MONEY AND THE PRICE LEVEL UNDER THE GOLD STANDARD*

This paper deals with the determination of the price level under the gold standard and related commodity standards (bimetallism, symmetalism, commodity-reserve currency). Since the "central bank" supports the nominal price of a reserve commodity such as gold under these systems, the determination of the absolute price level amounts to the determination of the relative price of the reserve commodity. In this sense the absolute price level becomes a determinate quantity that is amenable to usual supply and demand analyses, as applied to such things as gold production and non-monetary uses of gold. Although changes in the ratio of "money" to its commodity backing or shifts in velocity can influence the price level, the system possesses an important nominal anchor in the fixed price of the reserve commodity.

By way of contrast the absolute price level is determinate under a fiat (government-issue) currency system only up to the determination of the quantity of the fiat currency. Analysis of the price level involves, as its major element, a theory of government behaviour with respect to the quantity of money. In particular, there is no obvious nominal anchor that prescribes some likely limits to changes in the absolute price level.

The above discussion suggests that an important aspect of the gold standard or similar standards in relation to a fiat system is the (partial) separation of price level determination from governmental policy. This separation can be only partial since, at the level of the choice of a monetary regime, it is clear that the determination of money and prices cannot be divorced from the political process. The possibility for alterations in the underlying regime is exhibited by the gradual erosion of the international gold standard since 1914, and especially since the 1930s. The present analysis does not deal with this sort of change in the underlying "monetary constitution" (see Buchanan, 1962), but is rather confined to the workings of the system under a fixed monetary structure.

I. THE GOLD STANDARD

(A) Determination of the Price Level and the Money Stock

The framework of analysis is a closed economy that can represent either a single country or the world economy under fixed exchange rates. The stock of money, denoted by \( M \) and denominated in a nominal unit such as dollars, represents a liability of the central bank(s). It can be assumed that money takes the physical form of a paper claim, rather than directly embodying gold or some other physical commodity. However, the bank is assumed to stand ready to...
buy or sell any amount of gold offered or demanded in exchange for money at the fixed (dollar) price, $P_g$.\(^1\) If $G_m$ represents the stock of gold held by the bank, then the supply of money would equal $P_g G_m$ under a strict commodity standard where the paper claims represent literal warehouse certificates, and would exceed this amount under a partial commodity standard. I assume that the total money supply is

$$M^s = (1/\lambda) \ P_g \ G_m,$$

where the parameter $\lambda$, which satisfies $0 < \lambda < 1$, measures the gold "backing" of the monetary issue.\(^2\)

The demand for circulating medium, $M^d$, is assumed to depend on the "general price level of commodities", $P$, on real income, $y$,\(^3\) and on the opportunity cost rate for holding money rather than alternative assets. In the present set-up I assume that the principal alternative store of value is a commodity stock (or capital with a fixed real rate of return), so that the opportunity cost rate for holding money is measured by the expected rate of inflation, $\pi \equiv E(\dot{P}/P)$,\(^4\) where a dot denotes a time derivative. Formally, money demand is represented by

$$M^d = k(\pi) Py,$$

where the minus sign denotes a negative derivative which signifies that expected inflation and desired money holding are inversely related. The indicated unit income elasticity of money demand is convenient but not essential for the main analysis. The $k$-function can be thought of as an expression for the reciprocal of velocity.

The equation of money supply and demand from equations (1) and (2) implies the price level condition,

$$P = \frac{P_g \ G_m}{\lambda k(\pi) y}.$$

In the subsequent analysis a principal issue is the implication of fixity in $P_g$ – as guaranteed under the gold standard – for the short- and long-run behaviour of the general price level, $P$. Since equation (3) holds at all times, variations of $P$ around $P_g$ reflect movements in the right-hand-side variables, as represented in the combination, $G_m/(\lambda ky)$. For most of the analysis the variables $k$, $\lambda$, and $y$ are treated as exogenous, although subject to disturbances. For purposes of exposition I have also carried out the main analysis in a setting that omits sustained growth in output, $y$. However, I have indicated the

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\(^1\) This set-up for a convertible currency is the one described by Ricardo (1821), p. 241.

\(^2\) If money is defined to include commercial bank deposits, then the ratio of deposits to currency would influence the value of $\lambda$ under a fractional-reserve banking system. Alternatively, if $M$ is defined as high-powered money, then shifts in the deposit–currency ratio would influence the demand for "money", as represented by the $k$-function below.

\(^3\) Real income would include the value added in the gold industry net of depreciation on gold stocks. Similarly, $P$ would include $P_g$ with an appropriate weight.

\(^4\) Substitution between money and gold holdings implies that $E(\dot{P}_g/P_g)$ would enter as an additional negative argument of the money demand function. Since $P_g$ is assumed constant, the inclusion of this term would not alter the subsequent analysis.
necessary modifications to incorporate growth. At the present stage the focus is on endogenous movements of the monetary gold stock, $G_m$.

As stressed by Fisher (1922), pp. 99 ff., the two key determinants of the monetary gold stock in a dynamic context are gold production and the extent to which gold is held for non-monetary purposes. Let $g$ represent the rate at which new gold is produced. I assume that the current production function for a representative member of the gold mining industry can be expressed by the (real) cost function, $c(g)$, which describes the cost in commodity units for producing gold at rate $g$. Production is assumed to involve positive and increasing marginal cost — that is, $c', c'' > 0$. The nominal cost for producing gold at rate $g$ is $Pc(g)$, while the nominal revenue is $P \cdot g$ (with a common price for gold in monetary and non-monetary uses). Revenue-maximising behaviour on the part of gold producers, each of whom regards $P \cdot g$ and $P$ as exogenous, entails

$$c'(g) = \frac{P \cdot g}{P},$$  \hspace{1cm} (4)

which implies a supply function for new gold of the form,

$$g^s = g^s \left( \frac{P}{P \cdot g} \right).$$  \hspace{1cm} (5)

Let $G_n$ denote the stock of gold that is held for non-monetary (industrial, ornamental, etc.) uses. Gold held for these purposes is assumed to depreciate in an economic sense at the constant rate $\delta$. (Gold held by the central bank is assumed not to depreciate.) Since the main analysis abstracts from real income growth, $\delta G_n$ will turn out to measure the flow demand for gold in a steady state. More generally, this flow demand would also include the growth in $G_m$ and $G_n$ that is associated with sustained growth in $y$.

Non-monetary uses of gold would be deterred by a higher current relative price, $P \cdot g/P$, but would be encouraged by expectations of higher future values of $P \cdot g/P$. With $P \cdot g$ constant, expected future values of $P \cdot g/P$ vary inversely with $\pi$. Accordingly, I assume that the "target" stock of privately held gold is determined by a function of the form

$$f \left( \frac{P}{P \cdot g}, \pi \right) y,$$

which assumes, for convenience, a unit income elasticity. The underlying assumption that $P \cdot g$ is fixed seems to rule out the principal rationale for "speculative" gold hoards, so that the $f$-function should be thought of as pertaining to "real" uses of gold (for industry, ornamentation, etc.), rather than to a portfolio demand, per se. In this context it also seems natural to rule out rapid

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1 See also Thornton (1802), p. 266, Mill (1848), ch. ix, Friedman (1951), pp. 207 ff., and Whitaker (1976), section 1. Niehans (1977), in an interesting recent contribution, also discusses some of the topics that I consider in my analysis.

2 The exhaustible-resource property of gold could be captured by entering the accumulated stock of previously mined gold as a positive argument in the cost function. When the possibility of new discoveries and technical changes in mining are admitted, it is not clear that exhaustibility is an important characteristic over a relevant horizon. In any case the pertinent issue for subsequent analysis is the rate of "technical advance" in gold production relative to that in other industries — see section B2, below.
(that is, discrete) shifts in the non-monetary gold stock. Accordingly, I specify the non-monetary demand for gold in the form of a flow function,

$$g^d_n = \alpha [f(P/P_g, \pi) y - G_n] + \delta f(P/P_g, \pi) y.$$  (6)

Equation (6) assumes a desired gradual adjustment of $G_n$ toward its target position in accordance with the adjustment parameter, $\alpha > 0$. In addition, $g^d_n$ incorporates the "normal" replacement flow, $\delta f(...)$, that would be required to maintain the target value of $G_n$. Note that the form of equation (6) implies that $G_n$ has a negative effect on $g^d_n$. The form also implies $g^d_n = \delta f(...) y = \delta G_n$ when $G_n$ is equal to its target value. The net change in $G_n$ at any point in time is given by

$$\dot{G}_n = g^d_n - \delta G_n = (\alpha + \delta)[f(P/P_g, \pi) y - G_n].$$  (7)

Finally, with the monetary authority standing ready to buy or sell any amount of gold at price $P_g$, the change in the monetary gold stock is given by

$$\dot{G}_m = g^m - g^d_n = g^m(P/P_g) - \alpha[f(P/P_g, \pi) y - G_n] - \delta f(P/P_g, \pi) y.$$  (8)

Consider the situation where $y$, $\lambda$, $P_g$, and the forms of the $k$- and $f$-functions are fixed. The steady state of the system described by equations (3), (7) and (8) corresponds to

$$p = G_m = n = ?$$

It can also be supposed that $\pi$, the expected value of $P/P$, is equal to the actual value, zero, in the steady state. In order to simplify the analysis I assume at the outset that $\pi$ is fixed at zero even when $P$ is changing over time.

The steady-state values of $P$, $G_m$, and $G_n$, which will be denoted by asterisks, can be determined from equations (3), (7) and (8). Equations (8) and (7), together with $\dot{G}_m = \dot{G}_n = 0$, imply

$$g^m(P*/P_g) = \delta f(P*/P_g, \pi^*) y.$$  (9)

This condition (together with $\pi^* = 0$) determines the steady-state value, $P*/P_g$, and, hence, $P*$ from the equality between gold production and the replacement demand for non-monetary gold. In a model where $y$ was continually increasing, the steady-state flow demand for gold would have additional components that reflected the growing demand for gold stocks in monetary and non-monetary uses.

1 The alternative specification that substitutes $\delta G_n$ for $\delta f(...)$ in equation (6) would seem appropriate if adjustment costs applied to the net change in $G_n$, which equals $g^d_n - \delta G_n$, rather than to alterations in the gross flow, $g^d_n$. The alternative assumes that changes in the gross flow that are associated with changes in actual depreciation, $\delta G_n$, do not involve any adjustment costs. Hence, the alternative has the odd property that a rise in $G_n$ for a given value of $f(...)$, could raise the value of $g^d_n$. Although my preference is for the form of equation (6), the substitution of the alternative form would affect only a minor part of the dynamic analysis. (The form of the $G_m$ expression, below, would be altered.)

2 If the stock of previously mined gold were entered as a negative argument of the supply function (see note 2, p. 15 above), then $P$ would not be constant in a steady state. Because of the depreciation of non-monetary gold stocks, $P$ would have to fall continually in a steady state in order to provide the replacement flow of gold.
Equation (7) implies in a steady state that

$$G_n^* = f\left(\frac{P^*}{P_0}, \pi^*, y\right)$$ (10)

which determines the value of $G_n^*$ once $P^*$ is set from equation (9). Finally, the money-supply-equals-money-demand condition, equation (3), implies

$$G_m^* = \lambda k(\pi^*) y \frac{P^*}{P_0}$$ (11)

which determines the steady-state value $G_m^*$ (and, therefore, the money stock $M^* = \frac{1}{\lambda} P_0 G_m^*$), once $P^*$ is determined.

Consider a situation in which the outstanding gold stocks, $G_m$ and $G_n$, are currently fixed at levels that need not correspond to a steady state. Given the values of $y$, $\pi$, and $P_0$, the value of $G_m$ determines the current value of $P$ from equation (3). With $y$, $\pi$, etc., constant, the movements of $G_n$ and $G_m$ (and hence, of $P$) are determined from equations (7) and (8).

Figs. 1 (a, b) depict the steady-state values, $P^*$, $G_m^*$ and $G_n^*$, and also describe the dynamics of $P$, $G_m$ and $G_n$. The line in Fig. 1 (a), based on equation (3), relates the value of $P$ to the value of $G_m$. In Fig. 1 (b) the locus denoted by $G_{m} = 0$ indicates combinations of $G_n$ and $G_m$ that yield $G_{m} = 0$ in equation (8), taking into account the relation of $P$ to $G_m$ from equation (3). An increase in $G_m$ raises $P$, which lowers $G_n^*$ and raises $G_n$. Hence, $G_{m}$ falls when $G_m$ rises. Since an increase in $G_n$ reduces $G_n^*$, which implies an increase in $G_{m}$, the $G_{m} = 0$ locus is positively sloped. Similarly, equation (7) implies that the $G_{n} = 0$ locus is positively sloped. It can also be verified from equations (3), (7) and (8) that the $G_{n} = 0$ locus has a steeper slope than the $G_{m} = 0$ locus, so that the usual stability conditions are satisfied in this model (at least in the present case where $\pi$ is fixed throughout at its steady-state value of zero). The slopes of the two loci and the stability conditions are derived in the appendix.
The following sections analyse the effects of various disturbances in the "short- and long-run". The focus is on the determination of $P$ – notably, on the extent to which the gold standard insulates the price level from a variety of shocks.

(B) Properties of the Model

(1) Technical Progress in Gold Production (Gold Discoveries)

Consider a technical advance, discovery, etc., that reduces the marginal cost of producing gold, $c'(g)$, for a given value of $g$. Since the supply function, $g^s$, shifts upward, equation (8) implies that $\dot{G}_m$ is higher for given values of $P$ and $G_n$. Since there is no shift in the relationship between $P$ and $G_m$ from equation (3), the Fig. 2(a) curve does not move, but the $\dot{G}_m = 0$ locus shifts upward in Fig. 2(b). (A higher value of $G_m$ is now required, for a given value of $G_n$, to attain $\dot{G}_m = 0$.) The $\dot{G}_n = 0$ locus does not change, in accordance with equation (7).

Fig. 2 (b) shows that $G_m$ begins to rise in response to the disturbance. There is no immediate response in $P$ or in $\dot{G}_n$. As $G_m$ rises over time – as shown by the arrows in Fig. 2 (b) – there is a corresponding increase in $P$, which leads to an increase in $G_n$ and to a retardation in the growth of $G_m$. The new steady state is characterised by higher values of $G_m^*$, $G_n^*$ and $P^*$, the increases in $G_m^*$ and $P^*$ being equiproportional. It also follows from equations (4), (5) and (9) that (for a given shift in marginal production cost, $c'(g)$) the proportional increase in $P^*$ will be larger the larger the price elasticity of the supply function, $g^s$, and the smaller the magnitude of the price elasticity of the non-monetary gold demand function, $f$.

1 This analysis abstracts from the possibly different intertemporal implications of changes in technique versus discoveries of new gold sources. (See notes 2, p. 15, and 2, p. 16, above.)

2 Unless the contrary is noted, this and subsequent analyses neglect changes in $y$ or $\pi$. Real income would change in the present case because of the technical advance in gold production. I have neglected this income effect because it is likely to be of second-order significance. See below for a discussion of expected inflation effects.
This analysis accords with Mill's in predicting, first, a delayed and gradual rise of the price level in response to an increase in gold production, and, second, a coincident movement of $P$ and $G_m$ (and, hence, of $M$). However, these conclusions depend on the fixity of inflationary expectations, $\pi$, or on the constancy of velocity. If gold discoveries are perceived and if such discoveries are known to produce later increases in the price level, then $\pi$ would increase at the time of the discovery. The induced fall in money demand, $k(\pi)$, implies, from equation (3), that $P$ would rise for a given value of $G_m$.\(^2\) (A full analysis of the impact of a shift in $k$ is carried out in section 5, below.) In particular, there would be an initial jump in the price level before any movement occurred in $G_m$ or the money stock. Hence, the workings of price expectations would eliminate part of the lagged response of $P$ to gold discoveries and would produce a pattern where movements in $P$ led movements in $G_m$ and $M$.\(^3\)

A natural assumption is that $\pi$ corresponds to the time path of inflation that is generated by the model (rational expectations). However, I have not carried out this analysis within the present framework. One difficulty is that the various disturbances being considered here and below — to $c(g)$, $y$, $\lambda$, etc. — are presumably stochastic, which would have to be modelled explicitly in order to generate $\pi$ in a rigorous manner. The information possessed by individuals about gold discoveries, etc., would also have to be specified. In any event the present mode of analysis may be adequate to ascertain the major types of responses to the indicated disturbances.

For evaluating the gold standard as a device for stabilising the general price level, the main implication of the present exercise is that volatility in conditions of gold production (associated with gold discoveries and changes in mining technique) would lead to volatility in the general price level.

Without working through the details it can be noted that shifts in non-monetary gold demand — that is, movements in the $f$-function — have basically similar implications (although in the opposite direction) for the determination of the price level under the gold standard.\(^4\)

\(\text{(2) Changes in Real Income}\)

Consider a one-time increase in real income, $y$, while holding fixed the technology of gold production. This example would reflect the secular pattern in the economy if gold mining were subject to less "technical advance" or to greater diseconomies-of-scale than the typical industry. The analysis deals initially with a one-time income change, although the effects of sustained income growth are also noted.

Equation (3) implies that $P$ declines in inverse proportion to $y$ for a given

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\(^1\) "Alterations...in the cost of production of the precious metals do not act upon the value of money except just in proportion as they increase or diminish its quantity..." (Mill, 1848, p. 20).

\(^2\) There would also be a downward shift in the target stock of non-monetary gold, which would retard the acquisition of $G_n$.

\(^3\) This behaviour also appears in the perfect-foresight model developed by Brock (1975).

\(^4\) An upward shift in the $f$-function leads to decreases in $P^*$ and $G_m^*$ (which are in the same proportion), and to an increase in $G_n^*$. Again, if $\pi$ is held fixed, the dynamic movement of $P$ would lag behind the disturbance and would be coincident with the movement in $G_m$. 

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value of $G_m$ (with $\pi$ held fixed), so that the curve shown in Fig. 3(a) shifts rightward. It follows from equation (7) that $\dot{G}_n$ increases for given values of $G_m$ and $G_n$ if and only if the magnitude of the price elasticity of the non-monetary gold target demand function, $f$, is less than one. Fig. 3(b) depicts the case in which the elasticity equals one, so that there is no shift in the $\dot{G}_n = 0$ locus. In this situation equation (8) indicates that $\dot{G}_m$ rises for given values of $G_m$ and $G_n$, because of the rise in $g^s$.

![Fig. 3. Effect of increased real income.](image)

Equation (g) implies that the increase in $y$ leads, in the steady state, to a fall in $P^*$, as shown in Fig. 3(a). The induced increase in $g^s$ implies that $G_n^*$, which equals $g^s/\delta$ is a steady state, is increased. This property is exhibited in Fig. 3(b). The net movement in $G_m^*$, as determined from equation (11), is generally ambiguous, although $G_m^*$ must rise for the case depicted in Fig. 3.\(^1\)

The most important response to a discrete rise in $y$ is the immediate discrete fall in $P$. There is also, at least eventually, a period in which gold is accumulated in non-monetary form. The movement in $G_m$ and the implied further movement in $P$ are ambiguous. It is, however, unambiguous that the steady-state real stock of monetary gold $- P^* G_m^*/P^*$ increases with $y$.

The basic conclusion is that output growth\(^2\) – which dominates over "technical advances" in gold production – would imply secular decline in the price level. This result is often cited as a failing of the gold standard, although there would seem to be no objection to this sort of systematic – and hence, anticipated – deflation on business cycle grounds. The next sections consider the "remedies"

\(^1\) Generally, $G_m^*$ rises if and only if the sum of the absolute price elasticities of $g^s$ and $f$ exceeds one.

\(^2\) If growth in output is sustained over time, a new element is that the corresponding steady decline in the price level would be anticipated in the steady state – that is, $\pi^*$ would be negative. The forms of equations (6) and (7) would also have to be modified to incorporate the regular effect of changes in $y$ and $P$ on the flow demand for non-monetary gold. With growing real income and constant values for $\lambda$ and $k$ (and the assumed unit income elasticities for stock demands), it is possible to find a steady state in which the ratio of $G_m$ to $G_n$ remains constant only if the (steady-state value of the) price elasticity of the $f$-function is equal to minus one. In this case it can be shown that the steady-state inflation rate is $-\rho/(\eta_f + \eta_s) = -\rho/(1 + \eta_s)$, where $\rho = (1/y) d\eta/\eta$, $\eta_f$ is the magnitude of the price elasticity of the $f$-function, and $\eta_s$ is the elasticity of $g^s$. Note that this inflation rate is invariant with shifts in the $k$- or $f$-functions or with changes in $\lambda$. See Mundell (1971), chs. 8 and 13, for some other aspects of the case of sustained output growth.
for secular deflation of paper gold creation and of changes in the nominal price of gold.

(3) "Paper Gold"

It is frequently argued that the deflationist tendency of the gold standard can be countered by supplementing the world's gold stock with some form of paper gold. For example, the plans suggested by Keynes (1943), Triffin (1960, part II), and Mundell (1971, pp. 135–6) can be viewed in this context. Recent forms of monetary supplement include international reserve holdings in the form of U.S. dollars and special drawing rights at the International Monetary Fund. In the present model the creation of paper gold can be modelled by a decrease in \( \lambda \). Note that I retain the assumption that the central bank acts to maintain the (single) gold price, \( P_g \).

Consider a one-time decrease in \( \lambda \), which can be viewed as an increase in the money stock while holding fixed the initial amount of gold backing. Equation (3) indicates that \( P \) would rise for a given value of \( G_m \), as represented by the leftward shift of the curve in Fig. 4(a). It follows from equation (7) that \( G_n \) would rise for given values of \( G_m \) and \( G_n \). Hence, the \( \dot{G}_n = 0 \) locus shifts rightward in Fig. 4(b). Equation (8) implies that \( G_m \) would decline for given values of \( G_m \) and \( G_n \), as indicated by the downward shift of the \( \dot{G}_m = 0 \) locus in Fig. 4(b).

\[ \text{Fig. 4. Effect of increased paper gold or rise in velocity.} \]

The exact position of the new steady state in Fig. 4 can be ascertained from equations (9)–(11). Equation (9) implies that \( P^* \) is invariant with \( \lambda \). It follows from equation (10) that \( G^*_m \) is also unchanged. The downward movement in \( G^*_m \), as shown in equation (11), is therefore proportional to the fall in \( \lambda \), so that the steady-state money stock, \( M^* = (1/\lambda)P_g G^*_m \), remains fixed.

Initially, with \( G_m \) (and \( \pi \)) held fixed, the effect of the increase in \( M \) is to increase \( P \) in proportion. This price change induces a rise over time in \( G_n \) and leads also to a drop in gold production. \( G_m \) falls over time on both counts,
with $P$ declining from its initially higher position in proportion to the decrease in $G_m$. Eventually, a point is reached where $G_n$ is sufficiently high and $P$ is sufficiently reduced so that $G_n$ begins to fall. In the new steady state $G_n$ and $P$ have returned to their initial positions and the only net effect is the decline in $G_m$. Hence, the ultimate impact of increased paper money issue is to drive out part of the monetary gold stock without affecting the price level. In this sense—and as long as the value of $P_g$ is actually maintained—paper gold does not counter the deflationary tendency of the gold standard. However, volatility of paper note issue (that is, of the ratio of money to its gold backing) would lead to short-run volatility of the general price level.\(^1\)

It is worth noting that steady-state real balances, $\frac{M^*}{P^*} = \frac{P_g G_m^*}{\lambda P^*} = ky$, are invariant with $\lambda$, but the real value of the gold backing, $P_g G_m^*/P^*$, is positively related to $\lambda$. Hence, the resource cost associated with the maintenance of the gold standard is, on this count, an increasing function of $\lambda$. Correspondingly, the monetary authority’s steady-state “seigneurage” (in the sense of the stock of revenue from note issue)\(^2\) can be written as $ky - P_g G_m^*/P^*$, which is negatively related to $\lambda$. However, the maximum (stock) amount of steady-state seigneurage—approached as $\lambda \to 0$ and $G_m^* \to 0$—is $M^*/P^*$, which is fixed (for given values of $y$ and $\pi$) at $ky$. In the steady state an excess of the lump-sum proceeds from note issue over $ky$ is inconsistent with maintenance of the gold price, $P_g$. Attempts to secure additional revenue by issuing more paper currency would lead to more and more notes being presented to the central bank for conversion into gold at price $P_g$, which could lead to an increase in the gold price. (The next section deals with the effect of changes in $P_g$.) In this sense the paper gold route could eventually counter deflation by leading to the abandonment of the gold standard.\(^4\) Mundell’s (1971), pp. 133–5, discussion of the international economy during the decade after 1958 parallels this situation. The United States can be viewed as the world’s central banker during this period.

The above analysis must be altered somewhat in the presence of sustained output growth. For present purposes the important consideration is that the steady-state flow demand for gold, which appears on the right side of equation (9), would include a term to account for the growth over time in $G_m$.\(^5\) A decrease in $\lambda$ would reduce the flow of gold for this purpose and would therefore tend

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\(^1\) Since $P$ falls steadily after its initial discrete rise, $\pi$ would tend to become negative. This decline in $\pi$ would dampen the initial upward movement in $P$. More generally, the automatic response in $\pi$ would seem to reduce the short-run price level variance associated with a given variance of $\lambda$.

\(^2\) In this sense a partial commodity standard can “economise” on gold relative to a strict commodity standard. See Friedman (1951), pp. 215–6.

\(^3\) In the model where $y$ and $P_g$ are constant, the flow of revenue from new note issue is zero in the steady state.

\(^4\) Even before the standard was officially abandoned, paper gold issue could increase the price level by raising doubts about the maintenance of the price of gold. A rise in the expected future price of gold would reduce the demand for money and (depending on the reaction of $\pi$) also tend to raise the demand for non-monetary gold. The price level would rise with the decline in money demand, $k$, as shown in equation (3). Over time (with the actual value of $P_g$ held fixed), there would be a tendency for $G_m$ to rise and for $G_m$ and $M$ to decline (so that $P$ would tend to return to its original value unless the actual value of $P_g$ were altered).

\(^5\) The term is $(\rho + \pi) \lambda k(\pi) \frac{P}{P^*} \frac{P_g}{P_m}$, where $\rho$ is the proportionate growth rate of $y$. 

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to raise $P$ at any point in time. Although this channel implies that a lower value of $\lambda$ would be associated with a higher level of the time path of $P$, there would still be no effect of $\lambda$ on the steady-state inflation rate (see note 2, p. 20 above). Therefore it remains a valid conclusion that the (once-and-for-all)\(^1\) choice of the proportional allocation of currency backing between gold and paper does not alter the connection between the gold standard and secular deflation. This connection seems inescapable with $P_g$ held fixed if the gold-mining industry is perpetually less subject to “technical advance” than the rest of the economy.

(4) Changes in the Price of Gold

Consider a one-time increase in $P_g$ in a non-growth context. It follows from equation (3) that, for given values of $G_m$, $\lambda$, etc., $P$ would increase equi-proportionately. Further, equations (9)-(11) imply that this short-run solution, in which $P/P_g$, $G_m$ and $G_n$ are all unchanged, is also the new steady state.

For the case of sustained increases in $P_g$ the new element is that the associated increase in $P$ would be anticipated, as reflected in a rise in $\pi$. This increase would reduce the real demand for money ($k$ — see the analysis of this shift in the next section),\(^3\) but would not alter the principal conclusion from above that the growth rate of $P_g$ would be incorporated one-to-one in the steady-state growth rate of $P$. Notably, the growth rate of $P_g$ could be engineered so as to offset the deflationary tendency of the gold standard.\(^4\) Further (as suggested in the stable money proposal of Fisher, 1920, ch. iv), the value of $P_g$ could be adjusted continuously so as to prevent even short-run fluctuations in $P$.

A difficulty with this “solution” is that it converts the problem of price level determination from an automatic mechanism under the gold standard (with $P_g$ fixed) to a political choice of the time path of $P_g$. If this choice process is “reliable”, then the gold standard could have been dispensed with all along and replaced by a paper standard (at the saving of the resource cost for maintaining monetary gold stocks). Under a paper standard it would “only” be necessary to ensure a “reasonable” growth rate of the quantity of fiat money.

(5) Shifts in Velocity

Consider a one-time decrease in real money demand, $k(\pi)$. In the context of a fractional-reserve banking system where $M$ represents high-powered money, this shift could reflect an increase in the demand for deposits relative to currency.

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\(^1\) A steady decrease in $\lambda$ would have a positive effect on the movement of $P$ over time. However, this connection is subject to “diminishing returns”. That is, as $\lambda$ declines the flow demand for gold for monetary purposes becomes less important relative to the flow for non-monetary uses. If $\lambda$ decreases at a constant rate, $G_m/G_n$ would approach zero, and the steady-state value of $\pi$ would still be the one given in note 2, p. 20 above.

\(^2\) Fixity of $\lambda$ implies that there is sufficient new currency issue to maintain the ratio of $M$ to $P_g G_m$. If $\lambda$ rises (which would occur, for example, if $M$ were held fixed when $P_g$ increased), the above analysis could be used to analyse the additional effects.

\(^3\) Anticipated growth in $P_g$ may also shift the demand for non-monetary gold — see note 4, p. 22 above.

\(^4\) An exact offset would require setting $P_g/P_g = \rho/(1 + \eta_g)$, where $\rho$ is the growth rate of output and $\eta_g$ is the price elasticity of $g^t$. See note 2, p. 20 above.
Equations (3), (7) and (8) indicate that this shock can be described exactly as in Fig. 4, which was constructed for the case of a decrease in λ. The immediate effects of the drop in money demand are a discrete increase in P, a tendency for $G_m$ to fall over time, and a tendency for $G_n$ to rise over time. As $G_n$ rises and P falls along with $G_m$, the rising trend of $G_n$ is diminished and eventually reversed. The new steady state involves a restoration of the initial values of $P^*$ and $G_n^*$, with the only net effect being a decline in $G_m^*$. Real balances, $M/P^* = k_y$, and the real value of monetary gold, $P_m G_m^*/P^*$, are both reduced in the new steady state. One implication of this exercise is that the endogenous movement of monetary gold stocks under the gold standard operates to buffer the price level against velocity shifts.

As in the paper gold case, the analysis requires some modification in the presence of sustained output growth. A one-time reduction in $k$ lowers the steady-state flow of gold that is required to maintain growth in $G_m$. On this count, the disturbance would produce an upward shift in the price level path. However, the steady-state inflation rate would be invariant with $k$ (see note 2, p. 20 above).

(6) Some International Analysis

The model can be readily extended to a multiple country setting in which the gold standard prevails. Suppose that country $i$ ($i = 1, \ldots, N$) is characterised by parameter values $P_{gi}$, $\lambda_i$, $k_i$, $y_i$. The (fixed) exchange rate between country $i$ and, say, country $1$ is then $P_{gi}/P_{g1}$. Arbitrage implies that the relative price of gold and (tradable) commodities would be the same in each country, so that $P_{gi}/P_{g1}$ can be assumed to equal a common value, denoted by $P/P_{g1}$. The equality between money demand and supply in each country at all points in time requires, from equations (1) and (2),

$$G_{mi} = \lambda_i k_i y_i (P/P_{g1}) \quad (i = 1, \ldots, N).$$

(12)

For a given current value of the world’s monetary gold stock, $G_m$, equation (12) can be satisfied for all $N$ countries by determining the allocation of $G_m$ across countries (N–1 independent conditions) and by determining the value of $P/P_{g1}$—that is, by determining the “world price level”. The latter condition can be seen by summing over equation (12) and rearranging terms to get

$$\frac{P}{P_{g1}} = \frac{G_m}{\sum_i (\lambda_i k_i y_i)}.$$  

(13)

In the long run $P/P_{g1}$ is determined by the equality between steady-state flow supply and demand for gold, as in equation (9). The world’s monetary gold stock adjusts in the long run to satisfy equation (13) at this value of $P/P_{g1}$.

1 As in the case of a decrease in λ, a fall in π at the outset would improve this buffering action.

2 Under a fixed exchange rate regime it is necessary for only one country to peg the price of gold directly.

3 I am allowing instantaneous stock transfers of monetary gold (in exchange for commodities) across countries, although non-monetary gold still moves only in a smooth manner. The basic analysis would not seem to be altered if discrete shifts in $G_{mi}$ were ruled out (in which case equation (2) might be replaced by a flow demand for money function) or if discrete shifts in $G_n$ were permitted.
Conditions for determining $G_n$ in each country are analogous to those discussed in the one-country model.

In terms of volatility of general price levels, equation (13) indicates that the relevant influence is the variance of the world's "excess demand" for gold,

$$\left(\frac{1}{G_m}\right) \sum_i (\lambda_i k_i y_i).$$

Notably, if there is some independence across countries in movements of $\lambda_i$, $k_i$, and $y_i$, then (because of a law-of-large-numbers effect) the variance of the general price level in each gold-standard country would tend to decline as the number of countries adhering to the standard increased. In this sense the attractiveness of the set-up to a new country tends to rise with the number of countries that have already adopted the standard. However, it is possible that the inclusion into the gold-standard regime of a country with an especially volatile real demand, $\lambda_i k_i y_i$, would raise the variance of $P/P_g$. A mixing of countries with negative covariances of $\lambda_i k_i y_i$ would also tend to reduce the price level variance, although the empirical relevance of this point is not apparent.

I discuss below some examples of international disturbances that can be treated within the present framework.

(a) **Devaluation.** Consider a one-time devaluation in country $j$, which can be represented by an increase in $P_g$. If $\lambda_j$ remains fixed (implying that paper money in country $j$ rises equiproportionately with the increased nominal value of that country's monetary gold holdings), then it is immediate from equations (12) and (13) that the only impact of the devaluation would be an equiproportional increase in $P_j$. In particular, it follows from equation (13) and the fixity of $P_g$ for all the other countries that there is no spillover effect of the devaluation to prices abroad.

On the other hand, if $\lambda_j$ is allowed to rise with the devaluation (which is, perhaps, the point of the devaluation), then it follows from equation (13) – for a given value of $G_m$ – that $P/P_g$ would decline. That is, $P_j$ would fall in all countries $i \neq j$ that were maintaining the nominal price of gold (or were maintaining a fixed exchange rate with a country that was pegging the gold price). Further, $P_j$ would rise less than equiproportionately with $P_{gj}$ in the devaluing country. The explanation of these effects, indicated in equation (12), is that the fraction of the world's monetary gold stock held in country $j$ rises with the increase in $\lambda_j$. The smaller remaining stock can satisfy the demand in other countries only with a decrease in $P/P_g$.

As in the one-country case analysed before, the long-run solution would also include the adjustment of $G_m$ from gold production, etc. In the no-growth situation the steady-state effect of the devaluation on $P/P_g$ would be nil.

---

1 This analysis assumes that $G_m$ is proportional to the number of countries on the gold standard. See below.

2 This response is closer to equiproportional and the spillover effects to other countries are weaker the smaller the weight of country $j$ in the world's overall demand for monetary gold – that is, the lower the value of $\lambda_j k_j y_j / \sum (\lambda_i k_i y_i)$.

3 A "period" of balance-of-payments surpluses would be required for country $j$ to obtain the additional gold.
although some long-run effect (to the level of the $P/P_g$ path but not to the world inflation rate) would remain in a growth context.

(b) Increased Adoption of the Gold Standard. If an additional country, labelled $N+1$, adopts the gold standard, then

$$\sum \left( \lambda_i k_i y_i \right)$$

in equation (13) would rise with the inclusion of the term, $\lambda_{N+1} k_{N+1} y_{N+1}$. There would be a corresponding decline in $P/P_g$ while $G_m$ is held fixed.\(^1\) Since $G_{m,N+1}$ will now be absorbed by country $N+1$ in accordance with equation (12), the remaining countries can be satisfied with the reduced amount of monetary gold only if $P/P_g$ falls. As an example of this effect, the acquisition of large amounts of gold by the United States during the Resumption Period from 1875 to 1879 and somewhat thereafter (and, similarly, by Germany after 1871) should have exerted a depressing effect on prices in gold standard countries, such as England. Further, a country’s (credible) announcement of a future plan to adopt the gold standard (as by the United States in 1875) would have an immediate downward effect on prices in gold standard countries — that is, even before the new country increased its gold holdings. The mechanism is a decline in the expected inflation rate, $\pi$, in the gold standard countries, which raises the demand for money (as well as the demand for non-monetary gold) and correspondingly lowers the price level.

The analysis can be extended in the usual way to consider the long-run effects when $G_m$ is allowed to vary. In particular, for the no-growth case in which all countries are identical, the steady-state value of $G_m$ would be proportional to the number of countries on the gold standard (see note 1, p. 25 above).

(c) Multiple Commodity Standards. It is, of course, possible for different groups of countries to adhere to different commodity standards — for example, there could be a gold standard group and a silver standard group (or a group of countries on a fiat standard, possibly tied together via fixed exchange rates). It should be noted that this multiple-standard set-up differs from bimetallism, which is discussed below. One observation on a multiple-standard world is that the exchange rate between, say, the gold and silver blocs would be determined by the relative price of gold and silver (which can be assumed to be the same within either bloc). Some empirical evidence that supports this proposition is presented in Sayers (1931) in a study of the Indian/English exchange rate during 1919–20, and in Fisher (1935), pp. 4–5 and chart 5, and Friedman and Schwartz (1963), pp. 361–2 and 489–90, in analyses of the Chinese exchange rate and price level from 1929 to 1935.

An interesting application of the analysis, which amounts to an extension of optimum currency area theory (Mundell, 1968, ch. 12), would be to a determination of the optimal groupings of countries and the optimal number of groups. (I am abstracting here from means-of-payments considerations involved with a particular country’s use of a particular commodity for trans-

\(^1\) I am assuming no change in world demand for non-monetary gold.
actions, and I am also not considering the transactions benefits derived from adherence to a fixed exchange rate regime.) From the perspective of price level variance it seems that (1) a country that has an especially low variance of demand – that is, of \( \lambda_t k_t y_t \) – may find it advantageous to be isolated from the rest of the world; (2) with "free entry" to an existing commodity standard it seems infeasible to exclude from a group a "contaminating" country that has an especially high variance of demand; and (3) there could be incentive for an assortment among groups that exploits any negative covariances of demands. The empirical relevance of these propositions is not apparent.

II. OTHER COMMODITY STANDARDS

(A) Bimetallism

Two possible disadvantages of the gold standard (or an alternative single commodity standard, such as silver) are the short-run variability of prices in the face of volatile gold discoveries (and in the face of volatility in velocity and in the ratio of money to gold) and the tendency for secular deflation. Bimetallism has been advocated (Marshall, 1887, p. 204) as a mechanism for mitigating at least the short-run problem while remaining within the context of a commodity standard. I will first consider the usual form of bimetallism and then discuss Marshall's proposal for a "stable bimetallism", which is called symmetallism.

Returning to the context of a single closed economy, suppose now that gold and "silver" both serve as currency backing with

\[
M^s = \frac{1}{\lambda} \left( P_g G_m + P_s S_m \right),
\]

where \( P_s \) is the nominal price of silver and \( S_m \) is the monetary silver stock. I assume that the circulating medium takes the form of paper notes, rather than gold or silver in a physical sense, so that there is no issue here concerning imperfect substitutability between gold and silver in monetary use. (See Chen, 1972, pp. 96 ff., on this point.) The form of bimetallism that I am presently considering involves (the attempt at) fixed nominal prices for both gold and silver within a single country – that is, \( P_g \) and \( P_s \) are both taken to be constant. Money demand still takes the form of equation (2), so that the price level is determined from

\[
P = \frac{M}{k(\pi) y} = \frac{(P_g G_m + P_s S_m)}{\lambda k(\pi) y}.
\]

The supply of new gold from the production side is again described by equation (5). A similar analysis of silver production leads to the supply function

\[
s^s = s^s(P/P_s).
\]

I assume a flow demand function for silver in non-monetary use that parallels the gold specification in equation (6),

\[
s_n^d = \beta[k(P/P_s, \pi)y - S_n] + \epsilon_h(P/P_s, \pi)y.
\]

The price ratio, \( P_s/P_g \), could be entered separately to account for substitutability between gold and silver in non-monetary use. This addition seems to be inconsequential.
where $\epsilon$ is the depreciation rate for the non-monetary silver stock, $S_n$. The movement of $S_n$ over time is determined from

$$\dot{S}_n = (\beta + \epsilon)[h(P/P_s, \pi) y - S_n]. \quad (18)$$

Finally, the change over time in $S_m$ is

$$\dot{S}_m = s^s - s^d = s^s(P/P_s) - \beta[h(P/P_s, \pi) y - S_n] - \epsilon h(P/P_s, \pi) y. \quad (19)$$

The basic difficulty with bimetallism, which has been discussed theoretically and in an historical perspective by Mill (1848), ch. x, Jevons (1884), ch. xiii, Laughlin (1896) and Fisher (1922), ch. vii, among others, can be seen by observing two of the conditions that ought to characterise a steady state. Consider the equalities between flow supplies and demands for gold and silver, respectively, when the non-monetary stock of each metal is at its target level. The steady-state condition for gold is, again,

$$gs(P*/p_J) = \delta f(P*/p_J, \pi) y, \quad (9)$$

while that for silver is

$$ss(P*/p_s) = \epsilon h(P*/p_s, \pi) y. \quad (20)$$

Ostensibly, equation (9) determines $P*/P_J$, while equation (20) determines $P*/P_s$. However, there is nothing to guarantee that the set values of $P_g$ and $P_s$ are consistent with both relative price conditions. The system has a steady state (with positive values of both $G_m$ and $S_m$) that supports the set gold and silver prices only if the ratio, $P_g/P_s$, is consistent with the “natural” relative price that emerges from equations (9) and (20). Further, if $P_g/P_s$ happens to be set appropriately, then the composition of the monetary backing in the steady state is indeterminate—that is, $M^*$ is prescribed from equation (15), but the breakdown between $G_m^*$ and $S_m^*$ is not specified. To put the result differently, if $P_g/P_s$ is originally “correct”, any disturbance that would alter the values of $P^*/P_g$ or $P^*/P_s$ implied by equations (9) or (20) respectively (or any autonomous shift in the pegged ratio of $P_g$ to $P_s$) would move the system toward a position where either $G_m^*$ or $S_m^*$ vanishes, so that the fixity of either $P_g$ or $P_s$ could not be maintained. For example, it can be verified that “technical advance” in silver production, as represented by an upward shift in the $s^s$ function, would lead to the exhaustion of monetary gold stocks, $G_m$. The disturbance implies that the relative price, $P_g/P_s$, should rise. Under the form of bimetallism being considered, this relative price change can occur only by the exhaustion of $G_m$ (as implied by Gresham’s Law), after which $P_s$ is free to rise. In this case equations (9) and (20) would determine the values of $P_g^*$ and $P^*$, while equation (15) specifies the money stock (with the backing involving $G_m^* = 0$ and $S_m^* > 0$). Of course, this situation is precisely the silver standard (or, under an alternative shock, the gold standard) that has been analysed above.1 An alternative out-

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1 Laughlin (1896), ch. iii, discusses the effects of increased silver production up to 1820 in driving out monetary gold in the United States. He also discusses (ch. iv) the effects of a change in the pegged price ratio in 1834 (from 1:15 to 1:16 for gold versus silver) in tending to eliminate monetary silver, and (ch. v) the role of gold discoveries after 1850 in completing the elimination of silver money. According to Laughlin (p. 79), “...before 1834 the silver end was up. Now it was the gold end. How soon would it be the silver end again, if we adhered to such a system?”
come would be a compensating shift in the monetary authority’s “pegged” price ratio, \( P_g/P_s \). However, that alternative leaves unclear exactly what nominal price is held fixed under bimetallism.

(B) Symmetallism

Consider now Marshall’s (1887, pp. 204–6; 1923, pp. 64 ff.) proposal for a “stable bimetallism”, which is usually called symmetallism. Under this system the central bank does not attempt to stabilise the price of either gold or silver separately, but rather pegs the price of a reserve unit that corresponds to a specified combination of the two metals.\(^1\) Define a reserve unit as \( \gamma_g \) (ounces) of gold and \( \gamma_s \) (ounces) of silver. If \( R \) represents the number of these units held as a currency reserve, then the monetary stocks of gold and silver are

\[
G_m = \gamma_g R, \quad S_m = \gamma_s R. \tag{21}
\]

If \( P_r \) denotes the price of a reserve unit, then the nominal value of the currency backing is

\[
P_r R = P_g G_m + P_s S_m. \tag{22}
\]

Equations (21) and (22) imply that the price of a reserve unit is

\[
P_r = \gamma_g P_g + \gamma_s P_s,
\]

that is, a combination of \( P_g \) and \( P_s \), as set by the (fixed) weights, \( \gamma_g \) and \( \gamma_s \).\(^2\) Dividing through by \( P \) yields the more convenient condition,

\[
\frac{P_r}{P} = \frac{\gamma_g P_g}{P} + \frac{\gamma_s P_s}{P}. \tag{23}
\]

Under Symmetallism, the tie to the absolute price level is attained by pegging \( P_r \). However, the problem of standard bimetallism is avoided since the fixity of \( P_r \) does not imply fixity of any relative price – notably, \( P/P_g \) and \( P/P_s \) are free to adjust to underlying shocks.

Equations (14)–(20), which were derived for bimetallism, continue to apply. Note that the money supply is now

\[
M^* = \frac{1}{\lambda} P_r R = \frac{1}{\lambda} (P_g G_m + P_s S_m). \tag{24}
\]

The money-supply-equals-money-demand condition, equation (15), determines the steady-state value of \( M \) and therefore the steady-state nominal value of reserve holdings, \( P_r R^* \). Equation (21) then determines the composition of the monetary backing, given the weights, \( \gamma_g \) and \( \gamma_s \). Equations (9) and (20) determine the steady-state values, \( P^*/P_g \) and \( P^*/P_s \). Given these values, equation (23) and the fixed value of \( P_r \) determine the absolute price level, \( P^* \).

The operation of the symmetallic system is analogous to that of the gold standard, except that steady-state price movements are now also induced by shifts in the flow excess supply of silver, and the dynamics of price movements are now also affected by the silver supply and demand elasticities. Essentially,

\(^1\) An experimental coin made of “goloid” – a patented alloy of gold, silver and copper in which the ratio of silver to gold was 16 to 1 – was actually struck in 1878. A bill was proposed by Congressman Stephens (former Vice President of the Confederacy) to resolve the “silver question” by minting the goloid dollar. However, the measure did not get beyond the committee stage. One difficulty with the goloid coin is that it could not be distinguished from a silver coin in either colour or sonority. (See Judd, 1965, p. 177, and Hepburn, 1903, p. 299.)

\(^2\) It is possible, but not necessary, to define the units so that \( P_r \) is a weighted average of \( P_g \) and \( P_s \).
variability in $P$ would now involve a weighting of the variability in $P/P_s$ with
that of $P/P_g$. If there is some independence in the shocks that produce changes
in the silver relative price, $P/P_s$, from those that produce changes in $P/P_g$, and
if $P/P_s$ is not much more volatile than $P/P_g$, then there would be a law-of-
average type gain—in terms of reduced variance of $P$—by moving from the
gold standard to the bimetallic system. The choice of (relative) weights in
the construction of the reserve unit could be determined from an (inter-
temporal) objective of minimising price level variance. The resulting weights
would not necessarily bear a close relation to the relative weights of gold
and silver (or other commodities that might have been chosen for the reserve
unit) in national (world) product. For example, if $P/P_g$ were more stable
than $P/P_s$ (which could arise from differences in fluctuations in the supply
and demand functions and from differences in the elasticities of supply and
demand), then gold would receive a higher weight than silver in the reserve
unit even if gold’s share of GNP were lower than silver’s (which would reflect
differences in the average levels of supply and demand for gold and silver).

(C) Commodity-Reserve Currency

The logic of symmetallism can be extended to include a variety of commodities
in the reserve unit. This extended scheme, referred to as commodity-reserve
currency, was proposed by Benjamin Graham (1937, 1944) and Frank Graham
(1942), pp. 94-118, and was discussed in depth by Friedman (1951). (See also
Luke, 1975, and Weber, 1976.) By analogy to the symmetallic case, the broaden-
ing of the currency base can produce further reductions in price level variance.
Further, if the base includes products that resemble the overall commodity
basket in terms of technical advance and scale characteristics, then the tendency
toward secular deflation under the gold standard could be eliminated. At an
ideal level it would be possible to achieve any desired degree of stability in a
specified price index by designing the appropriate commodity-reserve bundle.

Friedman (1951) presents a quantitative criticism of commodity-reserve
currency on the grounds that a feasible base would be very narrow and would
therefore not guarantee more price stability than the gold standard. Friedman
(pp. 223-9) eliminates a variety of commodities on the grounds of poor storage
characteristics (oil, coal, manufactured products that are subject to obsolescence,
perishable agricultural products) or on grounds of inelastic short-run supply
conditions (storable agricultural products). In fact, these objections seem
surmountable by substituting, say, a one-year future (or a future in the 11- to
12-month range to avoid infinite turnover frequency) for each physical com-
modity.1 The use of futures not only eliminates significant storage costs, but

1 Friedman (pp. 225-6) discusses some problems with the use of futures. Some of these problems
relate to shifts of the reserve bundle between spot and future holdings of a particular commodity (along
the lines suggested by B. Graham), which has arbitrary elements and can interfere with the relative
price of future and spot commodities. However, this objection does not apply when a commodity
always enters the reserve bundle in the form of a one-year future. Friedman also notes (p. 246) that
“next year’s wheat is not the same as this year’s” — but a higher supply elasticity of next year’s wheat
suggests that this commodity may, in fact, be a more useful component of the commodity bundle than
this year’s wheat.

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also removes the entire resource cost (except for transaction costs in futures markets) from this part of the currency base. The supply elasticity of, say, one-year-ahead wheat would also seem to be much higher than that of spot wheat. Further, if commodity-reserve currency were in operation, there would be an incentive for the creation of a much wider range of futures than currently exists (say, for standardised manufactured products like automobiles and other durables), which could then be used to augment the reserve base. It is, in fact, imaginable to have a commodity reserve that is based entirely on futures.¹

Two remaining problems with the commodity-reserve proposal, also discussed by Friedman, are the difficulty in obtaining general acceptance and the possibility of political "tinkering" with the reserve base through changes in commodity weights. In these respects the gold standard is a superior system.

III. SOME CONCLUDING REMARKS

In relation to a fiat currency regime, the key element of a commodity standard is its potential for automaticity and consequent absence of political control over the quantity of money and the absolute price level. Essentially, the adoption of a commodity standard by any country would require a constitutional-type (political) decision that rules out the determination of the quantity of money over time through a series of political decisions. (See Buchanan, 1962.) It is not clear, a priori, that this sort of constitutional provision is more likely to obtain than, for example, a provision to expand the quantity of fiat money at a constant rate. In this context the choice among different monetary constitutions—such as the gold standard, a commodity-reserve standard, or a fiat standard with fixed rules for setting the quantity of money (possibly in relation to stabilising a specified price index)—may be less important than the decision to adopt some monetary constitution. On the other hand, the gold standard actually prevailed for a substantial period (even if from an "historical accident", rather than a constitutional choice process), whereas the world has yet to see a fiat currency system that has obvious "stability" properties.

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¹ Friedman (pp. 225–6) objects that the use of futures "changes the fundamental character of the currency from a warehouse certificate to an evidence of debt". However, for commodity reserve purposes the relevant question concerns the quantitative variances (and covariances) in the relative prices, $P_i/P_{i-1}$, where $P_i$ refers, say, to a one-year future in commodity $i$. This variance would be affected by, among other things, possible changes in the probability of fraud and inability to deliver on futures contracts. Qualitatively, it is not clear that these considerations differ from theft of commodity stocks, counterfeiting, changes in non-monetary demand for commodities, etc.


**APPENDIX**

The system that describes the motion of \( G_m \) and \( G_n \) can be written from equations (7) and (8) as

\[
\frac{\dot{G}_m}{G_m} = g^s\left(\frac{P}{P_g}\right) - \alpha \left[ f\left(\frac{P}{P_g}\right) y - G_n \right] - \delta f\left(\frac{P}{P_g}\right) y, \quad (A1)
\]

\[
\frac{\dot{G}_n}{G_n} = (\alpha + \delta) \left[ f\left(\frac{P}{P_g}\right) y - G_n \right]. \quad (A2)
\]

Equation (3) implies

\[
\frac{P}{P_g} = \frac{G_m}{\lambda k y},
\]

where \( \lambda, k, y, \alpha \) and \( \delta \) are all treated as constants for present purposes.
Defining $g^{st} = \delta g^s/\delta (P/P_g) < 0$ and $f' = \delta f/\delta (P/P_g) > 0$ and taking partial derivatives of equations (A1) and (A2) yields

$$\frac{\delta G_m}{\delta G_m} = -\frac{1}{\lambda k y} [(\alpha + \delta) y f' - g^{st}] < 0,$$

$$\frac{\delta G_m}{\delta G_m} = \alpha > 0,$$

$$\frac{\delta G_n}{\delta G_m} = \frac{1}{(\lambda k y)} [(\alpha + \delta) y f'] > 0,$$

$$\frac{\delta G_n}{\delta G_m} = -(\alpha + \delta) < 0.$$

The slope of the $\hat{G}_m$ locus in Fig. 1 is

$$-\left(\frac{\delta \hat{G}_m}{\delta G_m}\right) = \frac{\alpha \lambda k y}{(\alpha + \delta) y f' - g^{st}} > 0,$$

while that of the $\hat{G}_n$ locus is

$$-\frac{\delta \hat{G}_n}{\delta G_m} = \frac{\lambda k}{f'} > 0.$$

Both slopes are positive since $f' > 0$ and $g^{st} < 0$. It also follows that the $\hat{G}_n$ locus has a larger slope, as shown in Fig. 1.

The stability conditions are

$$\frac{\delta G_m}{\delta G_m} + \frac{\delta G_n}{\delta G_n} < 0$$

and

$$\left(\frac{\delta \hat{G}_m}{\delta G_m}\right) \left(\frac{\delta \hat{G}_n}{\delta G_n}\right) > \left(\frac{\delta \hat{G}_m}{\delta G_n}\right) \left(\frac{\delta \hat{G}_n}{\delta G_m}\right).$$

The first condition is satisfied immediately from above. The second condition corresponds to the proposition that the $\hat{G}_n$ locus is more steeply sloped than the $\hat{G}_m$ locus, which was also shown to hold above.

The stability conditions would also be satisfied if $\delta f(...)$ in equation (6) were replaced by $\delta G_n$ (note 1, p. 16 above), although the sign of $\delta \hat{G}_m/\delta G_n$ (and, hence, the inclination of the $\hat{G}_m$ locus) would then be indeterminate. A dependence of the expected inflation rate, $\pi$, on the time path of $P$ or other variables leads to deeper stability questions of the sort discussed by Cagan (1956) and Goldman (1972) under adaptive expectations and by Sargent and Wallace (1973) in a deterministic, rational expectations setting.

**References for Appendix**

