12
Money and Inflation

Tools: The quantity theory; central bank balance sheet; open market operations.

Key Words: Price level; inflation; hyperinflation; quantity theory; velocity; fiscal dominance.

Big Ideas:

- Inflation is the growth rate of the price level, which is typically measured by a price index.
- The quantity theory links the money supply with the price level and output. In the long run, an increase in the money supply results in an increase in the price level (inflation).
- Hyperinflation refers to an inflation rate of 100% per year or more. Hyperinflations follow a standard pattern: government deficits are financed with money, which produces inflation. We call this *fiscal dominance* over monetary policy.

Inflation is the rate of growth of the price level, typically measured by a price index. If prices are rising, on average, we have inflation. Milton Friedman, winner of the 1976 Nobel Prize in economics, once said: "Inflation is always and everywhere a monetary phenomenon. To control inflation, you need to control the money supply." Friedman believed what he said, but he also enjoyed thumbing his nose at the popular Keynesian theory of the 1960s, in which inflation was the result of excess demand for goods.

Was Friedman right? We consider his claim in the context of *hyperinflations*: episodes of annual inflation exceeding 100 percent per year. Although extreme, big inflations are a recurring phenomenon and a wonderful laboratory for studying inflation more generally. In these situations (but not necessarily in others), money growth is present, but it's invariably connected to government deficits. The keys to stopping a big inflation, then, are to balance the government's budget and prevent the central bank from expanding the money supply. The idea that inflationary monetary policy might stem from fiscal policy is generally referred to as *fiscal dominance*.

12.1 The quantity theory

Friedman's claim about inflation is based on a theory that is several centuries old: the *quantity theory of money*. Like a lot of good theory, it's based on an analogy. Think for a moment about the effect of a two-for-one stock split on the price of a stock. If it's now selling for 100, then you'd probably expect it to sell for 50 after the split. (This wouldn't be true if the split were a signal of some new information about the firm, but let's assume it's not.) The point is that the value of a firm's total stock of equity shouldn't depend on anything as arbitrary as the number of shares.

Now suppose we do the same thing with money. This is unrealistically simple, but makes the point effectively. Suppose that the government replaced every dollar with two "new dollars," marked so we could tell the difference between old and new notes. Then you'd expect that new dollars would be worth half as much as old dollars. That is, you'd expect prices of goods and services quoted in new dollars to be twice as high as prices quoted in old dollars. In short, changes in the quantity of money in circulation (the "money supply") executed in this way will be associated with proportionate changes in prices, with no effect on output. Why the latter? Because output is determined by productivity and inputs, and we wouldn't expect either one to be influenced by the number of pieces of paper used to make transactions.

Of course the world is more complicated than this, and monetary policy consists of more than just currency exchanges, but some of the same reasoning applies more generally (we'll look at some data shortly). The quantity theory is the result of two ideas: that money is not fundamental (pieces of paper don't change the productivity of the US or Chinese economies), and that its usefulness is in executing transactions. Let's start with the latter. In all developed economies, transactions consist of exchanges of goods and services for money. If we approximate the volume of transactions in an economy by nominal GDP, then we have $M = PY$, where Y is real GDP and

P is a measure of the price level such as the GDP deflator. This isn't quite right yet. A dollar can be used to execute several different transactions in a given year. To take this into account, we use

$$MV = PY, \tag{12.1}$$

where V is the *velocity* of money: the number of times a dollar is used to execute transactions in a given year.

At this level of generality, equation (12.1) is a tautology: For any data we collect on M, P, and Y, we simply choose V to make the equation hold. What gives the equation content is Friedman's assumption that velocity V is (at least approximately) constant. This implies that increases in M are associated with proportionate increases in PY. We add one further assumption to get Friedman's connection between money and prices: that real GDP is determined by the productivity and inputs of the economy, and is not affected by the amount of money in circulation. We can — and will — change that later, but it seems like a good place to start.

The same theory explains inflation if we express it in growth rates. As with growth accounting, we focus on continuously compounded growth rates where the growth rate of a variable X is $\gamma_X = \ln X_t - \ln X_{t-1}$. In logs, equation (12.1) and its first difference are:

$$\begin{aligned}
\ln M_t + \ln V_t &= \ln P_t + \ln Y_t \\
(\ln M_t - \ln M_{t-1}) + (\ln V_t - \ln V_{t-1}) &= (\ln P_t - \ln P_{t-1}) + (\ln Y_t - \ln Y_{t-1}) \\
\gamma_M + \gamma_V &= \pi + \gamma_Y,
\end{aligned}$$

where $\pi = \gamma_P$ is the inflation rate (the rate of growth of the price level). If we assume that velocity is constant,

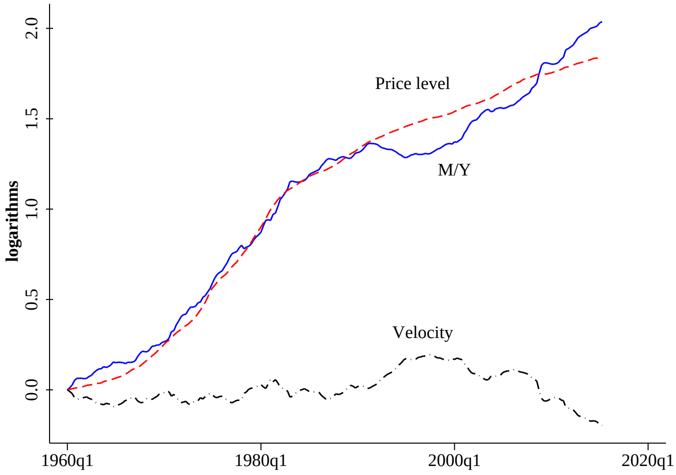
$$\gamma_M = \pi + \gamma_Y, \tag{12.2}$$

and changes in the growth rate of money are associated with changes in the growth rate of inflation and output. The second assumption is that the growth rate of money does not influence output, so changes in money growth translate one-for-one into changes in inflation. That's Friedman's argument, which depends on these two assumptions.

12.2 Evidence

It's not that easy to check the second assumption, but we can check the first (constant velocity) by looking at the components of equation (12.1). If velocity is constant, movements in the price level P mirror those in M/Y. We check this in Figure 12.1, which graphs both variables for the US. (Money here is M2.) The figure suggests that the theory is a reasonable approximation of the data, at least over the last fifty years or so. The two increasing lines (P and M/Y) show some differences, but their long-run movements are similar. Overall, velocity has been largely flat, but since the financial crisis of 2007-09 it has fallen amid record low interest rates. Time will tell whether or not the change is temporary.

Figure 12.1: The quantity theory in the long run.

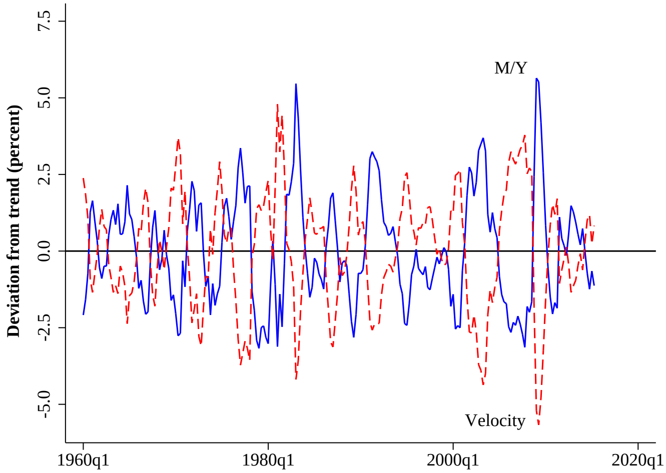


The short-run evidence for the quantity theory is much weaker. When we look at year-on-year growth rates, as we do in Figure 12.2, we see that velocity has as much short-run volatility as M/Y. As a consequence, movements in prices are virtually unrelated to movements in money. To put it bluntly, the quantity theory is a poor guide to short-run fluctuations in inflation rates.

12.3 Changing the money supply

Currency is a liability of the government, which can (and does) change the quantity in circulation. To see how this works, it's helpful to take a step back and consider the broader issue of government debt. We can divide the government's debt management into two related pieces. The first piece is the size of the debt. Measured in units of currency (dollars, say, or pesos), the debt changes over time as the government runs surpluses or deficits.

Figure 12.2: The quantity theory in the short run.



Mathematically, we might write:

$$\text{Debt}_t \quad = \quad \text{Debt}_{t-1} + \text{Deficit}_t.$$

This is an example of a government budget constraint, something we'll see more of later on. The second piece is the composition of the debt. In practice, governments have many different liabilities, but for the purposes of this discussion, let us say, it has two: government bonds and money (currency). In both theory and practice, these two pieces are typically separate, with the treasury issuing bonds to cover the entire debt and the monetary authority (central bank) buying back some of these bonds and issuing money in return.

Day-to-day monetary policy in most countries consists of what we term *open-market operations*: purchases or sales of government debt (bonds). At any point in time, the treasury's balance sheet looks something like:

Treasury

Assets		Liabilities	
		Bonds	200

and the central bank's looks like:

Central bank

Assets		Liabilities	
Bonds	100	Money	100

If it seems strange to treat money as a liability of the central bank (isn't money an asset?), think of it as a bond with the unusual feature that its nominal interest rate is zero. That's what it is, which makes it a good deal for the borrower.

An open-market purchase of bonds results in an increase in bonds held by the central bank and an equal increase in its monetary liability. For example, a purchase of 20 worth, of bonds would change its balance sheet to:

Central bank

Assets		Liabilities	
Bonds	120	Money	120

The result is an increase in the amount of money in private hands, since the private sector (the other side of this transaction) has reduced its holdings of government bonds and increased its holdings of money. Similarly, an open-market sale of bonds would reduce the amount of money in private hands.

The question we're leading up to is why money growth is so high in countries with big inflations. Why does the central bank keep issuing money?

12.4 Big Inflations

If inflation is as easily cured as Friedman suggests ("control the money supply"), why do big inflations happen? People who live through such episodes describe them as traumatic; they spend an hour or more every day converting cash into anything with stable value: real estate, cars, foreign assets. The economy is usually a mess, but whether that is cause or effect is hard to say. But if big inflations are so painful, why do governments let them happen? The problem, typically, starts with a government deficit. A political impasse makes it nearly impossible to reduce the deficit. Given the government's budget constraint, it must then issue debt. There is apparently no shortage of ready buyers of US debt (ditto other developed countries), but the same can't be said for every country. If no one will buy its debt, the only remaining option is to finance the deficit with money (read: oblige the central bank to purchase bonds from the treasury). In short, when the government can't pay its bills in any other way, it pays them with money, which is easy enough to print. The effect of this, of course, is inflation.

The impact here of fiscal policy (government deficits) on inflation is referred to as fiscal dominance, because fiscal policy dominates monetary policy. Nobel Prize-winner Thomas Sargent and his co-author, Neil Wallace, described a stark version of this. They showed that even a central bank that aims for low inflation will fail if the government issues debt without end. Think of the problem as a version of the time-consistency problem discussed in Chapter 6. If everyone knows that the central bank eventually will be compelled to print money to avoid outright default by the government, inflation expectations will rise today despite the central bank's caution. The key is that the bank cannot credibly commit to limit future money creation, while expectations of the future drive price setting today.

The conventional solution to ending a big inflation has two parts. The first is fiscal discipline: Balance the government budget. The second is monetary discipline: Separate the central bank from the treasury and tell the bank that its job is to maintain price stability. Though there are many fine points — how quickly must the deficit be eliminated? should the IMF supply short-term financing? — the outlines of the problem and its solution are clear. Going back to Friedman's quote: Inflation may be a monetary phenomenon, but the trouble often starts with fiscal policy and the political situation that led to it. When fiscal imperatives drive monetary policy — like the fiscal dominance in the Sargent and Wallace analysis — inflation eventually follows.

For someone operating an international business, the thing to remember is that "big inflations" are relatively common. What do you do if you're hit with one? You'll probably find that the most important thing you can do is streamline your cash management. If you can reduce the payment terms from (say) 60 days to 30 days, you increase your "real" revenue substantially. You may also find that big inflations lead to policies — such as price controls and capital controls — that make life more complicated. Finally, you may find that your financial statements are highly misleading, since they measure performance in terms of the local currency, the value of which is changing rapidly. For a US subsidiary, high inflation triggers a change in the rules for translating financial entries into dollars for tax and reporting purposes.

12.5 Inflation and interest rates

The interest rates we typically use are nominal: They tell us how much money we get in the future for a given investment of money today. Since inflation measures the change in the value of money, it shows up in interest rates. More concretely, we would say that the nominal interest rate equals the real interest rate (the interest rate adjusted for inflation) plus *expected* inflation:

$$i_t = r_t + \pi_t^e. \tag{12.3}$$

For a given real interest rate r, an increase in expected inflation raises the nominal interest rate one for one.

Here is the deeper explanation behind equation (12.3). Consider a one-year interest rate on a Treasury bill. The rate tells us how many dollars (say) we get in one year for a given payment of dollars today. For example, if a 12-month treasury bill has a price of \$96.15, its annualized yield is the value of i that solves

$$96.15 \quad = \quad \frac{100}{1+i_t}. \tag{12.4}$$

In this case, $i_t = 4$ percent. Thus, each dollar invested today gives us 1.04 dollars in 12 months. We refer to i_t as the *nominal rate of interest* — nominal because its refers to payments of currency.

For many purposes, we'd like to know not only the dollar yield, but also how much 1.04 dollars will buy when we get it. If we expect the inflation rate to be 3 percent a year, then we'd guess that three quarters of the interest will be eaten up by inflation. The investment gains us only about one percent in terms of purchasing power. We refer to the increase in purchasing power as the *real rate of interest* — real because it refers to the quantity of real consumption it finances. That gives us equation (12.3).

We can show this more formally by translating the words into equations more carefully. We have just argued that investors are interested not in the money the bond is a claim to, but in what that money will buy. If by "what that money will buy," we mean the basket of goods used to construct the CPI, we can define the real interest rate r as

$$(96.15/P_t) \quad = \quad \frac{100/P_{t+1}}{1+r_t},$$

where P_t is the CPI index in year t and P_{t+1} is the expected value of the same index in year $t+1$. What we are doing here is expressing the current bond price, measured in terms of what it will buy, as the discounted value of the principal, also measured in terms of what it will buy. Doing a little algebra, we find

$$(1+r_t)(P_{t+1}/P_t) \quad = \quad 100/96.15.$$

Then, equation (12.4) tells us that the real and nominal interest rates are related by

$$1+i_t \quad = \quad (1+r_t)(1+\pi_t^e),$$

where $(P_{t+1} - P_t)/P_t$ is the expected inflation rate between t (now) and $t+1$ (a year from now). Since the product $r_t \pi_t^e$ is a small number when expected inflation is low, it follows that

$$i_t \approx r_t + \pi_t^e, \text{ for small values of } r \text{ and } \pi_t^e,$$

where $\approx$ means "equals approximately." If we're careful about timing, we see that all three variables are comparisons between now and one year from now. Inflation is, therefore, typically understood to be expected inflation, since we don't know what inflation will be when we buy the bond. In principle, we could also take into account the risk inherent in inflation — but we won't.

Now that we're done with definitions, we can ask how inflation affects nominal interest rates. In principle, either component (the real rate or expected inflation) can change the nominal interest rate. In practice, we typically find that in periods of high and variable inflation, the inflation component dominates. This is approximately true of the US, where high-inflation periods (the 1970s and early 1980s) are high-interest-rate periods, too. It's even more evident in countries with very high inflation rates.

12.6 Velocity reconsidered

In very-high-inflation environments, people often find that the inflation rate accelerates quickly, often far exceeding the rate of money growth. One factor here is velocity, which typically rises sharply with inflation. Why? Because inflation (and nominal interest) is effectively a tax on holding money: The higher the tax, the less money you hold. During big inflations, people spend money as soon as they get it, because its value falls by the minute. It's common, for example, for people to buy groceries and gasoline as soon as they get their paychecks; if they wait even a day or two, their purchasing power falls.

If velocity V rises with inflation, then we can reconsider

$$\gamma_M + \gamma_V = \pi + \gamma_Y. \tag{12.5}$$

If γ_Y is approximately constant, then an increase in money growth not only produces inflation directly, but its impact is also magnified by the increase in the interest rate, which increases velocity ($\gamma_V > 0$). Similarly, when hyperinflations are reversed, we often see a larger drop in inflation than in money growth, as velocity falls.

Executive summary

1. Over long periods of time, inflation is closely related to money growth.
2. Extremely high rates of inflation are invariably associated with high rates of money growth.
3. High money growth is often the result of financing large fiscal deficits with money. The deficits, in turn, often reflect some kind of political gridlock.
4. High inflation is typically associated with high interest rates, since investors demand higher yields to compensate for the loss of purchasing power of the currency.

Review questions

1. Policy rule. Friedman suggested that the Fed might do better to adopt a rule in which it kept the growth rate of the money supply constant.
   (a) If the growth rate of real GDP is 3 percent, on average, what growth rate of the money supply would deliver average inflation of 2 percent?
   (b) What are the strengths and weaknesses of such a policy rule?

   Answer.

   (a) If velocity is constant, then equation (12.2) gives us a money growth rate of

   $$\gamma_M \quad = \quad \pi + \gamma_Y \quad = \quad 2 + 3 \quad = \quad 5.$$

   In words: Money growth accommodates inflation and economic growth.

   (b) Strengths: predictable, good average inflation performance, avoid major policy mistakes. Weakness: no room for policy to respond to current conditions. Compare, for example, policy in the aggregate supply (AS) and demand model (coming up).

2. Central bank independence. Why do many countries make central banks independent of the treasury?

   Answer. The idea is that monetary policy should focus on good long-term performance and, to accomplish this, should be immune to short-term political pressure. With respect to hyperinflations, you might argue that if the government does not have access to money finance, it will be forced to confront its deficit issues earlier, which is a good thing.

3. Zimbabwe. Zimbabwe ended its hyperinflation by abandoning its currency. Even official transactions were switched to either US dollars or South African rand. Does this seem like a good solution? Does it make sense for a country to abandon its currency?

   Answer. There's a long tradition of each country having its own currency, but there's good reason to think at least some countries would be better off using someone else's. Zimbabwe has shown no ability to manage it's own currency effectively, so using another sounds like a move in the right direction. There are other examples — Panama and Ecuador use the US dollar — and perhaps there should be more.

4. Interest rates and inflation. Go to FRED and find the three-month treasury bill rate (TB3MS) and the consumer price index (CPIAUCSL). Manipulate them as needed and graph the nominal interest rate and inflation rate together. What do you see?

   Answer. Do it and see!

If you're looking for more

Wikipedia has a nice article on hyperinflation, including a list of the biggest ones of all time. Steve Hanke and Nicholas Krus survey the compete history of hyperinflation in "World Hyperinflations." Search: "hanke krus hyperinflation." Two really good (but more technical) pieces about specific episodes are Thomas Sargent, "The ends of four big inflations," and Thomas Sargent and Joseph Zeira, "Israel 1983."

Symbols and data used in this chapter

Table 12.1: Symbol table.

Symbol	Definition
M	Money stock
V	Velocity of money
P	Price level
Y	Real output or GDP
ln	Natural log
γ_x	Continuously compounded growth rate of x
π	Inflation $(= P)$
π^e	Expected Inflation
i	Nominal interest rate
r	Real interest rate $(= i - \pi^e)$

Table 12.2: Data table.

Variable	Source
Nominal GDP	GDP
M2 monetary aggregate	M2SL
M2 velocity	M2V
Consumer price index	CPIAUCSL

To retrieve the data online, add the identifier from the source column to `http://research.stlouisfed.org/fred2/series/`. For example, to retrieve nominal GDP, point your browser to `http://research.stlouisfed.org/fred2/series/GDP`

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