Artigos

'Shoe-leather' costs of inflation: some estimates for Brazil*

José W. Rossi§

RESUMO

Neste artigo estimamos o custo 'sola de sapato' ('shoe-leather' costs) da inflação no Brasil, que é obtido calculando-se a área sob a curva de demanda por moeda. Duas especificações foram utilizadas para a demanda por moeda, a saber: o modelo log-log e o modelo semi-log. Como em anos recentes a demanda por moeda mostrou-se muito instável, ela foi estimada com dados trimestrais para o período de 1966 a 1985. Os resultados foram então comparados com aqueles obtidos por outros autores (com metodologias similares ou distintas daqui utilizadas) tanto para o Brasil como para os Estados Unidos e o Reino Unido.

Palavras-chave: custo sola de sapato, custo de bem-estar, custo da inflação.

ABSTRACT

In this article we estimate the 'shoe-leather' costs of inflation in Brazil, which are obtained by calculating the area underneath the demand for money. Two specifications were used for the demand for money, namely, the log-log model and the semi-log model. As the demand for money became too unstable in recent years, it was estimated with quarterly data for the period 1966–1985. Our results were then compared with those obtained by other authors using similar or distinct methodologies for either Brazil or the United States and the United Kingdom.

Key words: shoe-leather costs, welfare cost, cost of inflation.

JEL classification: E4, E41, C51, C81.

* I would like to thank two referees for their very helpful comments and suggestions, and also acknowledge the support provided by PRONEX/CNPq and PROCIÊNCIA (Uerj).

§ Universidade do Estado do Rio de Janeiro, UERJ.

Recebido em março de 2002. Aceito em julho de 2003.

1 Introduction

High rates of inflation have significant adverse effects on economic growth.[1] That being the case, the sacrifice in employment and output required to reduce inflation can easily be justified. Reducing inflation when it is already low could be questioned though. A possible objection in this case is that costs might surpass the benefits involved in reducing inflation. Not to be overlooked, however, is the fact that even when the benefits seem to be a small percentage of GDP, it may still be worthwhile to reduce inflation. The reason is while the benefits of reducing inflation are permanent, the desinflationary costs are generally only temporary. As an illustration, suppose the estimated benefit of moving from a specific annual rate of inflation to price stability is for a given year x percent of GDP. Assume additionally that GDP is expanding at an annual real rate of g and the real interest rate is r. The present value ($pvalue$) of such an annual benefit given in percentage of GDP is: $pvalue = x/(r-g)$ Thus with a benefit of 1% of GDP, a rate of growth of the economy of 3%, and interest rate of 5%, the present value of the benefit is 50% of GDP, a robust figure which will most certainly outweigh the cost of reducing inflation anywhere.[2]

The costs of inflation are either due to anticipated inflation or to unanticipated inflation. Although it is generally believed that the latter is the more significant of the two, we shall be concerned here only with the costs of anticipated inflation, and in fact with just a particular aspect of the problem, namely, the 'shoe-leather' costs of inflation. In the last section of the paper we briefly discuss other types of distortions caused by inflation.

The paper is organized as follows. In Section 2 we discuss the methodology used to calculate the 'shoe-leather' costs of inflation. Section 3 describes the data and discusses the results. In Section 4 we compare our results with those of other studies for Brazil as well as those for countries such as the United States and the United Kingdom. In Section 5 there is a discussion about the factors affecting the results of the welfare cost calculations. Final remarks are in Section 6.

2 Methodology for the 'shoe-leather' costs of inflation

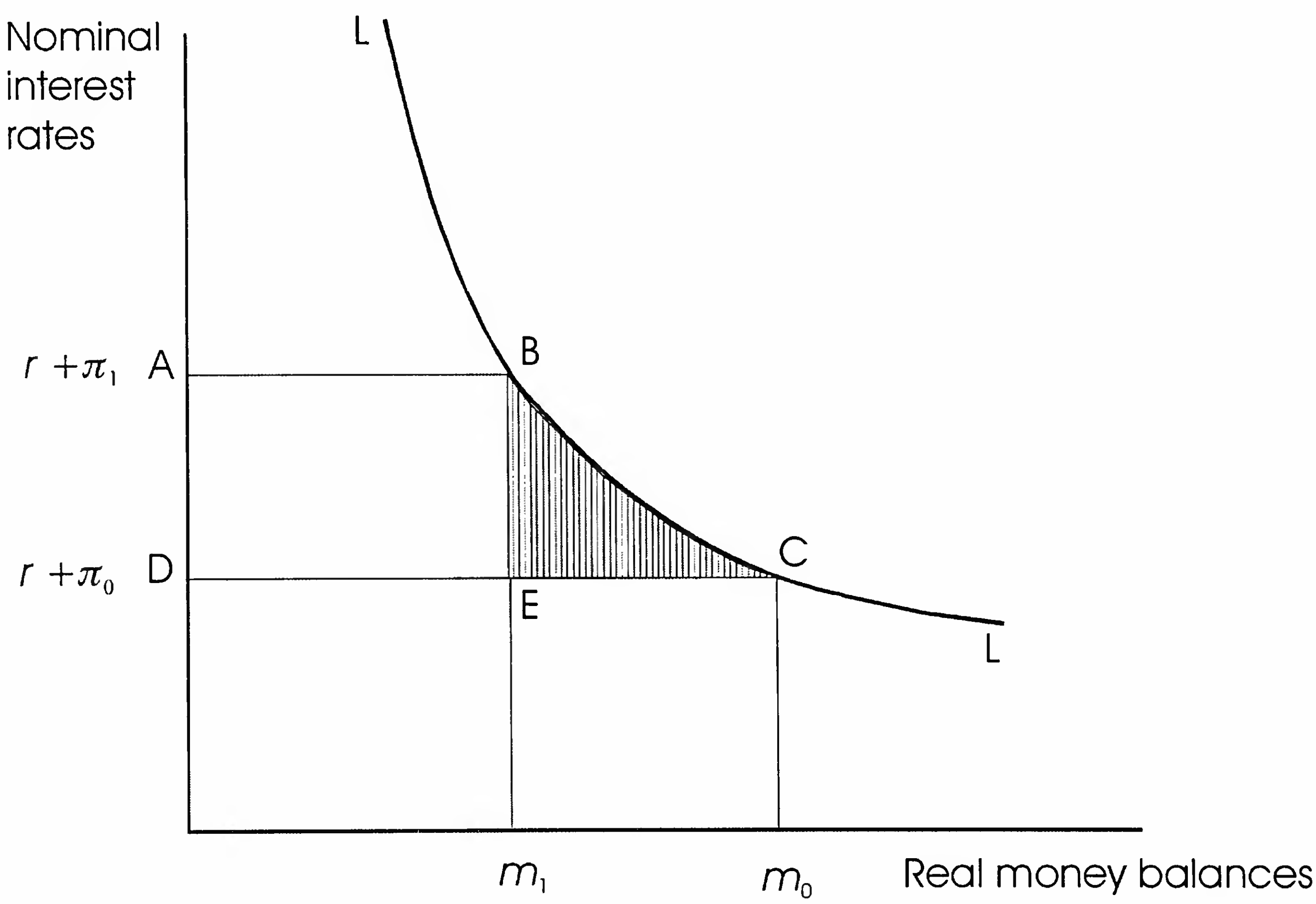
As inflation is viewed as a tax, the 'shoe leather' costs of inflation can be estimated using conventional demand curve analysis (namely, the 'consumer surplus' concept). In Figure 1 a

1 For example, Fischer (1993) estimated that for the United States a 1% rise in inflation causes a reduction of a 0.1 percentage point in its rate of growth, and it is believed this will be much higher at higher levels of inflation.

2 For a similar argument, see Feldstein (1996).

hypothetical (inverse) demand for real money balances is plotted. The nominal interest rate is on the vertical axis and the real money balances are on the horizontal axis. With the inflation rate initially at π_0 (by the Fisher equation the nominal interest rate will be $i_0 = r + \pi_0$), the corresponding demand for real money balances is m_0. The inflation rate rising to π_1 (i.e., the nominal interest rate is now $i_1 = r + \pi_1$), the demand for real money balances falls to m_1.[3] Although the 'consumer surplus' falls by more than the stripped area, part of that reduction goes to the government as tax revenue (seigniorage), and the government can always benefit consumers by an equivalent lump-sum reduction in tax; we have more to say on this in the last section of the paper. Only the stripped area is a 'deadweight loss' for it is that part of consumer welfare losses which benefits nobody. Therefore this area will represent the 'shoe-leather' costs of inflation.

Figure 1
The Shoe-Leather Cost of Inflation



3 Tower (1971) has argued that the welfare loss is in this case given by the area of the trapezium Bm_1m_0C, rather than by the stripped area as proposed by Bailey (1956). In fact, there is some controversy in the literature about which is the appropriate measure of the welfare cost in this case. Should it be Bailey's (1956) triangle (or Tower,s corrections of this), or Harberger's (1971) triangle? For a discussion on the issue of Bailey's versus Harberger's triangles see Yoshino (2002).

To make the calculation of the 'shoe leather' costs concrete let us follow McCallum (1989) and consider the case of the log-log model, namely, $Logm = \gamma_0 + \gamma_1 Logy + \gamma_2 Logr$, where m is real money balances, y is real GDP, and r is nominal interest rate. Next, impose a unity elasticity of real money balances with respect to income (i.e., $\gamma_1 = 1$), which gives the following (direct) demand for real money balances: $m = e^{\gamma_0} y r^{\gamma_2}$ To obtain the welfare cost of inflation (as a proportion of GDP) based on the 'consumer surplus' argument it involves first solving the demand for money equation for the interest rate (as a function of the real money balance), and then integrating such a function for the real money balances for any two given values of the interest rates. Alternatively, the same result could be obtained by integrating the appropriate area under the inverse demand for money. The two equivalent ways for calculating the 'shoe-leather' costs of inflation when the nominal interest rate goes from zero to r are, using Lucas (2000) notation:[4]

$$w(r) = \int_{m(r)}^{m(0)} \psi(x)dx = \int_0^r m(x)dx - rm(r) \tag{1}$$

where $\psi(m)$ is the inverse demand for money function. With a log-log demand for money (now written as $m(r) = Ar^{-\eta}$) this is

$$w(r) = A(\eta/1-\eta)r^{1-\eta} \tag{2}$$

while for the semi-log model (written as $m(r) = Be^{-\lambda r}$) it is[5]

$$w(r) = B[1-(1+\lambda r)e^{-\lambda r}]/\lambda \tag{3}$$

4 As noted by Wolman (1997), the term 'cost of inflation' may be misleading. The term 'cost of positive nominal interest rates' would probably be more appropriate. The term 'cost of inflation' is, however, well established in the literature.

5 Notice that the results for the second integral in equation (1) are for the log-log and semi-log functions, respectively, $Ar^{1-\eta}/1-\eta$, and $B(1-e^{-\lambda r})/\lambda$. Subtracting from these, respectively, $rm(r) = rAr^{-\eta}$ and $rm(r) = rBe^{-\lambda r}$ we get the results for equations (2) and (3).

These were the two equations used for calculating the 'shoe-leather' costs of inflation in this study.

3 Data and results

As mentioned already, equations (2) and (3) presume a demand for money with a unitary income-elasticity. This is required so that the ratio of money balances to GDP can be written as a function of just the nominal interest rate. Unfortunately, when a conventional demand for money function (here understood to be the log of real money balances as a function of log of real income, log of nominal interest rate and perhaps log of the inflation rate) was estimated by **OLS** using recent data (namely, quarterly data for the period 1975(I)-2000(I)) income-elasticity turned out to be negative.[6] Thus imposing in this case a unitary income-elasticity to the demand for money seems unwise.

Given the difficulty just mentioned, for our purposes here we had to rely on data of an earlier period. As the demand for money estimated with quarterly data for the period 1966(I)-1985(IV) by Rossi (1988 and 1989) gave reasonable estimates we thought it would be appropriate to use it here as well. This is a distinct feature of the present study. Other studies in Brazil in which the demand for money is estimated using more recent data in general do not give a good fit.

Some minor adjustments to the data were required, though.[7] The series of both real money balances and real income were in that early study given as index numbers. The methodology adopted here requires instead the levels of such variables, which were obtained as follows. First we took the level of the two variables from a distinct data source as given in a specific

6 It might be of some interest to show here the estimated demand for money in this case. We first describe briefly the data used in the estimation. The quarterly data covers the period 1975(I) to 1999(IV), its source being **Ipeadata.gov.br**. The variables were defined as follows. First, the information for the yearly income was obtained by simply multiplying the quarterly GDP data by 4. For the interest rate we use the CDB-rates, for these became more important than the Letras de Cambio rates, which were more relevant as an explanatory variable for the demand for money for an earlier period. As the CDB-rates were given on a monthly basis the yearly rates were obtained by simply elevating the monthly figures to the power 12, and then subtracting a unity from the result so obtained. The estimated money demand function was: $\text{Log}(M1/P) = 35.13(7.31) - 0.701(-3.3)\text{Log}(y) - 0.22(11.0)\text{Log}(r)$; $R^2=0.58$; $DW=0.21$, with t-values in parenthesis.

7 For a view of the data see Rossi (1988).

point in time.[8] By establishing a proportionality ratio between such data and those of the index number series we were able to reconstruct the levels of the two variables for the entire period from1966 to1985.[9]

Before discussing the results, we plot in Figure 2 the scattered diagram for the variables used for the demand for money. The ratio of real money balances to real income is on the horizontal axis and the nominal interest rate is on the vertical axis. Notice that the relationship between the two variables is clearly non-linear, and there is little dispersion of the observations around the underlining curve described by the data. This suggests that either the log-log or the semi-log specifications could be used as candidate for the money demand.

Reported in Table 1 are the findings of fitting these two models. For the log-log specification we report a set of three regressions. First, a conventional demand for money is shown in which the dependent variable is real money balances (in log) and the explanatory variables were the following (all in log): annualized real income (given by GDP), annualized nominal interest rate (given by the Letras de Câmbio rates; the original series was divided by 100), and the inflation rate (given by IGP-DI). Next, the function was estimated by omitting the log of the inflation rate as an explanatory variable. Then, we imposed to the latter a unitary income-elasticity which, as we have stressed, is equivalent to having the ratio of real money balances to real income as the regression dependent variable. Finally, the fourth set of results is related to the semi-log specification in which the dependent variable is, once again, the ratio of real money balances to real income and having just the nominal interest rate as explanatory variable.

The first two regressions in Table 1 were simply obtained by **OLS** with the sole purpose of checking whether or not income elasticity was close to unity, which appears to be the case here.[10] The results of these regressions seem reasonable in terms of either the overall fit or the

8 The source of such information was **Ipeadata.gov.br**. The level for both real money balances and real income was chosen to be that of 1975(I). To be sure that the results of the two series were truly compatible we also used in the exercise the level of the variables as given in 2000(I). As it should be expected, just the intercept of the fitted regression changed, and even so only marginally.

9 It should be noted that by such a procedure only the intercept of the earlier regression estimation would change. But since such a parameter is crucial for the 'shoe-leather' costs of inflation as calculated here, then prior to the model estimation the data adjustment just described was required.

10 The calculated t-value for the null hypothesis of a unity income elasticity based on of the first estimated regression was just 1.6, indicating such a hypothesis could not be rejected. Recall that an income elasticity of unity is required so that the estimation of the two subsequent equations of the table could be justified.

value of the individual coefficients, which all have the right signs and are statistically significant.[11] Also to be noted is that the income- and interest-rate elasticities do not change much when the inflation rate is omitted from the first to the second regression. One problem though is the very low Durbin-Watson values indicating that spurious regressions are a real possibility. As the main interest of the study is, however, concerning the last two equations only their estimation will be subject to close scrutiny. To these equations we now turn. First notice that their **OLS** estimation is statistically very significant. Nevertheless, low Durbin-Watson values indicate the possibility of spurious regression results. Thus both models were additionally estimated by two other procedures, namely by correcting for the presence of residual autocorrelation (**CORC**) and by the co-integration technique (**COINT**). With the **CORC** estimation significant changes occurred only for the fourth equation. The reason was that the residual autocorrelation coefficient was greater there than unity in which case the **CORC** result seems not to make much sense. In any event, for completeness, such a result is also reported here.

The last two equations of Table 1 were finally estimated by the cointegration technique. As it is known regressions using non-stationary variables can produce spurious results. However, if the non-stationary variables co-integrate, a long-run equilibrium among them can be established. So before applying the co-integration technique we tested the variables for non-stationarity. The unit root (Dickey-Fuller) test indicated that all variables were indeed non-stationary; more precisely, they were Integrated of degree one, **I(1)**, that is, stationarity is obtained after differencing the series just once.[12]

Being all the variables non-stationary we next tested the models for co-integration (using Johansen's test). The findings were that although the variables of the last equation co-integrated (Likelihood Ratio = 24.0, against critical values of 15.4 at 5% and 20.0 at 1%, respectively), co-integration was marginally rejected for the third equation. But notice that the two models

11 Attempting to capture possible seasonal effects caused by the Christmas season a dummy variable was also used for the forth quarter of the series. Although the dummy variable coefficient was statistically significant up to the 4.8% level, the coefficients of all the other variables did not change much by omitting the dummy variable from the regression. Thus such an omission does not seem to pose any important econometric problem.

12 More specifically, these were the values for the Dickey-Fuller unit root test both for the level and the first difference of the three variables of interest: Log(M1/Py): level (DF=2.08), first difference (DF=-4.64); Log(tjuros): level (DF=2.26), first difference (-4.37); tjuros: level (DF=2.81), first difference (DF=-5.40). In all cases the Dickey-Fuller test was carried out with an intercept and two lags for the first difference term.

differ only because while in one of them the explanatory variable is the level of the interest rate, in the other it is just the log of the interest rate. And according to Ermini and Granger (1993) co-integration in levels must imply co-integration in logs.[13] In view of the somewhat conflicting results obtained here we thought it reasonable to accept co-integration for both models. As a final observation in connection with these estimates, it appears that the results for the log-log model are in general better than those for the semi-log model, particularly due to the consistency of its results which along the three estimation procedures is better than that of the semi-log model.

Table 1
Estimate Results (quarterly data for the period 1965-1985)

Dependent Var.	Coefficients of Explanatory Variables					R^2	DW
	Const.	Log(y)	Log(r)	r	Log(P/P-1)		
1) Log(M1/P)							
OLS	-3.59	0.96	-0.50		-0.84	0.95	1.1
	(-12.8)	(31.9)	(-14.5)		(-2.6)		
2) Log(M1/P)							
OLS	-3.50	0.93	-0.58			0.95	1.1
	(-12.1)	(31.6)	(-36.5)				
3) Log(M1/Py)							
OLS	-4.19		-0.60			0.97	1.0
	(-320.8)		(-48.6)				
CORC	-4.18		-0.58			0.98	1.7
	(-178.6)		(-25.9)				
COINT	-4.24		-0.66				
4) Log(M1/Py)							
OLS	-3.36			-0.56		0.88	0.6
	(-132.7)			(-23.6)			
CORC	-2.34			-0.01		0.98	1.6
	(-1.1)			(-0.2)			
COINT	-3.44			-0.46			

Note: M1= nominal M1, P= price level, y= real GDP, r= nominal interest rate (Letras de Cambio rate), **OLS** = Ordinary Least Square, **CORC** = Correction for Autocorrelation, **COINT** = Cointegration; t-values in parenthesis.

13 This point has also been stressed in Chadha *et al* (1998).

Figure 2
The Demand for Money
(y=nominal interest rate, x=ratio of real money balances to GDP)

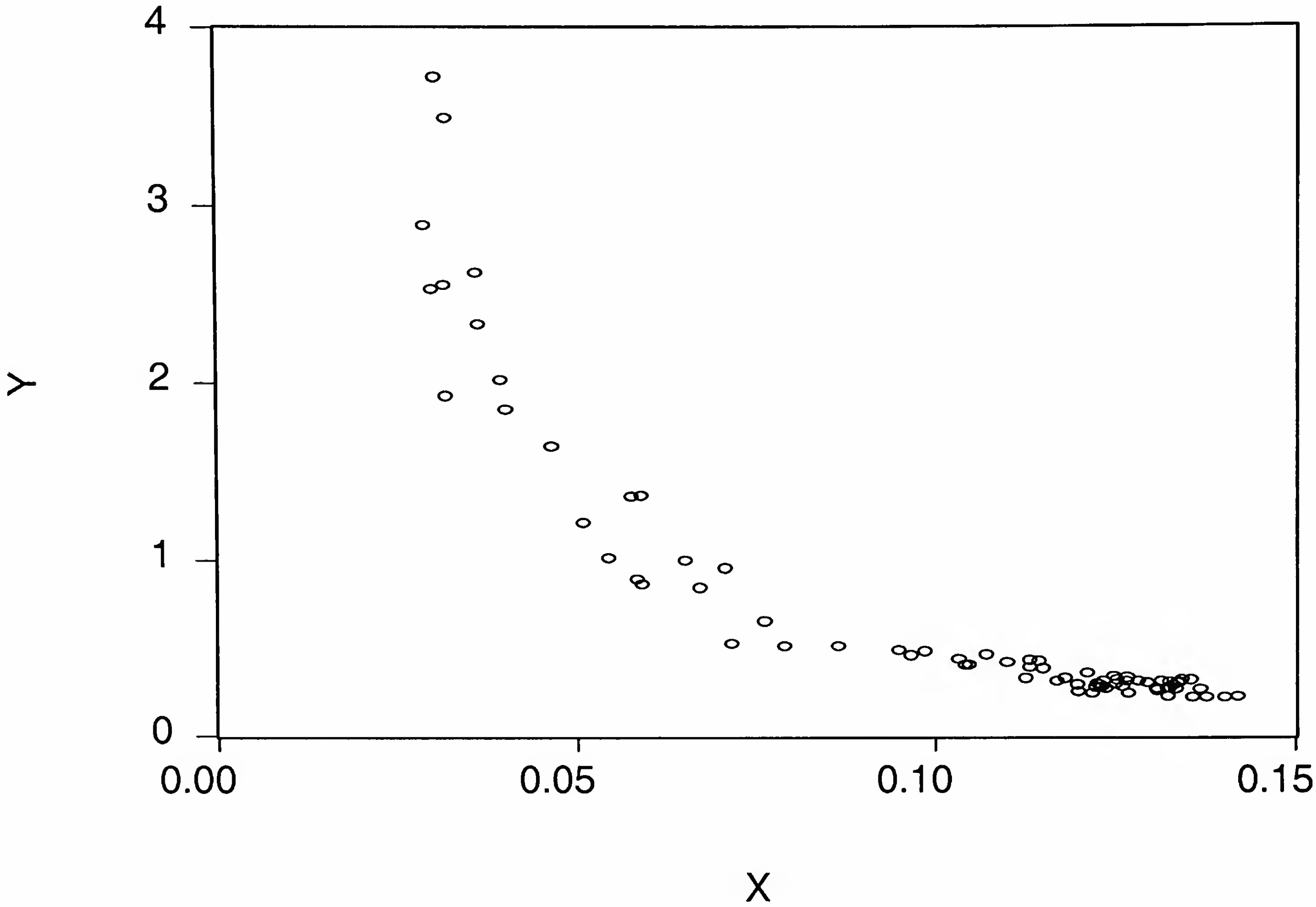


Table 2 summarizes the results for the 'shoe-leather' costs of inflation for the log-log and semi-log models using, respectively, equations (2) and (3). We do this for both a selected number of interest rates and by using distinct methods of estimation. In such calculations the highest interest rate was chosen according to the upper limit of such a variable in the data (see Figure 2). Notice that the welfare gains obtained by reducing the interest rate from 400% to zero are around 4% of GDP for both models. Such gains are much more evenly distributed in the case of the log-log model. In fact, for interest rate reductions below 20% the welfare gains with the semi-log model are quite negligible. They remain though high with the log-log model (around 1.5% of GDP). A caution note is in order here. Since very low rates of interest are not part of the data basis (the lowest interest rate is around 29% per year), care should be taken when using the estimated model for any projection well beyond the range of the data. Needless to say this applies to both low and high value extrapolations.[14]

14 Also to be noted, since there is some evidence (e.g., Rossi 1988 and 1989) of a downturn shift in the demand for money starting in the 1980's, which was not allowed for here, then our estimates might contain some upward bias.

Notice that for the log-log model the welfare gains are somewhat higher when the co-integration technique is used rather than either the **OLS** or **CORC** estimation. For the semi-log model it is the **OLS** estimation that yields higher estimates than the cointegration technique. In the latter case, however, due to the very low Durbin-Watson value the **OLS** estimation is not reliable.

Table 2
'Shoe-Leather' Gains from Reducing the Interest Rate (in % of GDP)

$w(r_2)-w(r_1)$	Log-Log CORC	Log-Log OLS	Log-Log COINT	Semi-Log OLS	Semi-Log COINT
$w(4.0)-w(0)$	3.946	3.782	4.522	4.055	3.827
$w(3.0)-w(0)$	3.517	3.350	4.100	3.098	2.791
$w(2.0)-w(0)$	3.140	2.826	3.581	1.908	1.629
$w(1.0)-w(0)$	2.260	2.112	2.834	0.674	0.542
$w(0.4)-w(0)$	1.583	1.437	2.081	0.136	0.103
$w(0.2)-w(0)$	1.200	1.107	1.647	0.036	0.027
$w(0.1)-w(0)$	0.900	0.803	1.304	0.000	0.000
$w(0.05)-w(0)$	0.690	0.600	1.033	0.000	0.000
$w(0.01)-w(0)$	0.360	0.305	0.600	0.000	0.000
$w(0.005)-w(0)$	0.272	0.228	0.475	0.000	0.000
$w(0.001)-w(0)$	0.145	0.116	0.276	0.000	0.000
$w(0.0001)-w(0)$	0.057	0.044	0.127	0.000	0.000
$w(4.0)-w(3.0)$	0.429	0.430	0.422	0.957	1.036
$w(3.0)-w(2.0)$	0.380	0.520	0.523	1.234	1.162
$w(2.0)-w(1.0)$	0.880	0.714	0.746	1.190	1.087
$w(1.0)-w(0.4)$	0.667	0.674	0.753	0.530	0.438
$w(0.4)-w(0.2)$	0.383	0.330	0.430	0.100	0.076
$w(0.2)-w(0.1)$	0.300	0.310	0.340	0.036	0.027
$w(0.1)-w(0.05)$	0.210	0.200	0.270	0.000	0.000
$w(0.05)-w(0.01)$	0.325	0.290	0.433	0.000	0.000
$w(0.01)-w(0.005)$	0.087	0.077	0.125	0.000	0.000
$w(0.005)-w(0.001)$	0.128	0.110	0.149	0.000	0.000
$w(0.001)-w(0.0001)$	0.087	0.070	0.149	0.000	0.000

4 Comparison with other results (for Brazil, the United States and the United Kingdom)

Take first the case of other studies for Brazil. If one considers the range of interest rate values used in this study our results do not differ much from those found, for instance, by Pastore (1997). This is particularly the case when the log-log model is used.[15] Pastore’s data basis contains, however, some more recent information than ours and his model estimation is also econometrically more sophisticated (for instance, his specification uses a Box-Cox transformation to distinguish between a short- and log-run income-elasticity for the demand for money), which makes the proximity of both studies results all the more remarkable. Furthermore, Pastore states that his welfare cost estimates for moderate inflation rates are close to those found by Simonsen and Cysne (1994). If we take this to mean inflation rates around 40% per year (notice that in the late 1980’s and early 1990’s the annual inflation rates were in a few occasions as high as 2500% annually which makes a 40% annual inflation rate indeed quite moderate for the period) then such results do not differ much from the present results either.[16]

Recently, Polato e Fava (2002) using a Sidrauski’s (1967) General Equilibrium model estimated (with quarterly data for the period 1975 to 1996) the welfare cost of a 10% inflation rate to be around 2% of GDP. This is somewhat higher than our result with, for instance, the log-log model, which for a 10% annual interest rate was around 1.3% of GDP. For high rates of inflation (between 300% and 400% annually) Polata e Fava’s findings of welfare costs between 4 and 5% of GDP are comparable to our results in Table 2 though.

Starting from very high rates of inflation, much higher welfare costs of inflation have been found for Brazil by Yoshino (2002). With a General Equilibrium approach he estimated the costs for an annual inflation rate of 2590% to be in the range of 16% to 39% of GDP. His estimates include though other distortions of inflation that go beyond the shoe-leather costs, namely, some distortions of inflation that take place in the banking sector. Pastore (1997), however, who uses a Partial Equilibrium analysis like the one used here, found that for an inflation rate as high as the one used by Yoshino the welfare costs of inflation would be around 8%. As such high rates of inflation are well beyond the range of our data set no attempt was made here at estimating the welfare costs of inflation for such cases.

15 For instance, with the log-log model we estimated the welfare gains by reducing the interest rate from 300% to zero to be around 4% of GDP, while Pastore (with the same model but distinct econometric estimation procedure and using more recent data) estimated the cost of a 215% inflation rate to be around 4.15% of GDP.

16 For such a rate of inflation our results with the log-log model are, like those in Pastore (1997), around 1.5% of GDP.

It is interesting also to compare our results with those for two developed countries such as the United States and the United Kingdom in which the inflation rates rarely go beyond 10% annually. Starting with the United States, Fischer (1981), using the monetary base for money, estimated the cost of going from zero to a 10% inflation rate to be just 0.3% of GDP, which Lucas (1981), using M1 for money, found it to be 0.45% of GDP.[17] More recently, Feldstein's (1996), using a linear function as an approximation to the demand for money, found the 'shoe-leather' costs of going from price stability to a 2% inflation rate to be only 0.2% of GDP.

If such estimates seem too low when compared to those in Table 2, one should be reminded that they indicate the benefits of moving only to price stability (by Fisher's rule this means to have a positive nominal interest rate), not as in Table 1 to Friedman's rule of zero nominal interest rate (by Fisher's rule this is equivalent of having a deflation equal to the real interest rate).[18] Not only results are always larger when moving to Friedman's rule, they can also be much affected by the specification used for the demand for money. For instance, Lucas (1994 and 2000) found that by moving from a 10% annual inflation rate to Friedman's rule the 'shoe leather' gains in the United States with the log-log model would be around 1.6% of GDP, which is twice the value he found with the semi-log model. Similarly, Chadha *et al.* (1998) found for the United Kingdom that a reduction in the interest rate from 5% to zero would, with the log-log model, result in welfare gains of 1.15% of GDP, which falls to just 0.25% of GDP with the semi-log model.

Thus for the same range of values for the interest rate the results for the United States and the United Kingdom seem much closer to those in Table 2.[19] The interest rates of our series were, however, much higher than those for either the United States or the United Kingdom.

17 For these and other numbers, see Pakko (1998).

18 As the results for the 'shoe-leather' costs of inflation can be quite sensitive to the choice of the base inflation rate (i.e., price stability versus the Friedman rule of deflation), this raises questions concerning the appropriate choice of the benchmark interest rate. In fact, the basis inflation rate should be chosen after following optimality principles. Thus, since the cost of printing money is virtually zero, then in attaining optimality the cost of holding money (given by the nominal interest rate) should be zero as well. By the Fisher equation this would suggest an inflation rate equal to the negative of the real interest rate (Friedman's rule of deflation). There are, though, problems with such a choice. For at least one reason, the inflation tax is a source of revenue for the government and as argued by Phelps (1973), a tax system is only efficient when it minimizes the welfare cost of a given flow of tax revenue. This requires the marginal cost of raising taxes to be the same along all sources of taxes. Thus the optimum rate of inflation might not be according to Friedman's rule. For further thoughts on these points see, for instance, Marty (1976 and 1994).

19 A caution note is in order here. For the reasons given above, our data do not cover the recent past, in which rates were much lower. Consequently, our estimates of the 'shoe leather' costs of inflation should be used carefully for low interest rates.

There those rates were seldom above 10% annually. Here, according to Figure 2, they were rarely below 30% annually, being frequently well above this, and even on a few occasions reached rates close to 400% annually. Given such large differences in rates the disruption in economic activity would obviously be much greater in Brazil. Thus it comes as no surprise that the benefits of attaining price stability (starting from such high rates of inflation in the case of Brazil) would be three or four times as large here as in those two countries. In fact, the differences in welfare were not larger due to the protection provided by a generalized price indexation prevailing in the Brazilian economy during the period here investigated.

5 Factors affecting the welfare cost results

There are a number of factors that can affect results for the welfare costs of inflation. Some of these can affect the results even within a given set of data, as is clearly the case when distinct specifications for the demand for money are used. Differences in results with either the log-log model or the semi-log model, to mention just the two most commonly specifications used for the demand for money, are well documented and are not difficult to explain. After all, as noted by Wolman (1997), while with the semi-log model there is a fixed relationship between the change in the nominal interest rate and the percentage changes in the ratio of real money balances to income, with the log-log model the relationship is between the percentage change in the nominal interest rate and the percentage change in that same ratio. The implication is that satiation regarding real money balances will eventually be attained with the semi-log model but never with the log-log model. In fact, in moving to Friedman's rule real money balances go to infinity with the log-log model. Given this, for low interest rates the area under the demand curve would be much larger with the log-log model than with the semi-log model.

The question to be asked then is "which model is the better of the two" There are two issues here, namely the models performance on theoretical and empirical grounds. It goes without saying that a good performance in one of these is not a guarantee for a good result on the other as well. Empirically, the results for both Brazil (at least as given either by the present study or by Pastore,

1997), and the United States (as given for instance by Lucas, 2000) seem to suggest that the log-log model fits the data better.[20] For the United Kingdom results are mixed. For in-

20 In fact, the matter on this aspect has not been settled yet. For example, Lucas's conclusions have been challenged, using data for the United States, among others by Wolman (1997), and Marty (1999). Some objections to Lucas's general conclusions have also been raised by Chadha *et al.* (1998) but with data for the United Kingdom.

e, Chadha *et al.* (1998) have shown, with data for the period 1870-1994, that while the run relationship seems to favor the semi-log, the dynamics of the short-run favors instead g-log model.

ven if the log-log model were to pass the empirical test altogether there would still remain ict that its property of non-satiation of money balances (as the interest rate approaches) is quite questionable. This property tends, as we have mentioned, to inflate the 'shoe-er' costs of inflation, particularly when moving from Friedman's rule to price stability.[21]

otwithstanding such a shortcoming, also on microeconomics grounds, the log-log model is to do better than the semi-log model. This has been demonstrated, as paradoxical as it appear, by both Chadha *et al.* (1998) and Wolman (1997) authors whom have them-es raised serious objections to Lucas's use of the log-log model with data for the United es.[22]

'here are still other reasons for differences in results for the welfare costs of inflation. sey and Ireland (1996) have for instance argued that the low 'shoe-leather' cost estimates id for the United States in a number of studies might be due to their use of a Partial Equi-um framework. With a General Equilibrium approach they found that the 'shoe-leather' s of inflation increase appreciably. And they reinforce their conclusion by mentioning simi-indings by Imrohoroglu (1992) who uses also a General Equilibrium model albeit quite dif-nt from that of Dotsey and Ireland.

is a counterpoint to the General Equilibrium argument it should be mentioned that it was tly by following such an approach that Lucas (2000) was able to demonstrate the appro-teness of the consumer surplus formula given in equation (1).[23] He further showed that em-ally the two approaches (General Equilibrium or consumer surplus formula obtained by a

---

1 response to this Wolman has proposed a model (namely, the transactions-time technology of the inventory-ieoretic model) in which satiation of real balances is attained at a very low interest rate. When applied to data from the Inited States within a General Equilibrium framework such a model gave indeed reasonable results, namely, the enefits of moving from price stability to the Friedman rule is around 0.6% of full income.

or instance, Wolman uses microeconomics principles to show that the log-log function is consistent with the inven-ory theory for the demand for money, which is not the case with semi-log function. Similar conclusions were reached y Chadha *et al.* (1998), but by following a procedure proposed by McCallun (1989).

ucas does that in the context of either a version of Sidrauski's (1967) General Equilibrium model (in which money nters the utility function directly) or within a version of the transactions technology model proposed by McCallum nd Goodfriend (1987).

Partial Equilibrium analysis) are undistinguishable with data for the United States.[24] Whatever the merits of these approaches, results can in fact vary greatly with the use of either one of them, and it is even difficult to say in which case the variability of results is smaller.[25]

If all the factors discussed above were not enough, the welfare cost results could also be affected by the choice of the monetary aggregates for the money demand. Unfortunately it seems the economic theory is not very helpful on the subject. In choosing a monetary aggregate the problem is not only in peeking one among the various traditional aggregates available but also in choosing between such aggregates and the corresponding ones obtained by weighting financial assets according to their moneyness (i.e., by the monetary services they provide), as done, for example, by a Divisia-type aggregate suggested by Barnett (1978 and 1980).[26] Since the traditional monetary aggregates are obtained by a simple sum of heterogeneous financial assets, it is difficult to defend them on scientific grounds. Thus the Divisia monetary aggregates have sometimes been suggested as an alternative choice.[27] However, although there is some empirical evidence suggesting such aggregates might on some aspects do better than their traditional counterpart, the choice between these two types remains an open question in the literature.[28] In any event, due to difficulties in obtaining information for the period here analyzed concerning the corresponding interest rates of the various financial assets of a given monetary aggregate, we were unable to calculate such aggregates for Brazil.

Once confined to the traditional monetary aggregates, M1 (currency plus demand deposits) was then the one aggregate chosen. Besides yielding a better fit to the demand for money, M1

24 Although the General Equilibrium approach is analytically superior the truth is that there are problems with both approaches. For instance, if on the one hand it is unacceptable using ad hoc specifications for demand for money (as done by the Partial Equilibrium analysis), on the other hand fixing parameters for the utility function is also a problem for the General Equilibrium analysis.

25 For some results for a number of studies using each of the two approaches see, for instance, Polato e Fava (2002).

26 A distinct approach to this problem has been suggested by Marty and Chaloupka (1988), and also Marty (1994). More precisely, they suggest differentiate roles played by currency and deposits when calculating the welfare costs of inflation; this is so because of the interest rates usually earned by deposits. Such differentiate roles were also proposed by Simonsen and Cysne (2001) when they extended some of Lucas's (1994 and 2000) analytical results.

27 See on this point the observations made by Lucas (2000). In fact, Cysne (2003) has recently shown that analytically a monetary aggregate of the Divisia-type should be a natural choice to be made in the context Lucas'(2002) Partial Equilibrium analysis derivation of the welfare costs of inflation.

28 For empirical evidence on this point see, for the United States, Barnett (1984), and Swofford and Whitney (1991); for the United Kingdom, Belongia and Chrystal (1991); and for Brazil, Rossi and Silva (1991), and Rossi (1993 and 2000).

is also the monetary aggregate most frequently used in studies in the area making it easier for comparison purposes.[29]

As a concluding remark to this section, given such a variety of approaches in calculating the welfare costs of inflation, it is not surprising that when surveying the empirical estimates for the United States Gillman (1995) concluded that for a 10% inflation rate the welfare costs of inflation ranged from 0.85% to 3% of real GDP.[30]

6 Final remarks

In spite of the importance of the shoe-leather costs it is only one, and perhaps not even the most important one, among various types of distortions caused by inflation.[31] We briefly comment on a few types of other distortions caused by anticipated inflation here.[32]

First, change in inflation can affect seigniorage. If the counterpart to the change in seigniorage is a lump-sum tax or a lump-sum subsidy (as may be the case), the welfare costs of inflation are still as calculated above. Taxes are in practice, however, not of a lump-sum type, but of a distorting nature (example, the income tax). This means that if seigniorage falls when inflation goes down then such a reduction in government revenue will have to be met by a distortionary tax, which will involve a deadweight loss. This indirect effect, which in general has an opposite sign to the direct effect as calculated above, could even supplant the latter.[33] Thus, reducing inflation could in principle produce a shoe-leather welfare loss rather than a benefit.

Another effect of anticipated inflation takes place through a tax structure imperfectly indexed. An obvious example is the case of a progressive income tax. If the tax brackets are not cor-

29 While Rossi (1988) by using distinct traditional monetary aggregates for the demand for money shows that results can change appreciably, Polato e Fava (2002) indicates that in her welfare costs estimation with a General Equilibrium approach the use of either the monetary base or M1 yielded similar results.

30 As the data information for the United States is in general much more reliable than elsewhere, such a range of values is indeed remarkable.

31 For a comparison among the various types of distortion caused by inflation see Feldstein (1996), for the United States, and Bahski *et al.* (1998), for the United Kingdom. And for a point of view on the relatively small importance of the shoe-leather costs when compared to other sources of distortion caused by inflation see Mishkin (1997).

32 On the various distortions caused by inflation see Driffill *et al.* (1990).

rected by inflation then the effective tax paid will increase with inflation for taxes are levied on nominal values.[34] The distortions in these cases are mainly in the consumption choice and in the housing investment decisions.[35]

Inflation also makes agents devote time to economize on money balances rather than on productive activities. Proof of this is the observation that during periods of high inflation there is an increase in the share of the financial sector in the GDP.[36]

To shorten the list of other effects, we shall just mention the menu-cost. With inflation comes the need for a revision on the list of prices, which, depending on its frequency, might represent a major cost for certain economic activities.

These various effects of inflation, if added to the 'shoe leather' costs, would certainly significantly increase the costs of the distortions caused by inflation. Dotsey and Ireland (1995), for example, suggest that these other distorting effects of inflation could be more than three times the corresponding 'shoe leather' costs in the case of the United States.[37] For Brazil, if we accept recent estimates by Yoshino (2002) such an increase would be even more dramatic (namely, the numbers in Table 2 would have to be multiplied by a factor of six) and this by just including what he calls inflationary overbanking costs (attempting to save transactions time economic agents demand more banking products).

33 For instance, if for every extra money unit of tax there is a deadweight loss of 0.4 then the welfare costs of such a government revenue change would be given by the change in seigniorage times 0.4; this is the so-called indirect effect.

34 It comes immediately to mind the fact the tax brackets of the income tax have not been corrected in Brazil since 1994. With an accumulated inflation since that time over 100% the resulting distortions may be indeed great.

35 Fischer (1993), for example, estimated that for a 10% annual inflation rate the tax-related distortion of inflation in the United States is between 2 and 3% of GDP. For a detailed calculation of the distortions of inflation on consumption and investment in connection with data for the United States and the United Kingdom see, respectively, Feldstein (1996) and Bakhshi *et al.* (1997 and 1998). They found for example that the costs of such distortions are much larger than those caused on the demand for money.

36 For instance, Dotsey and Ireland (1996) mention that Yoshino (1993) found a positive correlation over time between inflation and employment in banking both in the United States and other countries as well. Along the same line, Pakko (1998) mentions that Lamb (1993) reported that during the early 1990s in Brazil (when inflation was particularly high) the banking sector accounted for 15% of GDP, a share much higher than that observed in most countries.

37 In fact, as we mentioned Feldstein (1996) has calculated a number of distorting effects of inflation for the United States, which also inspired Bakhshi *et al.* (1997 and 1998) to undertake a similar exercise for the United Kingdom. Their estimates indicate that these other various distorting effects of inflation are indeed much larger than those caused by the shoe-leather costs.

Here we only recognized the importance of the various types of distorting effects of inflation other than the shoe-leather costs. No attempt was made at estimating them. This is so because each one of the various types of distorting effects of inflation commented above represents a major research undertaking, which is well beyond the scope of this study.

Summarizing, a distinct feature of this study is the fact that the results are based on a set of data, which although ending in 1985 covers a period enabling a reasonable estimation for the demand for money. After that period, the Brazilian economy went through much instability and as a consequence experienced a series of stabilization programs, some even of a heterodox nature. These facts seem to have some bearing on the demand for money, for it became then too unstable. This suggests that our estimates can probably be very useful for a comparison with those obtained by the studies using more recent data.

As a final point, in spite of a Partial Equilibrium analysis our estimates for the shoe-leather costs of inflation seem reasonable. The welfare gains of getting price stability are though 3 to 4 times higher than those found for countries such as the United States and the United Kingdom. However, while in one case we are talking about reducing inflation from 300% annually to zero, in the others such a reduction is only from 10% annually to zero. Thus such differences in results were to be expected. Our results are though comparable with those of other studies for Brazil, and this is so whether those studies use a Partial or General Equilibrium approach.

References

Bailey, M. The welfare cost of inflationary finance. *Journal of Political Economy*, v. 64, p. 93-110, 1956.

Bakhshi, H.; Haldane, A. G.; Hatch, N. Quantifying some benefits of price stability. *Bank of England Quarterly Bulletin*, p. 274-91, August 1997.

_______. Some costs and benefits of price stability in the United Kingdom. Bank of England, *Working Paper Series* n. 78, March 1998, 73p.

Barnett, William A. The user cost of money. *Economics Letters* 1, p. 145-149, 1978.

_______. Economic monetary aggregates: an application of index number and aggregation theory. *Journal of Econometrics*, 4, p. 11-48, 1980.

_______. Recent monetary policy and the Divisia monetary aggregates. *The American Statistician*, v. 38, n. 3, p. 165-172, Aug. 1984.

Belongia, Michael T.; Chrystal, K. Alec. An admissible monetary aggregate for the United Kingdom. *The Review of Economics and Statistics*, p. 497-503, 1991.

Chadha, Jagjit S.; Haldane, Andrew G.; Janssen, Norbert G. J. Shoe-leather costs reconsidered. *The Economic Journal*, v. 108, p. 363-81, March 1998.

Cysne, Rubens Penha. Divisia index, inflation and welfare. *Journal of Money, Credit, and Banking*, v. 35, n. 2, p. 221-238, Apr. 2003.

Dotsey, Michael; Ireland, Peter. The welfare cost of inflation in general equilibrium. *Journal of Monetary Economics*, v. 37. p. 29-47, 1996.

Driffill, John; Mizon, Grayham E.; Ulph, Alistair. Costs of inflation. *In:* Friedman, B. M.; Hahn, F. H. (eds.), *Handbook of monetary economics.* Vol. II. Elsevier Science Publishers B. V., 1990, cap. 19, p. 1013-66.

Ermini, L.; Granger, C. W. J. Some generalizations on the algebra of I(1) process. *Journal of Econometrics*, v. 58, p. 369-84, 1993.

Feldstein, M. The costs and benefits of going from low inflation to price stability. *NBER Working Paper*, n. 5469, 1996.

Fischer, Stanley. Towards an understanding of the costs of inflation. *Carnegie-Rochester Conference Series on Public Policy* 15, p. 5-41, 1981.

_______. The role of macroeconomic factors in growth. *Journal of Monetary Economics*, v. 32, p. 485-512, 1993.

Friedman, M. The optimum quantity of money. *In: The optimum quantity of money and other essays*. Chicago: Aldine, 1969.

Gillman, M. Comparing partial and general equilibrium estimates of the welfare costs of inflation. *Contemporary Economic Policy*, 13, n. 4, p. 60-71, October 1995.

Harberger, Arnold C. Three basic postulates for applied welfare economics: an interpretative essay. *Journal of Economic Literature*, v. 9, p. 785-97, 1971.

Imrohoroglu, A. The welfare cost of inflation under imperfect insurance. *Journal of Economic Dynamics and Control*, v. 6, p. 79-91, 1992.

Lamb, Christina. A roller coaster out of control. *Financial Times*, February 1993, 22.

Lucas, Robert E. Discussion of Stanley Fischer's 'towards an understanding of the costs of inflation: II' *Carnegie-Rochester Conference Series on Public Policy* 15, p. 43-52, 1981.

_______. The welfare costs of inflation. *CEPR Publication*, n. 394, Stanford University, CA, February 1994.

_______. Inflation and welfare. *Econometrica*, v. 68, n. 2, p. 247-274, March 2000.

Marty, Alvin L. A note on the welfare cost of money creation. *Journal of Monetary Economics*, p. 121-24, January 1976.

_______. The inflation tax and the marginal welfare cost in a world of currency and deposits. *Review of the Federal Reserve Bank of St. Louis*, v. 76, n. 4, p. 67-71, July/August 1994.

_______. The welfare cost of inflation: a critique of Bailey and Lucas. *Review of the Federal Reserve Bank of St. Louis*, v. 81, n. 1, p. 41-46, Jan./Feb. 1999.

Marty, Alvin L.; Chaloupka, Frank J. Optimal inflation rates: a generalization. *Journal of Money, Credit, and Banking*, p. 141-144, February 1988.

McCallum, Bennett, T. *Monetary economics*: theory and policy. MacMillan Publishing Co., 1989.

McCallum, Bennett T.; Goodfriend, Marvin S. Demand for money: theoretical studies. *In*: Eatwell, John; Milgate, Murray; Newman, Peter (eds.), *New Palgrave*: a dictionary of economics. London: MacMillan, 1987, p. 775-781.

Mishkin, Frederic S. Comment on the optimum quantity of money. *Journal of Money, Credit, and Banking*, v. 29, n. 4, p. 716-719, November 1997

Pakko, Michael R. Shoe-leather costs of inflation and policy credibility. *Review of the Federal Reserve Bank of St. Louis*, v. 80, n. 6, p. 37-48, Nov./Dec. 1998.

Pastore, Affonso Celso. Senhoriagem e inflação: o caso brasileiro. *Economia Aplicada*, v. 1, n. 4, p. 583-621, Out./Dez. 1997.

Phelps, E. S. Inflation in a theory of public finances. *Swedish Journal of Economics*, v. 75, p. 67-82, 1973.

Polato e Fava, Ana Claudia. *Custos de bem-estar da inflação*: uma comparação dos modelos de equilíbrio parcial e geral. 2002. 37p. Dissertação (Mestrado), FEA-USP, São Paulo.

Rossi, José W. A demanda por moeda no Brasil: o que ocorreu a partir de 1980? *Pesquisa e Planejamento Econômico*, v. 18, n. 1, p. 37-54, Abril 1988.

_______. The demand for money in Brazil: what happened in the 1980s? *Journal of Development Economics*, v. 31, p. 357-367, 1989.

_______. Agregação monetária com o índice de Divisia: aplicação ao caso brasileiro. *Pesquisa e Planejamento Econômico*, v. 23, n. 2, p. 251-268, Agosto 1993.

_______. Divisia monetary aggregates for Brazil. *Economia Aplicada*, v. 4, n. 3, p. 413-433, Julho/Setembro 2000.

Rossi, José W.; Silva, Maria da Conceição. Índices ponderados de agregados monetários para o Brasil. *Pesquisa e Planejamento Econômico*, v. 21, n. 3, p. 511-532, dezembro 1991.

Sidrauski, Miguel. Rational choice and patterns of growth in a monetary economy. *American Economic Review*, 57, p. 534-544, 1967.

Simonsen, Mario Henrique; Cysne, Rubens Penha. *Welfare costs of inflation*: the case of interest bearing money and empirical estimates for Brazil. Rio de Janeiro: Fundação Getúlio Vargas, julho 1994. Mimeografado.

_______. Welfare costs of inflation and interest-bearing money. *Journal of Money, Credit, and Banking*, v. 33, n.1, p. 90-100, February 2001.

Swofford, James L.; Whitney, Gerald A. The composition and construction of monetary aggregates. *Economic Inquiry*, v. XXIX, p. 752-761, October 1991.

Tower, Edward. More on the welfare cost of inflationary finance. *Journal of Money, Credit and Banking*, v. 3, n. 4, p. 850-60, November 1971.

Wolman, Alexander L. Zero inflation and the Friedman rule: a welfare comparison. *Federal Reserve Bank of Richmond Economic Quarterly*, v. 83, n. 3, Fall 1997

Yoshino, J. A. *Money and banking regulation*: the welfare costs of inflation. 1993. PhD dissertation, Department of Economics, University of Chicago: Chicago, IL.

_______. *The Brazilian welfare costs of inflation*. University of São Paulo, July 2002, 26 p. Mimeografado.