Chapter 18

Fiscal and Monetary Policy

In Chapter 14 we described how the government changes its outstanding debt over time so as to match its revenues and expenditures. In that framework, there was nothing intrinsically harmful about government debt. Now we turn our attention to the inflationary effects of persistent government budget deficits. This will give us a theory about the interplay between fiscal and monetary policies.

Imagine a government comprised of two competing authorities: a fiscal authority (in the U.S., the Congress and the President) and a monetary authority (in the U.S., the Federal Reserve System). The fiscal authority wants to finance government spending, while the monetary authority wants to keep inflation low. But inflation produces revenue for the government through a process known as *seigniorage.* If the monetary authority is dominant, it simply announces a sequence of inflation rates, which in turn implies a sequence of seigniorage revenues, and the fiscal authority takes this as given when making spending decisions. Completely dominant central banks are, however, extremely rare. Even the U.S. Federal Reserve System is statutorily a creature of the Congress and the Executive, and must, by law, balance the twin goals of fighting inflation and targeting full employment.

The case of a central bank (i.e., a monetary authority) that is not fully dominant is much more interesting. Note that this does not mean that the fiscal authority controls the money supply absolutely, merely that the fiscal authority does not have to credibly commit to a sequence of taxes sufficient to finance, in present value, its spending. In particular, we are going to assume that there is some limit on the debt-to-GDP ratio. That is, investors will only accept government debt up to some ceiling, defined in proportion to output. The monetary authority will control the money supply until this ceiling is reached, and thereafter it will fully accommodate government spending with seignorage revenue. This is the fashion in which government deficits are inflationary.

After presenting the theory, we will discuss the evidence. In a study of post-WWI hyperinflations in Germany, Austria, Hungary and Poland titled "The Ends of Four Big Inflations", Thomas Sargent illustrates this effect clearly. More recent monetary disturbances in some the successor states of the old Soviet empire can also be traced to persistent government budget deficits. This will provide us with a practical guide on how to end hyperinflations.

18.1 Are Government Budget Deficits Inflationary?

The model for this section is taken from a paper by Thomas Sargent and Neil Wallace, "Some Unpleasant Monetarist Arithmetic". The interested reader is advised to read the original paper, since it doesn't require very much math and is, despite the title, actually quite pleasant.

Government Budget Constraint

We will consider the problem of a government which must cover a sequence of real core deficits $\{D_t\}_{t=0}^{\infty}$:

$$D_t = G_t - \mathcal{T}_t, \text{ for all } t = 0, 1, \ldots, \infty,$$

where G_t is the real value of government expenditures and $\mathcal{T}_t$ is the real value of government revenues in period t. Notice that interest payments on the debt are not included in D_t (see Chapter 14 for more on the government budget constraint).

The government has some amount B^g_{t-1} of real debt outstanding at the beginning of each period t. The government must pay its creditors a real amount $(1+r)B^g_{t-1}$ in period t. Hence the total real excess spending of the government on goods and services and debt service, net of tax revenue, is:

$$\text{borrowing demand} = D_t + (1+r)B^g_{t-1}.$$

The government will finance this in two ways: (1) By issuing more bonds, dated end-of-period t (call these bonds B^g_t) and (2) By printing money and realizing the *seigniorage* revenue (more on what that is in a second). Hence government borrowing is:

$$\text{borrowing supply} = B^g_t + \frac{M_t - M_{t-1}}{P_t}.$$

Here M_t is the end-of-period quantity of pieces of paper with the words "Federal Reserve Note" and "In God We Trust" printed on them, also known as fiat currency. Take M_t to be strictly high-powered money, or the monetary base, which is under the control of the government.

For the government's books to balance it must borrow as much as it needs to, so:

$$D_t + (1+r)B^g_{t-1} = B^g_t + \frac{M_t - M_{t-1}}{P_t}, \text{ for all } t = 0, 1, \ldots, \infty. \tag{18.1}$$

Another way to write this is:

$$D_t + rB^g_{t-1} = (B^g_t - B^g_{t-1}) + \frac{M_t - M_{t-1}}{P_t}, \text{ for all } t = 0, 1, \ldots, \infty.$$

This form says that the government's real deficit plus the interest on the debt may be paid for by net new bonds ($B^g_t - B^g_{t-1}$) or seigniorage.

Seigniorage

The government has a monopoly on issuing pieces of paper with the words "Federal Reserve Note" written them. People want this stuff for transactions purposes, so they hold it even though it pays zero interest. As a result, the government can print more of the stuff and trade it for goods and services. We will not model the precise way in which the government does this. The effectiveness of this practice depends on how the general price level P_t responds to an increase in M_t.

Although seigniorage revenue in developed countries like the United States is currently very low, developing countries or countries in turmoil use it heavily. Internal bond markets and tax collection systems are often the first instruments of state power to vanish in turbulent times. Governments also often find direct taxation to be unpalatable for domestic political reasons, but are unable to sell bonds on international markets.

Consider the case of Zaire, an African country which is now called the Democratic Republic of the Congo. This government practiced a very bald form of seigniorage in which it would introduce a new denomination of the currency (the zaire), print up a bunch of notes and pack some of the print run into suitcases which were then distributed among government ministers. These ministers would then use the notes to purchase foreign currency on the black market as well as domestic goods and services. In the waning days of the rule of former president Mobuto Sese Seko, the government introduced the 500 zaire note and the 1000 zaire note. These were used, in part, to finance the president's cancer treatments in France. The population derisively termed the notes "prostates" and refused to accept them as payment in any transaction. The government's seigniorage revenue fell to zero and it succumbed to the rebels shortly thereafter.

More formally, the value of the seigniorage revenue in our model is the real value of net new notes:

$$\text{seigniorage} = \frac{M_t - M_{t-1}}{P_t}.$$

Notice that we will have to take a stand on how P_t varies with M_t to fully determine the seigniorage revenue.

Model Assumptions

To make this model work, we will have to specify a rule for output, population growth, how the price level is determined and what limits there are on borrowing. I list all of the model's assumptions here for convenience:

1. Output per capita y_t is constant and $y_t = 1$, but population N_t grows at the constant rate n, so $N_t = (1+n)N_{t-1}$, where $N_0 > 0$ is given. So total GDP each period $Y_t = y_t N_t$ is just equal to population.
2. The real interest rate on government debt is constant at $r_t = r$, and the government never defaults on its debt. This includes default by unexpected inflation when bonds are denominated in dollars. Thus we are dealing with inflation-indexed bonds. We also make the very important assumption that $r > n$. Without this assumption, most of the "arithmetic" is not so "unpleasant".
3. A stark monetarist Quantity Theory of Money relation with a constant velocity, $v = 1$:

   (18.2) $$P_t Y_t = v M_t.$$

   Combine this with the definition of Y_t in Assumption (1) above to find the price level in period t, P_t, is:

   $$P_t = \frac{M_t}{N_t}.$$

4. There is an upper bound on per-capita bond holdings by the public of $\bar{b}$. That is, $B_t^g/N_t \leq \bar{b}$.

In addition, to make life easier, we will specify that the government's fiscal policy, which is a sequence of deficits $\{D_t\}_{t=0}^{\infty}$, is simply a constant per-capita deficit of d. Thus:

$$\frac{D_t}{N_t} = d, \text{ for all } t = 0, 1, \ldots, \infty.$$

Define b_t^g to be the level of per-capita bond-holdings $b_t^g \equiv B_t^g/N_t$. Assumption 4 states that $b_t^g \leq \bar{b}$ for some $\bar{b}$. Notice that with the assumption that the constant per-capita output level is $y_t = 1$, b_t^g is also the *debt-to-GDP ratio.* Also, D_t/N_t becomes the *deficit-to-GDP ratio.*

Monetary Policy

The monetary authority (in the U.S., the Fed) produces a sequence of money stocks $\{M_t\}_{t=0}^{\infty}$. These then feed through the quantity theory of money relation (18.2) to produce a sequence of inflation rates. A *monetary policy* will be a choice for the growth rate of money. If the stock of debt is growing, eventually the bond ceiling will be reached and the Fed will no longer be able to pick an inflation rate, it will be forced to provide enough seigniorage revenue to cover the government's reported deficit. We call this the *catastrophe.* The catastrophe happens at date T. The catastrophe date T is itself as a function of choice made by the government.

Given money supply growth, the gross inflation rate in period t is:

$$\frac{P_t}{P_{t-1}} = \frac{M_t}{N_t}\frac{N_{t-1}}{M_{t-1}} = \frac{1}{1+n}\frac{M_t}{M_{t-1}}.$$

The net inflation rate is defined as $P_t/P_{t-1} - 1$. For simplicity, assume (with Sargent and Wallace) that the Fed picks a constant growth rate for money, θ, in the periods before the catastrophe. Thus:

$$\frac{M_t}{M_{t-1}} = 1+\theta, \text{ for all } t = 0, 1, \ldots, T.$$

This implies that inflation is:

$$\frac{P_t}{P_{t-1}} = \frac{1+\theta}{1+n}, \text{ for all } t = 0, 1, \ldots, T.$$

For $\theta > n$, the net inflation rate will be strictly positive. If the Fed dislikes inflation, it will seek to minimize the growth rate of money M_t/M_{t-1} by picking a low θ. Such a policy will decrease seigniorage revenue in the short run (until period T), forcing the fiscal authority to rely more on bond finance of deficits, bringing closer the catastrophe date T at which $b^g_T = \bar{b}$ and no more bonds may be sold. From period T on, the money supply expands to produce enough revenue to satisfy the government budget constraint.

Analysis

Our goal is to determine the time path of per-capita bond holdings b^g_t and to determine when (if ever) the limit of $\bar{b}$ is reached. Table (18.1) lists all of the variables and their meanings. In addition, let's list again all of the equations we know about this model:

(Gov. Budget Constraint) $$D_t = B^g_t - (1+r)B^g_{t-1} + \left(\frac{M_t - M_{t-1}}{P_t}\right).$$

(Fiscal Policy Rule) $$D_t/N_t = d, \text{ for all } t = 0, 1, \ldots, \infty.$$

(Monetary Policy Rule) $$M_t = (1+\theta)M_{t-1}, \ t = 0, 1, \ldots, T.$$

(Population Growth Rate) $$N_t = (1+n)N_{t-1}.$$

(Quantity Theory of Money) $$P_t = M_t/N_t.$$

Begin by dividing the government budget constraint (18.1) by N_t on both sides to produce:

$$\frac{D_t}{N_t} = \frac{B_t^g}{N_t} - (1+r)\frac{B_{t-1}^g}{N_t} + \frac{1}{N_t}\frac{M_t - M_{t-1}}{P_t}, \text{ for all } t = 0, 1, \ldots, \infty.$$

Now, we use the fact that $1/P_t = N_t/M_t$ to write this as:

$$\begin{aligned} d &= b_t^g - (1+r)\frac{B_{t-1}^g}{N_{t-1}}\frac{N_{t-1}}{N_t} + \frac{1}{N_t}(M_t - M_{t-1})\frac{N_t}{M_t} \\ &= b_t^g - \frac{1+r}{1+n}b_{t-1}^g + \frac{M_t - M_{t-1}}{M_t} \\ &= b_t^g - \frac{1+r}{1+n}b_{t-1}^g + \left(1 - \frac{M_{t-1}}{M_t}\right), \text{ for all } t = 0, 1, \ldots, \infty. \end{aligned}$$

Solving for b_t^g yields:

$$b_t^g = \frac{1+r}{1+n}b_{t-1}^g + d - \left(1 - \frac{M_{t-1}}{M_t}\right), \text{ for all } t = 0, 1, \ldots, \infty. \tag{18.3}$$

Notice that the evolution of per-capita borrowing b_t^g determined in equation (18.3) holds in all periods, including those after the catastrophe period T. Before period T the monetary policy specifies a growth rate of money, $M_t/M_{t-1} = 1 + \theta$, so seigniorage is constant and potentially low. The remaining borrowing is done by issuing bonds. After the catastrophe date T, monetary policy must produce enough seigniorage revenue to completely meet the government's borrowing needs, and per-capita bonds are constant at $b_T^g = b_{T+1}^g = \cdots = \bar{b}$.

After the catastrophe the evolution of the money supply is determined by the post catastrophe government budget constraint, so we replace b_t^g with $\bar{b}$:

$$\bar{b} = \frac{1+r}{1+n}\bar{b} + d - \left(1 - \frac{M_{t-1}}{M_t}\right), \text{ for all } t \geq T+1.$$

We manipulate this equation to solve for the growth rate of money:

$$\frac{M_t}{M_{t-1}} = \frac{1}{1 - d - \left(\frac{r-n}{1+n}\right)\bar{b}}, \text{ for all } t \geq T+1. \tag{18.4}$$

Notice that after period T, money supply growth is increasing in the terms d and $\bar{b}$. Not only does the Fed have to pay for the deficit d entirely out of seigniorage, it also has to pay the carrying costs on the public debt $\bar{b}$.

Thus the money stock must evolve as:

$$\frac{M_t}{M_{t-1}} = \begin{cases} 1+\theta, & t = 1, \ldots, T \\ \left\{1 - d - \bar{b}\left(\frac{1+r}{1+n} - 1\right)\right\}^{-1}, & t = T+1, T+2, \ldots, \infty. \end{cases} \tag{18.5}$$

Equation (18.5) gives us the evolution of the money supply in all periods, including those after the catastrophe. Notice that the money supply growth rate after T is not affected by the value of T. In other words, after the catastrophe hits, the inflation rate will be the same, no matter when it hit.

How much seigniorage revenue does the government raise, given θ, each period prior to the catastrophe? That is, what happens when we substitute in the Fed's monetary policy into equation (18.3)? From equation (18.3):

$$b_t^g = \frac{1+r}{1+n} b_{t-1}^g + d - \left(1 - \frac{M_{t-1}}{M_t}\right), \text{ for all } t = 1, 2, \ldots, \infty.$$

But in the periods before the catastrophe, money growth is simply θ, so:

$$b_t^g = \frac{1+r}{1+n} b_{t-1}^g + d - \left(1 - \frac{1}{1+\theta}\right) = \frac{1+r}{1+n} b_{t-1}^g + d - \frac{\theta}{1+\theta}, \text{ for all: } t = 1, 2, \ldots, T. \tag{18.6}$$

Notice this interesting result: Before period T, the government takes as seigniorage a fraction $\theta/(1+\theta)$ of GDP. Any remaining portion of the per-capita deficit d must be raised by net new bonds.

Finally, let's calculate b_t^g without reference to b_{t-1}^g. We can do this with recursive substitution from equation (18.6), using the assumption that $b_0^g = 0$:

$$\begin{aligned}
b_1^g &= \frac{1+r}{1+n} b_0^g + d - \frac{\theta}{1+\theta} = d - \frac{\theta}{1+\theta}. \\
b_2^g &= \frac{1+r}{1+n} b_1^g + \left(d - \frac{\theta}{1+\theta}\right) = \left(1 + \frac{1+r}{1+n}\right)\left(d - \frac{\theta}{1+\theta}\right). \\
b_3^g &= \frac{1+r}{1+n} b_2^g + \left(d - \frac{\theta}{1+\theta}\right) = \left[1 + \frac{1+r}{1+n} + \left(\frac{1+r}{1+n}\right)^2\right]\left(d - \frac{\theta}{1+\theta}\right).
\end{aligned}$$

And so on. The pattern should be clear from these first terms. In general:

$$b_t^g = \left[d - \frac{\theta}{1+\theta}\right] \sum_{i=1}^{t} \left(\frac{1+r}{1+n}\right)^{i-1}, \text{ for all } t = 0, \ldots, T. \tag{18.7}$$

Recall that $r > n$, hence the summation term is explosive.

Equation (18.7) neatly captures the Fed's dilemma in this model. By setting a low value for θ, the Fed trades low inflation today for an earlier onset of the hyperinflationary catastrophe. On the other hand, by choosing a relatively high value for θ the Fed suffers high inflation today but staves off the catastrophe point. Indeed, if:

$$\frac{\theta}{1+\theta} \geq d,$$

then there will be no catastrophe.

Determining The Catastrophe Date T

Given the time path for debt in equation (18.7), we can determine roughly in which period T the catastrophe hits. I say "roughly" because to keep the algebra neat we are going to assume that, at the monetary policy θ, end-of-period T debt b_T^g is perfectly equal to $\bar{b}$. You can see that it is easy to imagine cases in which b_T^g is slightly less than $\bar{b}$, in which case in period $T+1$ a residual amount of borrowing is allowed. However if T is large, this effect is unimportant. Thus at the end of period T:

$$\left[d - \frac{\theta}{1+\theta}\right] \sum_{i=1}^{T} \left(\frac{1+r}{1+n}\right)^{i-1} = \bar{b}.$$

For notational convenience, let $\gamma \equiv (1+r)/(1+n)$. Thus:

$$\sum_{j=0}^{T-1} \gamma^j = \frac{\bar{b}}{d - \frac{\theta}{1+\theta}}.$$

Recall that the sum on the left hand side of this equation is equal to $(1-\gamma^T)/(1-\gamma)$. Thus:

$$\frac{1-\gamma^T}{1-\gamma} = \frac{\bar{b}}{d - \frac{\theta}{1+\theta}} \equiv J,$$

where I have introduced J to keep the notation down. Manipulation produces:

$$\gamma^T = 1 - (1-\gamma)J.$$

Taking logarithms of both sides produces:

$$\begin{aligned} T\ln(\gamma) &= \ln\left(1-(1-\gamma)J\right), \text{ so:} \\ T(\theta,\bar{b}) &= \frac{\ln\left(1-(1-\gamma)J\right)}{\ln(\gamma)}, \text{ where:} \\ \gamma &= \frac{1+r}{1+n}, \text{ and:} \\ J &= \frac{\bar{b}}{d - \frac{\theta}{1+\theta}}. \end{aligned} \tag{18.8}$$

Notice that T is increasing in θ and $\bar{b}$. Indeed, for T to be finite, we must have:

$$\frac{\theta}{1+\theta} < d,$$

so that the government must resort to bond financing.

Some Examples

In Figure (18.1) we present the time path of debt, b_t^g, under two different values of θ, $\theta_1 = 0.03$ and $\theta_2 = 0.10$. In this model $n = 0.02, r = 0.05, d = 0.10$ and $\bar{b} = 1.5$. That is, the government is trying to finance a persistent core deficit of 10% of GDP and the maximum value of total debt is 150% of GDP. The government does not have to pay a very high real interest rate on its debt, but output is growing at the relatively low rate of 2% a year. With the tight monetary policy ($\theta_1 = 0.03$), the government hits the catastrophe 16 years into the policy, while with the loose monetary policy ($\theta_2 = 0.10$), the catastrophe occurs 61 years in the future.

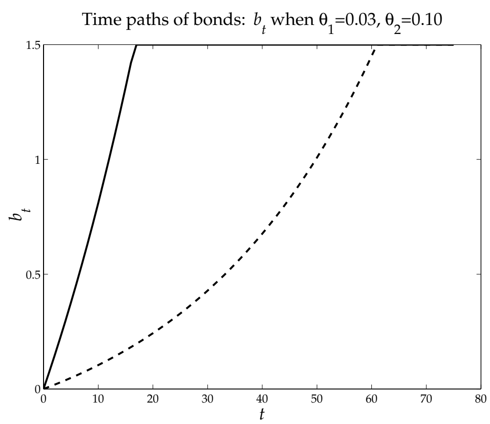

Figure 18.1: Evolution of the stock of per-capita debt holdings b_t under two monetary policies: the solid line under the tight money ($\theta = 0.03$) policy and the dotted line under the loose money ($\theta = 0.10$) policy.

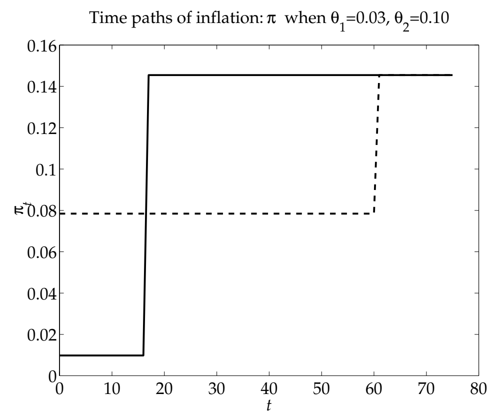

Figure 18.2: Evolution of the inflation rate π_t under two monetary policies: the solid line under the tight money ($\theta = 0.03$) policy and the dotted line under the loose money ($\theta = 0.10$) policy.

In Figure (18.2) we plot the inflation rates over time associated with the two monetary policies. Notice that the inflation rate π_t does not quite equal the growth rate of money since:

$$1 + \pi_t \equiv \frac{P_t}{P_{t-1}} = \frac{1}{1+n}\frac{M_t}{M_{t-1}}.$$

Before the catastrophe date T, inflation is constant at π_θ where:

$$1 + \pi_\theta = \frac{1+\theta}{1+n}, \text{ for all } t = 0, 1, \dots, T., \text{ so:}$$
$$\pi_\theta = \frac{1+\theta}{1+n} - 1 = \frac{\theta - n}{1+n}.$$

Note that π_θ will not vary with the deficit d or the maximum debt load $\bar{b}$. On the other hand, the catastrophe date T and the post-catastrophe inflation rate will vary with d and $\bar{b}$. After the catastrophe, inflation $\pi_T(d, \bar{b})$ will not vary with the pre-catastrophe monetary policy θ. We can calculate $\pi_T(d, \bar{b})$ from the evolution of the money supply, equation (18.5). Thus:

$$1 + \pi_T(d, \bar{b}) = \frac{1}{1+n} \frac{1}{1 - d - \bar{b}\left(\frac{1+r}{1+n} - 1\right)}, \text{ so:}$$

(18.9)
$$\pi_T(d, \bar{b}) = \frac{1}{1+n} \frac{1}{1 - d - \bar{b}\left(\frac{1+r}{1+n} - 1\right)} - 1 = \frac{r\bar{b} + d - n(\bar{b} + 1 - d)}{(1-d)(1+n) - \bar{b}(r-n)}.$$

The tight monetary policy is associated with very low inflation initially, $\pi_{\theta_1} = 0.0098$ but, as noted above, the catastrophe happens relatively early. The loose monetary policy is associated with a relatively high inflation rate initially, $\pi_{\theta_2} = 0.0784$ but the catastrophe is staved off for over 60 years. After the catastrophe the inflation rate is $\pi_T = 0.1455$, or about twice the rate with the loose monetary policy.

Application: Optimal Inflationary Policies

In this section we consider the trade-off between two monetary policies: (1) A policy of high inflation in which the catastrophe never occurs and (2) A low-inflation policy which brings forward the catastrophe date.

Notice from equation (18.7) that if the government sets $\theta = \theta^\star$, where:

$$\theta^\star \equiv \frac{d}{1-d},$$

then each period's seigniorage revenue is:

$$\frac{\theta^\star}{1+\theta^\star} = d.$$

That is, with the money supply growth rule set to $\theta^\star$ as defined above, the government raises enough seigniorage revenue to completely finance the real deficit each period. As a result the government never resorts to bond finance, so $b_t^g = 0$ all $t = 0, 1, 2, \ldots, \infty$ and the catastrophe never happens. When $\theta = \theta^\star$ inflation satisfies:

$$\pi_{\theta^\star} = \frac{\theta^\star - n}{1+n} = \frac{\alpha}{1-\alpha},$$

where $\alpha = d - n + nd$. Notice that if $d = n/(1+n)$ then $\pi_{\theta^\star} = 0$. That is, the government can pay for the real deficit entirely with seigniorage revenue and have zero inflation.

On the other hand, for any monetary policy $\theta < \theta^\star$, the government must resort to persistent debt financing and eventually face the catastrophe. We know from equation (18.9) above that after the catastrophe, inflation is $\pi_T(d, \bar{b})$. By examination, we see that:

$$\pi_T(d, \bar{b}) > \pi_{\theta^\star}.$$

Intuitively, by waiting until period T to begin financing excess government spending by printing money the monetary authority has allowed the fiscal authority to borrow up to its limit. The Fed then has to repay creditors out of seigniorage as well.

If the Fed dislikes inflation, it has an unpleasant choice: suffer inflation of $\pi_{\theta^\star}$ now or π_T at some future date T. As you can see, the Fed's choice of which policy to pursue depends in large part on how T varies with θ.

Variable	Definition
G_t	Real government spending at t
T_t	Real government tax revenues at t
D_t	Real government core deficit at t
Y_t	GDP at t, $Y_t = N_t$
N_t	Population at t
n	Constant population growth rate
r	Constant real net return on debt, $r > n$
M_t	end-of-period stock of money at t
P_t	exchange rate of money for goods at t
B^g_t	real par value of outstanding end-of-period debt
b^g_t	per-capita debt, $b^g_t = B^g_t / N_t$
$\bar{b}$	maximum possible value of b^g_t
B^g_{-1}	initial stock of debt $B^g_{-1} = 0$
T	"catastrophe date"–when $b^g_T = \bar{b}$
θ	Money supply growth rate before catastrophe
d	constant per-capita deficit (fiscal policy)

Table 18.1: Notation for Chapter 18. Note that, with the assumption that $Y_t = N_t$, variables denoted as per-capita are also expressed as fractions of GDP.

18.2 The Ends of Four Big Inflations

The most dramatic evidence of the validity of the Sargent-Wallace argument comes from the post-WWI hyperinflations in Germany and the successor states to the Austro-Hungarian Empire in a paper by Sargent, "The Ends of Four Big Inflations". What makes that case so special is that, not only was there a deficit-driven hyperinflation, once the fiscal authorities had made credible commitments to back all government debt by tax revenues, the inflation stopped (even though the printing presses were still running). These histories are valuable also because the problems facing the four nations in question bear much in common with those facing some of the successor states of the old Soviet empire.

The post-war central European inflations of 1919-1924 were a new, and deeply unpleasant, experience for its citizens. It is a commonplace to ascribe modern Germany's strong commitment to low inflation to a national horror of repeating those days. Yet it was not the abstract experience of seeing prices (and wages) climb to 10^{12} times their pre-war level that was so traumatic, nor was it the mild "shoeleather cost" studied in Chapters 4 and 8. As a result of the inflation, there were tremendous social dislocations as creditors were impoverished, as enterprises failed, as speculation flourished and as households hoarded illiquid assets rather than trading them for a currency whose value was essentially unknown. These were new phenomena at the time, but unfortunately since then they have been consistent hallmarks of monetary crises to the present day.

Sargent identifies four characteristics common to the hyperinflationary experiences in Poland, Hungary, Austria and Germany:

1. All four countries ran very large budget deficits.
2. All four countries took very similar, very dramatic, monetary and fiscal steps to end the hyperinflations.
3. In all cases, the inflation stopped very quickly.
4. After the inflationary episodes, there was a large and persistent rise in the level of "high-powered" money.

Governments ran deficits because, in the aftermath of the war, they made payments to the large numbers of unemployed workers, because state monopolies (such as railroads) kept prices artificially low and lost money, because governments subsidized basic necessities such as food and housing, and, in certain cases, because they had been ordered to pay war reparations of unknown amounts.

Sargent draws a clear distinction between government *actions* and government *regimes.* An action takes the form of a one-period decision of the government (cutting the subsidy on heating oil for one month, for example), with no credible assurance that the action will be repeated. In contrast a regime is a credible commitment to a sequence of actions, for example selling off the state railroad or making the central bank independent.

The solution to the hyperinflations, in all cases, was a switch in regime: governments abandoned deficits and seigniorage financing in favor of balanced budgets and independent central banks. In many cases, at least part of the credibility of the new regimes derived from international obligations. For example, in August of 1922 Austria signed agreements with the League of Nations binding her to fiscal balance and monetary stability.

In Germany, where the inflation was most dramatic, the largest single fiscal liability was the bill for war reparations. In the original treaty negotiations at Versailles, the Great Powers had been unable to fix a firm value on Germany's war reparations. In theory all of Germany was mortgaged for reparations, and indeed, in 1923 France occupied the Ruhr to drive home this point. In October of that year Germany issued a new currency, the rentenmark, whose initial value was 10^{12} reichsmarks.

Yet in 1924 the catastrophic German inflation stopped. Sargent reports several deliberate, permanent actions that constituted a regime shift. Among these, the government fired 25% of its workforce and cut employment in the state railroad system by about 180,000. Germany also negotiated a fixed, reasonable, value for its reparations bill with the treaty powers.

In all of these inflations, at some point the central banks were called upon to purchase almost all of the net new national debt issues. A common reform was to prohibit the central bank from purchasing government debt. This was a statutory commitment to fiscal discipline, and a good example of the difference between regimes and actions.

Once households were assured that the hyperinflationary regime was over, their holdings of currency rebounded remarkably. Thus even after the inflations had ended, governments continued to issue large quantities of new base money. This money was absorbed by households which had economized dramatically on their currency holdings during the hyperinflation.

The parallel to present-day countries such as Ukraine and Russia is clear. These too are new states without a history to guide investors, with bloated public sectors and inefficient systems of tax collection. In contrast with the earlier examples, they are committed, as much as possible, to fiscal discipline, although in some cases this required defaulting on some of the government's obligations (for example, Russian government employees must often wait months for paychecks). International organizations such as the IMF and foreign governments, just as in the 1920s, have acted as commitment devices to prevent the Russian government from using the printing press to meet its obligations. However, until either government spending obligations diminish or tax collections increase, there will be a persistent possibility of hyperinflation, with its attendant social dislocations.

Exercises

Exercise 18.1 (Easy)
The answers to these exercises can be found in Friedman and Schwartz (1963) *A Monetary History of the United States*, Chapter 7, entitled, "The Great Contraction"; the Barro textbook Chapters 4 and 18 but especially Chapters 7, 8, and 17; the article by Richard D. Porter, "The Location of U.S. Currency: How Much is Abroad?"; and Sargent *Rational Expectations and Inflation* (either the 1st or 2nd edition), Chapter 3, entitled "The Ends of Four Big Inflations",

and Chapter 5, entitled, "Some Unpleasant Monetarist Arithmetic".

1. What was the path of the money stock in the U.S. from January 1929 to March 1933? How did household's holdings of currency change over the same period?
2. What was the path of real income in the U.S. from January 1929 to March 1933? How did prices change over the same period?
3. In the period 1948-1991 have American real interest rates ever been negative? In the same period, has the U.S. inflation rate ever been negative? If so, when?
4. What is the evidence that inflation, in Milton Friedman's words, "is always and everywhere a monetary phenomenon"? In the long run? In the short run?
5. If you take the population of the U.S. to be 260 millions, roughly how many dollars of *currency* were in circulation for every U.S. citizen at the end of 1995? How much currency are you carrying right now? How do you account for this discrepancy?
6. Why do people hold currency and keep part of their wealth in low interest bearing accounts (like the Hyde Park Bank's zero interest checking account)?
7. Explain how a rational expectations view of agent's behavior (as defined by Sargent) can explain why inflation *seems* to have momentum, while in fact it does not.
8. What is *seignorage*? How much money did the U.S. raise via seignorage in 1991?
9. What is the Quantity Theory of Money? Explain the sense in which it is "just" an accounting identity.
10. What is a gold standard? True or false: Under a gold standard the quantity of money is fixed.

Exercise 18.2 (Easy)
Evaluate this statement: Government austerity programs cause civil unrest.

Exercise 18.3 (Moderate)
In each period t the government raises real tax revenue of T_t and spends (in real terms) G_t. Let $D_t \equiv G_t - T_t$ be the *real deficit* at time t. At the suggestion of a revered elder whose initials are M.F., the government is allowed to finance this deficit only by issuing fiat currency and obtaining the seignorage revenue. The government's budget constraint is thus:

$$D_t = \frac{M_t - M_{t-1}}{P_t},$$

where D_t is the real government deficit at t, M_t is the stock of money at t and P_t is the price level at t. Prices are related to the money supply by the Quantity Theory of Money relation with a constant velocity $v = 1$:

$$P_t Y_t = M_t.$$

Output Y_t satisfies $Y_t = N_t$, where N_t is population at t, and evolves according to:

$$N_t = (1 + n)N_{t-1},$$

with $N_0 = 1$. The government runs a constant per capita real deficit of d, so $D_t = dN_t$ for all t. Answer the following questions:

1. How must M_t evolve given M_{t-1} and d?
2. For what value of d is the inflation rate zero? That is, for what value of d will $P_t = P_{t-1}$?
3. A reasonable estimate for n is about 0.03. At this value, how large a deficit, expressed as a fraction of GDP, can the government cover by printing money and still not cause inflation?
4. Assume $d = 0$. What happens to prices?

Exercise 18.4 (Fun)
Through a map-making error in 1992 the Absolutely Autonomous People's Republic of Kolyastan (hereafter known as Kolyastan) was created out of the more rubbishy bits of neighboring successor states to the Soviet Union. The Kolyastani central bank is run part-time by a popular local weatherman on the state-run television station. The market for Kolyastan's chief export, really really big statues of Lenin, seems to have collapsed. Most of its citizens continue to work in the enormous state-run Lenin Memorial Lenin Memorial factory, which is currently producing no revenue at all. The government subsidizes consumption of bread and *kirghiz light* (the local liquor) by paying merchants to keep their prices artificially low. The Kolyastani currency, the neoruble, is made up of old Soviet rubles with the top left corner cut off. Inflation is currently running at 400% per month. Although the Kolyastani government claims to be financing most of its big budget deficits through bond sales, most of these bond sales, it turns out, are to the central bank. In desperation the Kolyastani government have turned to you, a University of Chicago undergraduate, for economic advice. Briefly outline your plan for Kolyastan's recovery. Be specific. How can the Kolyastani people be certain that the reforms proposed by the government will be maintained after you graduate?