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Budget Deficits, Stability, and the Monetary Dynamics of Hyperinflation

LARGE BUDGET DEFICITS FINANCED BY MONEY CREATION are widely believed to be the primary force sustaining prolonged high inflation processes. The relationship appears to be closer for hyperinflationary episodes, which are usually associated with the presence of massive budget deficits. Hyperinflation, understood in this paper as a process of accelerating inflation, in fact occurs because governments have unsustainably large budget deficits.[1]

A correction of the fiscal imbalance has been crucial for stopping hyperinflation. This factor is well documented in the works of Yeager (1981), Sargent (1982), and Webb (1986) on the hyperinflation episodes in the central European countries during the 1920s and by Sachs (1987) on the more recent Bolivian episode. Substantial reductions in the budget deficit, monetary reform, and a fixed exchange rate were crucial for the successful stabilization policies in those countries. Indeed, fiscal restraint, which in most cases meant outright elimination of the budget deficit, was probably the most important of these policy measures.

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[1] In this respect our definition of hyperinflation differs from Cagan's. By his definition, an economy experiences hyperinflation once the rate of inflation exceeds 50 percent per month. In the present paper hyperinflation is an inherently unstable process which countries could experience even if inflation remains below the 50 percent level arbitrarily set by Cagan.

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One distinctive feature of hyperinflationary episodes is that the rate of inflation accelerates over time,[2] thus suggesting that these processes are inherently unstable. Cagan's seminal work on this issue provides an alternative interpretation. In Cagan's view hyperinflationary episodes could only be unstable if they were "self-generating," and he considered that although "there is no reason why (self-generating inflations) could not occur; so far they have just not been observed" (p. 73). However, Cagan's stability analysis only considers the case in which the money process was exogenous.

If one extends Cagan's seminal paper through the introduction of money-financed budget deficits and rational expectations, and then analyzes the dynamic properties of the system, as was recently done by Evans and Yarrow (1981), Kiguel (1986), and Buiter (1987), the results are astonishing. Large money-financed budget deficits could be the source of instability; however, they could only lead to hyperdeflation. These deficits can never be the source of hyperinflation.

The presence of large budget deficits in a perfect foresight framework has a surprising effect on the dynamic behavior of inflation. Auernheimer (1976), Evans and Yarrow (1981), and Kiguel (1986) showed that in order to obtain a hyperinflationary process one needs to assume adaptive expectations. In other words, in Cagan's framework, large budget deficits could result in hyperinflation only when agents make systematic mistakes in forecasting the rate of inflation.

It has been recognized for some time that it is very difficult to justify the use of adaptive expectations in macroeconomic models. Economic agents eventually learn the process that generates inflation, and they will use that information in the formation of their forecasts on inflation. As a result, it is difficult to accept that large budget deficits would lead to accelerating inflation only in the presence of systematic mistakes.

In this paper we show that under plausible assumptions regarding the adjustment of the money market it is possible to find conditions under which large money-financed deficits can lead to hyperinflation even when agents have perfect foresight. The basic analytical framework is similar to the one used in Sargent and Wallace (1973), Evans and Yarrow (1981), Bruno and Fischer (1986), Dornbusch and Fischer (1986), and Buiter (1987). It assumes that budget deficits are entirely financed through seigniorage, a Cagan-type demand for money function and rational expectations (which in the present model, given the absence of uncertainty, is equivalent to perfect foresight). The main difference is that in the present model the money market does not clear instantaneously.

The paper is organized as follows. The next section introduces the basic analytical framework and discusses the dynamics of the model under a lagged adjustment in the money market. It will be argued that hyperinflation is an unstable process triggered by the government's attempt to obtain seigniorage in excess of the

[2]The diagrams (in Cagan 1956) describing the behavior of inflation in Germany, Hungary, and Greece as well as the annual data presented in Sachs (1987) on Bolivia are very persuasive in this respect. In these cases, inflation seems to be accelerating almost without bound up to the time of the stabilization effort.

revenue-maximizing inflation tax. Since there is no stable rate of inflation at which the government can finance its deficit, it is financed in an unstable fashion. Section 2 discusses in more detail the potentially destabilizing effects of budget deficits and the problems that policymakers face in controlling inflation. In section 3 we allow for the presence of lags in government revenues and show that in this case the economy is more likely to experience an unstable path of prices.

1. A MODEL OF HYPERINFLATION

In this section we present the basic analytical framework and discuss the dynamic behavior of prices. Throughout the paper we assume a closed economy, that output is exogenous and remains constant at the full employment level, and that economic agents have perfect foresight regarding the paths of prices, budget deficits, and the money supply. We postulate the Cagan demand for money function that can be written as

$$(M/P)^d = e^{-\alpha\mu} \tag{1}$$

where M represents the nominal money supply, P the price level, μ the expected rate of inflation and where α is a constant denoting the semielasticity of the demand for money with respect to the rate of inflation.

The government budget constraint can be written as

$$\dot{M} = P(g + rb) = Pd \tag{2}$$

where $\dot{M}$ denotes dM/dt, g is the primary deficit (i.e., total taxes minus expenditures net of interest payment), b is the real stock of government indexed debt and r is the real interest rate on this debt. Quantities g and r are exogenous to the model and are assumed to be fixed throughout the analysis. The total deficit, in real terms, is $d = g + rb$. Equation (2) implies that the deficit is financed entirely through money creation, and hence that the stock of bonds is also exogenously determined.

We define real money balances as $m \equiv M/P$. Differentiating them with respect to time yields

$$\dot{m} = \dot{M}/P - m\pi \tag{3}$$

where $\pi = \dot{P}/P$ (i.e., the actual rate of inflation).

There seems to be an increasing acceptance of the notion that markets fail to clear instantaneously; sticky prices and wages seem to be the rule rather than the exception (see for example Gordon [1981], Rotemberg [1982], and Parkin [1986]). In the absence of fully flexible prices, the goods and money markets could remain in disequilibrium for prolonged periods.

This view is incorporated in Cagan's seminal work by introducing partial (or

lagged) adjustment in the money market. In fact, a significant number of more recent empirical studies on the demand for money (e.g., Goldfeld [1973] and Aghevli and Khan [1977], among others) also utilize this type of adjustment mechanism.[3] One implication of this type of adjustment is that increases (reductions) in the nominal money supply would initially translate themselves into higher (lower) real money balances, hence leading to a temporary excess supply (demand) in the money market. This is in fact the approach that we follow in this paper.

Following these works, we assume that the market adjusts according to the following rule:

$$\frac{\dot{m}}{m} = \lambda[\ln(m^d) - \ln(m)] \qquad \lambda > 0 \tag{4}$$

where λ is a constant that denotes the speed of adjustment of the money market, and $\ln(m^d)$ and $\ln(m)$ are the logarithms of the demand and supply of real money balances. The adjustment process proposed in equation (4) describes the dynamics of inflation when the economy is in disequilibrium. Noting that $\dot{m}/m = \dot{M}/M - \pi$, we can rewrite (4) as

$$\pi = \dot{M}/M - \lambda\,(\ln(m^d) - \ln(m))\,. \tag{5}$$

This equation states that the rate of inflation will exceed the current rate of growth of the money supply whenever there is an excess supply of money. This is indeed a plausible adjustment mechanism because the existence of an excess supply in the money market, in this economy, implies an excess demand in the goods market. When these conditions prevail, inflation will accelerate with respect to its trend [given by $\dot{M}/M$ in equation (5)].

The dynamics of the economy can now be described in terms of a differential equation in real money balances. In order to obtain this equation we first solve for the log of the demand for money from equation (1) and for the rate of inflation from equation (3). We then substitute these two equations into (5) which yields the following differential equation:[4]

$$\dot{m} = \frac{-\lambda}{(1 - \lambda\alpha)}\,(\alpha d + m\ln(m))\,. \tag{6}$$

[3]One possible justification for this approach is based on the existence of fixed transactions costs similar to the ones presented in the Baumol-Tobin inventory model of the demand for money; in their presence individuals will in general adjust their portfolios at discrete intervals. More recently, Laidler (1984) derives a similar adjustment equation using a very different conceptual framework. His work starts from what is usually referred to as the "buffer stock approach" in the demand for money. Under this assumption the money market does not continuously clear and hence it can remain temporarily in disequilibrium.

[4]From (1) we readily obtain

$$\ln(m^d) = -\alpha\pi\,. \tag{1'}$$

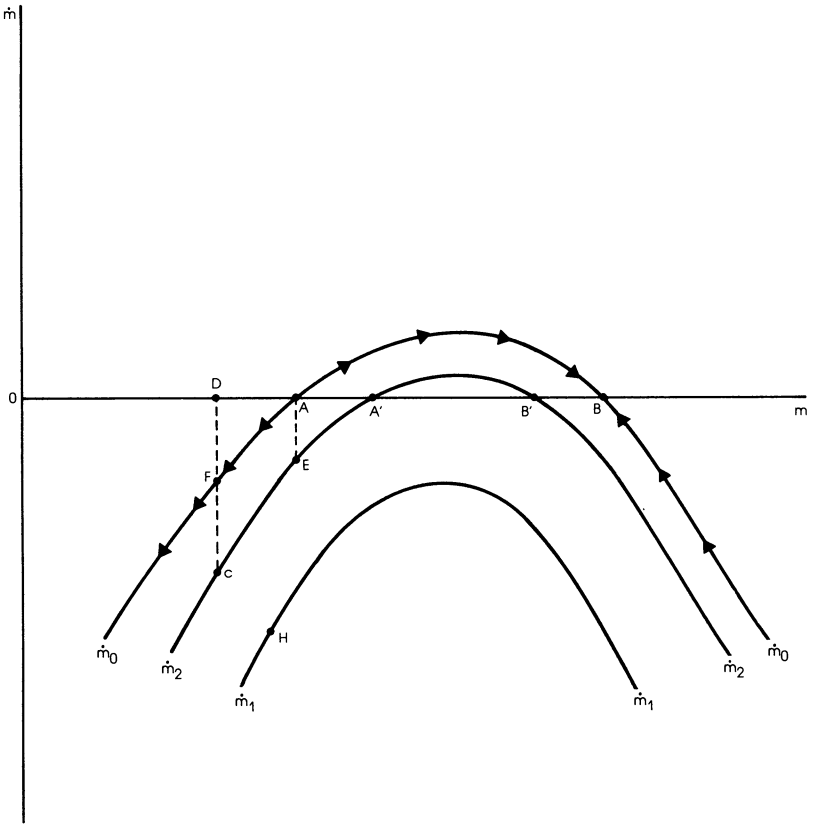

FIG. 1.

If we assume that the denominator is positive, then equation (6) corresponds to the $\dot{m}$ schedule shown in Figure 1 for a deficit d_0. As the value of λ increases, the system becomes closer to one with instantaneous adjustment. There are two stationary equilibria, one stable (point B) and one unstable (point A). Notice that the unstable trajectories to the left of point A will correspond to decreasing real money balances and increasing rates of inflation.[5]

Likewise from (2) and (3) we can solve for the rate of inflation so that

$$\pi = d/m - \dot{m}/m \,. \tag{3'}$$

Substituting (3') into (5) and solving for $\dot{m}/m$ yields (6).

[5]This equation is the same that one would obtain using adaptive expectations and continuously market clearing. This is not surprising, since Cagan (1956) obtained a similar result for the case where changes in the money supply are exogenous. The dynamic behavior of the economy will not be the same in both cases except for discrete changes in M at P_1 when it could differ. As will become apparent from the discussion at the end of this section, some stabilization strategies that the government can successfully implement when economic agents have rational expectations regarding the behavior of prices will fail under adaptive expectations. It is in this respect that our discussion differs from that of Cagan (1956).

Within this framework, we can now isolate situations in which the economy will experience accelerating inflation even when economic agents have perfect foresight. This will happen if the government increases the size of its budget deficit to a level such as d_1, for which there is no stationary value of the rate of inflation that can generate sufficient inflationary finance, the economy will experience an explosive path of prices. In terms of Figure 1, a larger deficit d_1 shifts down the $\dot{m}$ schedule to a level where it does not interact the horizontal axis (which in Figure 1 is shown by the $\dot{m}_1$ schedule). In the absence of a stationary equilibrium the system moves along an unstable trajectory. The dynamic adjustment of the money market generates a path characterized by decreasing real money balances and increasingly higher rates of inflation.[6] Large fiscal deficits can certainly become the source of hyperinflation.

The partial adjustment of the money market postulated in equation (4) plays a key role in explaining this result. The larger budget deficit increases the need for the only available financing resource, fiat money. Money is now expanded at a higher rate to finance the deficit creating a temporary excess supply in the money market. From equation (5) this leads to an increase in the rate of inflation. The new rate of inflation, which exceeds the rate of monetary growth, affects the money market equilibrium in two opposite directions. On one hand, it acts as a stabilizing force by reducing the supply of real money balances; on the other hand, it induces a reduction in the demand for money which tends to perpetuate the disequilibrium in the market. When the system does not have a stationary equilibrium, this last effect dominates the former and the resulting outcome is accelerating inflation. Along the unstable path, there is a continuous increase in inflation and in the rate of monetary growth.

Notice that along the unstable path the amount of seigniorage remains constant. From equations (2) and (3) we readily obtain

$$\dot{m} = d - \pi m \,. \tag{3'}$$

The first term on the right-hand side is seigniorage and the second is the inflation tax. Along the unstable path seigniorage remains constant while the revenue from the inflation tax is rising and real money balances keep falling as inflation accelerates. Seigniorage will equal the inflation tax only at the stationary equilibrium.

2. BUDGET DEFICITS, INFLATION, AND STABILIZATION

The present model introduces a plausible framework to examine hyperinflationary processes, and strategies for designing stabilization programs. It will also help us

[6]The unstable solution that we obtain in this exercise should be distinguished from the existing literature on speculative bubbles as developed by Obstfeld and Rogoff (1983) and Diba and Grossman (1986), among others. These papers do not rule out the possibility of inflationary bubbles, although such episodes are not *caused* by a fiscal imbalance. In addition, the dynamic systems analyzed in these models possess at least one stationary solution. On the other hand, in the present model unstable paths are generated by "large" fiscal deficits and correspond to cases in which there is no stationary solution for the rate of inflation.

to understand some of the existing puzzles in the relationship between budget deficits and inflation. To do so, we will further assume that prices are sticky and hence that real money balances are predetermined.

Stopping Hyperinflation

Fiscal adjustment is a prerequisite for stopping hyperinflation. The design of the stabilization strategy can be discussed with the help of Figure 1. Suppose the economy is initially at a point like H, moving along the unstable path $\dot{m}_1$ with accelerating inflation. The objective of the authorities is to move the economy to a stable stationary equilibrium such as A.[7] This will require a reduction in the deficit to d_0. However, this will not suffice to restore inflation stability since real money balances are below the steady state level (i.e., to the left of A); expansionary monetary policy is also needed. This can be achieved through an open market purchase of government bonds. Under rational expectations, the proper combination of fiscal and monetary policies will instantaneously stop hyperinflation.

In this specific example, as proposed in Dornbusch (1986), expansionary monetary policy supports the fiscal effort. Indeed, an open market purchase of government bonds reduces the interest payments and the value of the total deficit. The government can thus take advantage of the higher demand for money to reduce the deficit. In this case, the reduction in the primary deficit would be smaller than would otherwise need to be. The once-and-for-all increase in the demand for money that results from a successful stabilization effort contributes to a permanent reduction in the deficit.

The stabilization strategy just discussed is useful to explain the analytical implications of assuming partial adjustment in the money market and rational expectations vis-à-vis instantaneous adjustment in the money market and adaptive expectations. The reduced-form dynamic equations are similar in both cases. However, as just shown, when the right policy combination is followed, hyperinflation can be controlled instantaneously in the former case, while it will at best be reduced through a gradual process in the latter. The rigidity in expectations creates a strong barrier to rapid reductions in inflation.

Budget Deficits and Inflation Dynamics

A small increase in the budget deficit could lead to an unstable hyperinflationary process. Suppose that the economy is initially at a point like A in Figure 1, and there is a sudden increase in the budget deficit from d_0 to d_2 ($d_2 > d_0$) leading to a downward shift in the $\dot{m}_0$ schedule to $\dot{m}_2$. We consider this increase in the deficit small because the new schedule still intersects the horizontal axis (at points A′ and B′). Given the initial stock of real money balances (OA), the economy will now be at a point like E, moving along an unstable path. The rate of inflation will start to accelerate, real money balances will be falling, and the economy will eventually

[7] The authorities could also consider moving the economy to point B, the stable equilibrium. From the point of view of the discussion in this section, it is not crucial whether the authorities target A or B.

experience hyperinflation.

Once the economy starts to move along an unstable path, controlling inflation becomes a much more difficult exercise. Suppose that as in the previous example, the government, in an effort to achieve lower rates of inflation, later reduces the budget deficit to the original level d_0. In this case, however, the cutback is not sufficient to restore stability in the rate of inflation; at the prevailing higher rate of inflation, stabilization requires the use of even tighter fiscal policy. Assume that at the time when the deficit is reduced to its original level the economy is at a point like C, and the stock of real money balances at OD. Since point D lies to the left of A, the economy will remain along the unstable section of the $\dot{m}$ schedule in spite of the smaller budget deficit. Actually, for the government to achieve a permanently lower rate of inflation it would have to reduce the deficit further so that the stock of real money balances OD will lie within a stable path.

The above discussion provides useful insights regarding the role of tight fiscal policy in anti-inflation programs. First, it is apparent that small reductions in the deficit may not be sufficient to reduce permanently the rate of inflation. Second, it was also argued that there is not a one-to-one relation between deficits and inflation rates; while a given budget deficit might be associated with a stable rate of inflation under one set of initial conditions, it could also lead to an unstable path of prices under others. Finally, there is an interesting asymmetry emerging from this model. While small increases in the budget deficit can move the economy into unstable paths that can eventually result in large increases in inflation, stabilization of the rate of inflation (once the economy is moving along the unstable path) can require even larger contractions in the fiscal deficit. In particular, if the economy is in a sufficiently hyperinflationary state, the monetary authorities might find that the only feasible stabilizing alternative is the complete elimination of the use of inflationary finance.

3. FISCAL LAGS AND INFLATION

In the previous sections it was assumed that changes in the rate of inflation did not affect the size of the budget deficit. In most countries, though, this is not a plausible assumption given the timing of government revenues and outlays. As Olivera (1967) and Tanzi (1978) argued, while nominal government expenditure tends to move pari passu with inflation, the real value of government revenues falls during inflationary periods due to the existence of "collection" lags. Higher rates of inflation erode the real value of government revenues increasing the size of the budget deficit.

One simple way to introduce fiscal lags into the framework developed in the previous sections is to assume that

$$d = d(\pi) . \tag{7}$$

The potentially destabilizing effects of lags in government revenues is discussed in some detail in Aghevli and Khan (1977). As it is argued in that paper, instability

could arise when the government resorts to inflationary finance, simply because higher rates of inflation increase the financial needs of the government, and hence require increasing seigniorage. The increase in the money supply will reinforce the inflationary process, and can eventually result in a hyperinflationary situation.

The stability properties are similar to those of equation (6). The resulting dynamic equation is

$$\dot{m} = \frac{-\lambda}{[(1 - \lambda\alpha)]} (d(\pi) + (m)\ln(m)) . \tag{8}$$

We can still use the phase diagram presented in Figure 1 to illustrate this case. Notice, however, that due to the existence of the erosion in tax revenues points A and B are now associated with a lower rate of inflation than in the previous section. This implies that the economy can now enter an unstable path at rates of inflation that are lower than the ones that would lead to instability in equation (6).

Suppose that initially the deficit is d_2 and the economy is on the $\dot{m}_2$ schedule at an unstable point such as C. If the government does not take any policy measures, the economy will clearly experience increasingly higher rates of inflation. Suppose that instead the government reduces the basic fiscal deficit from d_2 to d_0, through lower government expenditure. The new path is shown by the $\dot{m}_0$ schedule. Given that real money balances are predetermined, the economy would move to a point such as F but it will continue to move along an unstable path. The reduction in the basic deficit will not avoid further increases in the rate of inflation; in fact, inflation will continue to rise. On the other hand, if the government imposes price controls, or finds other means to reduce initially the rate of inflation, for the same basic deficit the actual deficit will be smaller. In terms of Figure 1, it could move the economy to a point to the right of A, bringing the economy to a stable path and achieving the desired reduction in inflation. In this case price controls can be an effective tool during the early stages of an anti-inflationary policy. Interestingly enough, it might be possible to achieve a stable rate of inflation even without any changes in the basic budget deficit. If the fiscal lag is an important part of the financial requirements, then a *temporary* reduction in inflation might be sufficient to achieve a *permanently* lower rate of inflation.

LITERATURE CITED

Aghevli, Bijan, and Mohsin S. Khan. "Inflationary Finance and the Dynamics of Inflation: Indonesia, 1951–72." *American Economic Review* 67 (June 1977), 390–403.

Auernheimer, Leonardo. "The Effects of Inflationary Finance on Stability: A Theoretical Analysis." *Southern Economic Journal* 42 (September 1976), 502–507.

Bruno, Michael, and Stanley Fischer. "The Inflationary Process in Israel: Shocks and Accommodation." In *The Israeli Economy Maturing through Crisis,* edited by Y. Ben Peroth, pp. 347–71. Cambridge: Harvard University Press, 1986.

Buiter, Willem. "A Fiscal Theory of Hyperinflation: Some Surprising Monetarist Arithmetic." *Oxford Economic Papers* 39 (March 1987), 111–18.

Cagan, Phillip. "The Monetary Dynamics of Hyperinflation." In *Studies in the Quantity Theory of Money,* edited by Milton Friedman, pp. 25–117. Chicago: University of Chicago Press, 1956.

Carr, Jack, and Michael Darby. "The Role of Money Supply Shocks in the Short-Run Demand for Money." *Journal of Monetary Economics* 8 (September 1981), 183–99.

Diba, Behzad, and Herschel I. Grossman. "Rational Inflationary Bubbles." National Bureau of Economic Research Working Paper No. 2004, (August 1986), 1–8.

Dornbusch, Rudiger. "Tight Fiscal Policy and Easy Money: The Key to Stabilization." Mimeo, Massachusetts Institute of Technology, 1986.

Dornbusch, Rudiger, and Stanley Fischer. "Stopping Hyperinflations Past and Present." *Weltwirtschaftliches Archiv* 22 (February 1986), 1–14.

Evans, I. L., and G. K. Yarrow. "Some Implications of Alternative Expectations Hypotheses in the Monetary Analysis of Hyperinflation." *Oxford Economic Papers* 33 (March 1981), 61–80.

Goldfeld, Stephen. "The Demand for Money Revisited." *Brookings Papers on Economic Activity* 3 (1973), 577–638.

Gordon, Robert J. "Output Fluctuations and Gradual Price Adjustment." *Journal of Economic Literature* 19 (June 1981), 493–530.

Kiguel, Miguel A. "Deficit e Inflacion." *Revista de Desarrollo Economico* 26 (July–September 1986), 256–68.

Laidler, David E. W. "The Buffer Stock Notion in Monetary Economics." *Conference Papers,* Supplement to *Economic Journal* 94 (1984), 7–34.

_____. "Price Stickiness, Buffer-Stock Money, and Persistent Fluctuations in Output and Real Balances." Research Report No. 8809, University of Western Ontario, (May 1985), 1–24.

Obstfeld, Maurice, and Kenneth Rogoff. "Speculative Hyperinflations in Maximizing Models: Can We Rule Them Out?" *Journal of Political Economy* 91 (August 1983), 675–87.

Olivera, Julio. "Money, Prices and Fiscal Lags: A Note on the Dynamics of Inflation." *Banco Nazionale del Lavoro* 20 (September 1967), 258–67.

Parkin, Michael. "The Output Inflation Trade-off When Prices Are Costly to Change." *Journal of Political Economy* 94 (November 1986), 200–224.

Rotemberg, Julio. "Sticky Prices in the United States." *Journal of Political Economy* 90 (December 1982), 1187–1211.

Sachs, Jeffrey. "The Bolivian Hyperinflation and Stabilization." *American Economic Review Papers and Proceedings* 77 (May 1987), 279–83.

Sargent, Thomas J. "The End of Four Big Inflations." In *Inflation, Causes and Effects,* edited by Robert Hall, pp. 41–97. Chicago: University of Chicago Press.

Sargent, Thomas J., and Neil Wallace. "Rational Expectations and the Dynamics of Hyperinflation." *International Economic Review* 14 (June 1973), 328–50.

Tanzi, Vito. "Inflation, Real Tax Revenue, and the Case of Inflationary Finance: Theory with an Application to Argentina." *International Monetary Fund Staff Papers* 25 (September 1978), 417–51.

Webb, Steven B. "Fiscal News and Inflationary Expectations in Germany after World War I." *Journal of Economic History* 46 (September 1986), 769–94.

Yeager, Leland B. *Experiences with Stopping Inflation.* Washington: American Enterprise Institute, 1981.