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An Analysis of Friedman's Hypotheses on Monetary Correction

Many eminent economists have been in favor of indexation or monetary correction.[1] One can mention, for example, Edgeworth, Jevons, Marshall, Irving Fisher, and Keynes. More recently, Machlup, Musgrave, Patinkin, Tobin, Samuelson, and Friedman, among others, have also advocated indexation.[2] In a very recent publication [1], Milton Friedman has discussed in some detail—but only verbally—his arguments in favor of indexation for dealing with the present situation in many countries. He emphasized two points:

> . . .It would reduce the revenue that government acquires from inflation—which also means that government would have less incentive to inflate . . . [and] . . . it would reduce the initial adverse side effects on output and employment of effective measures to end inflation. [1, p.26]

In this paper, I analyze Friedman's hypotheses on monetary correction.[3] I present a more detailed study of his second hypothesis and I limit myself to a few comments in a short section regarding the first hypothesis—effects on government revenue from inflation.

In Section I, I discuss Friedman's argument that monetary correction—the widespread use of escalator clauses—reduces the undesirable side effects stemming from ending inflation, using his own theoretical model for

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the short-run division of a change in nominal income between prices and real output [2]. Following this longer discussion, Section II contains simulation exercises of the macroeconomic effects of indexation, as a complement to the analysis in Section I. In the shorter Section III, I consider Friedman's hypothesis about the effects of indexation on government revenue from inflation. Some conclusions are presented in Section IV.

[I] MONETARY CORRECTION AND THE SIDE EFFECTS

According to Friedman,

> Higher inflation reflects an acceleration in the growth rate of total money spending. Ending inflation requires a deceleration in the growth rate of total spending. The reason for the side effects from such change in total spending [the boom or the recession] is the time delay between an increased or decreased rate of growth of total money spending and the full adjustment of output and prices to that changed rate. . . . [1, p. 31]
>
> . . . A slowdown in total spending will . . . tend to be reflected initially in a widespread slowdown in output and employment. . . . It will take some time before these responses lead in turn to widespread reductions in the rate of inflation. . . . It will take still more time before *expectations* about inflation are revised. [encouraging] a resumption of employment and output. [1, p. 31]
>
> . . . These side effects fundamentally reflect distortions introduced into *relative* prices by *unanticipated* inflation or deflation, distortions that arise because contracts are entered into in terms of *nominal* prices under mistaken perceptions about the likely course of inflation. . . . The way to reduce these side effects is to make contracts in *real*, not nominal, terms. This can be done by the widespread use of escalator clauses. [1, pp. 33–34]
>
> . . . Indexation will shorten the time it takes for a reduction in the rate of growth of total spending to have its full effect in reducing the rate of inflation. As the deceleration of demand pinches at various points in the economy, any effects on prices will be transmitted promptly to wage contracts, contracts for future delivery, and interest rates. . . . Accordingly, . . . costs will go up less rapidly than they would without indexation. . . . [1, p.43]

In what follows, an attempt will be made to formalize Friedman's argument on the effects of indexation on the short-run trade-off between inflation and real output or inflation and unemployment, using his own "theoretical framework" [2]. It will become clear that Friedman certainly had the dynamic short-run model he developed in [2] in mind when he formulated his ideas on monetary correction.

The model can be summarized as follows:[4]

(1) $D \log y_t = D \log Y_t - D \log P_t$

(2) $D \log P_t = (D \log P_t)^* + \alpha[D \log Y_t - (D \log Y_t)^*] + \gamma X_t$

(3) $(D \log P_t)^* = \beta D \log P_t + (1 - \beta)(D \log P_{t-1})^*$

(4) $(D \log Y_t)^* = (D \log P_t)^* + (D \log y_t)^*$

(5) $DX_t = D \log y_t - (D \log y_t)^*$

One also hypothesizes with Friedman that $(D \log y)^*$ is a constant, and call it g hereafter. It must be noticed that $DX_t = X_t - X_{t-1}$, where $X_t = \log y_t - (\log y_t)^*$. The expectational model in (3) is an adaptive one.[5]

With $D \log Y_t$—the rate of change of nominal income—exogenous, the above model is complete. The endogenous variables are: $D \log y_t$, $D \log P_t$, $(D \log P_t)^*$, $(D \log Y_t)^*$, and X_t. Given the rate of change of nominal income, the past history of each variable, and the trend rate of growth of output g, the model explains the actual growth of real output, the rate of inflation, the formation of anticipations for inflation and nominal income, and the real output gap.

It is hypothesized that $1 > \alpha > 0$, $\gamma > 0$, and $1 > \beta > 0$.

Evidently, the model would be much more interesting for policy purposes if one replaced the hypothesis

(6) $D \log Y_t$ = exogenous variable

with any of the following three different formulations of Friedman's monetary theory of nominal income:[6]

(6a) $D \log Y_t = a\, D \log M_t \qquad a > 0$

(6b) $D \log Y_t = D \log M_t + b\, D\,[(D \log Y_t)^*] \qquad b > 0$

(6c) $D \log Y_t = (D \log Y_t)^* + c(D \log M_t^s - D \log M_t^d) + d(\log M_t^s - \log M_t^d) \qquad c, d > 0$

In that case, $D \log M$ (or $D \log M^s$)—the rate of change of the money supply (or the monetary base)—would be the exogenous policy variable.

As the model is recursive, one can, however, neglect (6a)–(6c) and undertake the analysis as if $D \log Y$ were the exogenous variable that makes the system move. This simplification seems to be quite adequate for the purposes of my analysis and, most important, it avoids the monetarist bias of equations (6a)–(6c).

The basic equation of the short-run model is certainly (2)—an accelerationist variant of the Phillips curve. It could also be written as

(2a) $D \log P_t = (D \log P_t)^* + \dfrac{\alpha}{1 - \alpha} DX_t + \dfrac{\gamma}{1 - \alpha} X_t$

that is, inflation is related to inflationary anticipations, with an accelerationist coefficient of unity,[7] to change in excess demand, and to the level of excess demand measured by the output gap X.

For the purpose of this analysis, I shall make one further simplification by assuming that $\alpha = 0$, neglecting, consequently, the change in the excess demand variable in the accelerationist equation (2a). The analysis that follows will be more manageable with such simplification, which does not affect the basic short-run Phillips curve-type trade-off between inflation and output or between inflation and unemployment, i.e., between $D \log P_t$ and X_t.

One can eliminate all the anticipated variables and reduce the system to a two-equation model:

$$(7) \quad D \log P_t = D \log P_{t-1} + \frac{\gamma}{1-\beta} X_t - \gamma X_{t-1}$$

$$(8) \quad X_t = D \log Y_t - D \log P_t - g + X_{t-1}$$

Notice that $D \log y_t$—the actual growth of real output—can always be obtained from equation (1), and that g or $(D \log y_t)^*$ is a constant.

The reduced forms of the model are:

$$(9) \quad D \log P_t = AD \log P_{t-1} + BX_{t-1} + (1-A) D \log Y_t - (1-A)g$$

$$(10) \quad X_t = -AD \log P_{t-1} + (1-B) X_{t-1} + AD \log Y_t - Ag$$

where

$$1 > A = \frac{1-\beta}{1-\beta+\gamma} > 0, \; 1 > B = \frac{\gamma\beta}{1-\beta+\gamma} > 0$$

and

$$1 > A + B > 0$$

Moreover, a third interesting reduced form, for $D \log y_t$, could be immediately obtained from $D \log Y_t - D \log P_t$, with coefficients $-A$, $-B$, A, and $(1-A)$, respectively, for the four independent variables that appear in (9) or (10).

After some substitutions, Friedman's model can be reduced to the following second-order difference equations:

$$(11) \quad D \log P_t = (A + 1 - B) D \log P_{t-1} - AD \log P_{t-2} + (1-A) D \log Y_t + (A + B - 1) D \log Y_{t-1} - Bg$$

$$(12) \quad X_t = (A + 1 - B) X_{t-1} - AX_{t-2} + AD \log Y_t - AD \log Y_{t-1}$$

For $D \log y_t$, the equation would then be:

$$(13) \quad D \log y_t = (A + 1 - B) D \log y_{t-1} - AD \log y_{t-2} + AD \log Y_t - 2AD \log Y_{t-1} + AD \log Y_{t-2} + Bg$$

Notice how the real variables X and $D \log y$ are affected by the *acceleration* of the rate of change of nominal income, as suggested by Friedman. More formally, one can now obtain impact multipliers, some interim multipliers, and the total multiplier[8] related to the effects of a change in the exogenous variable $D \log Y_t$—and, of course, $D \log M_t$—on the endogenous variables $D \log P_t$, X_t, and $D \log y_t$:

Period	$D \log P_t$	Sign	X_t	Sign	$D \log y_t$	Sign
0	$1 - A$	+	A	+	A	+
1	$A - A(A - B)$	+	$A(A - B)$	?	$A(A - B) - A$	−
...						
0 + 1	$1 - A(A - B)$	+	$A + A(A - B)$	+	$A(A - B)$	?
...						
...						
∞	1		0		0	

where

$$1 > A - B = \frac{1 - \beta - \gamma\beta}{1 - \beta + \gamma} > -1$$

It is important to notice that when $1 > A - B > 0$, or $A > B$, the ambiguous signs disappear.

It is also easy to see[9] that the solutions of the system of difference equations (9) and (10), which is equivalent to the second-order difference equations (11) and (12), will depend upon the roots of the characteristic equation

$$\lambda^2 - (A + 1 - B)\lambda + A = 0$$

These roots are, of course,

$$\lambda_1, \lambda_2 = \frac{(A + 1 - B)}{2} \pm \frac{\sqrt{(A + 1 - B)^2 - 4A}}{2}$$

where

$$2 > (A + 1 - B) = \frac{(1 - \beta)(2 + \gamma)}{1 - \beta + \gamma} > 0$$

It goes without saying that these real or complex roots depend upon β and γ, and I will come back to them later.

Having presented all these results derived from a discrete version of Friedman's dynamic model, one can now use them to discuss the question of indexation. Friedman's verbal reasoning will be interpreted as an argument that monetary correction leads or corresponds to a high value of β, i.e., β would be very close to 1.0 so that inflationary anticipations would adjust promptly to inflation in the case of an indexed economy. In contrast, one could think of the other extreme situation, where β is so close to zero that price expectations are practically unaffected by the current inflation rate—and institutional obstacles are the causes of the very slow adjustment process.

As can be seen in the table above, the value of β affects the impact and interim multipliers, that is, the short-run transitional period before the full effect of total spending on prices and real output. Naturally, as one would expect, β does not affect long-run or total multipliers: these are zero for real variables and unity for nominal variables; and long-run quantity theory of money implications could be derived using also (6a)–(6c).

I suggest that Friedman's hypothesis is that the monetary correction, with the consequent high value for β, will lead to a much more rapid adjustment process and "shorten the time it takes for a [change] in the rate of growth of total spending to have its full effect in . . . the rate of inflation" [1, p.43].

In other words, Friedman is not suggesting that monetary correction leads to a vertical Phillips curve in the short run or a vertical aggregate supply, a result one would obtain with $\beta = 1.0$. He seems to be saying only that, due to the quick expectational adjustment under indexation, the vertical Phillips curve in the short run is a result much closer to reality than without monetary correction. More generally, his point is simply that the greater the value of β, the closer the β to 1.0, and the greater the effect of economic policy (or nominal income) on prices and the smaller on real output. Therefore, an anti-inflationary policy in an indexed economy will reduce side effects on output and employment.

One can investigate his argument by looking at the effects of different β's on some multipliers as well as on the roots of the characteristic equation discussed above. Consider, for example, the signs of the partial derivatives of the multipliers from the above table with respect to β. Notice that $\partial A/\partial\beta < 0$, $\partial B/\partial\beta > 0$, and $\partial(A - B)/\partial\beta < 0$:

Period	$D \log P$	X	$D \log y$
0	+	−	−
1	?	?	?
. . .			
0 + 1	?	?	?
. . .			
. . .			
∞	0	0	0

Such results indicate that in fact the larger the value of β, the greater the impact multiplier for $D \log P_t$ and the smaller the impact multipliers for X_t and $D \log y_t$. As a matter of fact, in the extreme case where $\beta = 1.0$, we have then $A = 0$, and impact multipliers are equal to total long-run multipliers. The larger the value of β, the smaller the value of A and the smaller the effect of a change in the exogenous variable on the real variables.

However, when one begins to consider the first interim multiplier and the sum of the first two periods, for example, it is not necessarily true that the larger the β, the greater and the closer to 1.0 the sum for $D \log P_t$, and the smaller and the closer to zero the sum for X_t and $D \log y_t$. And this was also implicitly suggested by Friedman. It would be incorrect to suppose that he had only the impact or first-period multipliers in mind.

In order to obtain Friedman's result—greater effects on prices and smaller effects on real output with high values of β—additional restrictions must be imposed relating β and γ, or, more specifically, $A > B$, or $\beta < 1/(1 + \gamma)$. Observe that when $A < B$, one obtains the perverse result due to an overshooting effect: the sum of the multipliers for inflation is greater than unity for the first two periods, and consequently the multiplier for real output will necessarily be negative.

So much for the first two periods. More generally, the ambiguous signs of the effects of β on the interim multipliers can certainly be related to the characteristic equation $\lambda^2 - (A + 1 - B)\lambda + A = 0$. In fact, whenever $(A + 1 - B)^2 - 4A < 0$, or $\beta > \gamma/(\gamma + 4)$, the roots of the equation will be complex, resulting in oscillatory movements of the endogenous variables while they approach and before they reach their new long-run equilibrium values. The oscillation will be damped and not explosive because $A < 1$.

Thus, unless β has a small value, the complex root result is obtained. It can be shown that the derivative of $(A + 1 - B)^2 - 4A$ with respect to β is negative. If $\beta < \gamma/(\gamma + 4)$, then the new equilibrium values will be gradually and asymptotically approached, since the characteristic roots will be real. On the other hand, because of the smallness of β, the adjustment process will be slow—with a value for A closer to 1.0. Observe that for $0 < \gamma < 2$, the condition $\beta < \gamma/(\gamma + 4)$ is more restrictive than the former condition $\beta < 1/(1 + \gamma)$, valid for the first two periods.

All in all, these results suggest that in fact indexation, or a high value of β, tends to lead to a more rapid adjustment process, reducing short-run adverse trade-offs. On the one hand, a real expansionary boom will become more difficult with macroeconomic policies, but on the other hand, the recessionary effects of a deflationary policy will be reduced. However, for a given value of γ, the greater the β is, the greater also the probability of oscillations, with some overshooting in the transitional period. By contrast, a smaller value of β tends to produce a much slower but nonoscillatory path from $(1 - A)$ to 1 for inflation and from A to zero for output.

Thus, Friedman's hypothesis can be considered as consistent with his short-run dynamic model as far as the effect of indexation on the speed of adjustment is concerned. It is entirely correct in respect to the impact multipliers of macroeconomic policies. On the other hand, as far as interim multipliers are concerned, it must be pointed out that his hypothesis depends on specific relations between β and the Phillips curve coefficient γ. Moreover, adjustment paths tend to be oscillatory under indexation, in contrast to cases where expectations adapt slowly. Again, the value of γ is also an important feature of the process.

Therefore, it does appear that monetary correction "would reduce the . . . side effects on output and employment" [1, p. 26], but it might possibly lead to some perverse and even undesirable effects because of the overshooting phenomenon and the dampened oscillation due to the more rapid transmission of inflation and inflationary anticipations.

In the next section. these theoretical results will be illustrated with simulation exercises for different values of β.

(II) SIMULATIONS

To complement the analysis of Section I, a few simulation exercises are presented for two alternative macroeconomic policies with three different values for the expectational coefficient β.

In these simulations, there are two alternative policies—"gradualism" or "shock treatment." They correspond, respectively, to a gradual or a violent reduction in the growth rate of nominal output (third column in Tables 1 and 2). Evidently, a simplified hypothesis is used, such as the growth rate of nominal output equaling the growth rate of the money supply. Therefore, the rate of growth of nominal output is the exogenous variable.

Under the gradualist policy, the rate declines slowly, by 5 percent every period, reaching a 7 percent growth rate only at the fifth period. With the shock treatment, there is an immediate reduction in nominal output growth, from 37 percent—the initial hypothesis—to 7 percent. Other initial hypotheses for the simulations (period or year $-$ 1) are the following: inflation, 30 percent; deceleration of inflation, 0 percent; nominal output growth, 37 percent; real output growth, 7 percent; output gap, 0 percent.[10]

The simulations were made with the reduced forms (9) and (10). Potential output growth, $(D \log y_t)^*$ or g, is hypothesized to be 7 percent. The γ coefficient of the Phillips curve is hypothesized to be equal to 0.5. Three different values are considered for the β coefficient: 0.1, 0.5, and 0.9. The last value is supposed to reflect the behavior of an economy with a high degree of indexation, while the first value intends to reflect the other extreme case of a very slow process of expectational adjustment.

Tables 1 and 2 present the simulation exercises for seven periods, as well

TABLE 1 Gradualism: a Simulation

Years	Inflation	Deceleration of Inflation	Nominal Output Growth	Real Output Growth	Output Gap
			$\beta = 0.1$		
0	28.2	− 1.8	32.0	3.8	− 3.2
1	25.2	− 3.0	27.0	1.8	− 8.4
2	21.2	− 3.9	22.0	0.8	−14.6
3	16.7	− 4.5	17.0	0.3	−21.3
4	11.8	− 4.9	12.0	0.2	−28.1
5	6.6	− 5.2	7.0	0.4	−34.6
6	3.0	− 3.6	7.0	4.0	−37.6
Aver. 0–2	24.9	− 2.9	27.0	2.1	− 8.7
Long run	0.0	0.0	7.0	7.0	0.0
			$\beta = 0.5$		
0	27.5	− 2.5	32.0	4.5	− 2.5
1	23.1	− 4.4	27.0	3.9	− 5.6
2	17.7	− 5.5	22.0	4.3	− 8.3
3	11.8	− 5.9	17.0	5.2	−10.0
4	5.9	− 5.9	12.0	6.1	−10.9
5	0.2	− 5.7	7.0	6.8	−11.1
6	− 2.7	− 2.9	7.0	9.7	− 8.4
Aver. 0–2	22.8	− 4.1	27.0	4.2	− 5.5
Long run	0.0	0.0	7.0	7.0	0.0

Long run	0.0	0.0	7.0	7.0	0.0

			$\beta = 0.9$		
0	25.8	− 4.2	32.0	6.2	− 0.8
1	20.3	− 5.5	27.0	6.7	− 1.2
2	15.0	− 5.3	22.0	7.0	− 1.2
3	9.9	− 5.1	17.0	7.1	− 1.1
4	5.0	− 5.0	12.0	7.0	− 1.1
5	0.0	− 5.0	7.0	7.0	− 1.1
6	− 0.8	− 0.8	7.0	7.8	− 0.3
Aver. 0–2	20.4	− 5.0	27.0	6.6	− 1.1
Long run	0.0	0.0	7.0	7.0	0.0

TABLE 2 Shock Treatment: a Simulation

Years	Inflation	Deceleration of Inflation	Nominal Output Growth	Real Output Growth	Output Gap
			$\beta = 0.1$		
0	19.3	−10.7	7.0	−12.3	−19.3
1	11.7	− 7.6	7.0	− 4.7	−31.0
2	6.4	− 5.3	7.0	0.6	−37.4
3	2.8	− 3.6	7.0	4.2	−40.2
4	0.4	− 2.4	7.0	6.6	−40.6
5	− 1.2	− 1.6	7.0	8.2	−39.4
6	− 2.2	− 1.0	7.0	9.2	−37.2
Aver. 0–2	12.5	− 7.9	7.0	− 5.5	−29.2
Long run	0.0	0.0	7.0	7.0	0.0
			$\beta = 0.5$		
0	15.0	−15.0	7.0	− 8.0	−15.0
1	3.8	−11.3	7.0	3.3	−18.8
2	− 2.8	− 6.6	7.0	9.8	−15.9
3	− 5.4	− 2.6	7.0	12.4	−10.5
4	− 5.3	0.1	7.0	12.3	− 5.2
5	− 4.0	1.4	7.0	11.0	− 1.2
6	− 2.3	1.7	7.0	9.3	1.1
Aver. 0–2	5.3	−10.9	7.0	1.7	−16.6
Long run	0.0	0.0	7.0	7.0	0.0

$\beta = 0.9$

0	5.0	−25.0	7.0	2.0	− 5.0
1	− 2.9	− 7.9	7.0	9.9	− 2.1
2	− 2.0	0.9	7.0	9.0	0.0
3	− 0.4	1.7	7.0	7.4	0.3
4	0.2	0.6	7.0	6.8	0.1
5	0.1	− 0.1	7.0	6.9	0.0
6	0.0	− 0.1	7.0	7.0	0.0
Aver. 0–2	0.0	−10.7	7.0	7.0	− 2.4
Long run	0.0	0.0	7.0	7.0	0.0

as the average results for the first three periods (from period zero to period two). Long-run results are also indicated in these tables.

Let us consider first the results for period zero. Clearly, as a confirmation of the analysis in the previous section, a low value such as $\beta = 0.1$ makes the nominal output deceleration reflect much more on real output than on prices. In fact, in the shock treatment case, the 30 percent deceleration—from 37 percent to 7 percent—is initially divided between a price deceleration of only 10.7 percent and a real growth deceleration of 19.3 percent, leading to a serious recession. The same holds true, of course, under the policy of gradualism although on a minor scale (nominal output deceleration of 5 percent).

At the other extreme, the high $\beta = 0.9$ substantially reduces the real effects of the anti-inflationary policies. For example, with the shock treatment, the same 30 percent deceleration in period zero is divided into a 25 percent deceleration of prices and a 5 percent drop in the real output growth rate. Moreover, in the gradualist case, the contrast appears to be even more striking, since there is practically no real effect when $\beta = 0.9$ compared to the case $\beta = 0.1$.

If one selects the average values obtained for the first three periods (Aver. 0–2 in the tables), similar results are found. Under shock treatment, the 30 percent nominal output deceleration leads to a negative average real output growth with $\beta = 0.1$, while in the case $\beta = 0.9$ there is simply no real effect on the average. With gradualism, the case $\beta = 0.1$ leads to a division of the 10 percent average deceleration—from 37 percent to 27 percent—of nominal income as follows: minus 5 percent for the average inflation and minus 5 percent for the average real growth; and, again, the case $\beta = 0.9$ has practically no real average effects.

More generally, the simulation exercises indicate that, in fact, the higher the value of β is, the greater the price effects are and the smaller the real output effects of an anti-inflationary macropolicy. There are substantially different results when $\beta = 0.1$ is contrasted with $\beta = 0.9$, while $\beta = 0.5$ represents an intermediate example—for both gradualism and shock treatment.

As far as the overshooting phenomenon and the resulting oscillations are concerned, they are perhaps of secondary importance in these specific simulations because the first-period impact effects generally tend to be of greater magnitude than the interim effects—and this may be more evident in the case of shock treatment. Nevertheless, they should not be neglected, and there are some perverse effects in the simulations which help to indicate that they do have some relevance.

The shock treatment example provides evidence of the oscillations generated by high values of β. For instance, with $\beta = 0.9$, the apparently neutral 7 percent real growth figure for the average period 0–2 is actually a combination of low growth in period zero (2 percent) and high 9–10 percent growth rates in periods 1 and 2. In other words, there is an overshooting phenomenon in periods 1 and 2: the cumulative price deceleration (32 percent) is greater than the nominal "policy" deceleration (30 percent), leading to negative rates of inflation and real output growth rates 2 percent above the trend potential rate of 7 percent. It is the overshooting that makes the output gap between periods 0 and 2 move in the "wrong" but favorable direction in the case $\beta = 0.9$, in contrast to the extreme case $\beta = 0.1$, where a great recession is the side effect of the restrictive economic policy.

More generally, such overshooting phenomena are responsible for situations of decelerating inflation combined with high real growth rates—as in the shock treatment case, with $\beta = 0.9$ and $\beta = 0.5$, for some intermediate periods—and, of course, for the perverse situations of stagflation, accelerating inflation combined with low or negative real growth rates.

All in all, the simulations—as well as the analysis of Section I—seem to suggest that the more "shock treatment" characterizes a stabilization policy, in contrast to a gradualist approach, the more an indexed economy is necessary in order to reduce the side effects of the policy. If one recalls that policymakers tend to manifest their fear of the so-called feedback effects of indexation, these simulations indicate precisely the opposite: as suggested by Friedman, indexation facilitates the ending of inflation.

[III] INDEXATION AND REVENUE FROM INFLATION

Monetary correction of taxes and government securities—i.e., inflation-proofing the income tax and issuing purchasing-power bonds—would certainly reduce government revenue from inflation ("taxation without representation" [1, p. 29]), and, consequently, the authorities would have less incentive to engage in inflation. Friedman [1] discusses in some detail many indexation-type measures that would prevent the government from extracting more revenue (income tax) from higher *nominal* incomes[11] as well as avoid a greater real national debt by payment of negative real interest rates. These measures include (1) escalator clauses in the personal income tax for personal exemption, deductions, and tax bracket limits; (2) escalation of the base for calculating capital gains and depreciation of fixed capital assets for both the personal and the corporate income tax; and (3) issuance of purchasing-power bonds. Most of these measures have already been adopted in many countries.

There is, however, as Friedman points out [1], a third source of government revenue which is perhaps the most hidden form of taxation through inflation: additional money. Economists are used to studying the inflation tax as if its "rate" were the rate of change of the money stock (or the monetary base) and its "base" were the level of that monetary aggregate.[12] One could express this tax in real terms as DM/P, or $(DM/M) \times (M/P)$, where M is a monetary aggregate and P is the general price level.

Friedman mentions the following possibility:

> . . . Widespread escalation would restrict the government revenue from inflation simply to the direct tax on cash balances produced by the issue of additional high-powered money. . . . It would thereby reduce the revenue from a given rate of inflation, which could induce government to raise the rate of tax. [1, p. 44]

Thus, monetary correction might provide an incentive for a higher inflation tax rate and in this sense be indirectly inflationary, even if it had no direct inflationary effect, as was implicitly suggested in Sections I and II above.

The purpose of this short section is to analyze the basic consequences of carrying the idea of indexation even further, with monetary correction of the money supply (or of a great part of it) designed to reduce the direct inflation tax on cash balances. The specific example of Brazil will be considered in studying the possibility of a wider indexation of the money stock,[13] with only minor consideration given to operational problems. But it must be pointed out that high transaction costs could make implementation difficult. In fact, transaction costs are precisely the reason why even an indexed and neutral inflation presents a worse situation than price stability.

Monetary correction was introduced in Brazil in 1965–1966 and has been practiced on a very large scale since.[14] But the inflation tax has not been neutralized. Holders of money—in the M1 definition—are taxed with no monetary correction and zero nominal interest rate. However, if one considers a broader definition of money—for example, M3, including time deposits and savings deposits with monetary correction—then one might speak of a partial indexation of the money stock. Nominal interest rates have been zero (no indexation) for currency and demand deposits, in contrast to monetary correction plus a real interest rate for time and savings deposits.[15]

The partial indexation of the broadly defined money stock has caused the expected phenomenon where the indexed interest-bearing components have increased at much higher rates than the nonindexed zero-interest components. As a consequence of the variable nominal interest rate differential—inflation rate plus real interest—between time and savings deposits on the one hand and currency and demand deposits on the other, the ratio M3/M1 as defined above has jumped from 1.02 in 1965–1966 to 1.34 in 1973–1974. In other words, time and savings deposits represented only 2 percent of M1 in 1965–1966 and went up to 34 percent of M1 in 1973–1974.

To form an idea of the relative magnitude of the inflation taxes—they represented 10 percent of Brazil's 1973 GDP in the M1 case and 14 percent in the M3 case. In the latter case, due to the presence of some indexed components, only part of the inflation tax is effectively collected and not returned by the government and the banks—and this part is precisely the M1 tax.

What would happen if M1 were also indexed? Clearly, it would be costly and difficult to index paper currency and coins, but certainly not impossible; one could consider dating currencies, as in S. Gessell's stamp money proposal discussed in Keynes's *General Theory*. But the principle of monetary correction would seem to apply naturally to demand deposits, with an indexation corresponding to interest payment at the inflation rate. This should reduce the welfare loss of the inflation tax by restricting it to currency alone (15 percent of M1 in Brazil in 1973–1974). It would create roughly a real interest rate differential between other indexed deposits and demand deposits, as well as a "monetary correction differential" between demand deposits and currency. Except for currency, this new situation would actually merely duplicate interest differentials that would occur under price stability, in contrast to the previous situation where demand deposits had no indexation.

There is a widespread belief that this larger escalation of the money stock would be inflationary and that it could lead to runaway inflation. If one recalls that inflation is by definition the difference between the rate of change of the nominal money supply and the rate of change of the real money demanded, one can analyze this question by looking at the effects of the M1 indexation on the money supply and on the real demand for money.

As far as the real demand for money is concerned, the higher interest rate on money would increase in a once-and-for-all fashion the real demand for money, and in consequence the flight from other assets into money would have a deflationary impact. Velocity would not increase with accelerating inflation as it would without this type of indexation. In other words, if one simplifies the opportunity cost of holding money as the real interest rate plus the rate of inflation minus the interest rate on money, I might say that money indexation makes the real demand for money become dependent only on the real interest rate and entirely independent of the actual or the anticipated rate of inflation.

Therefore, by taking into consideration real output growth, M/P demanded would tend to increase at a more or less constant rate after the initial once-and-for-all *deflationary* effect. It is interesting to note—although this point will not be pursued further here—that the base of the inflation tax in real terms, M/P, becomes independent of the tax rate under money indexation, but that the tax proceeds are returned to the public, except for currency.

Turning now to the nominal money supply, I clearly have to assume that a greater indexation of the money stock would not reduce the present control of the monetary authorities over the monetary base. In other words, it has to be assumed that the payment of interest on money will not be financed by issuing additional base money. Consequently, looking at the money supply process as $M = mB$, where M is the money supply (M1 or M3), m is the corresponding monetary multiplier, and B is the monetary base, one has to assume that the indexation of demand deposits does not affect B, which will continue to be an exogenous policy variable.

But the broader indexation of the money stock, with the introduction of monetary correction for demand deposits, will certainly change the multiplier to the extent that ratios such as currency to demand deposits and time deposits to demand deposits will be substantially modified. One would expect, for example, a decline in these ratios due to a larger interest differential in the first case and a smaller differential in the latter case. Such declines would lead to increases in the monetary multiplier (for M1 or M3) and therefore, given the monetary base, to an inflationary increase in the money supply. However, this effect would also be of the once-and-for-all type, and there is always the alternative of a compensating one-time movement in the monetary base.

All in all, one could say that widespread escalation plus a largely indexed money stock would, in fact, be able to neutralize inflation—eliminating its harmful effects except for the welfare cost of the tax on holders of currency and coins—without having any permanent inflationary or deflationary effect of its own. Quite the contrary, the real demand for money should be more stable in this case.[16] The fact is that without money indexation[17] both the government and the banks continue to collect an inflation tax,[18] even in an indexed economy such as Brazil, causing a welfare loss to the holders of money. Hence, inflation is not entirely neutral even in countries such as Brazil, where only the costs of unanticipated inflation can be said to be neutralized by monetary correction. On the other hand, as suggested by Friedman, the conclusion seems correct that in Brazil the government's incentive to resort to inflation was diminished after the introduction of monetary correction.

(IV) CONCLUSIONS

This paper has analyzed Friedman's hypotheses on monetary correction. He emphasized that indexation would both ease the pains or side effects of reducing inflation and lower the government revenue from inflation. As far as the side effects are concerned, an analysis with his own dynamic model

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[IV] CONCLUSIONS

This paper has analyzed Friedman's hypotheses on monetary correction. He emphasized that indexation would both ease the pains or side effects of reducing inflation and lower the government revenue from inflation. As far as the side effects are concerned, an analysis with his own dynamic model indicates that indexation does indeed reduce them, even though it tends to provoke more oscillations and some overshooting effects in the main macrovariables. As to government revenue, Friedman's hypothesis is certainly correct[19]; I simply try to carry the idea of indexation even further by analyzing the case of monetary correction of demand deposits designed to reduce the direct inflation tax on cash balances.

NOTES

1. These terms refer to the "widespread use of price escalator clauses in private and governmental contracts" [1, p.25].
2. For a historical background on indexation and escalator clauses in general, see the collection of essays in [4], especially the paper by H. Giersch, and the appendixes in M. Friedman's essay [1]. An extensive bibliography on the subject can also be found in [4] and [1].
3. It must be emphasized here that Friedman regards escalator clauses simply as "a lesser evil than a badly managed money" [1, p.26] and believes that it would be "far better to have no inflation and no escalator clauses. But that alternative is not currently available [1, p.35]." He makes the point that monetary correction substantially increases transaction costs, but he thinks that this is the most promising expedient for "both reducing the harm done by inflation and facilitating the ending of inflation" [1, p.45].
4. See especially equations 39, 44, 45, and 46 in [2]. Notice that P represents the general price level, Y is nominal national output (or income), and y is real national output (or income), so that $Y = Py$. The notation used here follows closely Friedman's own symbols, but the *gap* between actual and potential real output, $\log y - (\log y)^*$, is called X. An asterisk denotes the *anticipated value* of the variable and, for consistency, $Y^* = P^*y^*$. A discrete formulation of the model is used, with $D \log P_t = \log P_t - \log P_{t-1}$ instead of $d \log P/dt$, etc. Logarithmic rates of change are used instead of percentage rates of change—but see Section II. Therefore, the inflation rate, for example, is $D \log P_t$ and not $(P_t/P_{t-1}) - 1$, but these are approximately equal, since $\log d = d - 1$ for small values of $d - 1$. No difference is made between potential real output and anticipated real output, y^*, and the logarithmic rate of change of potential or anticipated real output is a constant—the secular or trend rate of growth. Another expression often used by Friedman is "permanent" income or "permanent" price instead of anticipated income or anticipated price for Y^* and P^*, respectively.
5. This model has been used by Friedman since his permanent income hypothesis for the consumption function. In [2], the adaptive expectations model appears in equations 39 and 57. Notice that if $\beta = 1.0$, then $(D \log P_t)^* = D \log P_t$—an extreme case where actual inflation is always equal to anticipated inflation. If $\beta = 0$, then $(D \log P_t)^*$ is a constant unaffected by the prevailing inflation rate. More generally, $1 > \beta > 0$. The rationality of adaptive expectations and the rational expectations model—an elegant alternative expectational formulation—are discussed in [6].
6. See especially equations 38, 48, 51, and 52 in [2]. Notice that M^s or M refer to money supplied, and M^d refers to money demanded. Friedman used the *IS–LM* approach, the Fisherian theory of interest rates, and some additional hypotheses in order to formulate his theory of nominal income.
7. See also Lemgruber [6]. Believers in a long-run Phillips curve would certainly suggest a coefficient less than unity—but greater than zero—for the variable $(D \log P_t)^*$ in equation 2a or 2.

8. See also Theil [7].
9. See also Goldberg [5].
10. In these simulations, we have used percentage variations. It must be noted that, in the case of percentage variations, the identities (1) and (5) in the paper become approximations. They are really identities in the case of logarithmic variations. But see footnote 4 above. In order to relate the simulations with the notation used in Section I, notice that inflation = $D \log P_t$; deceleration of inflation = $D \log P_t - D \log P_{t-1}$; nominal output growth = $D \log Y_t$; real output growth = $D \log y_t$; and output gap = $X_t = \log y_t - (\log y_t)^*$.
11. "Inflation increases the yield of the personal and corporate income tax by pushing individuals and corporations into higher income groups" [1, p.30].
12. See, for example, Friedman [3] for an analysis of the revenue-maximizing rate of inflation, the revenue-maximizing rate of monetary growth, and the welfare costs of collecting the inflation tax. See also footnote 16 below.
13. It is surprising that Friedman—a supporter of payment of interest on money—does not discuss monetary correction of demand deposits in his essay [1].
14. See, for example, [8] and [4].
15. One should mention that in Brazil there is a prefixed or ex-ante monetary correction for time deposits and a postfixed or ex-post indexation for savings deposits. See also [8] and [4]. In this paper, I do not discuss these differences, but it should be stated that I have been writing about ex-post monetary correction in the preceding pages. The prefixed indexation is merely a semantic solution to avoid usury laws.
16. In fact, it could be argued that to the extent that the indexation of money avoids a drop in M/P as a consequence of more inflation and permits M/P to grow at a constant rate given by the growth of real output, monetary correction could *increase* the revenue from a given rate of inflation by increasing the base of the inflation tax. This result may appear inconsistent with what Friedman said in [1] (see the quotations at the beginning of this section) but would be perfectly consistent with his demonstration, in an article published in 1971 [3], that the maximum revenue from inflation can easily be found at very low rates of inflation or even deflation when one introduces growth into the story. For example, after the adjustment required by the once-and-for-all effects in the multiplier, the growth of the monetary base in real terms should be equal to the growth of both the real money supply and real output—and the government revenue from inflation produced might be maximized at the point of zero inflation (or full money indexation). But in order to establish whether there would be a net increase of revenue from a "larger" money indexation, one would have to analyze more carefully the precise division of the tax revenue between the public and the private sector; this is not attempted here due to the limited scope of this study. I am indebted to Miguel Broda for very helpful suggestions with respect to this aspect of the analysis.
17. Clearly, as a counterpart of this new indexation, the monetary authorities would have to index bank reserves.
18. However, one could argue that the banking system avoids the formal restrictions on interest payments and is forced by competition with other financial institutions to provide free banking services and greater facilities—such as more agencies—to their customers as a form of an implicit interest rate.
19. But see footnote 16 where a different result is suggested, perhaps simply because of alternative semantic interpretations of Friedman's texts.

REFERENCES

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