correction Model									
$m_t - m_{t-1} = -.086 u_{t-1} + \sum_{j=1}^4 \delta_j \Delta m_{t-j} + \sum_{j=1}^4 \eta_j \Delta i_{t-j} + \xi_t$ $R^2 = 0.49$ , $DW = 2.06$ , $Q(18) = 14.9$ (-2.7)***									
II. UNIT ROOT TESTS									
	Pre-Austral			Post-Austral					
	DF	ADF(1)	ADF(2)	ADF(3)	DF	ADF(1)	ADF(2)	ADF(3)	
Real Money Balances	-0.82	-0.71	-0.22	0.27	-1.99	-2.53	-2.61	-1.91	
Inflation/Interest rate	-0.71	-1.13	0.06	-0.30	-2.59	-3.73**	-4.41***	-2.51	

Notes: a. Statistics are in parenthesis except for  $E(1/a_1)$  where the standard deviation is reported. The standard errors in the cointegrating regressions are consistently estimated with the method proposed in a. NAR and West (1987).  
 b. SMA(12): Seasonal in Dec average Dec (DL2): Seasonal in Dec average Dec (DL2).  
 c. TSLs estimate I with instrumental variables using lagged interest rates and current and lagged rates of devaluation as instruments for  $i_t$ .  
 d. In model I, the TSLs with a Dec dummy is correct for an MA(1) error process.  
 e. \*, \*\*, and \*\*\* denote 10 percent, 5 percent, and 1 percent significance levels for the rejection of  $H_0$ .  
 f. The Stock-Watson regressions were computed with  $k=6$  for the pre-Austral period and  $k=4$  for the post-Austral period.  
 g. Data source: DATAFILE.

those obtained for the tablita regime. 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 tablita 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.

### 3. CONCLUSIONS

We started the paper with questions regarding the interpretation of high inflation in countries such as Argentina. Many of these questions can be addressed by comparing the Laffer curves that can be derived from our money demand regressions with the actual size of the inflation tax during the period. The data 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 percent per month for the tablita and the post-Austral period and 30 per-

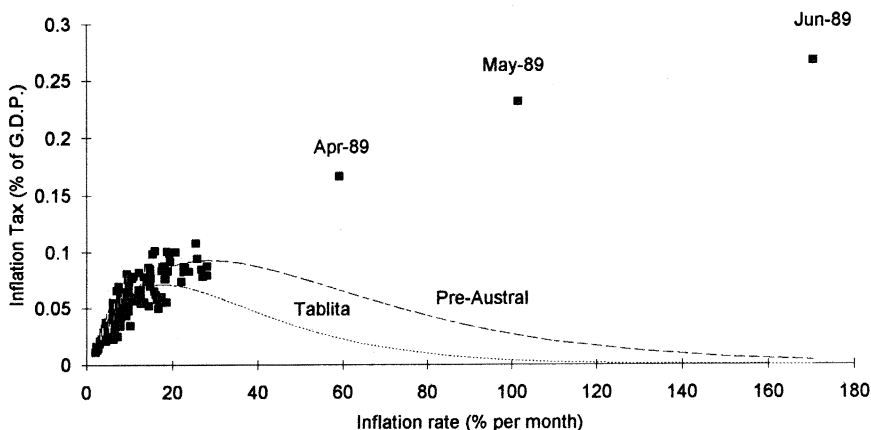


FIG. 1. The Laffer Curve and the Inflation Tax

cent 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 percent), mainly because their methodology did not consider different periods.

The Laffer curve, shown in Figure 1, 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 percent per month), but there was no risk of hyperinflation. Seigniorage was large, but it could be financed in a stable fashion. In contrast, for the period 1982–84 seigniorage exceeded 7 percent, 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 by 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 percent of GDP), the government was not able to control a full-blown hyperinflation.

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