V Money, Inflation and Monetary Policy (Continued)

3 Dynamic Inconsistency of Monetary Policy (Kydland and Prescott, 1977)

Money growth is the key determinant of inflation. Question: What causes high money growth (especially in those countries where the governments do not rely on money creation to raise revenue)? Although there is no trade-off between output and inflation in the long run, policymakers may pursue expansionary policies to push output temporarily above its normal level.

3.1 The Model

Assume that aggregate demand disturbances have real effects and inflation expectations affect aggregate supply:

$$y = \bar{y} + b(\pi - \pi^e), \quad b > 0, \tag{1}$$

where y = the log of output, $\bar{y}$ = the log of flexible-price output, π = inflation and π^e = expected inflation.

Also assume that the flexible-price output $\bar{y}$ is less than its optimal level y^* (due to, e.g., distortions, imperfect competition, externalities), that inflation above some level is costly, and that the marginal cost of inflation increases as inflation rises. The policymaker chooses inflation π (through money growth) to minimize

$$L = \frac{1}{2}[(y - y^*)^2 + a(\pi - \pi^*)^2], \quad y^* > \bar{y}, \quad a > 0, \tag{2}$$

subject to (1).

Suppose that the policymaker makes a binding commitment about inflation before expected inflation is determined. In this case, expected inflation will be exactly the same as actual inflation because of the binding commitment, i.e., $\pi^e = \pi$. As a result, (1) implies that output is also the same as its flexible-price output, i.e., $y = \bar{y}$. With $y = \bar{y}$, the policymaker's objective function (2) becomes

$$L = \frac{1}{2}[(\bar{y} - y^*)^2 + a(\pi - \pi^*)^2].$$

Obviously, the policymaker will simply choose $\pi = \pi^*$.

Now suppose that the policymaker chooses inflation taking expected inflation as given. Then the policymaker chooses π to minimize

$$L = \frac{1}{2}\{[\bar{y} + b(\pi - \pi^e) - y^*]^2 + a(\pi - \pi^*)^2\}.$$

The first-order condition is

$$b[\bar{y} + b(\pi - \pi^2) - y^*] + a(\pi - \pi^*) = 0,$$

which implies

$$\pi = \pi^* + \left(\frac{b}{a + b^2}\right)(y^* - \bar{y}) + \left(\frac{b^2}{a + b^2}\right)(\pi^e - \pi^*). \tag{3}$$

In this case, the policymaker chooses an inflation rate higher than the optimal inflation rate because if the public expects the policymaker to choose the optimal inflation rate, the marginal cost of slightly higher inflation is zero and the marginal benefit of the resulting higher output is positive.

In equilibrium, $\pi^e = \pi$ because there is no uncertainty. As a result,

$$\pi^e = \pi^* + \frac{b}{a}(y^* - \bar{y}) \equiv \pi^{EQ}.$$

3.2 Result and Discussion

Result: The policymaker's discretion leads to an equilibrium with the same output and a higher (than optimal) inflation rate.

Reason: The policy of announcing that inflation will be π^* and then producing that inflation after expected inflation is determined is not dynamically consistent (i.e., not subgame-perfect).

3.3 Possible Solutions to the Dynamic Inconsistency Problem

Consider the following three possible solutions:

- **Rules**: Monetary policy is determined by rules (i.e., binding commitments rather than discretion) and the central bank relinquishes the ability to determine the money supply. There still exist problems: (i) Rules cannot account for completely unexpected circumstances; and (ii) Low inflation rates were seen in many situations where monetary policy was not made according to fixed rules.
- **Reputation** (Backus and Driffill, 1985; Barro, 1986): If policymakers are in office for more than one period and the public does not know their characteristics, the public is unsure about what policies the policymakers will follow in future periods. If the public observes a lower inflation today, it will have lower expectations of inflation in the future, so the policymakers have an incentive to keep inflation low.
- **Delegation** (Rogoff, 1985): Another way to overcome the dynamic inefficiency problem is to delegate policymaking to conservative policymakers (who particularly dislike inflation (a higher

value of a)). When monetary policy is controlled by these individuals, inflation and expected inflation are lower. However, policymakers who do not have the same preferences as those of the public may not respond optimally to shocks.

3.4 Empirical Evidence: Central Bank Independence and Inflation

The independence of a central bank measures the delegation of policymaking to conservative policymakers.

- Empirical evidence: Independence and inflation are strongly negatively correlated (Alesina, 1988 and others).
- Limitations: (i) The independence is the source of the lower inflation? (ii) Central bankers' and government policymakers' preferences vary systematically with central-bank independence?

3.5 Limitations of Dynamic-Inconsistency Theories

- The importance of forward-looking expectations is not well established.
- The dynamic-inconsistency theories have difficulty accounting for large variations in inflation.

4 Seignorage and Inflation

The underlying cause of most episodes of high inflation and hyper-inflation is government's need to raise revenue from printing money (seignorage). This section studies the interactions among seignorage needs, money growth and inflation.

4.1 The Inflation Rate and Seignorage

Real money demand depends *negatively* on the nominal interest rate i and *positively* on real income:

$$\frac{M}{P} = L(i, Y) = L(r + \pi^e, Y), \quad L_i < 0, \quad L_Y > 0. \tag{4}$$

Consider steady states. Suppose output Y and the real interest rate r are unaffected by the rate of money growth $g_M = \dot{M}/M$ and actual inflation and expected inflation are equal. For simplicity, assume that output does not grow, then in steady state, the quantity of real balances is constant, implying that inflation equals the rate of money growth, i.e.,

$$\frac{M}{P} = L(\bar{r} + g_M, \bar{Y}). \tag{5}$$

The quantity of real purchases per unit time S that the government finances from money creation equals the increase in the nominal money supply per unit time divided by the price level:

$$S = \frac{\dot{M}}{P} = g_M \frac{M}{P} = \pi \frac{M}{P}. \tag{6}$$

That is, seignorage (inflation tax revenue) equals the tax rate π on real balances times the amount of real balances M/P. Combining (5) and (6) gives

$$S = g_M L(\bar{r} + g_M, \bar{Y}),$$

implying

$$\frac{dS}{dg_M} = L(\bar{r} + g_M, \bar{Y}) + g_M L_1(\bar{r} + g_M, \bar{Y}).$$

This condition generates an "inflation-tax Laffer curve".

Example (Cagan, 1956): Suppose

$$\ln \frac{M}{P} = a - bi + \ln Y, \quad b > 0,$$

which is equivalent to

$$\frac{M}{P} = Y e^{a-bi}.$$

Then we have

$$S = C g_M e^{-b g_M}, \quad C \equiv \bar{Y} e^a e^{-b\bar{r}}$$

$$\frac{dS}{dg_M} = (1 - b g_M) C e^{-b g_M}.$$

Based on Cagan's estimate of b (between 1/3 and 1/2), moderate seignorage needs give rise to substantial inflation and large seignorage needs produce high inflation.

4.2 Seignorage and Hyperinflation

If the public gradually adjusts its money holdings or its expectations of inflation to changes in the economic environment, then in the short run seignorage is always increasing in money growth and the government can obtain more seignorage than the maximum sustainable amount S^*. Hyperinflation arises when the government's seignorage exceeds S^*.

Desired money holdings are given by the Cagan money-demand function:

$$m^*(t) = Ce^{-b\pi(t)}.$$

Assume that the public adjusts its actual money holdings gradually toward desired holdings, i.e.,

$$\begin{aligned}\frac{\dot{m}(t)}{m(t)} &= \beta[\ln m^*(t) - \ln m(t)] \\ &= \beta[\ln C - b\pi(t) - \ln m(t)], \quad 0 < \beta < 1/b. \end{aligned} \tag{7}$$

Seignorage remains the same as before:

$$S(t) = g_M(t)m(t).$$

Suppose that initially the amount of real purchases G financed by seignorage is less than S^* and that G then increases to a level higher than S^*. The government can obtain the seignorage though increasing money growth and inflation. With rising inflation, real money holdings are falling, but still higher than the desired holdings due to gradual adjustments. As a result, the government is able to obtain more than S^*. However, with the real money stock falling, the rate of money growth is rising, leading to explosive inflation.

The dynamics of m: Since $\dot{m}/m = g_M - \pi$ and $g_M m = G$, we have

$$\pi(t) = g_M(t) - \frac{\dot{m}(t)}{m(t)} = \frac{G}{m(t)} - \frac{\dot{m}(t)}{m(t)}. \tag{8}$$

Combining (7) and (8) yields

$$\frac{\dot{m}(t)}{m(t)} = \frac{b\beta}{(1-b\beta)m(t)}\left[\frac{\ln C - \ln m(t)}{b}m(t) - G\right].$$

Since $b\beta < 1$ (by assumption) and $S^* = \pi m = (\ln C - \ln m)m/b < G$, we have

$$\frac{\dot{m}(t)}{m(t)} < 0.$$

As a result, the real money stock continually falling, money growth must be continually rising to raised the seignorage G.

Suppose $G < S^*$, then the economy has two steady states: a stable steady state with higher real money stock and an unstable steady state with lower money stock.

The above analysis explains the phenomena:

- Extremely high inflation
- Hyperinflation
- Fiscal problems and high inflation (and hyperinflation)
- Fiscal reforms and high inflation (and hyperinflation)

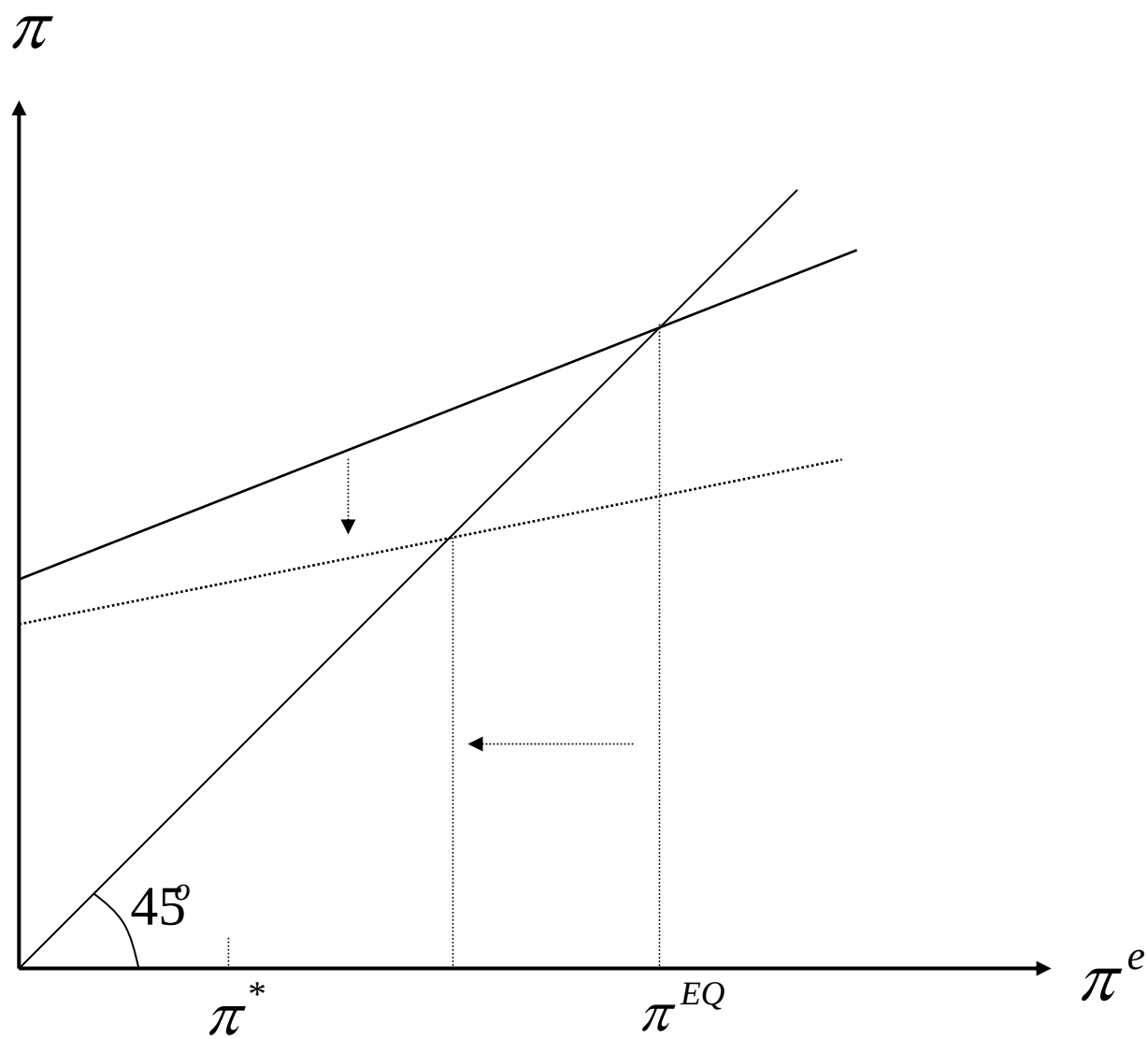

Figure 1: Inflation in the Absence of Commitment

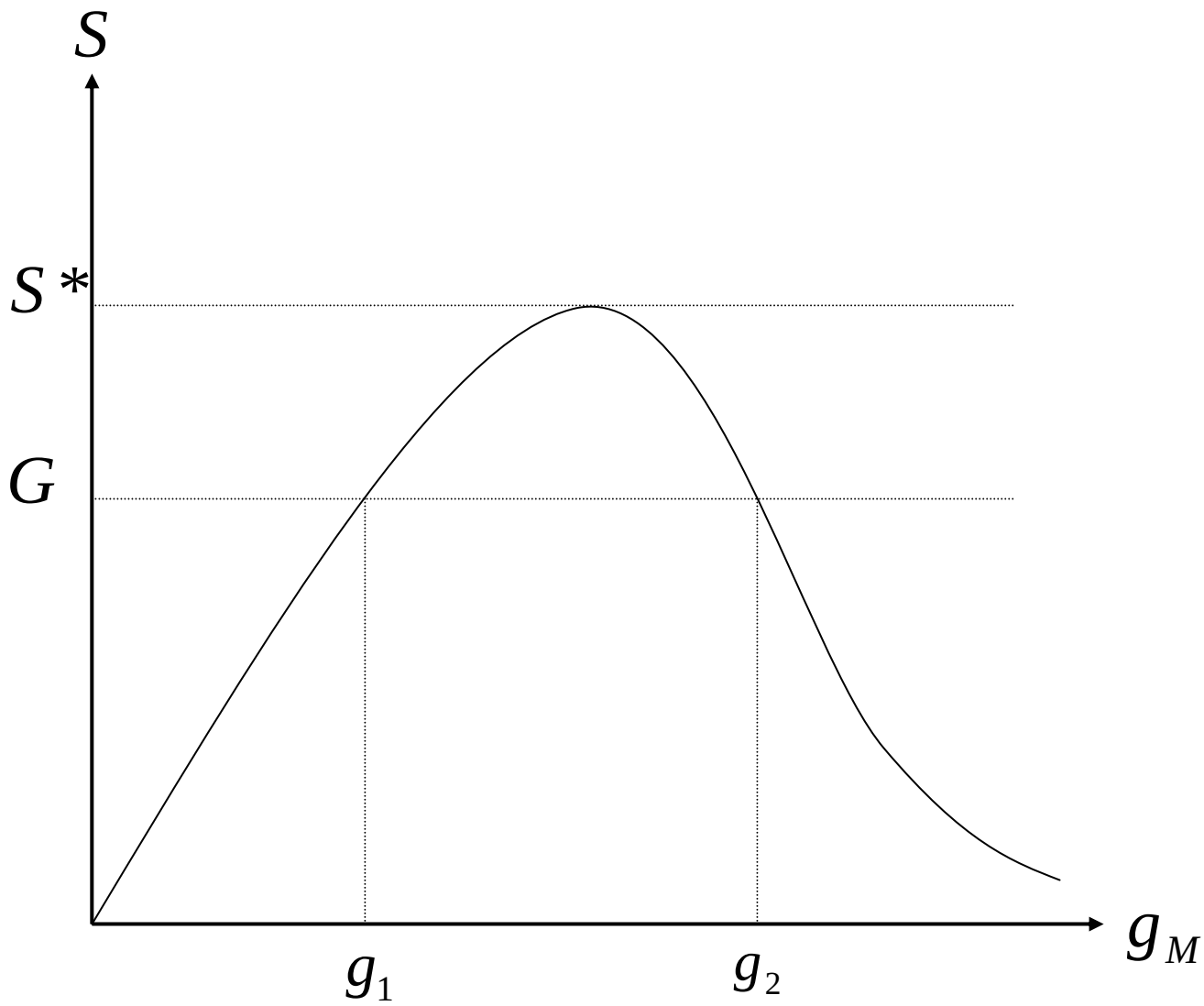

Figure 2: Inflation-Tax Laffer Curve

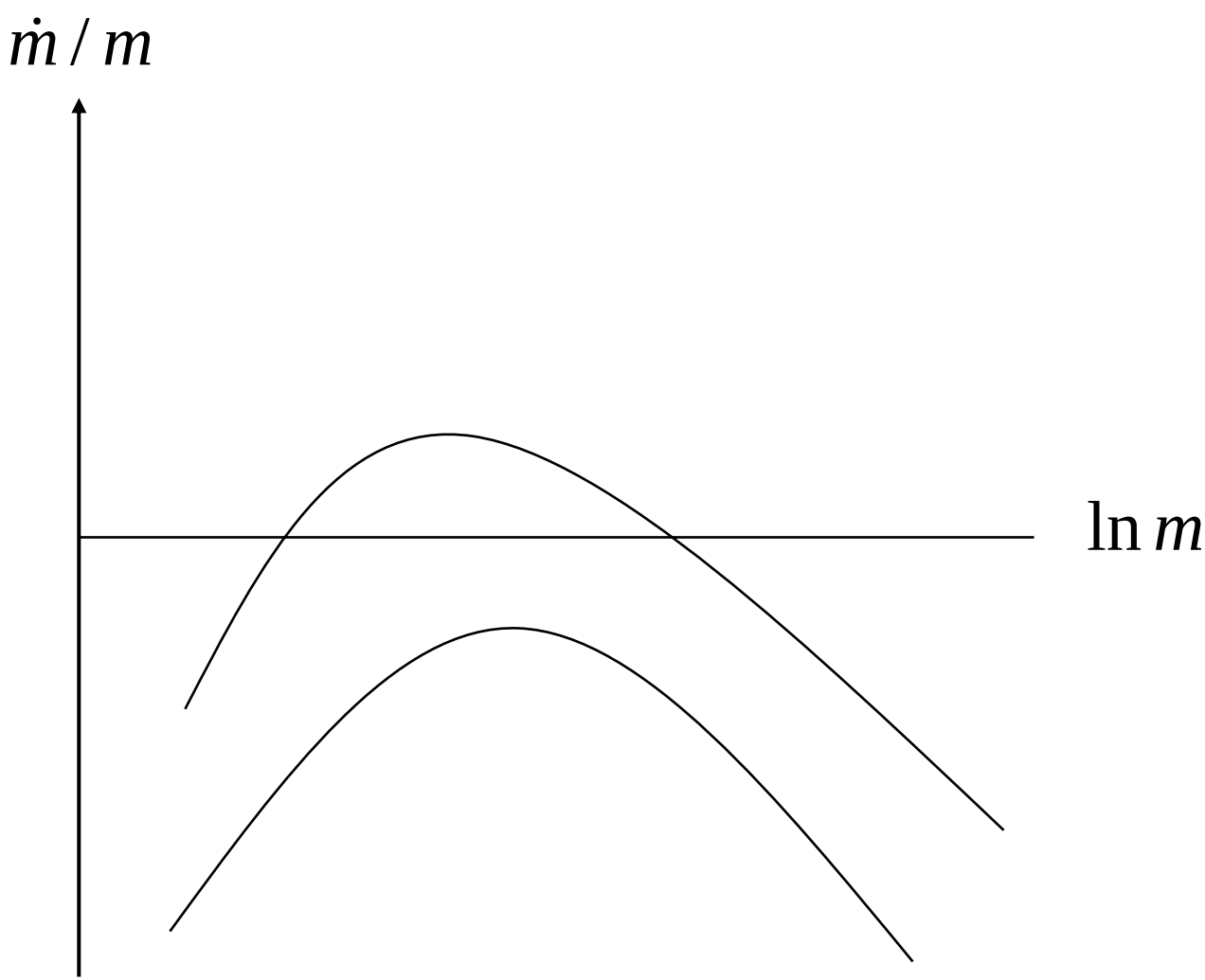

Figure 3: Dynamics of Real Money Stock