2

Commodity Money

Chapter 1 noted that the earliest money must have been a useful commodity. It ascribed the historical predominance of gold and silver over other commodity monies to their being both widely salable and having characteristics that made them particularly convenient (especially after the development of coinage) for use as hand-to-hand media of exchange. Even after the development of bank-issued money, and its displacement of coinage in most retail transactions, gold or silver remained the medium of redemption: the basic money in terms of which bank-issued money is denominated and redeemable.

This chapter considers the operating characteristics of a commodity standard (or commodity money regime), in particular how it determines the quantity and value of money. We generically define a commodity standard as a system in which money is meaningfully denominated in units of a useful good (or set of goods). A piece of money may be "full-bodied" and materially contain the money commodity, as a silver coin does under a silver standard. Or, it may be a claim denominated in, and redeemable for, a specified quantity and form of the commodity, for example a banknote or deposit redeemable for silver coin. A "useful good" (or "commodity") here means a good that is scarce, and in demand for non-monetary uses. Silver, to continue the example, has a positive market value even in economies where it plays no monetary role. A fiat money, by contrast, is useless outside its monetary role.

Note that, under the generic definition, a commodity standard does not require that the public actually carry full-bodied commodity money in their pockets and purses. The public might hold all its money in the form of redeemable claims (token coins, banknotes, and transferable deposits), with all full-bodied commodity money residing in bank vaults. Note also that

nothing in the definition, contrary to some alternative suggestions, refers particularly to what a central bank or any other government agency is prepared to do. It is not *generically* true that "a gold standard means that the central bank is prepared to buy and sell gold at a fixed price" (Schwartz 1986) or that "the pledge [of 'the monetary authorities'] to fix the price of a country's currency in terms of gold represents the basic rule of the gold standard" (Bordo 1993, p. 160). Gold standards in the generic sense – monetary systems using gold and gold-denominated claims – antedated central banking by centuries. A central bank (whose roles are discussed in chapter 4) is thus not necessary for a gold standard to exist. (And if a central bank *does* happen to be part of a gold standard, its transactions are better described as redeeming its own gold-denominated currency, than as "fixing the price of gold" or "fixing the price of domestic currency.")

For the sake of concreteness, the remainder of this chapter will speak in terms of a particular type of commodity money regime, namely a gold coin standard. (The same analysis would apply exactly to a silver coin standard, and would apply in most respects to a non-metallic commodity standard.) For analytical simplicity, we assume that the principle of unrestricted coinage applies, and that the coinage process is zero-priced. Anyone can bring as much gold as he likes to the mint (which may be a zero-cost competitive firm, or a state-owned institution) to be coined without charge. Existing coins may be melted down without cost or restriction. Under these conditions, gold can flow between monetary and non-monetary use unhindered, exactly equalizing its purchasing power in the two sectors.

Determining the Price Level

If money were denominated and prices quoted in troy ounces of gold, the unit in which gold is today ordinarily measured, the "price level", would simply be the price of a representative basket of goods in troy ounces of gold. In practice, there is usually a small complication. The monetary unit (or unit of account) has a distinct name, defined in terms of the money commodity (the "medium of account"). For example, the US economy, before 1933, used a unit of account called "the dollar," defined as .04838 troy oz. (or equivalently 23.22 grains) of gold, 90 percent fine.

With prices denominated in dollars, and dollars defined in terms of gold, the price level P in dollars is the product of two factors:

1. the gold content of the dollar, and
2. the purchasing power of gold in terms of the goods in the price index basket, or, equivalently, the relative price of the index-basket goods in terms of gold.

Where *P* denotes the number of dollars it takes to buy a representative basket of goods, we can decompose *P* into the product of two ratios as follows:

$$\frac{\$P}{\text{basket of goods}} = \left(\frac{\$Q}{\text{oz Au}}\right) \times \left(\frac{R\text{ oz Au}}{\text{basket of goods}}\right)$$

where $P = QR$.

In this expression, the ratio $Q / oz Au is the definition of the dollar in terms of gold (chemical symbol, Au). To return to the example cited above, the pre-1933 definition of the dollar, $1 per .04838 troy oz Au, was equivalent to $20.67 per troy oz Au (so $Q = 20.67$). A figure like .04838 oz of gold (per dollar) can be called "the gold content of the dollar." A figure like $20.67 (per oz Au) is sometimes called the "official price of gold," a potentially misleading expression. The figure in question isn't a market price ratio between two distinct goods, but simply follows mathematically from defining one "dollar" as a certain weight of gold. Unlike a price, the figure does not vary with supply and demand conditions.[1]

The ratio *R* oz Au/basket of goods is the inverse of the *purchasing power of gold*, hereafter abbreviated ppg. (The ppg is measured in baskets of goods per ounce of gold.) This *is* a market price ratio, the relative price of gold in terms of goods-baskets. It *is* a figure that changes with supply and demand conditions in the market for gold.

We assume for the rest of this chapter that the definition of the monetary unit in terms of gold (*Q*)does not change. It remains fixed by convention or law.[2] Our analysis accordingly focuses on the determination of the purchasing power of gold ($1/R$) by supply and demand. Events that increase the ppg must lower *P* in the same proportion; events that reduce the ppg, raise *P* in the same proportion.

The Simple Stock-flow Analytics of Gold Supply and Demand

For now we begin (and end) our thought-experiments in the benchmark position of *stationary equilibrium,* defined as an equilibrium in which the

[1] Nor need it be "official" in the sense of being sanctioned by any authority other than common usage or convention.

[2] Nothing of consequence depends on the specific definition; i.e. on the particular metallic weight of the unit of account ("the dollar") provided it does not change. Changes in the weight can have important transitional effects. A unilateral reduction of the dollar's weight (a devaluation of the dollar), combined with a legal rule that old debts can be discharged in an unchanged number of dollars, would cause a redistribution of wealth from creditors to debtors.

relative price and stock of gold are both constant over time, with neither demand nor supply curves shifting. Later, we consider non-stationary equilibrium growth paths. We focus on the gold standard economy as a whole, which may comprise many countries or the entire world, rather than on any small country taken by itself. For the world as a whole, additions to the total stock of gold (monetary plus non-monetary) can only come from gold mining.

We need to distinguish between the market for gold *flows* and the market for gold *stocks*. Flows of gold, such as the current rate of production of the gold mining industry, are measured in ounces per year. Gold stocks, like the quantity of monetary gold existing on a given date, are measured in ounces without a per-time-period dimension. In this chapter, lower-case italic letters are used to denote flow variables, upper-case italic letters to denote stock variables.

Flow equilibrium, *e,* is shown in figure. 2.1(a) by the intersection of flow demand and supply curves. The flow demand for gold is the total of *consumptive* demands for gold, i.e. demands that "use up" gold, or fix it permanently in non-monetary forms. The flow quantity of gold demanded, g^d, is a decreasing function of the relative price (or purchasing power) of gold, and the demand curve is thus downward sloping, for the standard reasons that demand curves are generally downward sloping. The higher is the ppg, the greater the incentive to substitute into alternative materials, and, so, the fewer the ounces of gold demanded each year for consumptive purposes.

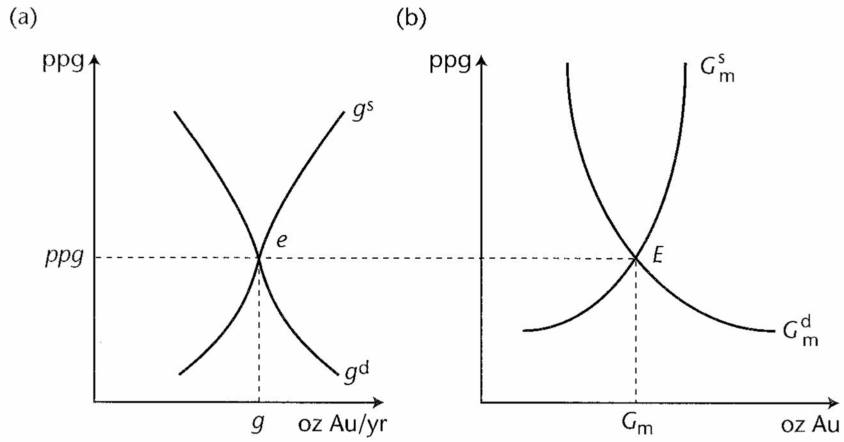

Figure 2.1 Stationary equilibrium in the markets for gold: (a) the market for gold flows is in equilibrium; (b) the market for monetary gold stocks is in equilibrium

For simplicity, we initially assume that the stationary flow demand for gold is entirely *non-monetary*. That is, we neglect wear-and-tear on gold bullion and coins. This is reasonable enough if all gold bars and coins reside in bank vaults, with bank-issued money forming the common circulating media.

The flow quantity supplied, g^s, is an increasing function of the ppg, and thus the supply curve is upward sloping, for the standard reasons supply curves are generally upward sloping. At a higher ppg, more ounces will be mined each year, as mine-owners find it profitable to dig deeper into gold veins, and to schedule longer working days.

Stock equilibrium, E, is shown in figure 2.1(b) by the intersection of monetary stock demand and supply curves. The monetary stock demand for gold represents demands by banks and the public to hold gold in monetary forms (coins or bullion). The stock quantity of monetary gold demanded, G^d_m, is a decreasing function of the ppg because (proportionately) fewer ounces are needed to accomplish transactions when ppg is higher.[3]

The stock quantity of monetary gold supplied, G^s_m, is assumed to be an increasing function of ppg, and thus the stock monetary supply curve is upward sloping (not vertical). The stock quantity supplied for monetary holdings is simply the difference between the total stock of gold (which is fixed at any moment), and the stock quantity demanded for non-monetary purposes. A downward-sloping demand curve for non-monetary gold items (such as candlesticks and jewelry) implies an upward-sloping supply curve for monetary gold. An increasing number of candlesticks and bracelets will be melted down and coined as the opportunity cost of holding them – the purchasing power of gold – rises.

Two peculiar features of our stationary equilibrium benchmark should be noted.

1 Under the assumption of zero wear-and-tear on monetary gold, the flow of gold into the mints must also be zero in stationary equilibrium. Otherwise, the stock of monetary gold would be increasing. The mints must be standing by idly, waiting for the next occasion of a temporary disequilibrium in which there is an excess flow supply to be coined.

[3] Proportionality is shown by drawing the monetary stock demand for gold curve as a rectangular hyperbola. The demand curve thus drawn is a compensated demand curve, or per Patinkin (1965, pp. 48–50) a "market-equilibrium curve," which assumes that an individual hypothetically confronted with higher prices is simultaneously given an equiproportional increase in nominal money balances. No result in this chapter rests on proportionality, however.

2 If there are *no* consumptive uses of gold – if every industrial use merely augments the total stock of non-monetary gold that is available to be melted down at negligible cost and coined – then any volume of gold mining increases the total stock of gold, and shifts the monetary stock supply curve to the right. In that case, no stationary equilibrium is possible, except where the gold mines also shut down. While it may be chemically true that gold atoms are preserved and not lost in every industrial use of gold, what matters here is whether the cost of conversion of gold from industrial uses to coins is negligible. If some gold is fixed into forms (e.g. fillings or circuit boards) from which it can be recovered only at a cost that will never in practice be worth bearing, that is economically equivalent to consumption. Additions to that part of the total gold stock shift only that part of the monetary stock supply curve that lies above the relevant range.

Let us now consider how the system responds, in the short run and in the long run, to simple supply and demand shocks.

Shifts in the monetary gold stock demand and supply curves

Beginning from a stationary stock-flow equilibrium, suppose that the monetary stock demand for gold increases. A large and sudden increase of this sort would occur when a large country joins the international gold standard, and goes about acquiring an inventory of monetary gold. A smaller, or more gradual, shift would occur with an increase in the real income of the gold-standard countries.

Graphically (see figure 2.2), the monetary stock demand curve shifts out from $G^d_{m_0}$ to $G^d_{m_1}$. Assuming that the ppg is proximately determined in the monetary stock market (rather than in the flow market), short-run equilibrium moves from E_0 to E_1, and the ppg rises immediately from ppg_0 to ppg_1. The only immediate response in monetary stock quantity supplied comes from converting non-monetary stocks of gold (melting down candlesticks and coining them). However, the monetary stock market is not in stationary equilibrium at E_1, because increased mining and reduced consumption of gold will lead, over time, to an accumulation of additional monetary gold stocks.

Over in the flow market, the higher value of gold at ppg_1 increases the flow quantity of gold supplied by the mines. The mining industry moves up the flow supply curve (g^s), from flow equilibrium point e_0 to the new short-run supply point e^s_1. Meanwhile, with the ppg higher, the flow quantity demanded for non-monetary (consumptive) purposes retreats up the g^d curve

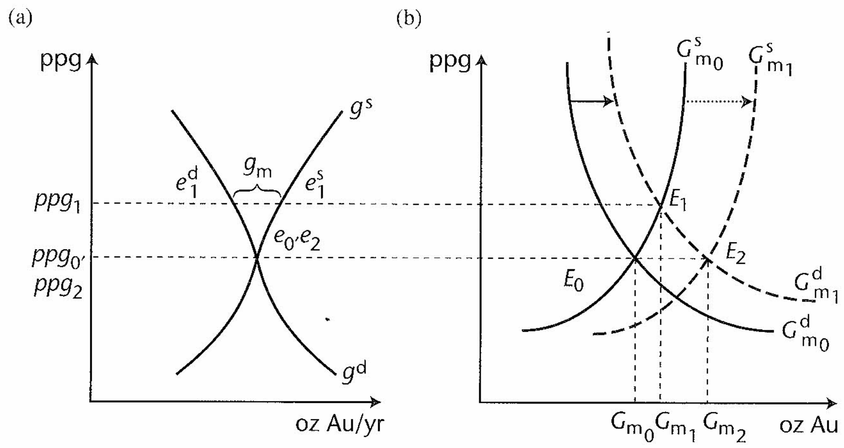

Figure 2.2 An increase in the monetary demand for gold: first, the stock demand for monetary gold increases – shown by the solid arrow in (b) – raising the ppg in the short run; then, – see (a) – the rise in the ppg increases the flow quantity supplied of gold from the mines, and reduces consumptive flow quantity demanded and the difference, g_m, flows into coinage each period; the accumulation of new coins over time gradually increases the stock of monetary gold – shown by the dashed arrow in (b) – so that, in the long run, stationary equilibrium is restored at the original ppg – as shown in both (a) and (b)

to e_1^d. The flow quantity supplied at ppg_1 exceeds the flow quantity demanded for consumptive purposes.

Where does the excess gold flow go? Assuming unrestricted coinage, mine-owners will take it to the mints to be coined, converting it directly into money. Mine-owners can obtain the value ppg_1 for their gold by coining and spending it, whereas additional sales to consumptive demanders are no longer possible except at a lower price. Gold flows into the mints at the rate shown graphically as g_m.

As a result of the new mint activity, the stock of monetary gold, G_m, begins to grow over time. As new coins accumulate, the monetary stock supply curve shifts gradually rightward, as shown in the shift from $G^s_{m_0}$ to $G^s_{m_1}$ in figure 2.2 (b). (The *gradual* shift is indicated by the *dotted* arrow.) As the monetary stock supply curve shifts rightward, monetary stock equilibrium moves from E_1 toward E_2. The ppg falls, from ppg_1 toward ppg_2. The stock of monetary gold G_m grows from G_{m_1} toward G_{m_2}. Where does the accumulation process end? Stationary equilibrium is restored only when the ppg reaches a level (call it ppg_2) that once again shuts off the flow of gold to the mints. Under the *ceteris paribus* assumption that there have been no shifts in the flow supply or demand curves, the purchasing power and annual volume of gold flow must return exactly to where they started: equilibrium points e_2 and e_0 coincide, and $ppg_2 = ppg_0$.

In this scenario, because the flow and stock quantities of gold supplied respond to the increase in the purchasing power of gold, the short-run change in the ppg (from ppg_0 to ppg_1) is fully reversed in the long run. A price-elastic supply of gold thus dampens changes in the ppg (and thus in the price level) due to monetary demand shifts. Ultimately, the demand shift is met entirely by an adjustment in the quantity and not in the purchasing power of gold. This result illustrates the *price-level-stabilizing property* of a gold standard that is often cited as a virtue by its proponents.

There are at least two ways of modifying the assumptions of the case just illustrated that would interfere with the exact restoration of the original ppg_0.

1 If we allow for an annual flow demand to replace wear-and-tear on monetary gold, equal to some percentage (say 2 percent) of the stock of monetary gold, then the starting and ending flow equilibria and will no longer exactly coincide ppg_0 ppg_2. Because the monetary gold stock is larger at stock equilibrium E_2, the flow demand curve g^d would be shifted somewhat to the right, and the new stationary equilibrium would imply a ppg_2 somewhat higher than ppg_0.
2 If gold mining is subject to a depletion effect, then the cost of gold mining rises with the total number of ounces previously mined. Mine-owners first dig up the gold deposits that are easier to reach, and leave for later those that are harder to reach. A depletion effect by itself pulls the flow supply curve leftward a bit each period, putting the ppg on an upward secular path. We can imagine a stationary equilibrium economy in which the net movement in the flow supply curve for gold is zero, because the depletion effect is just offset each period by technical advances in gold mining and extraction, or by a series of new prospecting discoveries. In such an economy, a monetary demand shock that increases the volume of mining would accelerate depletion, and shift the flow supply curve g^s to the left on net. Again, ppg_2 would be somewhat higher than ppg_0.[4]

In arriving at his well-known estimate of the resource cost of a commodity standard, Milton Friedman (1953 and 1960) considers a case in which neither of these complications obtains. Thus the long-run path of the ppg remains flat in the face of ongoing steady growth in the monetary demand for gold. As G^d_m shifts out, annual gold mining shifts G^s_m out just enough to

[4] For numerical simulations of the impact of a depletion effect, see Bordo and Ellson (1985).

maintain a constant ppg. The constant ppg continues to generate the same amount of mining every period. This case is further discussed and illustrated below.

A *decrease* in the monetary stock demand for gold – due for example to a large country leaving the gold standard and shedding its monetary gold stocks, or banks switching to lower reserve ratios – sets an exactly contrary chain of events in motion. The purchasing power of gold falls. Graphically, the monetary stock demand curve shifts to the left, moving the equilibrium point down the monetary stock supply curve. (In figure 2.2b, letting E_2 represent the initial stationary equilibrium, and assuming the demand curve shifts from $G^d_{m_1}$ to $G^d_{m_0}$, the new short-run equilibrium is at the unlabelled intersection of $G^d_{m_0}$ and supply curve $G^s_{m_1}$.) The stock of monetary gold immediately shrinks somewhat, because the lower relative price of gold increases the stock demand for non-monetary gold. Money-holders melt down some of their existing coins because they can now own gold jewelry and candlesticks at a lower cost.

In the flow market, the lower ppg causes an increase in the volume of consumptive demand for gold, and a fall in the output of the mines, such that a *negative* flow of gold into coinage arises. That is, while the ppg is depressed, each year the flow demand for gold will consume not only the entire output of the mines but also some portion of the existing stock of coins and monetary bullion, further shrinking the stock of monetary gold. The monetary stock supply curve gradually shifts to the *left* over time, as monetary gold *de*cumulates. The shrinkage helps to bring the purchasing power of gold back up, and continues (absent wear-and-tear and depletion effects) until the original ppg is restored. (In figure 2.2b, long-run equilibrium would be reached at E_0.)

In these scenarios, the movement of the monetary stock supply curve is gradual, and is the endogenous result of the flow-market effects of movement in the ppg. A sudden and exogenous shift in the stock supply curve is somewhat harder to imagine. The plot of the film *Goldfinger* provides one fanciful example: Goldfinger plans to set off a thermonuclear device in Fort Knox to render the gold there useless by radioactive contamination. If we assume that nuking the gold is the equivalent of making it disappear, we can treat the event as a sudden leftward shift in the stock supply curve, and proceed as we did in analyzing demand shifts. (The graphics are left as an exercise to the reader.) As Goldfinger intends, the nuking would indeed drive up the value of his own gold stocks. In the long run, however, the higher ppg would encourage extra gold mining, and discourage gold consumption, enough to eventually re-accumulate the lost gold and reverse the effect on the ppg. The final stationary equilibrium position would coincide exactly with the initial position. Absent depletion effects, Goldfinger's plan is pointless in the long run.

Precisely the opposite effects would be produced by an event from classical mythology: a sudden one-time shower of gold coins from heaven. The ppg would drop in the short run, and return again to its original level in the long run as mining was discouraged and gold consumption was encouraged. From the point of view of Old World, the looting of gold from the Aztecs and Incas by the Spanish conquistadors had the same effect.

A less fanciful source of shifts in the monetary stock supply curve follows from the fact that the curve reflects the given total stock of gold minus the demand for non-monetary stocks of gold. A sudden craze for genuine gold jewelry, by shifting rightward the (not shown) *non-monetary* stock demand curve for gold, would shift leftward the monetary stock supply curve. A drop in the popularity of gold jewelry would, conversely, shift the monetary stock supply curve to the right. The short-run and long-run adjustments described above would follow.

Shifts in gold flow supply and demand curves

Suppose that a significant new lode of gold ore is discovered, completely by accident, or, suppose that an inexpensive new technique is accidentally discovered for extracting gold from ore previously not worth mining. New gold mines open. Graphically (as shown in figure 2.3), g^s_0 shifts out to g^s_1, and the flow

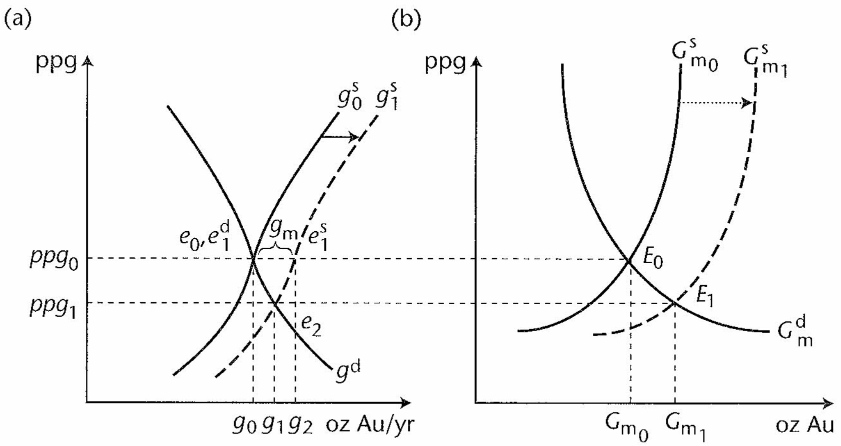

Figure 2.3 An increase in the flow supply of gold: following the discovery of a new gold lode, new mines open, shifting the flow supply curve for gold – in (a) – to the right and opening a flow of gold into coinage, g_m; then, in (b), the accumulation of new coins gradually increases the monetary gold stock over time and permanently reduces the ppg

supply of gold increases. We continue to assume that the ppg is proximately determined in the monetary gold stock market, so there is no *immediate* change in the ppg with the shift in flow supply. Change in the ppg will occur gradually as the accumulating new gold increases the monetary gold stock.

At ppg_0, production shifts from e_0 to e_1 on the new flow supply curve g_1^s. A larger flow, g_1, begins to come from the mining industry. There being no immediate change in the quantity demanded for non-monetary uses, the new flow quantity supplied exceeds the quantity demanded for non-monetary uses. As in the earlier case (figure 2.2(a)) the excess, denoted g_m, goes to the mints to be coined. Over time, as the newly minted coins accumulate, the stock supply curve of monetary gold, G_m, gradually shifts from G_{m_0} to G_{m_1} in figure 2.3(b). As G_m gradually rises, the ppg falls, moving along the unchanged monetary stock demand curve G_m^d.

The adjustment process eventually reaches its limit, and a new stationary equilibrium is established, at e_2 and E_2, with the new market-clearing value of gold equal to ppg_1. The height of ppg_1 is determined by the intersection of g_1^s with g^d, the point at which the flow of new gold into the mints, g_m, returns to zero. At any ppg above ppg_1, g_m remains positive, so coined gold continues to accumulate, shifting G_m further to the right and pushing the ppg further down. Once ppg_1 has been reached, the flow into the mints stops and stationary equilibrium has been re-established.

The opposite case of a *decrease* in the flow supply of gold could be similarly traced. We have noted that a depletion effect would gradually push the flow supply curve to the left. A nuclear accident in a major mining region would have the same effect more suddenly. An exogenous event that caused a sharp increase in the wage rates of miners (such as a rise in their productivity in other industries) would also do the trick of pushing the flow supply curve to the left. The result would be a permanent *increase* in the purchasing power of gold.

Unlike in the cases of monetary demand shocks, the change in the purchasing power of gold caused by a flow supply shock is permanent. The ppg does not return to its original starting point. This result illustrates the potential vulnerability of the price level to gold supply shocks under a gold standard, a feature often cited as a drawback by the gold standard's critics.

The size of the movement in the purchasing power of gold depends on the size of the supply shock, obviously. It also depends on the slopes of the flow supply and demand curves. At a lower ppg, the flow quantity demanded for consumptive uses rises, and this dampens the drop in the ppg. The flatter (more price-elastic) is the non-monetary flow demand curve, the smaller is the change in ppg. (This could be shown graphically be redrawing figure 2.3 with a flatter flow demand curve, an exercise left for the reader.) Likewise, the flow quantity supplied by mine-owners falls as the ppg falls; we move down along g_1^s from e_1 to e_2. The flatter (more price-elastic) is the flow supply curve, the smaller is the change in ppg before e_2 is reached. Thus, the greater the elasticity of flow demand and supply for gold, the more dampened are potential price-level movements.

The Historical Sources of Gold Supply Disturbances

Analyzing the stock supply and demand for gold in a similar fashion (while leaving the flow market implicit), Hugh Rockoff (1984) emphasizes that an observed change in the monetary gold stock is not always the result of a supply shock. It is often (as in figure 2.2 above) an endogenous adjustment to a situation in which, perhaps due to a previous demand shock, the gold market is temporarily out of long-run stock equilibrium.

A similar point can be made about shifts in the flow supply curve. If the flow supply curve in figure 2.3(a) is a *short-run* supply curve, showing the supply response from existing mines *only*, a shift in its position may speed the system's return to, rather than disturb, the long-run equilibrium value of the purchasing power of gold. For example, suppose that an increase in monetary stock demand for gold raises the ppg temporarily above its long-run level. The high ppg creates excess profits in mining. The rise in the profitability not only prompts mine-owners to work existing mines more intensively (the effect shown by moving up the existing short-run flow supply curve), but it also stimulates increased *prospecting* for new sources of gold. When new sources are found, the short-run flow supply curve rotates or shifts such that an even greater flow quantity is supplied at the high ppg. The increased flow of gold from the mines brings the ppg back to its long-run normal value more quickly than if there had been no discovery.[5]

Thus we need to distinguish between

1. gold discoveries that are endogenous (movements along the long-run flow supply curve) and that stabilize the purchasing power of gold in the long run, and
2. discoveries that are exogenous (shifts of the entire flow supply curve) and destabilize the ppg.

[5] Thus, as is generally the case, the long-run supply curve is more elastic than the short-run supply curve. If, in the transition from short run to long run, the supply curve were to make a parallel shift to the right (rather that rotating on the original flow equilibrium point), the long-run equilibrium ppg would be reduced. This would obtain if the fixed costs of operating a mine were entirely sunk costs once a mine is opened, so that existing mines will produce less but none will shut down (from inability to cover its average cost even while covering its marginal cost) at a lower ppg.

Which picture fits the major historical gold strikes? Rockoff (1984, pp. 625–7) understandably judges the California discovery of 1848, which was purely fortuitous, to have been an exogenous supply shock. The initial discoveries in Australia and New Zealand a few years later were by prospectors, but those prospectors were inspired by the California discovery rather than responding to a high purchasing power of gold, so these may also be counted as exogenous and destabilizing supply shocks.[6] Later discoveries in western Australia, however, and other major discoveries of the nineteenth century, namely South Africa (1874–86), Colorado (1890s), and Alaska (1890s) followed years of intense prospecting due to a high ppg, and may be counted as endogenous and stabilizing.

Like the discovery of a new gold field, technological progress in gold mining can also shift out the flow supply curve. But again, such a shift helps to stabilize the purchasing power of gold if it offsets a shift in the monetary demand for gold that would otherwise raise the ppg. An increase in money demand normally accompanies economic growth, and an important source of economic growth is technological progress in industry and agriculture generally. Technical progress in the gold mining industry thus helps to stabilize the ppg when it proceeds at roughly the same rate as technical progress generally. Historically, probably the only technological innovation big enough to have been potentially a significant source of supply disturbance was the invention of the cyanide process for extracting pure gold from ore, a breakthrough that greatly expanded the profitable exploitation of the South African gold deposits. However, Rockoff (1984, p. 830) notes that the research that led to a commercially useful version of the cyanide process (introduced in 1899) "was the product of the high price of gold prevailing in the mid-1880s." Thus, like many gold field discoveries, the development of the cyanide process may be viewed as part of an endogenous movement along an elastic long-run supply curve.

How long did it take to reach the long run? In the event of a sizable increase in the stock demand for gold, how many years would elapse (absent other shocks) before the increase in the ppg was at least half reversed by the supply response? (If the adjustment process slows down as the distance from long-run equilibrium shrinks, complete reversal might take place only in the limit.) No precise estimate is available in the literature, but deviations of the ppg above, or below, its long-run trend did last for decades. So, the adjustment process probably required a decade or more on average, particularly if we factor in prospecting as part of the process. Long and

[6] Rockoff (1984, p. 621, table 14.1) reports that the world monetary gold stock grew at an average annual rate of 6.39 percent during the period 1849–1859. In no other reported decade (1839–1929) was the growth rate above 3.79 percent.

variable lags could separate the emergence of a high ppg from the discovery of new gold fields, the bringing of additional gold mines on line, and, finally, the accumulation new gold output sufficient to restore the normal purchasing power of gold. Bordo (1984, p. 217, n. 36) reports statistical evidence that the lagged response of gold output to a deviation in the purchasing power of gold was strongest at a lag of 25 years.

The Benefits of a Gold Standard

A commodity standard like gold provides a credible "anchor" for the price level. The money stock automatically adjusts to counteract shocks to money demand, at least in the long run, as discussed above. The money supply cannot be *arbitrarily* increased: shocks to the quantity of money only occur when there are shocks to the profitability of producing gold. These properties limit movement in the price level, and anchor the expected price level. The expected inflation rate has a zero mean (or a negative mean, if a depletion effect operates), at least over long time horizons, in a system where the gold standard prevails and is expected to be left alone. Rolnick and Weber (1994) find that the average rate of inflation in historical commodity money (silver and gold standard) episodes has been approximately –.5 percent per year. This suggests that the "long-run stock supply curve" for monetary gold is almost, but not quite, flat. A mild depletion effect, or a wear-and-tear effect with secularly growing monetary gold stocks, appears to have operated.

Fiat money systems have typically behaved differently. Though economists have imagined and proposed firmly anchored fiat systems, and some fiat systems have behaved better than others, actual fiat money systems have exhibited much higher inflation on average. Rolnick and Weber (1994) reckon an average fiat inflation rate of approximately 6.5 percent per year when cases of fiat hyperinflation are omitted. (The number is closer to 18 percent when hyperinflations are included).

In addition to the *average* rate of inflation, investors worry about the *unpredictability* of the price level or the inflation rate. Clear and meaningful measurements of unpredictability, allowing a reliable historical comparison of commodity with fiat regimes, are hard to make, basically because expectations cannot be directly observed. One important piece of evidence strongly suggests, however, that investors had greater confidence of their ability to predict the price level, at least at long horizons, under the historical gold standard: the long-maturity end of the bond market has sharply contracted with the switch to fiat standards. Risk-averse investors naturally shy away from (unindexed) securities that promise payoffs of nominal dollars 25 years in the future, if they cannot confidently forecast the purchasing power of the dollar 25 years ahead. Under the gold standard in the nineteenth century, some railroad companies found ready buyers for 50- and 100-year bonds. Today, corporate bonds of 25 or more years in maturity are uncommon. As calculated by Benjamin Klein (1975, p. 480), the weighted average maturity of new corporate debt issued by US firms during the 1900–1915 period was 29.2 years; during the 1956–1972 period it was 20.9 years. One would expect that the figure has shrunk even more since 1972.

The main utilitarian arguments for adhering to a gold standard rest on the proposition that it more reliably preserves the purchasing power of money (gold is said to be more "trustworthy" and "honest") than a fiat standard.[7]

1 A more reliable unit of account lowers the risk of long-term nominal contracts, as we have just noted with respect to bonds. Lower risk on long-term bonds encourages more long-horizon investment. When savers are more willing (do not demand so large a purchasing-power risk premium) to buy long-term bonds, a firm with a long-payback project, like a railroad company, can more cheaply sell bonds long enough to match the duration of its expected payoff stream from the real assets being financed. Such duration-matching eliminates the significant refinancing risk involved in relying on short-term debt, which is the risk that interest rates will be higher when the firm goes to roll over its debt. High-payoff long-horizon investment projects are therefore not shelved simply because of inflation risk, which undoubtedly aids economic growth, though the size of the effect would be hard to estimate.

2 The gold standard's automatic mechanism for determining the quantity of money arguably reduces the burden of tracking the current, and likely future, money supply (the "fed-watching" costs in the current US monetary regime). This benefit relates to *how* the gold standard provides a reliable nominal anchor: market forces determine the money stock, rather than a committee of central bank officials who are subject to changes in outlook and possibly to political pressures. In later chapters, we discuss a variety of models for predicting the actions of a discretionary monetary authority. For now, the point is that investors may feel compelled to spend more on obtaining up-to-date information on the system's probable direction under a fiat standard. As Meltzer (1986, p. 124) puts it, "the flexibility that permits government to change [monetary] policy . . . has a cost: anticipations about the future conduct of policy are altered, and uncertainty about the future conduct of policy increases."[8]

3 Classical defenders of the gold standard emphasized the importance of preserving "the ancient and honorable parity." So long as convertibility and other gold-denominated contracts are enforced as written, and the gold content of the monetary unit is not reduced, currency-holders under a gold standard are free from the government tax on currency-holding ("seigniorage" or "the inflation tax") imposed – often unexpectedly – by an arbitrary monetary expansion or debasement that makes the path of the price level jump.[9] The tax is particularly severe in a hyperinflationary expansion or an extreme debasement. The absence of seigniorage eliminates not only the standard welfare cost of the inflation tax (resources used up in keeping real balances low, e.g., by making additional trips to the bank), but also eliminates wasteful rent-seeking struggles over the spending of the proceeds.

[7] Commentators sometimes speak of the gold standard's "mystique". Presumably, this means that the commentator is not persuaded by history (or by such figures as those in the text) that a gold standard is more reliable than a fiat standard, and does not understand why others are.

Historically, it is of course true that governments sometimes (or chronically, under some regimes) reduced the gold content of the monetary unit, the ratio Q oz Au/\$. What does such a policy accomplish? In the *long run*, in terms of our price-level equation above, the policy has no impact on the ppg or its inverse R oz Au/basket of goods). It does not affect the real determinants of the flow supply or demand for gold, or alter real gold stocks (measured in ounces). It does not shift the curves in any of our gold-market diagrams (note that the vertical axis is in baskets/oz Au, not in nominal terms). Rather, the long-run effect of the policy is merely to raise the price level P in proportion to the increase in $1/Q$. Why bother, then? First, because there is a one-shot scaling-down of the government's real debts if those are denominated in units of account rather than in bullion weight of gold. Second, where the government has a mint monopoly, combining a debasement with a recoinage reaps seigniorage. When existing coins are called in, and their gold content is reduced, the gold extracted from each existing coin constitutes tax revenue to the government.

[8] Rockoff's evidence (1984, p. 62, table 14.1) indicates that the standard deviation of annual percentage rates of change (around decade-average rates of change) has usually been larger for the US monetary base, 1949–1979, than it was for the world's stock of monetary gold, 1839–1929. Meltzer's (1986) risk and uncertainty estimates (produced by multistate Kalman filter techniques) run mostly in the opposite direction, but are based on a shorter gold standard sample period.

[9] A detailed account of seigniorage is provided in chapter 7. The absence of surprise tax levies on currency holding is presumably an important part of what is meant by those who speak of gold as "honest money."

Barring seigniorage is a benefit to coin-holding members of the public, but a sacrifice to the government. For that reason, an unalterable gold standard was historically viewed as an important constraint on those activities of governments, particularly war-making, that were commonly financed by the burst of revenue available through a large seigniorage levy.

The Resource Costs of a Gold Standard

The leading objection economists have made to commodity standards are the resource costs involved: paper money is much cheaper to produce than gold coins.

The resource costs of an ongoing gold standard (meaning, the opportunity cost of the resources tied up) have both stock and flow components. The *stock* resource cost is the cost of *holding existing* monetary gold. Its magnitude is the value of all the "inherited" gold coins and bullion, if that gold were given over to non-monetary uses like tooth fillings, jewelry, and electronics. The *flow* resource cost is the cost of *acquiring additional* gold (and of replacing worn coins, if wear-and-tear is non-zero). Its magnitude is the value in alternative employment of all the labor, capital, and land devoted each period to mining gold for monetary purposes, or to producing net exports to be traded for monetary gold.[10] To avoid double counting, the alternative-use (stock) and production (flow) costs should not be added together for the same ounce of gold.

Acquiring additional gold is ordinarily called for to meet growth in money demand. A country switching from a fiat to a gold standard would incur a one-time (stock) resource cost of acquiring the gold needed for coinage and bank reserves, and, in subsequent years, would incur the (flow) resource costs of acquiring additional gold as money demand grew. Stock resource costs would be zero under a gold standard only if gold (like fiat money) had no value in non-monetary uses. Flow resource costs would be zero only if the monetary gold stock could not grow (all gold mines and other sources had already been exhausted) or no flow of gold into the mints was called for (demand for monetary gold did not grow, and wear-and-tear on existing gold coins was zero).

[10] Because the reward necessary to secure the services of a factor in a competitive market is at least what others are willing to pay for it, which equals their estimate of the value it would contribute to their production, the standard measure of the alternative value of any input is the rate of pay (wage or rental) it currently receives. Some factors may be specific to the gold-mining industry – for example, specialized machines or skills of experienced gold-miners – and not as valuable outside of the industry, but an end to the mining of gold *for monetary purposes* is not an end to the industry as a whole.

Switching to a fiat money regime does not *automatically* escape these resource costs. First, to eliminate the stock resource cost, banks and central banks that are holding gold when the transition to fiat money is made must sell off their gold stocks to release the gold for alternative uses. For whatever reason, the world has not in fact seen a meltdown of more than a small fraction of central banks' gold stocks since the end of the classical gold standard or even since the end of Bretton Woods. (Central banks have at least stopped accumulating gold, so that the system no longer incurs flow resource costs to meet increased money demand.) Second, if the public is uncertain about the reliability of a fiat money, and buys newly minted gold coins and bullion as an inflation hedge, flow resource costs of a (quasi-) monetary kind *are still* incurred.

For these two reasons, it is an empirical question under which regime the resource costs are actually lower in a particular country's, or the world's, case. Sufficient data on gold quantities – ounces mined and held – are not available to answer the question. Privately held stocks of quasi-monetary gold have most likely risen since the 1971 end of Bretton Woods. Certainly they have risen in the US, where private gold ownership was illegal between 1933 and 1975. However, precise quantities are unknown because individuals do not (or do not reliably) report the sizes of their holdings (for obvious reasons). Another way to address the question, though, is to look at data on the real price of gold. Assuming that the switch in regime has altered only the world monetary stock demand for gold (leaving unshifted the monetary stock supply curve and the flow supply and demand curves), the question of whether world resource costs are lower under fiat regimes reduces to the question of whether the monetary stock demand for gold has fallen. The answer is "yes" if, and only if, the purchasing power of gold has fallen. A lower ppg implies that more of the existing stock and flow have been freed to non-monetary use, and less mining activity is being undertaken. A higher ppg implies the opposite.

In point of fact, the purchasing power or real price of gold is higher today than it was in the gold standard era. $300 per ounce in 1998 is equivalent to more than $60 at 1967 prices, whereas gold was $35 per ounce in 1967. It is equivalent to more than $31 at 1929 prices, whereas gold was $20.67 per ounce in 1929.[11] The implication is that the switch to fiat standards has *increased* rather than decreased the (quasi-) monetary stock demand for gold, and has ironically *increased* the resource costs of the monetary system.

A well-known, and still-cited, estimate of the flow resource cost of a gold standard is Milton Friedman's (1953; 1960) theoretically derived estimate that the costs of acquiring new gold would annually consume 2.5 percent of

[11] Using 1967 = 100 as the base year, the CPI for 1928 and 1929 was 51.3; for November 1998, it was 492.

national income. If this estimate were accurate, a gold standard would be very expensive indeed. Friedman assumes that wear-and-tear is zero, and focuses entirely on the annual amount of gold mining or importation called for by growing real money demand. (A constant stock of monetary gold cannot be an equilibrium in growing economy, in a world with non-exhausted mines, because, with growing money demand, the ppg would continually rise, making mining increasingly profitable.)

To estimate the size of the ratio $\Delta G/Y$, where ΔG is the dollar value of the annual change in the stock of monetary gold and Y is annual national income, Friedman decomposes it into other ratios for which, given further assumptions, empirical values can be found and plugged in:

$$\frac{\Delta G}{Y} = \left(\frac{\Delta G}{\Delta M}\right)\left(\frac{\Delta M}{M}\right)\left(\frac{M}{Y}\right)$$

where M is the size of the M2 money stock and ΔM is the annual change in M2. It will be easiest to consider the ratios in reverse order. To plug in a value for (M/Y), Friedman (1960) took the most recent ratio of M2 to net national product (NNP), namely M2/NNP = .625. More recent figures are very similar in magnitude,[12] so there is no problem here. Plugging in a value for the second ratio, the annual growth rate in the money stock $(\Delta M/M)$ requires an assumption about the behavior of gold stock. Assume (just as we did in figure 2.2 above) that all long-run equilibrium points lie along a flat "long-run supply curve" such that the purchasing power of gold always remains at the same level as monetary demand grows.[13] Then the stock of monetary gold must adjust to keep the quantity of money equal to the quantity demanded at a constant ppg. In other words, the money stock must grow at the rate just sufficient to maintain a constant price level or zero inflation rate. Such an economy is pictured in figure 2.4.

We can find the implied money growth rate using the dynamic equation of exchange

[12] In other words, the velocity of M2 is back in the same neighborhood, though it has drifted a bit in the interim.

[13] I put "long run supply curve" in quotes because normally a long-run Marshallian supply curve describes a long-run relationship between price and *flow* quantity supplied, not the long-run stock results of the accumulation of flows. (A stock supply curve is normally drawn on the assumption of a *fixed* total stock being allocated among competing uses). A sufficient condition for the long-run value of the ppg to be constant is that the long-run flow supply curve is flat. The same result obtains without a flat flow supply curve if the flow supply and demand curves simply continue to intersect at the same ppg, either because neither shifts or because they always happen to shift in parallel.

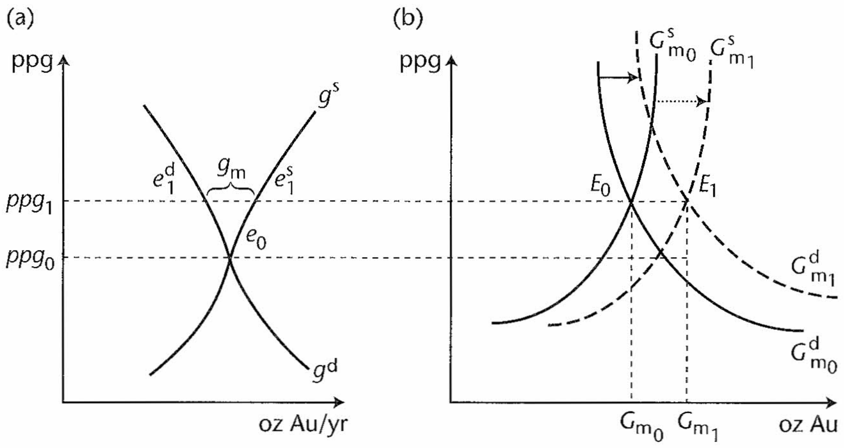

Figure 2.4 Ongoing steady growth in the monetary demand for gold: as shown in (b), the monetary stock demand for gold increases steadily each period; the ppg is continually kept at ppg_1, above its stationary equilibrium value ppg_0; in (a) the high ppg generates a flow of gold into coinage each period g_m; in (b), the accumulation of new coins shifts the monetary gold stock to the right each period, balancing the increased stock quantity demand at ppg_1

$$\frac{\Delta M}{M} + \frac{\Delta V}{V} = \frac{\Delta P}{P} + \frac{\Delta y}{y}$$

where $\Delta V/V$ is the rate of growth of velocity, $\Delta P/P$ is the inflation rate, and $\Delta y/y$ is the rate of growth of real income. We plug in empirically derived figures for the real income growth and velocity growth terms (whose difference is the rate of growth of real money demand), plug in zero for the inflation rate, and solve for money stock growth. Historical evidence on secular trends at the time of Friedman's estimate suggested that $\Delta V/V$ as –1 percent and $\Delta y/y$ as 3 percent were appropriate per annum figures. Thus, the implied $\Delta M/M$ equals 4 percent. The money stock would have to grow at 4 percent per annum under a gold standard to keep the ppg constant given the assumed rates of real income and velocity growth.

Finally, we need a value for $(\Delta G/\Delta M)$, the ratio of additional gold to the additional M2 money stock. In other words, how many dollars' worth of gold has to be mined to support $100 worth of new M2? Friedman assumed, remarkably, that the stock of gold equals *100 percent* of M2, so that G/M = 1 and $\Delta G/\Delta M = 1$. That is, he assumed that banks hold 100 percent reserves of gold, not only against demand liabilities, but even against time deposits.

His rationale was that he wanted to estimate the resource costs of a "pure" gold monetary system, a system in which all forms of money (and even all time deposits) are literally gold or warehouse receipts for gold.

Plugging in all these figures,

$$\frac{\Delta G}{Y} = \left(\frac{\Delta G}{M}\right)\left(\frac{\Delta M}{M}\right)\left(\frac{M}{Y}\right)$$
$$= (1)(.04)(.625)$$
$$= .025$$

Thus the value of newly acquired gold each year would equal 2.5 percent of GNP. Put another way, 2.5 percent of GNP would be the economy's annual cost of acquiring gold, given that, in equilibrium, the cost of extracting or importing new gold equals the value of the gold extracted or imported.

Whatever its value as an estimate of the resource cost of a 100 percent-reserve gold standard,[14] Friedman's calculation gives a huge overestimate of the resource costs of a gold standard with an advanced banking system in the absence of legal reserve requirements. A gold standard, as noted early in this chapter, generically means a system in which money is *meaningfully denominated* in gold. It need not be the case that every piece of money *consists of* gold or is backed 100 percent by gold in a vault. Historically, most payments in gold-standard systems were made with fractional-reserve banknotes, and demand deposits, that were denominated and redeemable in gold coin. Reserve ratios were nowhere near 100 percent against these demand liabilities, let alone against banks' total liabilities including time deposits.

To reach a more reasonable estimate of the resource cost of a generic gold standard, we need to plug in a more reasonable figure for the ratio of gold to money in the broader sense, *G/M*. The stock of monetary gold equals bank reserves plus gold coins. Together, these have historically been a small fraction, not 100 percent, of M2. Continuing to work with M2 as the measure of the money stock, we can estimate the ratio by figuring

$$\frac{G}{M} = R + \frac{C_p}{M} = \left(\frac{R}{N} + D\right)\left(N + \frac{D}{M}\right) + \frac{C_p}{M}$$

[14] It is hard to understand why Friedman used M2 rather than M1 as the relevant measure of the money stock, since the time deposits included in M2 are clearly not media of exchange. Even the advocates of a 100 percent-reserve gold standard (e.g. Rothbard 1995) limit the application of their reserve requirement to demand liabilities. (For a critique of the 100-percent reserve position, see Selgin and White 1996).

where R is bank reserves, C_p is gold coins held by the public, and M is M2. $R/(N + D)$ is the ratio banks maintain between their gold reserves and their demand liabilities (bank-issued currency notes and deposits), $(N + D)/M$ is the ratio of currency notes and deposits (i.e. M1 minus coins) to the M2 money stock, and C_p/M is the ratio of coins to M2. In sophisticated gold-based banking systems without legal restrictions on reserve ratios, like Scotland's in the nineteenth century, the stock of bank reserves equaled about 2 percent of demand liabilities.[15] Coins in the present-day USA are about 8 percent of currency, currency is about 51 percent of M1, and M1 is about 32 percent of M2. Currency notes and demand deposits are thus about 30.7 percent of M2, and coins about 1.3 percent of M2. (Note that treating all coins as full-bodied gold coins errs on the side of overestimating the amount of gold in use, because small change under a gold standard can and often did consist of redeemable token coins.) Multiplying the reserve ratio of 2 percent by the currency note and demand deposit portion of M2 (.288), and adding the coin portion:

$$\frac{G}{M} = .02(.307) + .013 = .00614 + .013 = .01914$$

Assuming that the marginal reserve ratio $\Delta G/\Delta M$ is the same as the average reserve ratio G/M, the marginal ratio of gold to the broad money stock thus equals approximately 2 percent. Plugging in 2 percent where Friedman plugged in 100 percent obviously reduces our estimate of the resource cost of a gold standard to *one-fiftieth* of Friedman's figure:

$$\frac{\Delta G}{Y} = \left(\frac{\Delta G}{M}\right)\left(\frac{\Delta M}{M}\right)\left(\frac{M}{Y}\right)$$
$$= (.02)(.04)(.625)$$
$$= .0005$$

Taking fractional reserve banking into account thus reduces the estimated resource cost of a gold standard down to 0.05 percent, or five hundredths of 1 percent, of national income.

An adjustment might also be made to the second ratio. Recall that Friedman's 1960 figure of $\Delta M/M = 4$ percent assumed annual real income growth of 3 percent and velocity growth of –1 percent. Since 1960 in the USA, the 3 percent figure for annual real income growth has held up fairly well. Annual velocity growth was actually about +3 percent during 1960–1980 (as inflation rose), but has been approximately 0 percent since 1980 (as infla-

[15] Some Scottish banks held reserve ratios as low as .5 percent.

tion fell). Plugging in velocity growth of 1 percent in place of Friedman's –1 percent would reduce the implied money growth figure to 2 percent, cutting the resource cost estimate in half, resulting in a revised figure of .00025 (or .025 percent) two-and-a-half hundredths of 1 percent of national income. By this benchmark, Friedman's estimate is *100 times too high* for a system with fractional reserves..

The estimate might be further tweaked, in either the upward or the downward direction. The estimate would rise if we add in an allowance for wear-and-tear depletion of the existing monetary gold stock, which would require additional mining to offset it, but such depletion is most likely trivial in a sophisticated monetary system. Gold bars held in clearinghouse vaults are seldom handled and thus do not wear away. Gold coins in circulation do suffer wear, but, for that very reason, a token coinage is likely is likely to replace them. Because two-thirds of the monetary gold stock consists of coins in our estimates above, assuming the replacement of full-bodied coins with fractionally backed tokens would reduce our estimates by another factor of three, making our most optimistic estimate less than .01 percent of national income.

Is a Gold Standard Worth the Resource Cost?

Suppose it is agreed that a reasonable range of estimates of the resource cost of a gold standard is .01 to .05 percent of national income. Assume, ideally, that these resource costs could be entirely avoided under a fiat regime. Does a gold standard provide enough advantages, in comparison to a fiat standard, to make the resource cost worth bearing from the perspective of enhancing net national income? One advantage, comparing actual gold and silver standards with actual fiat standards, is lower inflation. Rolnick and Weber (1994) find that the average annual rate of inflation under commodity money has been approximately 7 percentage points lower (–.5 percent versus 6.5 percent per year, excluding episodes of fiat hyperinflation). The public bears a lower deadweight loss from the distortions associated with a 7 percent tax on holding money. How large an advantage is that as a percentage of national income? A standard approach to estimating the welfare cost of inflation is to plot a money demand curve against the inflation rate, and then to measure the size of the deadweight loss triangle under the curve (the amount by which the dollar value of lost consumer surplus exceeds the gained government revenue from monetary expansion) at specified rates of inflation. Two commonly cited estimates of the cost of a 10 percent inflation rate, arrived at this way, put it respectively at .3 or .45 percent of national income (see Cooley and Hansen 1989, p. 744). If the welfare cost of a 7 percent inflation rate differential (going from –.5 percent to 6.5 percent) can conservatively be put at one-half of the lower figure (the area of the deadweight loss triangle varies as the square of its leg, and $.7^2 \approx .5$), it is still three times our upper-bound estimate of the resource cost of a gold standard. A gold standard's resource cost is worth bearing if the alternative is a fiat standard with 6.5 percent inflation.

To put the same idea the other way around, a *fiat* standard is not worth having where its deadweight burden exceeds .05 percent of national income, which (following the above interpolation method) implies that it is not worth having where it produces an inflation rate of about 4 percent or more. A country where fiat money is managed so as to keep inflation below 4 percent can do without a gold standard; but a high-inflation country would be better off with gold.

As an alternative approach to the sizes of costs and benefits we are talking about, note that Robert Lucas (1987) has tried to put a price tag on the risk caused by instability (variation) of real consumption in the post-war economy. Assuming a reasonable degree of risk aversion on the part of a representative consumer, Lucas conservatively estimates that bearing the risk is equivalent to a loss of one-tenth of 1 percent of income. This figure is two to ten times our estimate of the resource cost of a gold standard. If monetary instability is an important source of income instability, a gold standard would only have to relieve a fraction of monetary instability to cover its resource costs.

But would a gold standard even contribute in the right direction to relieving monetary or consumption instability? "Countercyclical" or "activist" monetary policies are not possible with a system in which the gold standard automatically, rather than a central bank with discretion, regulates the quantity of money. That may be a blessing or a curse, depending on whether activist monetary policies actually relieve instability, or instead they (inadvertently) contribute to it. The effectiveness of activist policy is a familiar theme in the Keynesian–Monetarist debate in macroeconomics. We defer discussion of that debate to later chapters, but simply note that a gold standard is more likely to appeal to those who, like Monetarists, find that central bank activism tends to be destabilizing in practice.

Attempts to measure real income instability under the classical gold standard, to contrast it with instability in the post-war era, often conclude that real income was *less* stable under the gold standard. These measurements may not be reliable as indicators of the degree that would be experienced under a modern gold standard, however, for two reasons. The first reason relates to the data: real and nominal national income statistics for the pre-World-War-I period are not based on as broad an array of industry data as are post-war statistics, making cross-regime comparison problematic (Romer 1986). Second, the banking system in the USA, and other nations, was regulated in ways that almost surely contributed to monetary instability. It would be necessary to disentangle these regulatory effects from any instability due to the gold standard as such.

Questions

1 If, under a gold standard, banks are required by law to hold 100 percent reserves of gold against demand liabilities, what does that imply for the purchasing power of gold, monetary stock of gold, and annual production of gold? How does it affect the resource costs of the monetary system, compared to leaving reserve ratios legally unrestricted?

2 Is the opportunity cost of holding currency higher for individuals in a gold standard regime, or in a fiat money regime?

3 Did the gold rushes of the nineteenth century stabilize, or destabilize, the purchasing power of gold?

4 Under a gold standard, does technological progress produce a tendency toward a rising, or a falling, price level?

5 "The development of the clearing system and of fiduciary media [fractionally backed bank-issued money] has [historically] at least kept pace with the potential increase of the demand for [metallic] money brought about by the extension of the money economy, so that the tremendous increase in the exchange value of money, which otherwise would have occurred as a consequence of the extension of the use of money, has been completely avoided . . . If it had not been for this, the increase in the exchange value of . . . the monetary metal, would have given an increased impetus to the production of the metal." (Ludwig von Mises, 1980, p. 333)

(a) Use flow and stock supply-and-demand diagrams to illustrate the impact of an increase in the demand for metallic money, ceteris paribus. How do your diagrams show an "increase in the exchange value of the monetary metal" (purchasing power of gold), and an "increased impetus to the production of the metal"?

(b) Assume that Mises's first sentence is historically accurate. Illustrate the *joint* impact of the increase in the demand for money (as shown in (a)) together with the development of clearing and fractional-reserve banking.

6 Assume a closed gold-standard economy in which

(a) all potential gold-extraction sites have already been discovered,

(b) the marginal cost of extracting gold rises as existing sites are depleted, and

(c) the real demand for money is a constant fraction of annual real income. What do these conditions imply for the long-run path of the price level as real income grows? (Assume that wear-and-tear on monetary gold is zero.)

7 Using flow and stock supply-and-demand diagrams for gold, show short-run and long-run responses of the ppg, stock of monetary gold, and flow production of gold, to each of the following events. Assume that flow and stock markets begin and end in stationary equilibria.

(a) An economical process is accidentally discovered for extracting gold from seawater.

(b) A huge treasure of gold is discovered in a fleet of wrecked ships on the floor of the Caribbean.

(c) Banks develop inventory-management techniques that reduce their demand for gold reserves.

(d) "Audiophile" gold DVDs become popular, using discs that bond gold to plastic in a way that makes the gold unrecoverable at any relevant price.

(e) Goldfinger vaporizes the gold in Fort Knox.

(f) Solid gold jewelry becomes suddenly more popular.

8 Joseph T. Salerno (1987) writes: "Under a genuine gold standard, then, the growth in real output tends to naturally call forth additions to the money supply." Explain how one might reach this conclusion. That is, why and how does growth in real output of non-money goods and services in an economy (real GDP) lead to growth in the stock of monetary gold?

9 "Proponents of the gold standard cite its low-inflation record. These days, money's stable value during the gold standard has come to be associated with gold per se. However, the gold standard ultimately worked because of restraint, the restraint to hold gold's dollar price constant rather than make periodic revaluations. In short, it is the commitment, not the commodity, that makes paper money hold its value – then and now. The real [guarantee of stable-valued money] is honesty, not gold." (Haslag 1996)

(a) Explain how periodically changing "gold's dollar price" (the defined gold content of the dollar) would change the inflation rate under a gold standard. That is, spell out the role the gold content of the dollar plays in determining the price level in dollars, and how changing the former changes the latter.

(b) Suppose the gold content of the dollar is "honestly" held constant. Is that enough to make the dollar "hold its value" – i.e. does it imply a constant purchasing power for the dollar? If so, explain why. If something more is required for stable purchasing power, identify what it is and explain why.

10 In the spirit of Friedman's general approach to calculating the resource cost of a commodity standard, what would go into a compa-

rable calculation of the resource cost of a fiat standard? Are there any important difference between the costs of an *ideal* fiat regime and the costs of *actual* regimes seen today?