The Inflation Tax is Likely to be Inefficient at any Level

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I. Introduction

Standard efficiency models in public finance call for equating the marginal cost of taxation from alternative sources. According to standard calculations from the literature on the optimal inflation tax, the double digit inflations most countries suffered during the 1970s were closer to optimal than the substantially lower rates of the 1980s. Several recent papers have pointed to the prospective loss of national seigniorage as a major cost of adopting a common European currency.[1]

The elasticity of demand for money with respect to expected inflation is usually estimated to lie in the range from 0.5 to 3.0. This implies an optimal inflation rate from 200 to 33 percent by the standard Bailey (1956) type calculations. We argue in this paper that the previous calculations of the standard optimal inflation tax likely contain a substantial upward bias because they are based on the assumption that inflation is perfectly anticipated.[2] This is seldom the case. Moreover, a mounting body of evidence suggests a positive relationship between the rate and

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1 See, for example, *Dornbusch* (1988), *Drazen* (1989), and *Grilli* (1989).

2 The qualitative implications of inflation uncertainty for the optimal inflation tax was briefly noted in *Logue* and *Willett* (1976), but as far as we know, this issue has not been subsequently analyzed in any detail.

Kimbrough (1986) suggests another problem with the optimal inflation tax literature: If money is an intermediate good, then the optimal inflation tax literature suggests that its tax rate should be zero. It would be greater than zero only if money is used in final consumption, as the standard inflation tax literature assumes. See also *Faig* (1988). We note that both papers do not allow for deadweight costs of labor income taxation, making it optimal to fund all government exependitures through the income tax.

variability of inflation.[3] While causation may run both ways if greater variability increases uncertainty (*Devereux* [1989] and *Cooley* and *Hansen* [1989]), this is likely to lower output because individuals must devote more resources to more frequent contracting, shifting in the supply schedules of risk-averse agents. We show in Section II the sensitivity of revenue-maximizing and optimal rates of inflation to output loss due to inflation uncertainty. In section III, calculations for seven OECD economies show that the output loss from inflation uncertainty need not be large for the optimal rate of inflation to fall to zero. Typically the size of the output loss is less than the few available estimates of it.[4] The traditional intuition of many economists that inflation is an inefficient form of taxation may be correct after all. In the concluding section, we explore how open economy and political economy considerations are influenced by this analysis.

II. How the Output Effects of Inflation Uncertainty Alter the Calculations of Optimal Inflation

A government has two sources of revenue. It may tax labor income at a flat rate of t or it may tax money balances at a rate of π. Its revenues are calculated to be

$$R = ty + \pi(M/P) \tag{1}$$

where is real income and M/P is real money income. If raising revenue from each source reduces the size of the tax base, we set taxes such that $MC_t = MC_\pi$. There is little doubt that the marginal costs of labor income taxation are substantial. *Browning* (1987) finds that the size of the marginal welfare costs is impossible to estimate with great precision, but that it will likely exceed 9 percent of additional revenues. *Stuart* (1984) and *Ballard, Shoven,* and *Whalley* (1985) find that the range of costs per dollar of revenue raised lies between 15 and 50 percent.

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3 See *Frohman, Laney* and *Willett* (1981) and *Holland* (1984) for surveys of the evidence. The point has been debated; for example, *Fischer* (1981; 1984) argues that inflation and uncertainty are jointly caused by supply shocks. Frohman, Laney and Willett find that for the U.S. the effect persisted even in a sample from which the OPEC shocks were removed, though the size of the effect was reduced.

4 Estimates of this "Friedman effect" are given in *Mullinean* (1980), *Levi* and *Makin* (1980), *Evans* (1983), and *Holland* (1986).

The welfare costs of inflation are usually depicted as the area under the money demand curve in excess of some (assumed constant) real rate of interest. Using a Cagan money demand function of the form

$$M = A \cdot y^{\alpha} \cdot e^{\beta i}$$

it is usually found that the marginal cost of inflationary finance is equal to $\eta/(1 - \eta)$, where η is the interest semi-elasticity of demand. It is from this calculation that the optimal inflation rates of 30 - 200 percent come.

These considerations are based on the traditional Fisherian effect that anticipated inflation raises nominal interest rates and lowers money demand while leaving income and output basically unaffected.[5] However, if inflation cannot be perfectly anticipated, the associated reduction in output can be substantial. Since output is an element in the money demand function specified above, output loss will lower the base on which the inflation tax is imposed.

If uncertainty is unrelated to average inflation, then incorporation of uncertainty would lower the absolute level of resources obtainable, but would not alter the marginal conditions of optimal inflation rates. Higher inflation on average raises uncertainty and reduces the marginal revenue gains from inflation. Consider the total derivative of the money demand function with respect to inflation:

$$\frac{dM}{d\pi} = \frac{dM}{di} \cdot \frac{di}{d\pi} + \frac{dM}{dy} \cdot \frac{dy}{d\pi} = -\beta M \cdot \frac{di}{d\pi} + \frac{dM}{dy} \cdot \frac{dy}{d\pi} \tag{2}$$

The Fisher effect $i = r + \pi$ gives $di/d\pi = 1$ if real interest rates are not affected by fully anticipated inflation.[6] A vertical long-run Phillips curve renders $dy/d\pi = 0$ and the traditional evaluation can follow, such as in *Bordo* and *Stuart* (1986).

5 See for example *Bailey* (1956), *Phelps* (1973), and *Tower* (1976). For a recent survey and references to the literature see *McClure* and *Willett* (1988). Within the paradigm of the Lucas supply curve, it would be inflation uncertainty relative to price uncertainty that matters. For an interesting treatment of the inflation tax within a cash-in-advance model that also finds an upward-sloping supply curve, see *Cooley* and *Hansen* (1989).

6 Reasons why this might not be true include tax wedges between nominal and real interest rates as discussed by *Darby* (1974) or *Feldstein* (1976) and the effect of inflation uncertainty directly on money demand as discussed by *Klein* (1975). We assume this to simplify the analysis; if transactions costs from higher inflation raises real interest rates, the reduction in both revenue-maximizing and optimal inflation rates is reinforced.

The *Friedman* hypothesis is that higher inflation lowers output, so that $dy/d\pi = f < 0$. To see this expand this derivative by the chain rule

$$\frac{dy}{d\pi} = \frac{d\sigma_\pi}{d\pi} \cdot \frac{dy}{d\sigma_\pi} \tag{3}$$

The first term in the product represents our claim that higher inflation leads to higher inflation uncertainty; the second term is the Friedman effect from uncertainty to output. The second term is negative. *Froyen* and *Waud* (1987) found that higher and more variable inflation increased uncertainty in Canada, the U.K. and the U.S. in the 1970s, though not for West Germany. *Welch* (1989) provides similar evidence for Brazil. Froyen and Waud also demonstrate that for Canada and the U.K., increases in aggregate price uncertainty had negative output effects. Lower output reduces revenue gained from the income tax, lowering the benefits to government of higher inflation. This is obtained by taking the derivative of the revenue equation (1) with respect to inflation

$$\frac{dR}{d\pi} = M + \pi \cdot \frac{dM}{d\pi} + t \cdot f \tag{4}$$

Employing equations (2) and (3) we can solve for the revenue-maximizing rate of inflation to be

$$\pi_{RM} = \frac{1 + t\,(f/y)\,(y/M)}{-(\beta + \alpha\,(f/y))} \tag{5}$$

This includes the traditional result of $-1/\beta$ as a special case where $f = 0$.

Following *Bailey* (1956, 100 - 01), the area of the money demand curve that results from a rise in nominal interest rates represents the deadweight loss of inflationary finance. This measurement W^* requires expansion as well to include the output reduction from the uncertainty effect.

Suppose the real rate of interest is .01. Let output equal 1000, and the values of the parameters A, α and β equal 1, 1 and -1 respectively. Individuals thus currently desire to hold 990 in real balances. The government desires to raise real revenue by increasing the money supply by 2% per annum. The area under the demand for money function as the quantity of real balances desired declines from M to M^* represents the usual welfare loss. This would be computed by taking the definite integral of the money demand function between nominal interest rates of 1 and 3

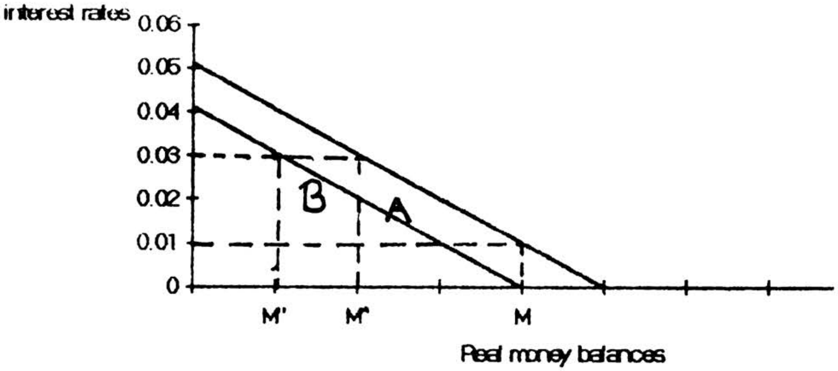

Figure 1: Money Demand with output effects

percent, graphically shown as the triangle A. With our parameters, the loss is 0.392, or about 0.4 % of output. The gain would be two percent of the remaining base, or 19.41. The marginal cost per dollar gained is 0.02. But this understates the total decline in the demand for money if output effects occur. A decline in output due to expected inflation adds to the loss by shifting in the money demand curve. As we showed above, this would decrease the revenue base on which the inflation tax would operate, and reduce the revenues generated from an income tax. It also increases the size of the welfare cost by the area of rectangle B in the graph. This loss represents the loss of additional services from money because fewer transactions are being made: higher transactions costs reduce the number of transactions. If $f = 0.1$, which we argue later is the lower bound of possible Friedman effect parameters, the amount of money demanded will fall by an additional 1.94. This raises the welfare cost of the inflation tax to .4308, thus understating the cost by about 10 %.

Algebraically, the marginal welfare cost of raising the inflation rate by one more point can be viewed as

$$\frac{dW}{d\pi} = (\beta + \alpha \cdot f/y) \cdot i \cdot M + f \cdot \phi < 0 \tag{6}$$

where ϕ is the change in welfare resulting from a one-unit change in income, which we assume equals one. To simplify, we assume a social welfare function with output as the sole determinant. The traditional welfare cost of βiM thus understates the true welfare cost in two ways: (i) the traditional deadweight loss per point of inflation is increased by the lowering of money demand as demonstrated above (as given by the expression $\alpha(f/y)\,iM$); and (ii) the inclusion of output reduction in the consideration of welfare losses (the value $f\phi$).

We can now calculate the marginal welfare cost of inflationary finance by taking the ratio of equation (6) to equation (4)

$$MC_\pi = \frac{-dW/d\pi}{dR/d\pi} = \frac{-i(\beta + \alpha \cdot f/y) + \phi(f/y) \cdot (y/M)}{1 + (\beta + \alpha \cdot (f/y)) + t(f/y) \cdot (y/M)}$$

Note again that the Bailey solution of $-i\beta/(1+\beta)$ is obtained if $f = 0$. Using the Fisher relation for the value of i above, we can solve for the optimal inflation rate as

$$\pi^* = \frac{MC_\pi(1 + t \cdot (f/y)(y/M)) + \phi \cdot (f/y)(y/M)}{-(\beta + \alpha \cdot f/y)(1 + MC_\pi)} - r \qquad (7)$$

Note that the optimal inflation rate depends on the marginal tax rate and the velocity of money when the Friedman effect is present. Higher marginal tax rates lower the revenue received from a one percent change in the inflation rate without any change in the welfare costs. Thus higher income tax rates lower the optimal inflation rate.[7] Higher velocity will also reduce the optimal inflation rate both by lowering the level of revenues received from seigniorage (note the expression $(f/y)(y/M) < 0$) and by raising the welfare costs. Countries like Germany with relatively high velocity and income tax rates can be expected to have lower optimal inflation rates than those with lower tax rates and lower velocity like Japan. More surprisingly, countries with low nominal interest rate elasticities will have lower revenue maximizing rates when a Friedman effect is present.[8] It is precisely those countries that gain the most from seigniorage according to the Bailey formula.

III. How Big an Effect?

To illustrate the likely order of magnitude the Friedman effect would have on the revenue-maximizing and optimal inflation rates, we use pub-

[7] This point is also made by *Bordo* and *Stuart* (1986). In that work they calculate the optimal inflation rate for tax rates between 21 and 70 percent given the marginal welfare burdens of those income tax rates demonstrated by *Stuart* (1984). Bordo and Stuart do not include discussion of a Friedman effect.

[8] You see this by noting that $\frac{d\pi_{RM}}{d\beta} = \frac{1 + t(f/y)(y/M)}{(\beta + \alpha(f/y))^2} < \frac{1}{\beta^2}$ where the right hand side of the inequality represents the comparative static if $f = 0$.

lished estimates of money demand for seven industrial countries from *Boughton* (1981). He models money demand roughly similar to *Cagan* (1956), regressing money on inflation, real interest rates, income, and lagged money. His long run inflation elasticities are in the second column of table 1. The next two columns show historical averages of the ratio of GNP to money and the average tax rate for the period 1960 - 86. There were often breaks in the data series; where this occurred, we used only the more recent part of the series. All data are from the 1988 *International Financial Statistics Yearbook.*

Browning (1987) estimates that the marginal welfare burden of the income tax was roughly a minimum 8 - 10% of revenue.[9] *Shoven, Ballard,* and *Whalley* (1985) and *Fullerton* suggest marginal costs in the area of 30 - 50%. We use the rates of 10, 30, and 50 percent as three estimates that likely encompass all plausible values. Note that higher costs would dramatically increase the optimal inflation rate when uncertainty effects are absent.

Levi and *Makin* (1980) and *Froyen* and *Waud* (1987) have estimated the size of the Friedman effect. Levi and Makin find that a one percentage point rise in inflation lowers employment by 0.1 to 0.2 percent in the United States. Using the higher estimate and Okun's Law that a one percent rise in unemployment reduces GNP by 3 percent gives a value for $f/y = 0.6$. If there were a one-to-one relationship between rates of change of employment and output, the lower end of their estimate would give a value for $f/y = 0.1$. We considered these along with the values 0.3 and zero.

The latter four columns of Table 1 show the revenue-maximizing inflation rates. The actual inflation rate is show for comparison purposes. The reduction in revenue-maximizing rates is most pronounced in the cases we delineated at the end of section II: countries with high velocities and high tax rates lose the most from the presence of uncertainty effects. With a sizable Friedman effect the revenue-maximizing rates decline a minimum of 40% for Italy, the country Boughton shows to have the highest interest elasticity and lowest income tax rate. In two cases, Germany and the United Kingdom, a high Friedman effect leads government to not inflate at all.

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9 *Browning* suggests that the welfare costs cannot be accurately measured. His range of estimates runs from 10 - 200 percent. We are taking his low-end estimate for our computations without comment on its accuracy. *Gordon* (1976) suggests that 3.3% is too high an estimate, but we find no agreement elsewhere with this assertion.

Table 1

Revenue-Maximizing Inflation Rates

Country	Interest Elasticity	GNP/ Money	Avg. Tax Rate	Actual Inflation	π_{RM} if $f/y = 0$	π_{RM} if $f/y = .1$	π_{RM} if $f/y = .3$	π_{RM} if $f/y = .6$
Canada	− .30	6.76	.18	6.2	333.3	219.6	105.8	30.0
France	−1.66	3.27	.37	7.4	60.2	49.9	32.5	12.1
Germany	− .42	6.12	.27	4.4	238.1	160.5	70.0	0.8
Italy	−2.99	2.27	.20	11.1	33.4	30.9	26.3	20.3
Japan	−1.41	3.24	.11	4.6	70.9	63.9	52.2	39.1
U.K.	−1.19	5.21	.33	8.5	84.0	64.2	32.5	− 1.8
U.S.A.	−0.76	4.66	.20	5.2	131.6	105.4	68.0	32.4

Dates for averages run 1960 - 1983 except Japan ends 1979, France begins 1972, Germany begins 1968, and Canada begins 1969. Elasticities from Boughton (1981). Velocity and average taxes from *IMF Yearbook,* 1988.

Optimal inflation rates for f/y equal to zero and 0.1 are shown in Table 2. In every case when the Friedman effect coefficient was set to 0.3 or 0.6, we obtained negative optimal rates.[10] With a small Friedman effect of 0.1, optimal inflation rates are positive for some countries if the marginal cost of the income tax is high, but these still fall substantially from their perfect certainty levels. Interestingly, the optimal rate for Italy in this case is very close to its actual rate. With lower deadweight costs of the income tax, the optimal rate is negative in all but one case.

To view this slightly differently, we display in Table 3 the size of the output loss ratio f/y necessary to make the revenue- and welfare-maximizing rates of inflation equal zero. In five of seven cases, the output loss necessary to remove any revenue gain from the inflation tax is implausibly large. For example, the output loss necessary to remove incentives for inflationary finance in Japan would be 2.8% for a one per-

[10] We do not believe that the current empirical evidence should be interpreted as suggesting that negative inflation rates would show less variability and uncertainty than zero rates. Thus, on uncertainty-minimizing grounds, a zero rate of inflation would seem to be the appropriate long-run target and we treat calculations of negative rates as if they were zero. Friedman (1956) argues that a slightly negative rate of inflation would maximize consumer surplus by driving the nominal rate to zero and maxizing the area under the money demand curve.

Table 2

Optimal Inflation Rates

	For $MC = 10\%$		For $MC = 30\%$		For $MC = 50\%$	
Country	$f/y = 0$	$f/y = 0.1$	$f/y = 0$	$f/y = 0.1$	$f/y = 0$	$f/y = 0.1$
Canada	36.7	−161.7	130.0	−134.1	250.0	−88.8
France	6.6	− 14.9	23.5	− 4.7	45.2	9.6
Germany	26.2	−111.8	92.9	− 90.4	178.6	−56.1
Italy	3.7	− 4.7	13.0	2.5	25.1	12.2
Japan	7.8	− 16.6	27.7	− 3.0	53.2	15.7
U.K.	9.2	− 37.4	32.8	− 27.5	63.0	−12.4
U.S.A.	14.5	− 48.0	51.3	− 29.3	98.7	− 2.2

For data sources, see Table 1.

cent increase in inflation. The critical values of f/y that reduce the optimal inflation rate to zero are quite modest in contrast. A one percent rise in inflation would only have to reduce output by 0.2% in Italy for the optimal rate of inflation to be zero even if it had a highly distortionary ($MC = 50\%$) tax system. The values for the other countries are lower still.

Table 3

Critical Values of the Friedman Effect

Country	For $\pi_{RM} = 0$	For $\pi^* = 0$ if $MC = 10\%$	For $\pi^* = 0$ if $MC = 30\%$	For $\pi^* = 0$ if $MC = 50\%$
Canada	−0.822	−0.015	−0.042	−0.068
France	−0.827	−0.029	−0.083	−0.129
Germany	−0.605	−0.016	−0.045	−0.072
Italy	−2.203	−0.043	−0.125	−0.200
Japan	−2.806	−0.031	−0.090	−0.146
U.K.	−0.581	−0.019	−0.052	−0.082
U.S.A.	−1.073	−0.021	−0.061	−0.098

IV. Conclusions

In some countries with high levels of government expenditures and relatively inefficient tax systems, some continued reliance on the inflation tax may be efficient. More empirical research on both the inflation-uncertainty and uncertainty-output relationships for industrialized countries is needed. On the basis of our current knowledge, however, we would be surprised if inflation turned out to be an efficient form of taxation for many of the industrial countries.

The effects of uncertainty on optimal inflation rates take on greater importance in open economies. Higher and more variable rates of inflation generate greater incentives for international currency substitution, which increases the elasticity of domestic money demand to higher inflation. (*Melvin* [1985, 1988].) We have shown here that this reduces the optimal and revenue-maximizing inflation rates.

A number of economists, e.g., *Dornbusch* (1988), *Drazen* (1989), *Grilli* (1989) and *Cody* (1991) raise the possible loss of seigniorage as an issue in the current debate over European monetary integration. Our analysis suggests that on efficiency grounds these concerns are misplaced. Still, there could be political costs to governments that give up national control over seigniorage. Inflation is no longer a hidden tax after the experiences of the 1970s, but many voters may still perceive it less well than changes in income and direct taxes. Governments would thus have political incentives to push inflation above the efficient rate. The politically optimal rate of inflation may lie above the economically optimal level.

Our analysis also has implications for the debate over whether modern political economies tend to suffer from inflationary biases. (*Willett* [1988a, 1988b].) Skeptics could find refuge in the traditional optimal inflation tax literature. Actual inflation rates of the industrial economies tended to lie below the efficient levels calculated by traditional analysis. Our results suggest to the contrary that there is an empirical basis for concern that democratic governments have an inflationary bias.

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Zusammenfassung

Inflationssteuer vermutlich in jeder Höhe ineffizient

Die traditionelle Berechnung der optimalen Inflationssteuer führt zu optimalen Inflationsraten von zwischen 30% und 200%. Dies läßt jegliche von erwarteten höheren Inflationsraten verursachte Outputkosten außer acht. Wir behaupten, daß die Literatur nach Friedmans Vortrag anläßlich des ihm verliehenen Nobel-Preises die Hypothese stützt, daß höhere Inflation zu geringerem Wachstum führt. Dieser Friedman-Effekt senkt sowohl die optimale Rate als auch die Rate, die die Gesamtsteuereinnahmen der Regierung auf Grund von Inflation und aus der Einkommenbesteuerung maximiert. Einfache Berechnungen zeigen, daß, wenn eine angenommene Inflationsrate von 10% das Wachstum um 1% pro Jahr reduziert, die optimale Inflationsrate in den industrialisierten Volkswirtschaften gleich Null ist, wenn die Grenzkosten der Einkommensteuer nicht extrem hoch sind. Das Motiv der Einnahmeerzielung bleibt, wenn auch durch den Friedman-Effekt reduziert, ziemlich stark.

Summary

The Inflation Tax Is Likely to be Inefficient at any Level

The traditional calculation of the optimal inflation tax yields optimal inflation rates between 30 and 200 percent. This ignores any output costs generated by higher anticipated inflation. We argue that the literature since Friedman's Nobel lecture supports the hypothesis that higher inflation lowers growth. This Friedman effect lowers both the optimal rate and the rate that maximizes the government's total revenue from inflation and income taxation. Simple calculations demonstrate that if a 10% anticipated inflation reduces growth by 1% per annum,

the optimal rate of inflation in industrialized economies is zero unless the marginal cost of the income tax is very high. The revenue motive, while reduced by the Friedman effect, remains relatively strong.

Résumé

Les plus-values fiscales de l'inflation sont probablement inefficientes, quelque soit leur montant

Le calcul traditionnel de l'impôt optimal prélevé par l'inflation entraîne des taux optimaux d'inflation qui vont de 30% à 200%. Il ne tient compte d'aucuns coûts de production qui résultent des attentes de l'augmentation des taux de l'inflation. Nous affirmons qu'à la suite de l'exposé que Friedman a fait lorsqu'il lui a été remis le prix Nobel, la littérature soutient l'hypothèse qu'une hausse de l'inflation entraîne une baisse de la croissance. Cet effet-Friedman réduit autant le taux optimal que le taux qui maximise les rentrées fiscales totales du gouvernement provenant de l'inflation et des impôts sur les revenus. De simples calculs montrent que, si un taux d'inflation supposé de 10% réduit la croissance d'1% par an, le taux d'inflation optimal dans les économies industrialisées est égal à zéro, si les coûts marginaux des impôts sur les revenus ne sont pas extrêmement élevés. Le motif de réalisation de rentrées persiste assez fort, même s'il est réduit par l'effet-Friedman.