On the Feasibility of Returning to the Gold Standard*

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Abstract

The gold standard is back in the news following a series of announcements from the Trump Administration indicating that the President was considering candidates for the open positions on the Federal Reserve Board who are sympathetic to the idea of restoring the gold standard. Among most economists, however, the gold standard remains overwhelmingly unpopular, although there are some economists who contend that returning to such a regime today would offer several benefits over the current monetary system. Whether doing so would be desirable is secondary to whether it would be feasible. What would the appropriate parity be? How much gold would it require? Is the existing gold stock sufficient to support it? How much would it cost? This paper takes up these questions. I argue that the current market price of gold is likely close to the appropriate parity, and that at this price, the gold stock is sufficiently large to enable the world's largest economies to return to the gold standard, although doing so would entail a one-time outlay of roughly $3.5 trillion. I also find that the ongoing costs of maintaining the gold standard would, on average, require the countries considered in this study to dedicate approximately $383 billion per year acquiring monetary gold.

Keywords: Gold Standard, Monetary Institutions, Resource Costs

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1 Introduction

The gold standard is back in the news following a series of announcements from the Trump Administration indicating that the President was considering candidates for the open positions on the Federal Reserve Board who are sympathetic to the idea of restoring the gold standard. Judy Shelton - the President's newest pick - recently argued that gold is "universally acknowledged as a monetary surrogate with intrinsic value" (2018, p. 387). Likewise, Herman Cain and Stephen Moore - both of whom subsequently removed themselves from consideration for the positions - have made similar comments extolling the gold standard in the past, although Moore did walk back his earlier support for gold after the President announced that he was considering him for the Federal Reserve Board (Cain, 2012; Moore, 2019). That the President would nominate individuals to the Federal Reserve Board that are sympathetic to the idea of restoring the gold standard is unsurprising given that he, too, has expressed an interest in doing so (GQ, 2015).

Among most economists, however, the gold standard remains overwhelming unpopular (IGM Economic Experts Panel, 2012). The consensus view is that the gold standard is a relic of a past marred by macroeconomic instability that central banks helped to alleviate (Bernanke, 2012). Despite this consensus, there are some economists who contend that when compared against the track record of modern central banking, macroeconomic performance under the "Classical" gold standard (1879-1914) was superior in some respects and no worse in others, and that returning to the gold standard today would offer several advantages over the current fiat regime, such as lower inflation and price-level uncertainty as well as increased trade

and capital flows brought on by the creation of a common currency area (Hogan, 2015; Hogan et al., 2018; Selgin et al., 2012; White, 2015).

Whether adopting the gold standard today would be desirable, as some contend, is secondary to whether doing so would be feasible. Indeed, the prospect of returning to such a monetary system raises several important questions that would need to be addressed prior to its implementation. What would the appropriate parity be? How much gold would it require? Is the existing gold stock sufficient to support the resumption of redeemability? How much would it cost to implement and maintain? Without answers to these questions, the case for returning to the gold standard is incomplete. The aim of this paper is to derive plausible answers to these questions in order to assess whether it would be feasible for the world's leading economies to adopt the gold standard in the near future.

Answering these questions first requires clarifying what exactly a gold standard is, especially because considerable confusions continues to surround it. Accordingly, the following section defines the gold standard, provides a brief overview that clarifies both the private and public sector's roles under the type of gold standard that I consider in this paper, namely one characterized by competitively-produced money with gold serving as the *medium of redemption*. In Section 3, I present a model of this sort of monetary system based on those found in McCallum (1989) and White (1999) that illustrates how the price level is determined under a gold standard and provides some insight into what the appropriate parity would be if the gold standard were adopted today. The relevant implication of the model is that the appropriate re-entry parity, i.e., the parity that would avoid both inflation and deflation, is likely

close to the current market price of gold.

Using this price as the appropriate parity, in Section 4 I evaluate whether the official gold holdings of the world's largest economies (in terms of gross domestic product) would be sufficient to replace the current level of fiat reserves with an equivalent amount of gold, and if not, how much gold would be necessary to do so.[1] These economies are: Australia, Brazil, Canada, China, the Eurozone, Great Britain, India, Japan, Russia, South Korea, and the United States.[2] Together, these economies represent approximately 80 percent of gross world output. I find that while only the Eurozone, Russia, and the United States have official gold holdings sufficient to support the resumption of redeemability, the stock of above-ground gold would be sufficient to meet the excess demands of the remaining countries. My estimates indicate that the cost of acquiring this gold would require a one-time outlay worth approximately $3.5 trillion, although this figure drops by nearly a factor of ten when using a historically-realistic reserve ratio.

In addition to acquiring the gold necessary to implement the gold standard initially, there is the much larger cost of acquiring the gold necessary to meet the derived demand for monetary gold in a growing economy. In Section 5, I use the aforementioned model of the gold standard to estimate the share of each country's output that would need to be allocated each year to acquiring the gold necessary

[1]The world's ten largest economies vary depending on which organization the reader consults, e.g., the International Monetary Fund versus the World Bank, etc. There is significant overlap, however. To ensure that the top ten economies were considered regardless of the reporting organization, I included the world's eleven largest economies.

[2]The countries that are currently part of the Eurozone are: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia, and Spain.

for the regime to be sustained. Using current reserve ratios, I find that, on average, the countries considered in this study would need to dedicate roughly 0.564% of their output each year to maintain the gold standard, an amount equivalent to $383 billion. As before, the size of the estimate depends on the reserve ratios used to derive it. Using a reserve ratio consistent with historical experience under the gold standard, I find that the share of output necessary to sustain the gold standard falls to 0.184%, or $125 billion per year.

This paper is not the first to consider these questions, particularly those related to the resources costs of implementing and maintaining the gold standard. Milton Friedman (1951; 1960), for example, famously criticized the gold standard on the grounds that the resource costs of maintaining it in the Untied States would range from 1.5 to 2.5 percent of national income each year, or an annual outlay of roughly $350 billion. A properly-managed fiat standard, Friedman argued, could provide monetary stability while avoiding these costs. Of course, that there are costs associated with the gold standard is not by itself a sufficient argument against such a regime. What matters is how these compare to those associated with the set of feasible alternatives (Demsetz, 1969). Indeed, as Milton Friedman (1986) would later argue in response to his own earlier criticism of the gold standard, the resource costs of a system based on irredeemable paper money are likely larger than is commonly recognized. Taking Friedman's conjecture as their starting point Watts & Snyder (2015) recently tried to assess which regime entailed higher resource costs by comparing the the demand for gold in the United States during the the "Classical" gold standard era to that since the end of the Bretton Woods system. They find that while the demand for

gold was generally higher during the "Classical" period, episodes of macroeconomic volatility under the current fiat system increased the demand for gold to levels on par with that under the gold standard.

On the other side of the resource cost argument, there are those who have criticized Friedman's approach on the grounds that his assumption of 100 percent reserves for both demand and time deposits significantly overstates the costs involved with maintaining a gold standard.[3] Using a more historically realistic reserve ratio, White (1999, p. 47) finds that for the United States the resource costs of maintaining the gold standard would be 0.05 percent of national income, or approximately $9 billion per year. White (2012) has also offered a proposal detailing how the United States could return to the gold standard, which takes a similar approach to that used in this paper, and more recently, he has provided estimates of the amount of gold that other countries, including China, the Eurozone, and Japan would need to support the resumption of gold redeemability, although his treatment is not as systematic that provided in this paper (White, 2015).

Unlike other studies that have tended to focus almost exclusively on the United States,, this paper takes an international perspective. Such a perspective is necessary for three reasons. First, to reap the benefits of a common currency area, more countries than just the United States would need to adopt it. Second, with only one country on the gold standard - even one as large as the United States - the purchasing power of gold would be subject to significant speculative demand, likely

[3]Friedman justified this assumption by arguing that a "partial" gold standard was prone to instability and government intervention (see also: Simons (1936)). Thus, Friedman saw only two viable monetary standards: one wherein both demand and time deposits are 100 percent backed by gold or a government-administered fiat currency.

increasing rather than decreasing price-level uncertainty. Third, and perhaps most importantly, for the gold standard to act as an effective monetary rule, adherence to it must be self-enforcing.[4] During the "Classical" gold standard era, adherence to the standard mitigated the time inconsistency problem and, in consequence, rewarded those countries whose commitment to redeemability was seen by investors as credible with favorable access to international capital markets (Bordo & Kydland, 1995; Bordo & Rockoff, 1996). The system worked, in part, because it incentivized adherence to gold redeemability. Thus, in assessing the feasibility of returning to the gold standard today, consideration must be given to countries other than the United States.

2 What Is a Gold Standard?

Long ago, Milton Friedman (1961) noted that there was considerable confusion over what precisely a gold standard is. He argued that this confusion had misled some economists to support government fixing of the price of gold, which, in his view, was not only not a "real" gold standard, but had caused a great deal of monetary mischief. This confusion persists today. For instance, Barry Eichengreen (2011), writing more recently, criticized supporters of the gold standard on the grounds that the regime is at odds with its proponent's commitment to free markets because implementing the gold standard requires the government to legislate the price of gold, which, as Friedman rightly noted, is incorrect. Because confusion of this sort continues to

[4] A self-enforcing monetary rule is one wherein the agents have an incentive to uphold it even under less than ideal conditions such that external enforcement is unnecessary (Salter, 2014).

surround the definition and workings of the gold standard, a few clarifications are in order that will help frame the analysis throughout the remainder of this paper.

Following Rolnick & Weber (1997), I use the term monetary standard to refer to those items that act as the *unit of account* and back the items that circulate as the generally accepted medium of exchange, i.e., money. For instance, under a commodity standard, the monetary commodity, e.g., gold, serves as the *medium of account*, with the *unit of account* being defined - either by law or convention - as a specific quantity thereof. Money in such a regime may include "full-bodied" coins consisting of the monetary commodity itself or fiduciary media issued by governments and other financial institutions that are meaningfully denominated in the commodity *unit of account*, i.e., kept at a fixed par value, such that the monetary commodity serves also as the *medium of redemption* (White, 2015).

Note that according to this description, the government's involvement in the monetary system - if it is involved at all - need not extend beyond defining the *unit of account* as a specific amount of the monetary commodity and potentially issuing liabilities that can be redeemed for the monetary commodity, which it may do in competition with private banks. Historically, of course, the governments of countries on the gold standard did intervene substantially in monetary affairs. Prior to World War 1, these interventions were normally limited to times of war, which meant that during peacetime the gold standard was largely decentralized such that the purchasing power of each country's monetary unit was determined by the forces of supply and demand. Following World War 1, however, the gold standard became much more centralized as the governments of gold-standard countries took an active

role in managing the value of their currency, either by redefining the *unit of account* - as the United States did in 1934 - or by directly buying and selling gold to influence the purchasing power of their currency, which the United States did in 1933 as part of Roosevelt administration's gold purchase plan.

The point I want to emphasize here is that despite governments' historical interventions into the gold standard, nothing inherent to the operation of a commodity standard requires the existence of an official monetary authority, nor does it imply anything about what such an authority is prepared to do if one exists. Indeed, proponents of the gold standard point to the regime's ability to function effectively without a government-sanctioned monetary authority - such as a central bank - as one of the gold standard's benefits. These proponents argue that because the monetary authority may be subject to political pressure that undermines its commitment to gold redeemability, a decentralized gold standard may be a more effective constraint on monetary mismanagement than an officially-sanctioned standard would be (Selgin & White, 2005; White, 2012). Moreover, even setting aside these political economy concerns, the knowledge problems inherent to any centralized monetary system - including a government-managed gold standard - introduces the possibility of policy errors that can have catastrophic consequences as the experience during the Great Depression painfully illustrated (Humphrey & Timberlake, 2019; Salter & Smith, 2017).

Because of the problems associated with centralized systems, the analysis throughout the remainder of this paper will done under the assumption of a decentralized gold standard where the government's role in monetary affairs is limited to providing

the basic legal framework necessary to enforce contracts and property rights. With these clarifications out of the way, I now turn to the substantive questions with which this paper is concerned.

3 What Would the Appropriate Parity Be?

If those countries considering the gold standard would like to retain their existing *unit of account*, they will need to select a new parity between it and gold. This choice is far from arbitrary. If the chosen parity is too low, gold will flow out of the country, resulting in a potentially painful deflation that will continue until the domestic price level decreases to a level consistent with international equilibrium. On the other hand, if the chosen parity is too high, the reverse will occur: gold will flow into the country and an inflation will ensue until the price level increases sufficiently to cut off the flow of gold from the rest of the world. Assuming that avoiding either scenario would be desirable, the appropriate parity is that which is consistent with maintaining the existing price level. To derive an estimate of what the appropriate parity would be, I will use a simple model of the gold standard that illustrates how the price level is determined under such a regime.[5]

Historically, countries on the gold standard defined the *unit of account* in terms of a specific quantity of gold. For instance, prior to 1933, the dollar in the United States was defined as .04838 troy ounces of gold - a figure sometimes referred to as the "gold content of the dollar." In cases such as this one, with prices quoted in

[5]The model that I use in this section draws on elements found in McCallum's (1989, pp. 250-258) and White's (1999, pp. 28-36) models of the gold standard. Other, similar treatments can be found in Barro (1979) and Niehans (1978, pp. 140-153).

dollars, and dollars defined in terms of gold, the price level (in dollars) is the product of two factors: (1) the the gold content of the dollar, and (2) the relative price of gold in terms of a representative basket of goods. Letting P denote the number of dollars necessary to purchase this basket, the relationship between the price level and the two aforementioned factors can be expressed as follows:

$$\frac{\$P}{basket\ of\ goods} = (\frac{\$Q}{oz\ Gold}) \times (\frac{R\ oz\ Gold}{basket\ of\ goods}) \tag{1}$$

where $P = QR$.

The first term on the right-hand side of equation (1) is the definition of the currency unit - in this case the dollar - in terms of gold. Using the pre-1933 definition of the dollar in the United States of \$1 per 0.04838 ounces of gold, Q would be equal to \$20.67 (1/0.04838 = \$20.67). Note that while this figure is sometimes misleadingly referred to as the "official price of gold," it is not a market price, i.e., it does not respond to changes in supply and demand conditions. Rather, this figure follows mathematically from the definition of the *unit of account* as some specific quantity of gold. The second term on the right-hand side of equation (1) is the inverse of the *purchasing power of gold*, i.e., the amount of gold necessary - in ounces - to purchase a representative basket of goods. Unlike the first term, however, the second is a market price, and as such, does respond to changes in supply and demand conditions.

Equation (1) indicates that to maintain the existing price level during the transition to a gold standard, those countries joining the regime should select a parity consistent with making the value of the first term equal to the inverse of the second. The problem is that the restoration of the gold standard would surely influence the

purchasing power of gold, making it difficult to know ex ante precisely what the parity should be. While the extent of this effect is ultimately an empirical question, it is possible to use a simple model of the gold standard to produce at least a ballpark estimate of how the resumption of gold redeemability would affect the *purchasing power of gold*, which, in turn, can offer some insight as to what the appropriate parity would be.

Recall from the previous section, that the type of gold standard I am considering is of the decentralized sort where the government plays no special role in the monetary system. Accordingly, I assume that each country's circulating medium consists entirely of privately-issued liabilities, which are fractionally-backed by gold. Under this sort of "free banking" system, private firms competitively produce banknotes and transferable deposits that they stand ready to redeem for gold at the chosen parity.[6] I assume also that the commitment on the part of these money-issuing institutions to redeem their liabilities at "the official price of gold," denoted as Q, is perfectly credible such that the purchasing power of "inside" money is equal to the *purchasing power of gold*. Finally, I assume that there are no restrictions on coinage and that the coinage process is zero-priced, which guarantees that the *purchasing power of gold* will be equal across monetary and non-monetary uses.

The model consists of two markets - the market for gold flows, which are measured in ounces of gold per year, and the market for gold stocks, which are measured simply in ounces. The stock demand for gold is a function of the demand for monetary and non-monetary gold. To identify the factors influencing the demand for monetary

[6]See Selgin (1988) for a theoretical analysis of free banking systems and White (1984) for a historical analysis of this sort of regime worked in practice.

gold, I begin with a demand function for the medium of exchange, e.g., dollars, demand deposits, time deposits, etc. Let M denote the money supply, e.g. M2, y denote income, and P the price level.[7] The demand for money can then be expressed as:

$$\frac{M}{P} = L(y, \pi) \tag{2}$$

where $L_y > 0$ and $L_\pi < 0$. Note that the opportunity cost of holding money in this model is the inflation rate, π, such that the relationship between money balances and the inflation rate takes the form proposed by Cagan (1956).

Next, consider the relationship between the money supply, M, and the quantity of gold reserves, G_m, held by the banking system. Letting $G_m Q$ denote the dollar value of monetary gold the reserve ratio can be expressed as:

$$\lambda = \frac{G_m Q}{M} \tag{3}$$

For simplicity, I assume that the reserve ratio is fixed.

The stock demand for monetary gold in this economy derives from the public's demand for money as a *medium of exchange*. To determine the derived demand for monetary gold, first solve (3) for M, substitute this expression into (2), and then solve for G_m. Accordingly, the stock demand for monetary gold can be expressed as:

$$G_m = \lambda \frac{P}{Q} L(y, \pi) \tag{4}$$

[7]Note that a fraction of the economy's output may include gold, in which case P will reflect the price of gold, although I assume that its influence on the overall price level is relatively small.

Note that per equation (1), P/Q is equal to the inverse of the *purchasing power of gold*, R. Thus, equation (4) can be rewritten as:

$$G_m = \lambda RL(y, \pi) \tag{4'}$$

which simply states that as the amount of gold necessary to purchasing a representative amount of good increases, so too will the demand for monetary gold.

People also demand gold for non-monetary uses. To account for this fact, I assume that the stock demand for non-monetary gold can be expressed as:

$$G_n = f(y, \frac{Q}{P}, \pi) \tag{5}$$

Note that per equation (1), Q/P represents the *purchasing power of gold*, or $1/R$, such that equation (5) can be rewritten as:

$$G_n = f(y, \frac{1}{R}, \pi) \tag{5'}$$

where $f_y > 0$, $f_{1/R} < 0$, and $f_\pi < 0$. Thus, the demand for non-monetary gold is an increasing function of the economy's output and a decreasing function of *the purchasing power of gold*. The intuition behind the inverse relationship between the demand for non-monetary gold and the rate of inflation is similarly straightforward. The demand for a durable good is positively related to the expected future rate of change of its relative price, which means that if people expect the *purchasing power of gold* to increase in the future, they would like to own more of it now. Since I have

assumed that Q is fixed, an increase in the *purchasing power of gold* implies a fall in the price level and vice versa.

The total stock demand for gold is therefore equal to the sum of $(4')$ and $(5')$. Letting G_0 denote the stock of gold at a particular point in time, the *purchasing power of gold* must adjust to satisfy:

$$G_0 = \lambda R(y, \pi) + f(y, \frac{1}{R}, \pi) \tag{6}$$

Assuming that the economy's output is largely independent of monetary policy, inflation expectations have already been determined, and the reserve ratio is fixed, then there is only one variable in (6) that can adjust to ensure stock equilibrium: the *purchasing power of gold*, which, per equation (1), will mean a change in the price level.

To explain how the stock of gold changes over time, I now turn to the market for gold flows. I assume that the flow supply of gold is positively related to its purchasing power, i.e., as the relative price of gold increases, more gold will be mined. Accordingly, let $g(1/R)$ denote the flow supply of gold, where $g' > 0$. Next, consider the sources of flow demand: depreciation and consumption. If gold constituted all, or even a part of the circulating medium, it would be necessary to account for the effect of depreciation on the monetary gold stock when considering the flow demand for gold. However, because I have assumed that the circulating medium consists entirely of "inside" money, the effect of wear-and-tear can be ignored, which means that the flow demand for gold consists entirely of demands that "use up," or essentially destroy gold such that it would be prohibitively costly to recover. I assume that

the rate at which gold is "used up" by consumers and producers is a function of output, the *purchasing power of gold*, and inflation - just as it is with the stock demand for non-monetary gold. In consequence, the consumptive flow demand for gold is proportional to the stock demand for non-monetary gold such that it can be denoted as $\delta f(y, 1/R, \pi)$, where δ reflects the degree of proportionality. Combining the expressions for flow supply and demand, the rate of change of the total stock of gold can be expressed as:

$$\Delta G = g(\frac{1}{R}) - \delta f(y, \frac{1}{R}, \pi) \tag{7}$$

where ΔG denotes the change in the gold stock. From equation (7) it follows that the stock of gold available for monetary and non-monetary uses will be increasing whenever $g(1/R)$ exceeds $\delta f(y, 1/R, \pi)$ and vice versa.

At any given point in time, equilibrium in the market for gold stocks determines the *purchasing power of gold* and thus the price level. However, it is equilibrium in the market for gold flows that determines whether the economy is in a state of stationary equilibrium, i.e., a state wherein the stock and *purchasing power of gold* as well as the price level are constant. For instance, if the *purchasing power of gold* is such that $\Delta G > 0$, the stock of gold and the price level will be increasing over time. This adjustment process will continue until the *purchasing power of gold* adjusts to the point where additions to the gold stock are just offset by those demands that "use up" these additions.

Figure 1 depicts the adjustment process discussed in the previous paragraph. The vertical axis plots the *purchasing power of gold*, $1/R$, and it applies to both

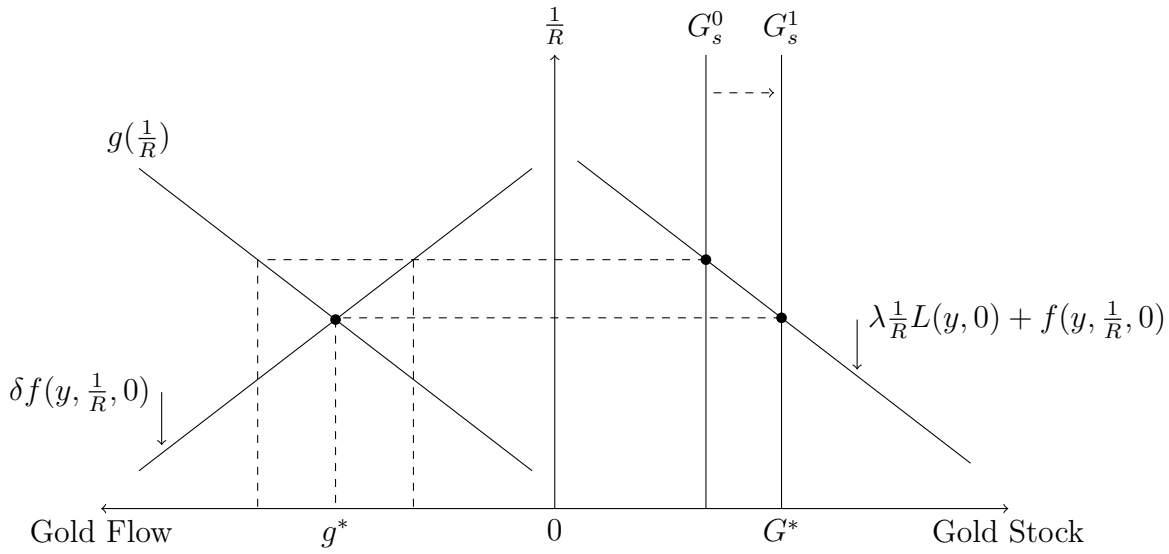

Figure 1: Stock/Flow Analysis of the Gold Standard

the right- and left-hand sides of the diagram, which measure the markets for gold stocks and flows, respectively. The downward-sloping curve on the right-hand side of Figure 1 represents the demand for gold stocks. If the stock supply of gold is G_0, the *purchasing power of gold* is above that which would clear the market for gold flows, i.e., the flow quantity of gold produced by the mining industry exceeds that demanded for consumptive uses. In this case, the stock of gold will increase, which will put downward pressure on the *purchasing power of gold* until stationary equilibrium is restored.[8]

The model has several notable implications that are relevant for the questions that I am considering in this paper. It suggests that if the adoption of the gold standard

[8]As Figure 1 makes clear, the positions of the stock and flow demand curves depend on π. Stationary equilibrium requires that those curves be drawn under the assumption that $\pi = 0$. That is, in stationary equilibrium, not only must the price level remain constant, but this constancy must be correctly anticipated.

did not increase the stock demand for monetary gold then the appropriate parity would be that which is consistent with the current market price of gold. Taken at face value, this scenario seems unlikely since there is not currently a derived demand for monetary gold in the sense described in the model. If, for example, there was currently no demand for monetary gold the model indicates that the resumption of gold redeemability would shift the stock demand curve to some extent, which will, all else equal, increase the *purchasing power of gold*. In that case, using the current market price to define the *unit of account* would cause a temporary deflation.

However, just because there is not currently a derived demand for monetary gold in the sense described in the model does not mean that the demand for monetary gold is non-existent. In point of fact, both governments and private individuals, continue to own and purchase substantial amounts of monetary gold. Its unclear how much of this demand reflects efforts to hedge against inflation, but some fraction of it surely does. As Figure 1 indicates, there is a tendency for the *purchasing power of gold* to remain constant provided that the flow supply and demand curves do not shift. In consequence, there would be little need to hedge against inflation because of the regime's inherent tendency to stabilize the price level. It follows, then, that some of the monetary gold currently being held as a hedge against inflation would be liquidated following the adoption of the gold standard.

Which of the two demand effects will dominate? The model can provide insight into this question as well. Assuming that the end of the Bretton Woods system affected only the monetary stock demand for gold, the question reduces to whether the *purchasing power of gold* has increased or decreased in the intervening years.

In fact, the real price of gold is higher today than it was during any other period when it played an integral part of the international monetary system, which suggests, perhaps paradoxically, that the abandonment of the gold standard actually increased the stock demand for monetary gold. So, while it is impossible to say exactly what the *purchasing power of gold* would be if the gold standard were adopted today, the foregoing analysis implies that the current market price is a plausible upper bound on what the appropriate parity should be.

4 Is There Enough Gold?

Using the the current market price of gold as the appropriate parity, it is now possible to determine whether the existing stock of monetary gold is sufficient to support the existing money stock in the world's largest economies, and if not, how much additional gold would be required to facilitate the transition to a gold standard. To answer these questions, I begin by comparing the current market value of the official gold stocks held by the world's largest economies to their currently required level of fiat reserves. Of course, under the type of decentralized free banking system that I have assumed would displace the existing monetary order, the level of reserves in the banking system would be endogenously determined by profit-maximizing banks rather than statutorily imposed.[9] However, the current level of required fiat reserves is a useful benchmark because it is likely higher than that which would obtain under a free banking system, and in consequence, can be used to derive a "worst case"

[9]See White (1999, pp. 56-60) for a formal presentation of how the reserve ratio is determined in a free-banking regime.

estimate of the amount of gold that would be necessary to support the resumption of gold redeemability.[10]

Assuming that the market price of gold closely approximates the appropriate parity, and that the required reserve ratio remains constant, then estimating the amount of gold necessary to support the resumption of gold redeemability is a straightforward exercise. First, rearrange (3) in terms of G_m:

$$G_m = \frac{\lambda M}{Q} \tag{8}$$

Here, λM denotes the level of reserves, which, when divided by the appropriate parity, yields the amount of gold necessary to support the resumption of gold redeemability. Net gold demand is then simply the difference between (8) and current official gold holdings.

The International Monetary Fund records official gold holdings as part of their International Financial Statistics.[11] According to their estimates, all of the countries that I consider in this study, with the exception of Canada, have some amount of official gold holdings as of January 2019. To calculate the market value of these holdings, I multiplied the quantity of official gold holdings by market price of gold on January 1, 2019, which I obtained from XE.[12] While most of the countries considered in this study maintain data on the level of required reserves, one caveat about these figures are in order. Australia, Canada, and Great Britain do not have statutorily-

[10]White (1999, p. 47), for example, reports that during the free-banking era in Scotland the ratio of bank reserves to demand liabilities was roughly 2%.

[11]These statistics are available online at: http://data.imf.org.

[12]These quotations are available online at: https://www.xe.com.

mandated reserve requirements. To address this issue, I used the average ratio of currently required fiat reserves to broad money for the other countries considered in this study and then multiplied this figure by the relevant broad money aggregate in Australia, Canada, and Great Britain to derive an estimate of "required" fiat reserves for each country that can be used as a benchmark to estimate what their net gold demand would be. Table 1 reports my results.

Of the eleven countries I considered, only three have official gold holdings sufficient to support the resumption of gold redeemability given the market price and their currently required level of fiat reserves: the Eurozone, Russia, and the United States. To support gold redeemability, the remaining eight countries would need to acquire approximately 2.7 billion troy ounces of gold; an excess demand of approximately $3.5 trillion as of January 2019, the overwhelming source of which is China's dearth of official gold holdings relative to its current level of required reserves.

Leaving aside China for the time being, the economies whose official gold holdings are currently insufficient - Australia, Brazil, Canada, Great Britain, India, Japan, and South Korea - could acquire additional gold reserves from the surpluses owned by the Eurozone, Russia, and the United States, which total approximately 384 million troy ounces. That is, setting China aside, in the aggregate, the official gold holdings of the remaining 10 economies are sufficient to support the resumption of gold redeemability. Nonetheless, because these latter countries may be unwilling to part with their excess supplies, it will be helpful to put these estimates into perspective by comparing them to the total amount of above-ground gold in existence.

According to the World Gold Council, the total stock of above ground gold as

Table 1: Net Gold Demand

Country/Area	**Required Reserves**[a]	**Gold Holdings**[b]	**Gold Price**[c]	**Market Value**[d]	**Net Gold Demand**[e]
Australia	AUD 124.36	2.21	AUD 1,820.48	AUD 4.02	(66.10)
Brazil	BRL 437.98	2.16	BRL 4,978.62	BRL 10.75	(85.81)
Canada	CAD 94.81	0.00	CAD 1728.61	CAD 0.00	(54.85)
China	CNY 23,722.37	59.24	CNY 8,807.57	CNY 521.88	(2,633.55)
Eurozone[f]	EUR 126.77	346.45	EUR 1,117.56	EUR 387.18	233.01
Great Britain	GBP 99.80	9.98	GBP 1,004.27	GBP 10.02	(89.40)
India	INR 4,870.13	19.03	INR 89,238.76	INR 1,698.21	(35.54)
Japan	JPY 10,038.70	24.60	JPY 140,485.35	JPY 3,455.94	(46.86)
Russia	RUB 2,429.00	66.43	RUB 88,580.86	RUB 5,884.43	39.01
South Korea	KRW 60,973.65	3.36	KRW 1,430,029.06	KRW 4,804.90	(39.28)
U.S.	USD 192.07	261.50	USD 1,282.43	USD 335.36	111.73
Total		**794.96**			**(2,667.64)**

[a]In Billions

[b]Millions of Troy Ounces

[c]As of January 1, 2019

[d]In Billions

[e]Millions of Troy Ounces; Negative Values in Parentheses

[f]Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain

of 2018 was approximately 6 billion troy ounces.[13] Table 2 summarizes the World Gold Council's estimates. Of the roughly 6 billion troy ounces of above-ground gold, approximately 2.4 billion of it exists in monetary form - split between governments and private investors. Assuming that the countries not included in this study would be unwilling to part with their existing gold reserves, which could be the case if they also intend to adopt the gold standard, then the excess demand would need to be met either by private gold hoards or the current stock of non-monetary gold.

Table 2: Above-Ground Stock of Gold

	Troy Ounces (In Millions)	**Percent of Total Stock**
Jewellery	2,959.28	47.57
Official Holdings	1,068.36	17.18
Private - Bars & Coins	1,248.69	20.07
Private - ETFs	78.46	1.26
Other	865.54	13.91
Total	**6,220.33**	

Excluding China, the estimates reported in Table 2 indicate that the current stock of privately-owned monetary gold, which totals nearly 1.3 billion troy ounces, is more than sufficient to meet the excess demand of Australia, Brazil, Canada, Great Britain, India, Japan, and South Korea, which is approximately 418 million troy ounces in total. Recall that in the previous section, I argued that the adoption of the gold standard would likely reduce the current private stock demand for monetary gold that people currently use to hedge against inflation. My estimates indicate that private stock demand for monetary gold would need to decrease by roughly 33 percent

[13]These estimates are available online at: https://www.gold.org/goldhub/data/above-ground-stocks.

to supply these countries with the amount of gold necessary to support resumption. Returning now to the issue of China, even if the adoption of the gold standard entirely eliminated the private stock demand for monetary gold, my estimates indicate that the world's current stock of monetary gold would be insufficient to meet demand. In this case, a substantial amount of non-monetary gold - such as jewelry - would need to be reallocated to monetary uses.

Since the reserve ratio influences how much gold the resumption of redeemability would require, it is worth considering how these estimates would change if the reserve ratios I used were reduced to a level consistent with those that existed under gold-based free banking systems in the past. White (1999, p. 47) reports that during the free-banking era in nineteenth century Scotland, the ratio of bank reserves to demand liabilities was roughly 2 percent. Using this figure in conjunction with broad money aggregates for each country to derive an estimate of how much gold would be necessary to support the resumption of redeemability paints a drastically different picture.[14]

As Table 3 indicates, the excess demand for monetary gold decreased from roughly 2.7 billion troy ounces to 272 million, which, as of January 2019, would be worth roughly $350 billion. Moreover, whereas my previous estimates indicated that the private stock demand for monetary gold would need to decrease by roughly 33 percent - *excluding* China - to accommodate the excess demand for monetary gold, under a two percent reserve ratio the private stock demand for monetary gold would only need to decrease by 22 percent *including* China. In this case, the currently existing private

[14]Note that doing so increases the stock demand for monetary gold for those countries whose current ratio of required fiat reserves to broad money is less than two percent.

Table 3: Net Gold Demand under a 2% Reserve Ratio

Country/Area	**Required Reserves (2% RR)**[a]	**Gold Holdings**[b]	**Gold Price**[c]	**Market Value**[d]	**Net Gold Demand**[e]
Australia	AUD 40.60	2.21	AUD 1,820.48	AUD 4.02	(20.09)
Brazil	BRL 47.46	2.16	BRL 4,978.62	BRL 10.75	(7.37)
Canada	CAD 30.95	0.00	CAD 1728.61	CAD 0.00	(17.91)
China	CNY 3,255.16	59.24	CNY 8,807.57	CNY 521.88	(310.26)
Eurozone[f]	EUR 217.52	346.45	EUR 1,117.56	EUR 387.18	151.81
Great Britain	GBP 32.58	9.98	GBP 1,004.27	GBP 10.02	(22.46)
India	INR 2,654.51	19.03	INR 89,238.76	INR 1,698.21	(10.72)
Japan	JPY 19,161.65	24.60	JPY 140,485.35	JPY 3,455.94	(111.80)
Russia	RUB 7.84.47	66.43	RUB 88,580.86	RUB 5,884.43	57.57
South Korea	KRW 48,998.79	3.36	KRW 1,430,029.06	KRW 4,804.90	(30.90)
U.S.	USD 192.07	271.44	USD 1,282.43	USD 335.36	49.84
Total		**794.96**			**(272.29)**

[a]In Billions
[b]Millions of Troy Ounces
[c]As of January 1, 2019
[d]In Billions
[e]Millions of Troy Ounces; Negative Values in Parentheses
[f]Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain

stock of monetary gold would be more than sufficient to support the resumption of redeemability without the need to reallocate non-monetary gold.

In sum, the stock of above-ground gold is sufficient to support the resumption of redeemability. If the ratio of currently required fiat reserves to broad money were to remain the same under the sort of gold standard I'm considering, then a substantial amount of gold would need to be reallocated from non-monetary uses and the total cost of doing so would be roughly $3.5 trillion. A large part of this cost can be avoided, however. Using an historically realistic reserve ratio, the cost of acquiring the gold necessary to implement the gold standard falls by a factor of ten and the need to reallocate gold from non-monetary uses disappears.

5 How Much Would the Gold Standard Cost to Maintain?

Acquiring the gold necessary to support the immediate resumption of gold redeemability is only one component of the total costs involved with adopting the gold standard. The second, and potentially much larger cost of implementing such a regime consists of acquiring the gold necessary to maintain the gold standard once its been adopted. This cost arises for two reasons. First, if gold constitutes part of the circulating medium, then the stock of monetary gold will need to be replenished as it depreciates from wear-and-tear. This depreciation can largely be avoided, however, by using gold for settlement purposes, i.e., as bank reserves, while utilizing other forms of money that are cheaper to produce and maintain - such as banknotes

and transferable deposits - for transaction purposes. The second factor - meeting increases in money demand - may involve more substantial costs, however.

Recall from the model that I presented in Section 3 that the demand for monetary gold derived from the demand for real money balances, which increases with income. Thus, as the economy grows, so too will the demand for monetary gold.[15] How much it would it cost to acquire the gold necessary to meet this increasing demand? To answer that question, I adopt Friedman's (1951; 1960) well-known approach, which yields an estimate of the share of an economy's output that would need to dedicated to acquiring monetary gold each year. Unlike Friedman, however, I assume as before that the money supply - consisting of bank-issued liabilities - will be fractionally-backed by gold rather than fully-backed.

For the reasons I already outlined, I assume that the existing stock of monetary gold does not depreciate so that additions to the stock thus serve only to meet money demand in a growing economy. Let ΔD denote the monetary value of the annual change in the stock of monetary gold and Y income. The fraction of income that must be devoted annually to maintaining the gold standard is therefore $\Delta D/Y$. This relationship can be decomposed into three components:

$$\frac{\Delta D}{Y} = (\frac{\Delta D}{\Delta M})(\frac{\Delta M}{M})(\frac{M}{Y}) \tag{9}$$

where $\Delta D/\Delta M$ is the ratio of the the annual change in the monetary value of the

[15]Note also that if the economy is growing and there is still gold that can be mined, the model implies that a fixed stock of monetary gold is inconsistent with stationary equilibrium because the *purchasing power of gold* would be continually increasing, which would make gold mining increasingly profitable.

stock of monetary gold to the annual change in the money stock, $\Delta M/M$ is the annual growth rate of the money stock, and M/Y is the ratio of the money stock to income. I use the M2 money stock as the measure of M, the change in M2 for ΔM, and gross domestic product as the measure of income. Thus, M/Y is the ratio of M2 to gross domestic product.[16]

To derive an estimate for $\Delta M/M$, I assume that the stock of gold adjusts to ensure that the long-run *purchasing power of gold* - and therefore the price level - remain constant as the demand for money increases.[17] In order for the stock of gold to increase in each period, the *purchasing power of gold*, $1/R$, must be above that which would clear the market for gold flows such that $\Delta G > 0$. Figure 2 depicts such a situation. The stock demand for gold is increasing each period - reflected by the rightward shift of the stock demand curve from G_d^0 to G_d^1 - such that the *purchasing power of gold* is at a level above that consistent with stationary equilibrium. At this higher purchasing power, the flow quantity supplied, g_s exceeds that demanded, g_d, which causes the stock of gold to increase - reflected by the rightward shift of the stock supply curve from G_s^0 to G_s^1 - to meet the increased stock quantity demanded.

Since the stock of gold adjusts to stabilize its purchasing power, the price level remains constant and thus the rate of inflation is zero. Plugging this result into the

[16]Data on the money supply for each country came from the Federal Reserve Economic Database and output data came from the World Bank's Open Data database. These series are available online at: https://fred.stlouisfed.org/ and https://data.worldbank.org/

[17]This assumption follows from the model presented in Section 3, which illustrated that whenever the *purchasing power of gold* is different from that which would clear the market for gold flows, the stock supply of gold will adjust to ensure equilibrium in the flow market. Thus, the gold standard automatically stabilizes the price level, provided that either the long-run flow supply curve is perfectly elastic or the flow supply and demand curves continue to intersect at the same *purchasing power of gold*.

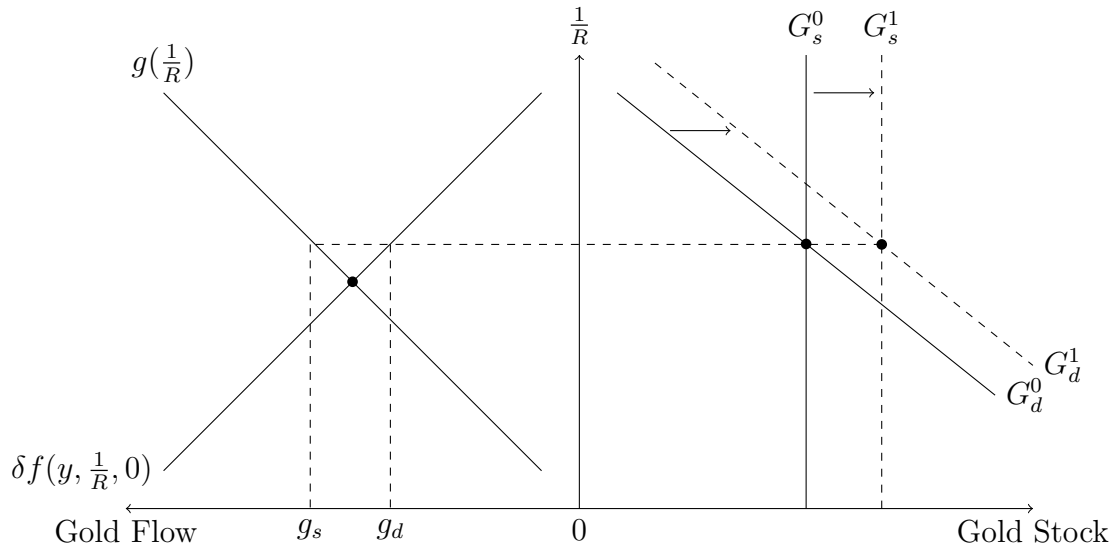

Figure 2: The Demand for Monetary Gold in a Growing Economy

dynamic equation of exchange, its possible to derive an estimate for $\Delta M/M$:

$$\frac{\Delta M}{M} = \frac{\Delta Y}{Y} - \frac{\Delta V}{V} \tag{10}$$

where $\Delta Y/Y$ and $\Delta V/V$ are the growth rates of income and velocity, respectively. As before, I use gross domestic product as the measure of income. To derive a measure of the growth rate of velocity, I calculated the ratio of nominal gross domestic product to the M2 money supply for each country in this study, and then used that ratio to estimate the average growth rate of velocity.

Finally, to derive estimates of $\Delta D/\Delta M$, I assume that the marginal reserve ratio is the same as the average reserve ratio, D/M. Thus, a straightforward measure of this component is the ratio of the bank reserves reported in Table 1 to the M2 money supply. For Australia, Canada, and Great Britain, I employed the same hypothesized

reserve ratio that I used to derive the estimates presented in the previous section.

My findings - reported in Table 3 - indicate that, on average, the countries considered would need to dedicate 0.564% of their output each year to acquiring the gold necessary to meet the increasing demand for monetary gold.[18] To put these numbers in context, recall that the countries considered in this study account for nearly 80% of gross world output, which is roughly $85 trillion. Thus, my estimates indicate that sustaining the gold standard would cost approximately $383 billion per year, with most of this cost being borne by China due to the rate at which its economy has been growing, the ratio of its money supply to gross domestic product, and its relatively high reserve ratio.

As equation (9) illustrates, the costs of sustaining the gold standard are an increasing function of the reserve ratio. Accordingly, consideration should be given to how lowering the reserve ratio to a level consistent with historical experience would affect my estimates. To do so, I again used a reserve ratio of two percent, which reduces my estimates of the average share of output necessary to sustain the gold standard to 0.184%, or roughly the equivalent of $125 billion per year. Table 5 reports these estimates.

Despite not being on a gold standard of any sort, these countries - with the exception of Japan - continue to accumulate stocks of monetary gold. It will be useful to see how they compare to the share of output these countries are currently using to purchase monetary gold. With the exception of Australia and Great Britain, the World Gold Council maintains data on the demand for the monetary gold among

[18]The data used to generate these estimates is available upon request.

Table 4: The Costs of Sustaining the Gold Standard

Country/Area	**RGDP**[a]	**%ΔRGDP**	**%ΔV**	**%ΔM**	**M2**	**RR**[b]	**M2:RGDP**[c]	**ΔG/RGDP**
Australia	AUD 1,692.00	3.49%	8.76%	-5.27%	AUD 2,029.96	6.13%	1.20	0.555%
Brazil	BRL 4,009.00	4.11%	-2.28%	6.39%	BRL 2,373.06	18.46%	0.59	0.698%
Canada	CAD 1,940.53	3.20%	-1.36%	4.56%	CAD 1,547.66	6.13%	0.80	0.223%
China	CNY 78,594.87	8.23%	-2.46%	10.69%	CNY 162,757.84	14.58%	2.07	3.227%
Eurozone	EUR 2,595.03	1.52%	-2.54%	4.06%	EUR 10,876.14	1.17%	4.19	0.198%
Great Britain	GBP 1,817.00	2.44%	-2.12%	4.56%	GBP 1,629.03	6.13%	0.90	0.251%
India	INR 130,108.43	5.37%	-2.13%	7.50%	INR 132,725,.29	3.67%	1.02	0.281%
Japan	JPY 540,402.00	3.76%	-1.89%	5.65%	JPY 958,082.30	1.05%	1.77	0.105%
Russia	RUB 87,480.00	0.69%	5.30%	-4.61%	RUB 39,223.60	6.19%	0.45	0.166%
South Korea	KRW 1,556,000.00	7.51%	-4.26%	11.77%	KRW 2,449,939.40	2.49%	1.57	0.461%
U.S.	USD 17,304.98	3.04%	-0.35%	3.39%	USD 13,571.96	1.42%	0.78	0.038%

[a]Billions of Local Currency Units in 2017

[b]Reserve ratio of current bank reserves (see Table 1) to M2.

[c]Ratio of M2 to Real GDP.

Table 5: The Costs of Sustaining the Gold Standard under a 2% Reserve Ratio

Country/Area	**RGDP**[a]	**%ΔRGDP**	**%ΔV**	**%ΔM**	**M2**	**RR**[b]	**M2:RGDP**[c]	**ΔG/RGDP**
Australia	AUD 1,692.00	3.49%	8.76%	-5.27%	AUD 2,029.96	2.00%	1.20	0.181%
Brazil	BRL 4,009.00	4.11%	-2.28%	6.39%	BRL 2,373.06	2.00%	0.59	0.076%
Canada	CAD 1,940.53	3.20%	-1.36%	4.56%	CAD 1,547.66	2.00%	0.80	0.073%
China	CNY 78,594.87	8.23%	-2.46%	10.69%	CNY 162,757.84	2.00%	2.07	0.443%
Eurozone	EUR 2,595.03	1.52%	-2.54%	4.06%	EUR 10,876.14	2.00%	4.19	0.340%
Great Britain	GBP 1,817.00	2.44%	-2.12%	4.56%	GBP 1,629.03	2.00%	0.90	0.082%
India	INR 130,108.43	5.37%	-2.13%	7.50%	INR 132,725,.29	2.00%	1.02	0.153%
Japan	JPY 540,402.00	3.76%	-1.89%	5.65%	JPY 958,082.30	2.00%	1.77	0.200%
Russia	RUB 87,480.00	0.69%	5.30%	-4.61%	RUB 39,223.60	2.00%	0.45	0.054%
South Korea	KRW 1,556,000.00	7.51%	-4.26%	11.77%	KRW 2,449,939.40	2.00%	1.57	0.371%
U.S.	USD 17,304.98	3.04%	-0.35%	3.39%	USD 13,571.96	2.00%	0.78	0.053%

[a]Billions of Local Currency Units in 2017

[b]Reserve ratio of current bank reserves (see Table 1) to M2.

[c]Ratio of M2 to Real GDP.

those countries considered in this study.[19] The data span the time period between 2010 and 2019. To calculate the average share of output dedicated to acquiring monetary gold, I multiplied the quantity of monetary gold that these countries acquired each year times the average gold price - in terms of their currency - over that same time period. I then divided this value by gross domestic product from that year to derive an estimate of the share of each country's output used to purchase gold and then averaged across all of these estimates. Table 6 reports my results.

Table 6: Comparing the Estimated Costs of Sustaining a Gold Standard

Country	**Current Share**	**Estimated Share**	**Estimated Share (2% RR)**
Brazil	0.002%	0.698%	0.076%
Canada	0.011%	0.223%	0.073%
China	0.126%	3.227%	0.443%
Eurozone	0.240%	0.198%	0.340%
India	0.607%	0.281%	0.153%
Japan	-0.007%	0.105%	0.200%
Russia	0.01%	0.166%	0.054%
South Korea	0.041%	0.461%	0.371%
United States	0.018%	0.038%	0.053%
Average	**0.117%**	**0.600%**	**0.196%**

On average, my estimates indicate that these countries are already spending roughly $80 billion per year - or 0.117% of their output - acquiring monetary gold. While fiat regimes can, in principle, avoid the costs associated with sustaining the gold standard, in practice, my estimates suggest that they have not done so. Thus, to the extent that this continued demand for gold reflects people's attempts to hedge against potential inflation that presumably wouldn't exist under the gold standard, the costs of sustaining such a regime may actually be somewhat less than what my

[19]This data is available online at: https://www.gold.org/goldhub

earlier estimates indicate.

6 Conclusion

Advocates of the gold standard have tended to focus on the regime's merits without giving as much consideration to the practical issues surrounding its implementation. The purpose of this paper was to take up these issues by answering some basic questions about the feasibility of adopting such a regime today. I argued that the current market price of gold is likely an appropriate parity to use for the resumption of gold redeemability, and that at this parity and at the currently required level of fiat reserves the stock of above ground gold is sufficient to support the adoption of the gold standard. However, if the current reserve ratios remained constant across both regimes, the adoption of the gold standard would involve a substantial reallocation of gold from non-monetary to monetary uses, requiring a one-time outlay worth approximately $3.5 trillion, although this figure would decrease substantially if the reserve ratio fell to its historical level. I also argued that the countries included in this study would, on average, need to dedicate roughly 0.564% of their output to meet the increasing derived demand for gold reserves in a growing economy, although as before, using a lower reserve ratio decreased these estimates substantially. Moreover, I showed that the countries considered in this study are already spending $80 billion a year on monetary gold, and in consequence, the additional gold necessary to sustain the gold standard would require an additional annual outlay of $328 billion using current reserve ratios or $54 billion under a two percent reserve ratio.

One question that I did not address is whether my estimates of the costs of a gold standard would be worth the benefits of adopting it today. Answering this question is difficult for several reasons. First, whether one sees the features of the gold standard as beneficial depends on how sanguine they are about policymakers' abilities to manage monetary and macroeconomic affairs. An ideally-managed fiat regime could not only avoid the sort of resource costs discussed in this paper, but may also be able to dampen macroeconomic fluctuations. The evidence that I have presented here suggests that in practice, fiat regimes have deviated from this ideal, at least as far as the resource costs are concerned. Another reason why it is difficult to weigh the costs and benefits is that there is not a consensus on what the gold standard's benefits are, although there is general agreement that on average, and over the long run, inflation was lower under the gold standard than it has been under the current regime.

Estimates of the costs of inflation vary, but one well-known estimate by Lagos & Wright (2005) suggests that even a moderate amount of inflation can be quite costly.[20] For example, they find that an inflation rate of four percent entails a welfare loss - measured in terms of reduced consumption - equal to roughly five percent. On average, the countries I considered in this study have had an annual inflation rate over the past ten years of roughly three-and-half percent. Considering that consumption generally represents the largest share of output, their estimates, combined with evidence that I provided in the previous section, suggest that the benefits from lower inflation exceed the costs necessary to sustain the gold standard.

[20]See Cooley & Hansen (1989) and Lucas (2000) for additional estimates of the welfare costs of inflation.

Of course, the benefits from reduced inflation are only one facet of the costs and benefits involved with restoring the gold standard. Consideration should be given to others as well.

While my results indicate that returning the gold standard would be feasible in the narrow sense considered in this paper, other, more fundamental margins of feasibility might be considered - especially those related to institutional and political factors. For example, one of the reasons that the the "Classical" gold standard worked as well as it did was that it was a spontaneously-evolved system that did not rely explicitly on governments to operate effectively (Selgin, 2015). Is it feasible to "implement" a spontaneously-evolved system? There is not an obvious answer this question. The need for a better understanding of this, and other fundamental issues related to the design and implementation of alternative monetary institutions seems to me to be the primary impediment to restoring a system like the gold standard.

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