Lecture Note on the Gold Standard

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1   Introduction

The gold standard is an important historic example of a fixed exchange rate regime. To some it is the ideal system because it takes central banks out of the exchange rate business. It is also seen as a natural system, as opposed to one that derives from government behavior. This is really a simplification of how the gold standard really worked. And it ignores the fact that the gold standard only really worked under peculiar historic circumstances.

What is important to recognize is that the gold standard involves a commitment. It is a rule based system. That is one of the big attractions.

Precisely because the gold standard flourished during a particular historical period, and because that period was the zenith of globalization and capital flows across countries, it is worthwhile trying to understand how it operated, and why it evolved. It is important to understand the "rules of the game" that were needed for its operation. This helps us understand its demise, and suggests why it would be hard to re-establish gold.

Studying the gold standard also is useful because it is a pure example of a fixed exchange rate. So if we understand the gold standard fixed exchange rates and currency boards are much easier to study.

2   The Specie-Flow Mechanism

It is useful nonetheless to examine Hume's specie-flow mechanism. This is really the first general equilibrium adjustment model in economics. It is a powerful model, and it is still useful, though it is based on simplified assumptions which produce the sharp predictions.[1]

Consider a world where prices are flexible and where all transactions take place with gold coins. Also assume that there is a fixed supply of gold in the world. These coins are minted at a fixed parity in each country. There are no banks and no capital flows.[2] Whenever goods are exported a merchant receives payment in gold. Not wanting gold, the merchant takes this to the mint and receives gold coins at the fixed parity. To purchase imports a merchant pays with gold. To get the gold the merchant takes coins to the mint and sells them for gold at the fixed parity, which is then used to pay for the imports. The recipient in the foreign country takes the gold to the mint and obtains coins.

Now consider the case of a country with a trade surplus. This means that more gold is coming in to the country than is leaving. Hence, the supply of gold coins in the domestic economy is increasing. With more circulating medium (specie) the price level will increase. This follows from the assumption of price flexibility and full employment.[3] The increase in domestic coinage increases aggregate demand and pushes up prices. But this

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[1]Hume wrote: "Suppose four-fifths of all the money in Great Britain to be annihilated in one night...what would be the consequence? Must not the price of all labour and commodities sink in proportion, and everything be sold as cheap as they were in those ages? What nation could then dispute with us in any foreign market, or pretend to navigate or to sell manufactures at the same price, which to us would afford sufficient profit? In how little time, therefore, must this bring back the money which we had lost, and raise us to the level of all the neighbouring nations? Where, after we have arrived, we immediately lose the advantage of the cheapness of labour and commodities; and the farther flowing in of money is stopped by our fullness and repletion." Hume, *Of Money.*

[2]Or you can think of banks with 100% backing of notes by gold.

[3]Though Hume did not argue that this would happen automatically; rather it would take some time so that at first output would increase before prices.

reduces the competitiveness of exports and increases the attractiveness of imports. Hence, the flow of gold will be reversed until prices return to their equilibrium levels. This is Hume's specie-flow mechanism, a complete explanation of the adjustment of price levels to shifts in the money supply across countries.

It is important, for this model (let alone for the gold standard as a monetary regime) to be useful, that we can extend the analysis to a world with banks and paper money. It turns out that this is not all that difficult. Assume that paper currency exists but that central banks stand ready to convert paper currency into gold at the fixed rate, as is the case in the foreign country. Suppose that Great Britain runs a trade surplus with France. That means that British exporters are accumulating franc notes. Not needing that many notes, they present the excess to the Bank of France for exchange into gold.[4] They then take the gold to the Bank of England and get more sterling notes. The domestic money supply rises, and the same adjustment as before, takes place. The systems works pretty much like it does with coin. Gold flows cause relative prices to change in Britain and France in a manner that reverses the gold flow.

Notice that because gold flows offset trade imbalances through adjustments in price levels, movements in prices tended to be cyclical rather than trending. Without growth in the world supply of gold inflation could not be sustained. Of course discoveries of gold, such as the Spanish discoveries in the Americas, did lead to increases in general prices, but the world trend in prices depended on the balance between the growth in production of goods and the growth in the production of gold.

This points to one of the key features of the gold standard system: the world price level is endogenous, determined by the worldwide supply and demand for gold.

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[4]This probably involves the intermediation of British banks which transfer to their correspondents in France.

Although the international gold standard is often termed an international monetary system, it is not the product of design. It was an *order*, and it had its rules, but these were the product of experience not an international conference or agreement. Nonetheless it is important to understand these rules.

3 Rules of the Game

One can list 6 rules of the international gold standard.

1. Fix a gold price (parity) and convert gold freely between domestic money and gold at that price.

2. No restrictions on the export of gold by private citizens or of capital across countries.

3. Back national banknotes and coinage with gold reserves and condition long-run money growth on gold reserves

4. In short-run liquidity crises resulting from a gold outflow, have the central bank extend liquidity at higher interest rates (Bagehot's Rule).

5. If rule 1 is temporarily suspended restore convertibility at the soonest feasible point in time at the old parity.

6. Allow the common worldwide price level to be determined endogenously by world demand and supply of gold.

Rules 1-3 are the essential features of gold. Rules 4-6 are more active. Rule 4 is somewhat controversial, but is critical to its feasibility. Rule 5 is critical to expectations. Countries on the gold standard suspend convertibility during wartime. The fact that countries obeyed rule 5 made this less

worrisome. The expectation that parity would be restored limited specula-
tion against the system. It meant that suspensions were not overly penalized
and that contingencies such as war did not impose unnecessarily harsh costs.

3.1   Gold Points

Notice that if rules 1-2 hold then exchange rates are determined by the fixed
parities. Let x be the dollar price of an ounce of gold, and let y be the
sterling price. Then $\frac{x}{y}$ is the fixed exchange rate – the dollar price of sterling.
Notice that arbitrage keeps the spot price equal to this amount, plus or minus
the transactions cost of shipping gold across countries. If T_{UB} is the cost of
shipping gold to Britain, and if T_{BU} is the cost of shipping to the US from
Britain, then it is profitable to export gold to Britain if

$$S_t > \frac{x}{y - T_{UB}} \tag{1}$$

where S_t is the spot exchange rate of the pound at time t. To see this, buy
an ounce of gold for x dollars. Now ship the gold to the UK. You know have
$y - T_{UB}$ ounces of gold. Now exchange this for dollars at the current spot
rate. You have $S_t(y - T_{UB})$ dollars (dollars are costless to ship). So for you
to make money you need $S_t(y - T_{UB}) > x$, which is condition 1. Similarly,
it is profitable to import gold to the US if

$$S_t < \frac{x - T_{BU}}{y} \tag{2}$$

so we could write

$$\frac{x}{y - T_{UB}} \le S_t \le \frac{x - T_{BU}}{y} \tag{3}$$

where the limits in (3) are referred to as *gold points*. During the gold standard
period the exchange rate was almost always within the gold points.[5] More-

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[5]There were violations, of course, but this occurs primarily because of increasing mar-
ginal cost of arbitrage. Think of shipping so much gold at once!

over, the bounds were rather small, though they varied with shipping and other costs. Shipping costs declined dramatically during the 19th century, especially the second half after the steam turbine went into use.

3.2   Gold Devices

It is important to note, however, that *gold devices* were used to maintain the exchange rate. For example, if gold was flowing out, governments sometimes raised the price of gold – violating rule 1 – to augment supplies. This allowed them to avoid using monetary policy – higher interest rates – to attract capital. It also allowed the gold points to widen somewhat. Note that falling transport costs would otherwise have reduced the gold points, so this provided some flexibility.[6] This greater flexibility may have been useful, and it was not all that harmful as long as nations adhered to rule 5.

3.3   Restoration Rule

McKinnon refers to Rule 5 as the restoration rule. This was key. It allowed for the contingent suspension of convertibility, but with eventual restoration at parity. The primary contingency was war. Britain suspended in 1847, 1857, and 1866, but after each time parity was soon restored. Restoration after the Napoleonic wars took a long time (till 1821), and the US took 17 years to restore parity after the Civil War, but the fact that it took place heightened confidence about the future price level.

   Notice that adherence to Rule 5 meant that rule 3 could be followed without major threat. If the government used gold devices these would clearly be temporary, as would be suspension. If a country experienced a rise in interest rates this would be less likely to trigger speculation against the currency. Little exchange risk would be anticipated given rule 5. Thus a rise

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[6]Keynes (in the *Treatise*, vol. 2, page 291) had advocated that central banks have a 2% bid-ask spread on gold, so as to widen the gold points, irrespective of transport costs. When designing Bretton Woods the two percent band was also adopted.

in rates would trigger an inflow of funds, rather than signal higher risk of depreciation. This made interest rate movements more stabilizing.

This may seem fine in theory but did it work? Turns out that there is an interesting way to test the credibility of the gold points. This utilizes the idea of arbitrage and the comparison of short-term interest rates. Let R_t^* be the current short-term sterling interest rate, and let $\overline{S}$ be the maximum value that the exchange rate can take according to the gold points. Then $\frac{\overline{S}}{S_t}$ is the maximum appreciation of sterling over the period of the investment. So the domestic interest rate could never exceed $\overline{R}_t$, where this is defined by:

$$\overline{R}_t = (1 + R_t^*)\frac{\overline{S}}{S_t} - 1. \tag{4}$$

We can similarly calculate the lowest value that the domestic interest rate could take $(\underline{R}_t)$ consistent with the lower bound of the gold points:

$$\underline{R}_t = (1 + R_t^*)\frac{\underline{S}}{S_t} - 1 \tag{5}$$

Using the expressions (4) and (5) we have bounds for the domestic rate. That is, whether $\underline{R}_t \leq R_t \leq \overline{R}_t$ held during this period. Amazingly, economists have found that short-term rates did stay within these *credibility* bounds. Not just for the US but also for France and Germany. This was true even when short-term interest rates were rather volatile.

It is this high degree of credibility of the system that made capital flows so substantial in this period. Credibility meant that modest interest rate swings could cause large capital flows, obviating the need for large flows of gold. This also led to the stability of the price level over long periods.

4   A Model

To better understand the gold standard it is good to first ask how the gold standard works in a single country. You might wonder about this because we would not really inquire into the functioning of a currency board or some other regime in a single country. An exchange rate regime involves two countries. But the gold standard is also an example of a commodity money. So by starting with a single country we can focus on the commodity money aspect, and then translate this to an exchange rate regime. It will turn out that the extension is practically trivial.

4.1   Closed Economy Model

Does it make sense to think about a closed economy? Yes. A gold standard makes sense here as a commitment device. The reason is that it can limit discretion which can be costly. To see this, think about a monetary authority that would like to keep inflation low. It could promise this. This would encourage people to use money. But once people believe this a monetary surprise could lead to lower unemployment. This brings a temporary gain over sticking to the promise of low inflation. Of course the temptation to do this makes the promise of low inflation incredible. The problem is called *time inconsistency.*

Another example would be taxation. The government can tax things that have been accumulated, like capital. Or they can use distortionary taxation, such as on tax labor income. Taxing capital is costly because it may lower growth, via lower capita investment. Once accumulated, however, it is sunk. The optimal policy for the government may be to tax labor income and commit not to tax capital. But once capital is accumulated the cost of taxing it in any period is zero – it cannot be decumulated The government is tempted to tax capital not labor to avoid the distortion of labor taxation. So the government may want to tax accumulated assets via surprise inflation.
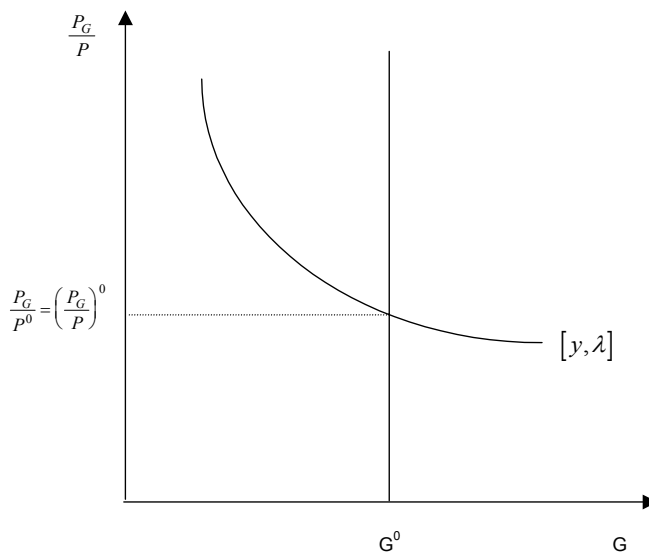
Figure 1: Price-level determination with a given Gold Stock

But if investors recognize this they will not invest. The government would thus like to commit to no taxes on capital But this needs to be credible. The idea is that commitment to the gold standard makes this credible.[7]

Because we have a gold standard, the dollar price of gold, P^G, is given. In the short-run the gold supply is fixed at G^0. We also have a demand function for gold, as in figure 1, which is drawn with a negative slope.

What determines the demand for gold? Gold is used for two purposes: non-monetary, such as jewelry, dentistry, etc., and monetary. The non-monetary demand for gold will be a decreasing function of its relative price, $\frac{P^G}{P}$. It will also depend on real income, y. If economic activity increases so should the non-monetary demand for gold.

Monetary demand for gold depends on its use for transactions. Suppose that gold is used to back the currency. Then if G_M is the quantity of gold used as reserves, and M is the stock of money, then $\lambda = \frac{P^G G_M}{M}$ is the reserve

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[7]But as we will see, the gold standard is a contingent rule – suspension is possible under certain circumstances. That makes this more credible actually than a total straightjacket.

ratio. If only gold were used as money, then λ would equal unity. In general it satisfies $0 < \lambda \le 1$.

This implies that the quantity of monetary gold demanded depends on the public's demand for dollars. Thus,

$$G_M = \frac{\lambda M}{P^G} \tag{6}$$

But this depends, according to standard theory, on real income and the price level. Hence, $M = PL(y)$, where $L' > 0$. Hence, using this in 6 we obtain

$$G_M = \frac{\lambda PL(y)}{P^G} \tag{7}$$

which implies that the monetary demand for gold depends positively on real income and λ, and negatively on the relative price of gold in terms of goods.

Because both the monetary and non-monetary demand for gold depends negatively on the relative price, and positively on y, λ we obtain the function as in figure 1. Notice that, because the price of gold is fixed, the supply of gold, in conjunction with the level of demand, determines the price level. If the stock of gold increased, or real income decreased, this would increase the price level.

We have examined the consequences of a given stock of gold, but what determines the stock? Consider figure 2, which shows the flow supply and demand for gold. The flow supply depends positively on the relative price of gold, because it is more profitable to produce gold when its price is higher.

Subtractions from the gold stock depend on wastage. We denote by δ the depreciation of the gold stock in non-monetary use, and $f\left(\frac{P_G}{P}, y\right)$ is the non-monetary demand for gold. We are assuming that money held as reserves does not depreciate. At the relative price $\left(\frac{P_G}{P}\right)^*$ the flow supply and demand are equal, so the stock of gold is not changing. If the relative price were higher than this then the flow supply would exceed demand and the stock would grow, and vice versa.
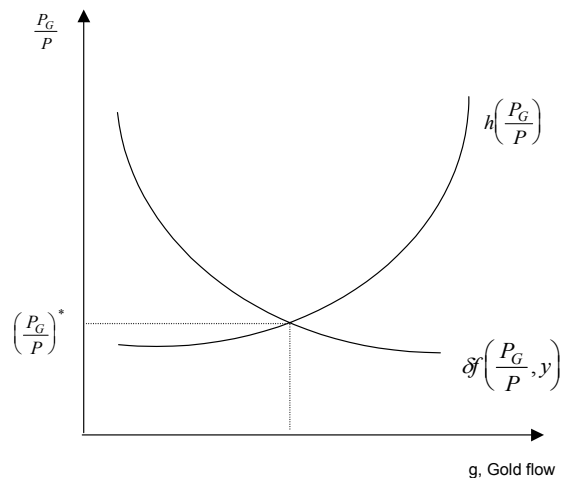
Figure 2: Flow supply and demand for gold.

We now put the two analyses together. Consider figure 3. If the initial gold stock is G^0, then the price level is $\left(\frac{P_g}{P}\right)^0$. This is the short-run equilibrium price level. But at this price the flow supply of gold is greater than its demand. This causes the stock to rise. Once the stock of gold increases to G^*, however, flow supply and demand are equal so that we are in long-run equilibrium.

Suppose that a new gold field was discovered, increasing the flow supply of gold. Suppose we were initially in long-run equilibrium. The discovery shifts $h(\cdot)$ to the right, causing the stock of gold to increase at the initial relative price of gold. As the stock increases the relative price of gold falls until the flow supply equals demand.

What about a shift in λ? Suppose that the Central Bank reduces λ. This would cause the demand function for monetary gold to fall, shifting the demand function to the left. At the given stock of gold, this would cause the relative price of gold to fall. But this would cause the flow supply to fall below demand, causing the stock of gold to fall. Eventually, the stock of gold falls sufficiently so that the relative price of gold returns to its initial level.

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$\frac{P_G}{P}$

$D_N + D_M$

$\left(\frac{P_G}{P}\right)^0$

$\left(\frac{P_G}{P}\right)^*$

G^0 G^* G

$\frac{P_G}{P}$

$h\left(\frac{P_G}{P}\right)$

$sf\left(\frac{P_G}{P}, y\right)$

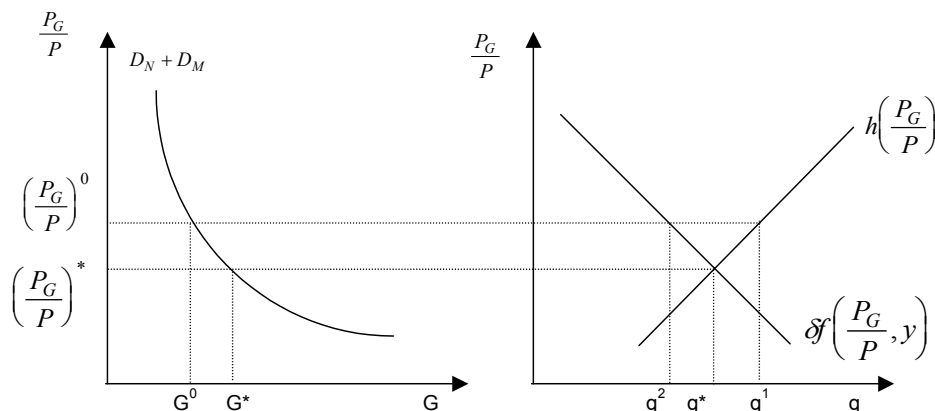g^2 g^* g^1 g

Figure 3: Gold Standard Model

We should note, however, that if the Central Bank starts to use λ too much as a policy instrument we cease to have the gold standard.

4.2   Open Economy Version

Now how do we modify the model for the open economy? This turns out to be quite easy. All we do is replace the flow supply function. Instead of depending on production, we now have it depend international trade in goods and services. If exports exceed imports the supply of gold increases, and vice versa. But what will the trade balance depend on? Clearly, this will depend on the relative price of gold. If the domestic price level increases then imports will increase. It will also depend on the domestic and foreign income, $\frac{y}{y_f}$.[8] So we can now write the flow supply function as $h\left(\frac{P_G}{P}, \frac{y}{y_f}\right)$, with $h_1 > 0$, and $h_2 < 0$. we know have figure 4. The key difference now, however, is that the flow supply of gold will adjust much faster. It no longer depends (only) on production, but on the flow of gold due to trade.

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[8] If our income rises relative to foreigners income then net exports will fall, due to the relative increase in our imports.
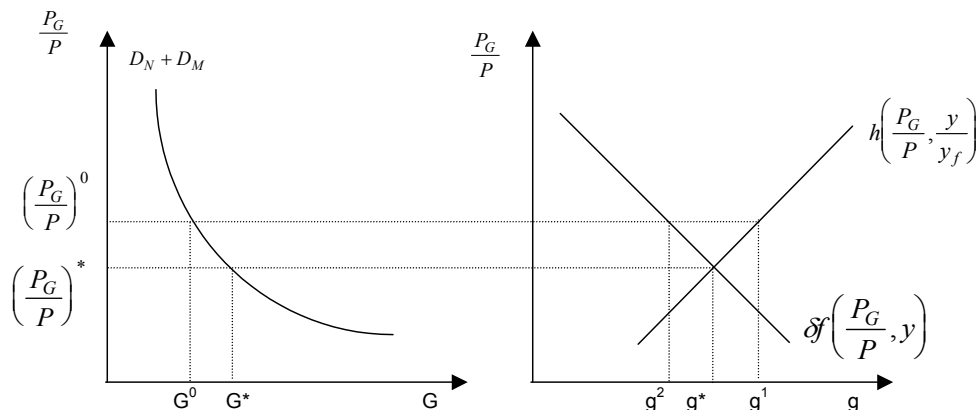
Figure 4: Gold Standard in the Open Economy

The key feature of the gold standard model is that the price level depends on the stock of gold. We can see here the specie-flow mechanism at work. If the stock of gold increased due to some discovery the relative price of gold decreases, which is the same thing as saying that our price level rises relative to foreigners (who are also tied to gold). This means that the flow supply will be less than demand, causing G to fall. The decrease in G causes our prices to fall until we return to the initial equilibrium.

Notice that under the gold standard changes in the demand for money (or changes in income) can have short-run effects, but no long-run effects on inflation. Suppose money demand increases. This would shift the stock demand for gold to the right, causing the relative price of gold to rise. This would imply that we are more competitive, and the gold inflow would exceed its depreciation. The ensuing increase in the stock of gold would cause our prices to rise until we returned to the initial equilibrium relative price. This is analyzed in figure 5.

Our model of the gold standard works quite well to explain the automatic adjustment of the system. It can – unlike Hume's version – account for
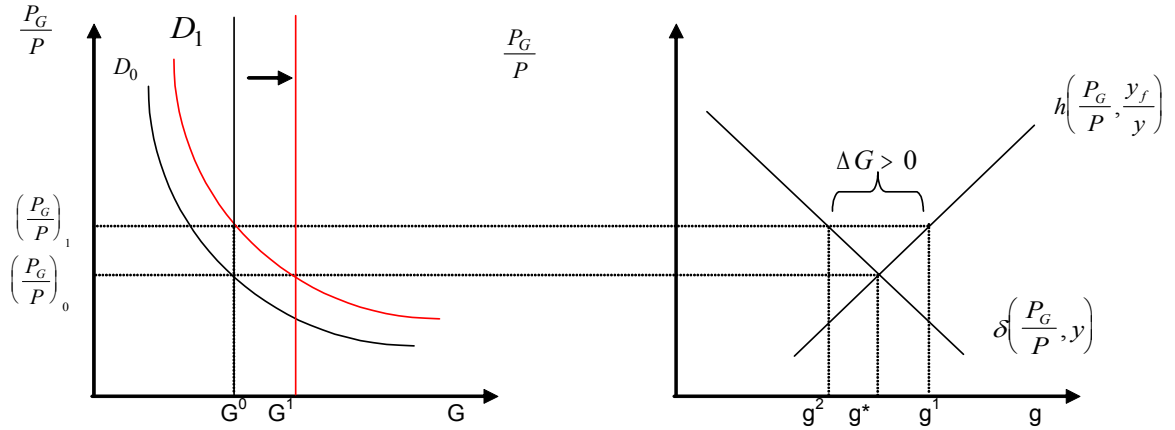
Figure 5: An Increase in Money Demand

capital flows as well, since we have paper money. We would only need to make the flow supply of gold depend on the interest differential in addition to the relative price of gold and relative income, $h\left(\frac{P_G}{P}, \frac{y}{y_f}, \frac{r}{r_f}\right)$, where $h_3 > 0$ because a positive interest differential would cause capital to flow into the economy. This would require foreigners to purchase domestic currency with their currency, which would then be traded for gold, increasing the supply at home.

4.3   Rules of the Game

The major way in which this model departs from the actual operation of the gold standard is that gold flows were not, in fact, as large as the model suggests. The model suggests that gold flows are on the order of magnitude of the trade balance (or the trade balance plus the capital account if we consider capital flows). In fact, however, gold flows were much smaller than this level. How could this be?

The explanation for the missing gold flows is monetary policy. Although

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the ideal system is passive, in fact monetary authorities could intervene to
speed up monetary adjustment. Rather than wait for gold flows to move the
price level, a central bank could undertake policy to move the money supply
in anticipation of the gold flows. Suppose that our price level is too high:
at the initial relative price of gold we are running a trade deficit (in modern
parlance we might say that the currency is over valued). Over time gold would
flow out of the country, reducing our money supply, and restoring external
balance. But this could take time. To speed this up, and to avoid the loss of
gold, the central bank could act to tighten monetary policy *in anticipation*
of the gold outflow. This could occur via an increase in the discount rate,
for example. Rather than wait for a reduction in the gold supply to reduce
the stock of money, active monetary policy tightens liquidity in advance. So
the fall in prices does not have to wait for the fall in gold.

When the central bank was tightening in anticipation of an outflow, and
vice versa, this was referred to as "playing by the rules of the game." The
phrase is Keynes's and thus postdates the classical system; in real time there
were no written rules, this is just what was expected.[9] Why would the central
banks behave this way? Notice that it is not the obvious response.

- The gold outflow will lead to a tightening of domestic credit and a
  deflation in the price level

- Anticipating this outflow the central bank is tightening *before* the out-
  flow of gold occurs. Why? To avoid the loss of gold that will eventually
  occur.

Of course once we allow for the central bank to intervene there is always
the possibility that they could do this in the "wrong" way – against the rules
– by trying to prevent the domestic money supply from responding to gold

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[9]Of course playing by these rules meant augmenting gold flows not sterilizing them.
This is very unpopular, potentially, as it involves sacrificing internal balance for external
balance.

flows. In modern parlance this is called *sterilization.* But this could only be conducted for short periods of time, because eventually a country would run out of gold. Moreover, it was inconsistent with the rules, and prior to 1914 countries treated the gold standard as an institution that could not be discarded.

Still it is important to note that as long as governments remained committed to rule 5 the credibility of the system afforded some leeway for monetary policy. Interest rates could respond to shocks because people believed that par values would not change. So temporary deviations from monetary orthodoxy would not lead to shaken faith in the system. This could be true as long as countries commitments to rule 5 were credible. The gold standard was seen as restraining time-inconsistent policies.

4.4   Evaluation

The advantage of the gold standard is that it ties the world price level to the world supply of gold. This is an advantage because it prevents inflation (unless there is a gold discovery). Notice that the gold standard does not prevent fluctuations in the price level, however. What it does produce is long-run price stability.

The gold standard brought benefits. Adherence to the standard meant lower interest rates. This is a clear finding, perhaps 40 to 50 basis points. Adherence to the gold standard conferred a "seal of approval." It mattered more for bond prices than macro fundamentals. Why not? It was a better signal. Globalization was enhanced and prices integrated.

- There may be a problem. We need to look at expected returns not yields to see if the seal of approval really worked

- There is a theoretical problem that is important here. Suppose that the bond market punishes a country that goes off gold. If all other

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characteristics are equal this creates an arbitrage opportunity.[10]

You might think that this is really the British Empire effect, but this is incorrect. In the interwar period being a member of the British Empire did cause lower rates, but prior to 1914 access to London markets was independent of this. Adherence to the gold standard brought lower rates.

Does this mean that the gold standard was some perfect order that we should go back to? That is not the argument. Rather it is to see the clear benefits of the system and then to ask *why* it has not been restored. This allows us to ask the question of *which features* of the gold standard make it so difficult to resurrect.

But the gold standard is also problematic. It ties the world money supply to the production of a commodity. There is no inherent reason why the growth in gold supplies will be related to the needs of international liquidity. When gold discoveries are rare, the world supply of gold will not increase as fast as real income. This would be deflationary. Between 1873 and 1896, the frequency of gold discoveries was rare while economic growth was rapid.

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[10]One problem with the model is that it requires the bond market to behave in a collective manner. The sound money equilibrium is only attainable if the bond market punishes countries today that left gold in the past. Thus if two nations issue bonds with identical expected cash flows, the bond market assigns a lower price to the nation that abandoned gold. Punishment creates an arbitrage opportunity as it implies two assets can promise the same payments but trade at different prices. Despite this, punishment is consistent with equilibrium as long as the bond market is sufficiently patient to forgo current arbitrage profits in exchange for a future of sound money. If bond market prices were set by a small number of patient agents this equilibrium would be easy to attain. In reality, the bond market is made up of many finite lived investors who collectively set prices but individually are approximate price takers. If an individual investor is sufficiently small that his investment decision does not influence the market price, the investor can take advantage of the arbitrage opportunity without altering the equilibrium. Individually each small investor may realize he has no market power. Collectively, however, their actions result in bonds with identical expected cash flows receiving identical prices regardless of past adherence to the gold standard. In sum, the good housekeeping equilibrium relies upon the bond market collectively forgoing present day profits in order to punish governments that deviate from sound money. With many participants, the equilibrium requires a collective action mechanism to prevent arbitrage seeking investors from pushing the prices of gold and non-gold bonds together.

With the world demand for money exceeding the growth in its supply, the price level had to fall. That explains why price levels fell dramatically (53% in the US). Gold rushes led to the opposite effect. One reaction to gold shortages was the demand for bimetallism, which I discuss below.

One major factor that led to the breakdown of the gold standard – or rather the inability to re-assemble it after WW1 – is the rise of universal suffrage and democracy. The gold standard depended on rule 5. But rule 5 means that deflationary adjustments will take place. The distributional effects are uneven. It is probably the case that democracy enfranchised groups that disproportionately suffer, or appear to suffer, from deflationary shocks. And a rising belief that these can be avoided led to abandonment of rule 5. Moreover, the benefits of obeying rule 5 manifested in greater access to world capital markets. But after WW1 international capital flows were much smaller. Of course one reason they were much smaller was the decline of the gold standard. So one has to be very careful to avoid a circular explanation.

4.5   Value of the Seal

The value of the seal of approval is evident in interest rates. For the US we see that long-term interest rates fell towards UK rates after the US went on gold (see figure 6). It is interesting to note that yields on gold notes were *higher* than paper notes prior to resumption. This may seem strange. But gold was expected to depreciate relative to greenbacks in this period, and it did. When issued a greenback equalled a gold dollar. During the civil war the greenback had depreciated, but the US was committed to return to parity. Hence, the premium on the gold notes. We can see similar results for other countries.

For example, Argentina and Brazil show clear decreases in yields when on the gold standard (figure 7).
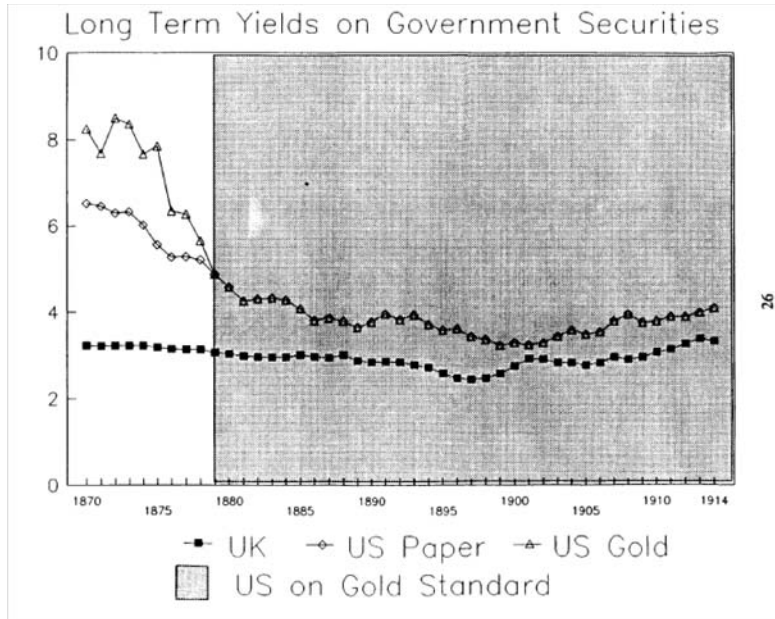
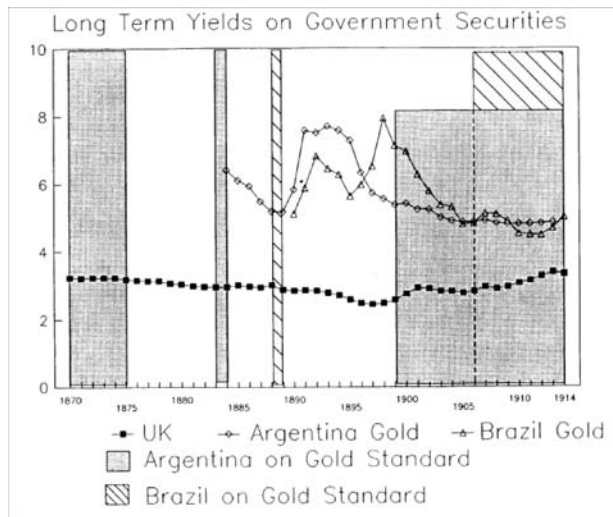Figure 6: Interest Rates and the Gold Standard in the US
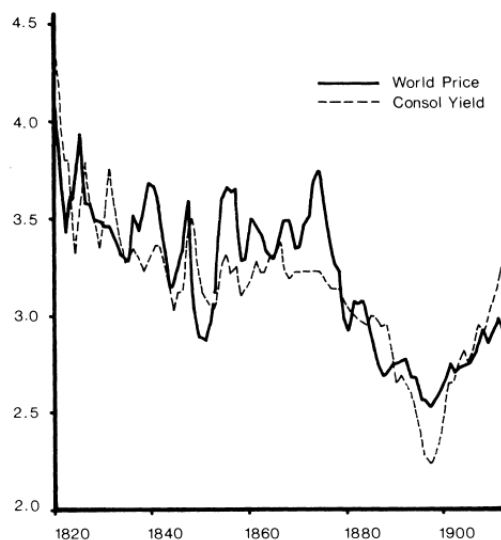

Figure 7: Argentina and Brazil

Figure 8: The World Price Level and the Consol Yield

5   Gibson's Paradox

The Fisher relation tells us that nominal interest rates should be correlated with expected inflation. But during the gold standard period, interest rates were correlated not with inflation but with the price level. Keynes named this Gibson's paradox, and it is evident in figure 8. There is essentially no correlation with inflation during this period – not too surprising, since there was no strong trend to inflation under the gold standard. But why the relation to the price level?

One way to think about this is to note that gold is a durable asset. Hence, the demand for it will depend on interest rates. When interest rates rise the cost of holding this asset increase. The willingness to hold the stock of gold depends on the rate of return to other physical assets. Shocks to this return will then affect the price of gold.

What is the real price of gold, ρ? Clearly it is $\frac{1}{P}$ ($\equiv p_G$) since to buy

gold you sell goods.[11] So fluctuations in the real price of gold tell us what happens to the price level. Hence, if we can explain why the real price of gold is negatively correlated to interest rates, we have explained why the price level is positively correlated with interest rates.

Consider a simple model: the two purposes for holding gold are monetary (as bank reserves), G_m. and non-monetary (jewelry, etc.), G_n. Money demand depends on income and interest rates (as before), so we can write

$$\frac{M}{P} = l(i, y), \quad l_i < 0, l_y > 0 \tag{8}$$

which just says that the real money supply equals real money demand (which depends negatively on the nominal interest rate and positively on real income).[12] The relationship between the stock of money and the stock monetary gold is fixed by the reserve ratio, λ:

$$M = \mu G_m \tag{9}$$

notice that $\mu = 1/\lambda$, and we have set the nominal price of gold to unity. Finally, we have

$$G_m + G_n = \overline{G} \tag{10}$$

where $\overline{G}$ is the fixed gold stock (we are ignoring the flow considerations).

How about non-monetary gold? People hold gold because they get services from it. Let us denote the marginal service flow as $D(G_n)$, with $D_{G_n} < 0$, in other words, diminishing returns. Notice that the marginal service flow is decreasing in the amount of non-monetary gold. Agents would equate this to the cost of holding gold, which is $rp_G - \dot{p}_G$. This follows because when interest rates rise the costs of holding gold increases since the interest

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[11]We are just setting the dollar price of gold $P_G = 1$.

[12]Notice that the Fisher relation implies $i = r + \pi^e$. Since the real price of gold is the inverse of inflation, we could write this as $i = r - \frac{\dot{\rho}^e}{\rho^e}$, where $\dot{\rho}$ is the rate of change of the price of gold, so the last term is the expected increase in the price of gold.
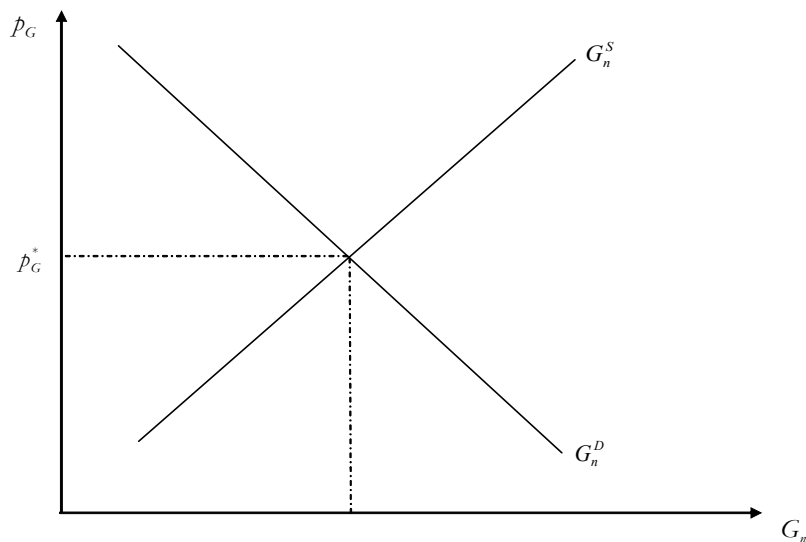
Figure 9: Determination of Price of Gold

is foregone. But if the asset appreciates in value the holding cost falls. This means that

$$\dot{p}_G = rp_G - D(G_n). \tag{11}$$

Now suppose we are in steady state so we can assume that the real price of gold is constant. Then, $\dot{p}_G = 0$. This means that (11) becomes

$$D(G_n) = rp_G \tag{12}$$

and (8),(9), and (10) imply

$$l(r, y) = \frac{\mu(\overline{G} - G_n)}{P}. \tag{13}$$

Expression (13) is just money market equilibrium: the lhs is real money demand the rhs is real money supply.

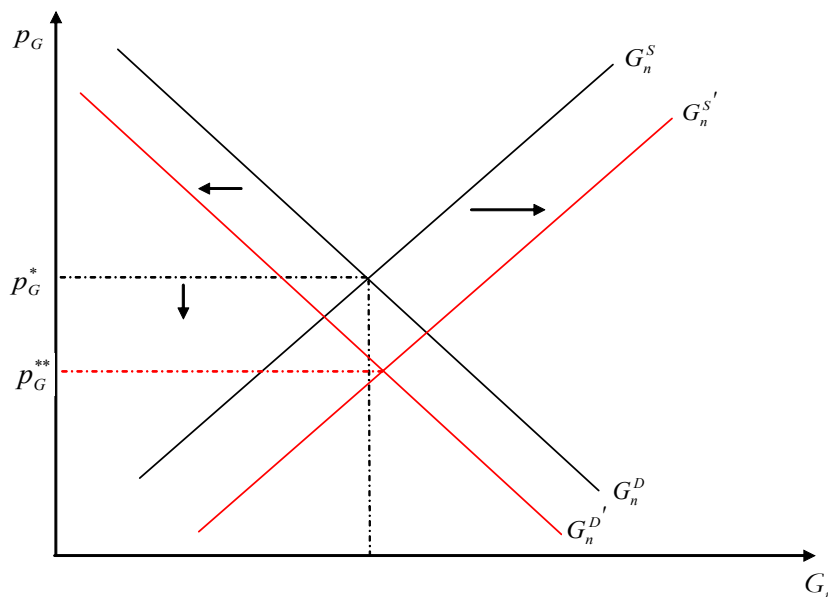We can put this together in a simple picture. From (12) we see that

Figure 10: Rise in the Interest Rate

the demand for non-monetary gold (G_n^D in figure 9) is negatively related to
the real price of gold. If the latter rises we must hold less non-monetary
gold so that the service flow increases. From (13) we see that an increase in
non-monetary gold is only consistent with monetary equilibrium at a higher
p_G. So the supply curve G_n^S is upward sloping. So we have figure 9. Now
suppose that the interest rate exogenously increases. From (12) we can see
that G_n^D must shift to the left. This follows because with a higher interest
rate the cost of holding gold has increased, so the dividend flow must increase
which only occurs with less non-monetary gold. What about G_n^S? From (13)
we see that this reduces money demand, so the LHS decreases. Monetary
equilibrium thus requires the RHS to decrease. At a given price level this
means that G_n^S must increase so the supply curve shifts to the right. *The
result is that p_G must clearly fall.* But this means that the price level must
increase with the rise in the interest rate, which is Gibson's paradox.

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6   Bimetallism

When gold production lagged the growth in output the pressure on the world price level was deflationary. This had two effects. One was to increase the reward to further gold discovery, and to conservation of non-monetary uses of gold. The second effect was to increase the use of silver as a medium of exchange. By maintaining a fixed rate of exchange between gold and silver (say 15.5 to 1 as in France in the first half of the 19th century, or 16-1 as in the US), silver production could make up for shortages of gold. As gold became scarcer the return to silver discoveries increased, because countries on bimetallic standards exchanged gold and silver at the fixed rate. Two types of money circulated simultaneously.

When countries went off silver to the gold standard silver flowed to those countries, like India and China, that were still on silver.[13] Since the UK was on gold, the rupee, for example, depreciated against the pound. This hurt Indian competitiveness, and it also raised the rupee cost of servicing India's debts.

Under bimetallism the amount of money in circulation is given by $M = \lambda[P^G(G+\frac{P^s}{P^G}S)]$. Notice that if the price of silver is too low then there will be no monetary silver. The higher the price of silver relative to gold the greater will be S.

Notice that as long as the production of gold and silver did not get too far out of line bimetallism was feasible. But if gold became scarcer a country like France could quickly run out of one metal. Agents would go to the mint in France with silver and exchange it for gold. Of course, the mint could raise the price of gold in terms of silver. But this would reduce the return to silver miners, and it would reduce the world supply of media of exchange. Political

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[13] "Miss Prism: That would be delightful. Cecily, you will read your Political Economy in my absence. The chapter on the fall of the Rupee you may omit. It is somewhat too sensational. Even these metallic problems have their melodramatic side." Oscar Wilde, "The Importance of Being Earnest.

interests that supported debtors would agitate in favor of silver coinage.

In fact the saga of the *Wizard of Oz* is[14] an allegory about bimetallism. Wholesale prices in 1890 were about 55% of their 1869 level. Real output had grown during the 1870's by about 5.0%, while the stock of money grew only by about 2.6%. The problem was the lack of specie. Congress responded, in 1890, with the Sherman Silver Act, which began coining some silver in limited amounts (at a rate far above 16 to 1). This caused panic that the US would leave the gold standard, and Grover Cleveland achieved its repeal. Unemployment in 1892-96 was over 12%, so when Democrats met in Chicago their cry was for bimetallism at 16 to 1.[15] Recall Bryan's call that "Thou shall not crucify mankind upon a cross of gold."

And thus Baum told the story in his book. Oz, in fact, stands for ounces of gold. Dorothy from Kansas is the honest American from the heartland,[16] and the Scarecrow stand for farmers.[17] The Tinman represents the workers

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[14]See Hugh Rockoff, *JPE*, 98, 4, August 1990.

[15]The market rate at that time was closer to 31 to 1. Hence free coinage would have led to some outflow of gold. But notice that free coinage really amounts to increasing the total stock of specie (like painting silver gold), which undoubtedly was in short supply at the time. Moreover, the low market price was directly related to the absence of a monetary demand for silver. Bimetallism would have increased the demand.

[16]Silver shoes walking on a golden road; henceforth Dorothy becomes the innocent agent of Baum's ironic view of the Silver issue. Remember, neither Dorothy, nor the good Witch of the North, nor the Munchkins understand the power of these shoes. The allegory is abundantly clear. On the next to last page of the book Baum has Glinda, Witch of the South, tell Dorothy, "Your Silver Shoes will carry you over the desert.....If you had known their power you could have gone back to your Aunt Em the very first day you came to this country." Glinda explains, "All you have to do is knock the heels together three times and command the shoes to carry you wherever you wish to go." (p.257). William Jennings Bryan never outlined the advantages of the silver standard any more effectively. Not understanding the magic of the Silver Shoes, Dorothy walks the mundane – and dangerous – Yellow Brick Road.

[17]He complains of no brain – not understanding what the moneymen from the east tell him – but of course he finds that he has one by the end.

who are ruined by the eastern powers,[18] and the Cowardly Lion is Bryan.[19] The Wicked Witch of the East is Wall Street – the advocates of tight money and most especially Grover Cleveland. The Wicked Witch of the West is drought – at that time ruining farms in Kansas and Nebraska (hence, destroyed by water).[20] Emerald City is Washington, where people must wear green shaded glasses; thus they are forced to see the world through the shade of money. Toto stands for "teetotaler," the prohibitionists, who agreed with the populists on silver.[21] The Wizard is really just a man, and his solution for Dorothy's problem – the balloon – vanishes like hot air. Dorothy is eventually saved by Glinda, the Good witch from the South, the region the populists hoped to ally with, and all she has to do is click together her *silver* shoes.[22] Thus when silver is coined along with gold all is solved.

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[18]Once an independent and hard working human being, the Woodman found that each time he swung his axe it chopped off a different part of his body. Knowing no other trade he "worked harder than ever," for luckily in Oz tinsmiths can repair such things. Soon the Woodman was all tin (p. 59). In this way Eastern witchcraft dehumanized a simple laborer so that the faster and better he worked the more quickly he became a kind of machine. Here is a Populist view of evil Eastern influences on honest labor which could hardly be more pointed.[16] There is one thing seriously wrong with being made of tin; when it rains rust sets in. Tin Woodman had been standing in the same position for a year without moving before Dorothy came along and oiled his joints. The Tin Woodman's situation has an obvious parallel in the condition of many Eastern workers after the depression of 1893.

[19]This apparently is because by 1900, in his second race with McKinley, Bryan no longer fought the bimetallism issue. Baum is thus picturing him as a coward.

[20]Would inflation serve like water to end the problems of the farmer? What about the Fisher effect?

[21]What about the Winged Monkeys? There are an Oz substitute for the plains Indians. Their leader says, "Once we were a free people, living happily in the great forest, flying from tree to tree, eating nuts and fruit, and doing just as we pleased without calling anybody master." "This," he explains, "was many years ago, long before Oz came out of the clouds to rule over this land" (p. 172). But like many Indian tribes Baum's monkeys are not inherently bad; their actions depend wholly upon the bidding of others. Under the control of an evil influence, they do evil. Under the control of goodness and innocence, as personified by Dorothy, the monkeys are helpful and kind, although unable to take her to Kansas. Says the Monkey King, "We belong to this country alone, and cannot leave it" (p. 213). The same could be said with equal truth of the first Americans.

[22]In L. Frank Baum's classic fairy tale, Dorothy did NOT wear Ruby Slippers. Rather, she wore silver shoes. It was Noel Langley, one of MGM's screenwriters who is credited with making this change for the 1939 classic film. As a result, it is virtually impossible to

While free coinage of silver would offset the shortage of gold, and would have offset the deflationary effects of the gold standard in the last quarter of the 19th century, the gold standard was on its way. This was partly due to the difficulties of operating a bimetallic standard.[23] Another factor was increased gold discoveries – primarily South Africa – that alleviated the gold shortage at the appropriate moment. It was also due to the fact that the strongest economy, Britain, had adopted the gold standard, and countries that traded with Britain found it advantageous to adopt the same system to facilitate trade.

Was Bryan foolish?[24] Who could have known that gold would be discovered?[25] And wasn't the money stock too tight? Certainly it was in the period of deflation. Moreover, given the size of the US it is unlikely that the market rate could have stayed at 31-1 while the US coined at 16-1. Silver would be shipped to the US in exchange for gold. The price of silver would have risen and the world money stock as well.

7   Interwar Period

Between the wars the gold exchange standard was developed. This basically differed from the classical gold standard in several ways.

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think of The Wizard of Oz without it conjuring up images of the Ruby Slippers. They in effect have become a household word.

[23]Though these were probably overstated given the size of the US. The so-called instability of a bi-metallic standard was illusory. Two legs are better than one.

[24]With regard to bimetallism (Bryan's views on evolution and creationism is different matter altogether)? Probably not foolish, but too late. The time for coining silver was in 1873 before the big deflation. By 1896 the horse had left the barn.

[25]It is interesting to note that many gold discoveries that stabilized the system were fortutitous. The California gold rush was prompted by the construction of Sutter's Mill on the American river. This was the response to agricultural expansion in California. Similarly, discoveries in South Africa and Australia in the 1890's occurred as populations expanded to new areas. These were less a response to a high price of gold than to population pressures and lower travel costs. An exception to this is the introduction of the cyanide process for extracting gold from rock. This was a response to the high price of gold. See Rockoff 1984.

- withdrawal of gold coins from circulation and concentration of gold stocks in central banks

- emergence of the dollar as a second reserve currency

- reduced wage and price flexibility especially in US and UK

- central banks no longer wished to play by the rules – emergence of popular democracy

- asymmetry of debtor and surplus countries – the former must adjust, the latter does not have to – this creates a *deflationary bias*

  - but didn't this operate before the War as well? Yes, but then the center of the system was the Bank of England which was privately owned. A profit making institution would not want to hoard gold. The same cannot be said for the Federal Reserve or the Bank of France after the war.[26]

- fractional reserves (by Central Banks) also led to deflationary bias. Much of gold holdings was backing for the domestic money supply. This left less gold to be used for external flows.[27] For a deficit country this meant that a small outflow would threaten the currency, but obviously no effect for surplus countries. Moreover, it meant that a small reduction in gold stock had a big effect on the money supply.

Mundell argued that the primary failure of this system in the interwar period was too low a price of gold. The dollar price of gold was left unchanged even though prices had risen substantially, perhaps overvaluing the dollar by

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[26]Recall that France restored gold at a parity that undervalued the franc.

[27]For example, in 1929 according to the League of Nations, for 41 countries with a total gold reserve of $9.378 billion, only $2.178 billion were "surplus" reserves, with teh rest required as cover for the money stock (Bernanke 2000, 73).

35-40%.[28] In the UK and other European countries that implemented rule 5, eventually, the rise in prices during WW1 was even higher. A higher gold price would have increased liquidity.

Example 1 *Too low a price of gold*

What happens when the gold price is set too low relative to the price level, as in the US and UK after WW1? Too low a price of gold – or too high a value of domestic currency – means that there is excess demand for gold domestically, and that the gold flow will be negative – our prices are too high so we lose gold to our trading partners. Notice that adjustment requires the gold stock, and hence domestic prices to decline. If this happens then the relative price of gold returns to its equilibrium level. This is the automatic adjustment mechanism of the specie-flow mechanism.

- The problem in the interwar period is that prices were rigid downward, so the deflationary pressure lead to unemployment not just a fall in prices

- Democracy made the fall in unemployment unacceptable

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[28] As Bordo notes: "The key problem was that the major countries returned to gold at misaligned real exchange rates. All the belligerents had serious inflations during the war and the restoration of the original gold parities involved deflation and recession. As it turned out Britain restored parity at $4.86 with an overvalued real exchange rate while France and Germany each greatly devalued their currencies and restored parities at undervalued real levels The U.S. never left the gold standard but U.S. prices did not return to the prewar level so that its real exchange rate was also undervalued. This misalignment meant that the U.S., France and Germany tended to run current account surpluses while Britain, and its empire and countries economically linked to it, ran deficits. Under the gold standard, this meant that gold tended to flow towards the surplus countries. Also under the gold standard rules, both creditors and debtors were supposed to adjust to the imbalances: creditors by allowing domestic price levels to rise; debtors by deflation. As it turned out both the U.S. and France continuously sterilized their gold flows and prevented adjustment. As a consequence they imposed deflationary pressure on Britain and on the rest of the world."

Consider figure 11. Initially the gold stock is at G_0. Given the price level increase during the war ($P_{1920} > P_{1913}$) equilibrium requires a price of gold high enough so that the relative price is $\left(\frac{P^G}{P}\right)^*$. But suppose that the gold price is set too low, so that we are at $\left(\frac{P^G}{P}\right)^0$. Because of downward wage and price rigidity the price level cannot just fall so that we return back to point A. Instead we are at point B. Then there is excess demand for gold at this low price, and we are running a balance of payments deficit – the flow of gold is negative, equal to the distance yx. To relieve the excess demand – to make the gold standard function at all – the demand for gold must fall, either by a decrease in income (as in the figure) or a decrease in λ.

- By the rules of the gold standard we must eventually get to point C. Here the price level has fallen so that we are once again in stock-flow equilibrium. This happens as $g < 0$ causes $G_0 \rightarrow G_1$. The fall in gold leads to lower prices and we end up at C. Deflation saves the day.

- "Playing by the rules" the Central Bank could tighten monetary policy to hasten the fall in prices so that less gold must leave the country. That is, policy reinforces the deflation.

- But if the Central Bank is unwilling or unable to sacrifice internal balance for external balance then problems arise. If they sterilize the gold flow, prices do not fall, and we stay at B, losing gold. This cannot go on forever. If they conduct expansionary policy to combat the recession it is even worse. Suppose that they reduce reserve requirements. This will cause the price level to rise even further, and enhance the rate at which we lose gold.

- This is a key point: in the interwar years the willingness to sacrifice internal balance for external balance was weak

But contrary to this are two points: first, the gold cover ratio was little changed; second, foreign exchange reserves could substitute. But the problem
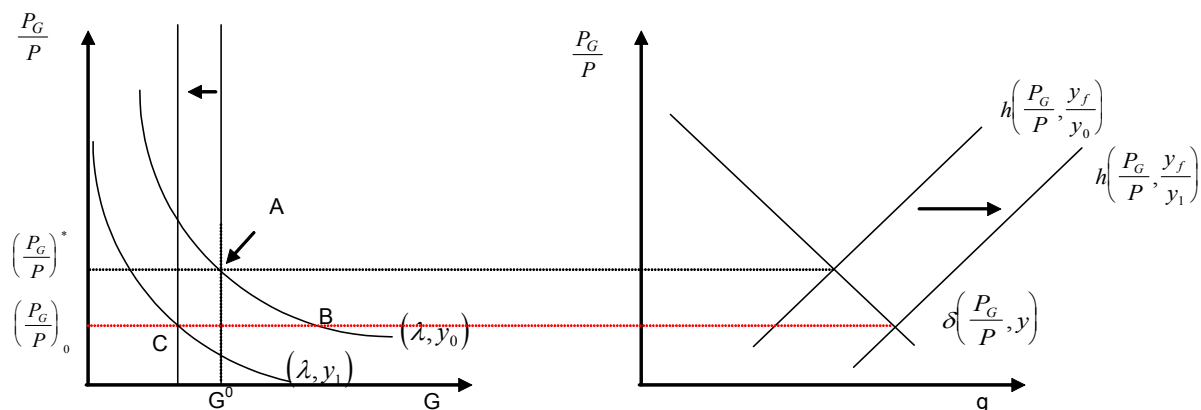
Figure 11: Too Low a Price of Gold

of foreign exchange reserves was that they only work when gold prices are stable. Because $\lambda < 1$, the amount of pounds or dollars was in excess of the monetary value of gold. Other countries could use dollars or pounds as reserves rather than gold itself, as long as they believed that the UK and US would maintain the value of their currencies. Hence, some liquidity could be provided by foreign holdings of dollars and pounds. That is why this was called the gold exchange standard. Sometimes this was called *pyramiding* of reserves. Gold supports a greater amount of total world liquidity than would be the case if $\lambda = 1$ in all countries. The ratio of foreign exchange reserves to gold grew gradually prewar, but became more important in the interwar period till 1931 (when UK left gold). It was much more important still in the Bretton Woods period, as is evident in figure 12:

Now suppose that other countries fear that the pound or dollar will be devalued – that is their domestic currency price of gold increased. Central banks in these countries would exchange dollars and pounds for gold. Hence, the *share* of total world reserves held in the form of currency would fall and the *share* held in gold would rise. But since total gold is unchanged, total
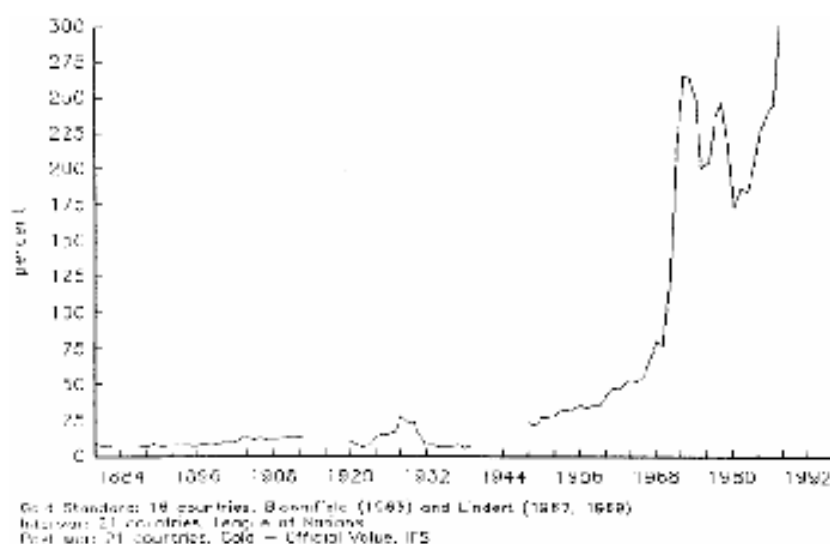
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Figure 12: The Ratio of Foreign Exchange Reserves to Gold Reserves (source: Bordo and Eichengreen).

world liquidity decreases. The gold exchange standard thus requires the leading powers to act responsibly, as Britain did in the classical period. But in the interwar years the US and France did not follow the rules of the game. Both countries sterilized surpluses, exerting deflationary pressure (thus for the UK y_f was falling, causing gold to flow out). They took gold from the rest of the world instead of being passive. This put more pressure on the UK and along with it the fear that the UK might devalue. This reduced world liquidity.

The key point is that during the interwar period countries became much more concerned with internal balance. And when they tried to maintain external balance this forced painful adjustments that they were unwilling to carry through. A consequence of this was that in the reconstruction of the postwar system the preference was for domestic monetary independence.

With countries focused on internal balance – and doubts on rule 5 – the ability to *use* monetary policy for stabilization was actually reduced. This ironic result is important to understand. Suppose that a country allowed the exchange rate to depreciate temporarily (say by reducing the reserve ratio) in response to a bank panic. If the attachment to rule 5 was credible, investors would know that the currency would soon appreciate as it must if rule 5 was adhered to. Hence, there would be no currency run. Interest rates could fall in the wake of this expansionary policy *because* investors expect future appreciation, and the economy could be stabilized.[29] Now suppose instead that the central bank had no credibility with regard to rule 5. Then any currency depreciation relative to gold might lead investors to worry about the future value of the currency. Hence, interest rates would have to rise to offset the risk that the currency might depreciate further, and thus the ability to use stabilization policy is weaker despite the greater demand for it.[30]

Two other problems are important. First, most gold was concentrated in three countries – US, France, and Germany. From 1927 to 1930 the share of world gold in these three countries rose from 56% to 63%. This pushed deflation on the rest of the world. Second, central bank credibility declined as they no longer played by the rules of the game. This threatened confidence in the system. Increasing pressure for domestic stabilization. Central banks started to liquidate foreign exchange reserves – the ratio of foreign exchange reserves to gold fell from 37% in 1930 to 11% by the end of 1932. More deflationary pressure.

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[29]Suppose that the current spot rate has appreciated, thus $S_t > \overline{S}$, where the latter is the upper limit of the gold points. If rule 5 is credible investors must expect the future spot rate to decline (the dollar appreciate in value). Suppose that they expect this to occur next period. Then $\underline{S} < S_{t+1} < \overline{S}$, which means that $S_{t+1} < S_t$. If the dollar is expected to appreciate interest parity suggests that current interest rates decrease relative to foreign rates. Hence, belief in rule 5 makes exchange rate expectations stabilizing – they exhibit *negative* feedback. This is all due to the credibility enhancing effect of rule 5.

[30]The application of this idea to modern financial crises in countries where policy is not credible is impossible not to recognize.

Moreover, there were insufficient discoveries of gold. Perhaps the system was saved earlier by fortuitous gold discoveries. The gold rush, after all, was not caused by prospectors, but by the accidental discovery at Sutter's Mill. Periodic gold discoveries offset the deflationary bias in the system. By the interwar period luck had run out. Only pyramiding reserves could help, but this leads to Triffin dilemma.

Eventually, US left gold, then revalued gold to \$35 per ounce (from \$20.65), but the system really collapsed.

8 Bretton Woods

The Bretton Woods system was not exactly the gold standard, but what is called the gold exchange standard. All countries fixed their currencies in terms of the dollar, while the dollar was fixed to gold. Central Banks held reserves in the form of dollars, but these were claims on US gold supplies.

Five differences from the previous system.

- pegged exchange rates became adjustable subject to the existence of a fundamental disequilibrium[31],

- controls on capital flows to add credibility given that monetary policy would be driven by domestic concerns

- IMF created

- limits imposed on private holdings of gold

- the asymmetric position of the US

These innovations dealt with the problems that were thought to have plagued the previous system – deflationary bias from overvalued pegs, a

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[31]And exchange rates were stable. Japan did not revalue the yen from 1949 to 1971. Britain only once, Germany twice in the first 20 years from 1950!

mechanism to contain destabilizing capital flows, a global liquidity short-age, and a mechanism to influence governments that were pursuing unstable policies.

Observers felt that currency depreciation in response to the depression was bad for world trade. They equated depreciation with imposing tariffs. This presumption was probably incorrect, but it was widely felt.[32] Capital mobility was feared because observers noted how fear of devaluation led to speculation against currencies as foreign exchange reserves were liquidated. This was further buttressed by the fear that without rule 5 any attempt at stabilization policy would lead to destabilizing speculation.[33] The problem with inadequate reserves and a need to control devaluations led to the creation of the IMF. Keynes wanted the IMF to provide temporary liquidity and to make the position of creditors and debtor countries symmetric (by taxing surpluses). This was not adopted, however, because the US was the big surplus country during WW2 and did not want this. Nor did it want a competitor for the dollar, so Keynes *bancor* did not see life.[34]

This system contained a key asymmetry; with regard to the US. This is a consequence of the *redundancy* problem.

- If you have n countries there are only $n-1$ independent exchange rates. Hence there is an extra degree of freedom. In the gold standard this was solved by everyone tying to gold. To solve the problem now, the US fiat money was tied to gold.

Notice that this system required the US to act as the nominal anchor.

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[32] Certainly devaluations helped the economies that devalued. But if others followed this could increase liquidity without changing relative prices. Tariffs necessarily distort relative prices.

[33] We shall see that really this was essential if countries wanted to pursue independent monetary policies. The "impossible trinity" is that a country cannot simultaneously have a fixed exchange rate, and independent monetary policy, and capital mobility. We shall demonstrate this later.

[34] But special drawing rights were created in the mid 1960's in response to the Triffin dilemma discussed below.

Basically it had to conduct monetary policy in a responsible way so that
the fix to gold was stable. It had to be open to capital flows, run low fiscal
deficits, and remain passive in exchange markets. For this system to work
the US had to conduct monetary policy so as to keep other countries happy
with the loss of their monetary independence.

But these innovations did not deal with the fundamental difficulty – how
to cope with increased liquidity needs. Fast economic growth increased liq-
uidity demands. Inelastic gold supply and limited price flexibility made this
more acute. Only pyramiding foreign exchange could cope – now essentially
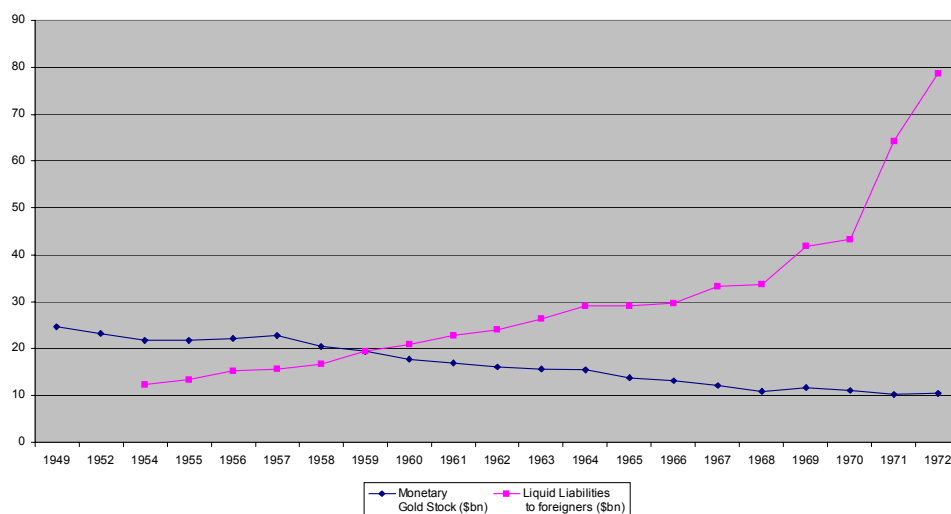increased dollar holdings.

Figure 13: The Triffin Dilemma

The problem with this system again had to do with international liquidity.
If the rest of the world is growing faster than the US – which was the result
of the greater reconstruction after WW2 and postwar parities – then they
would experience more rapid increased in the demand for money. Given their
fixed exchange rates with the dollar, the only way for them to expand their
money supplies was to increase their holdings of dollars. Hence, the only

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way for world liquidity to go up was for the US to run balance of payments deficits. This would increase the holdings of dollars in the rest of the world.

The world was enmeshed in the "Triffin dilemma." To keep the supply of international liquidity equal to demand the US had to run balance of payments deficits. But the increasing stock of dollars held outside the US increased the likelihood that Fort Knox had insufficient gold to back up the dollar. DeGaulle used to complain about the fact that the US could run balance of payment deficits by simply printing dollars. As Jacques Rueff used to note, "if my tailor is willing to give me a suit every time I give him a piece of paper I will be happy and keep doing it." But the expectation that I will keep doing it could lead to a run on the dollar. If all foreigners tried to cash in their dollars we would not be able to meet demand. If the US acted to curb deficits, on the other hand, there would be insufficient liquidity in the rest of the world.[35]

Note the difficulty:

- If the US continued to run deficits it supplied liquidity but this threatened the gold backing

- If the US cut back on deficits there would be a liquidity shortage

- If the US raised the price of gold it would be going back on its commitment and threaten the system.[36]

To meet this problem two possibilities emerged. First, an artificial asset could be created to act as a reserve currency, "paper gold." This was the function of SDR's issued by the IMF. Second, the US could devalue. In fact, both occurred.

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[35] In effect there was a conflict between the *quantity* and the *quality* of reserves. The greater the quantity of dollars outside the US, the lower the quality of these reserves. This was the same problem that plagued the interwar gold exchange standard.

[36] If a country does it once it may do it again. Hence, countries would prefer to hold gold rather than dollars. But then the system would revert to the gold standard from gold exchange.

The latter was the ultimate demise of the system. US inflation meant that other countries had to import inflation. Those that did not want this threatened to exchange their dollars for gold. But there was not enough. The US decided it wanted an independent monetary policy and went off gold. We ended up with the non-system that has existed since 1973.

The non-system has involved floating rates between major currencies and fixed rates among others. For a long time there was fear that floating rates would be bad due to the effects of speculation. Destabilizing speculation. Can this happen? Is it an important problem in the modern era? We need to know more about how floating rates work.
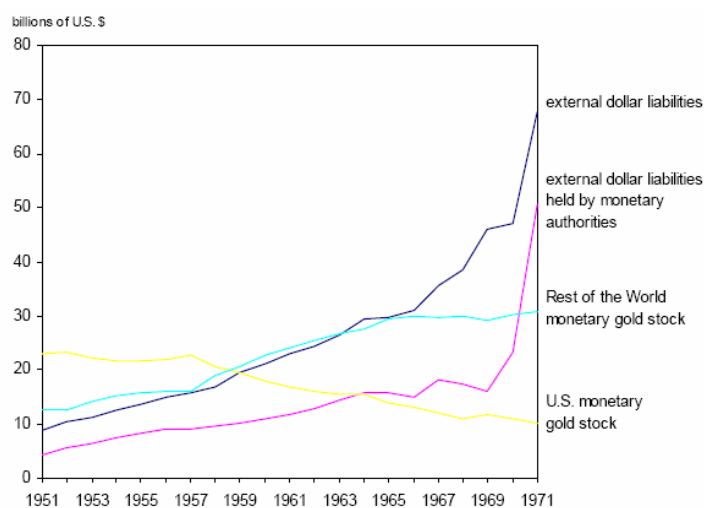

Figure 14: More on the Triffin Dilemma

9   Bretton Woods II

Dooley, Folkerts-Landau, and Garber (DFG) argue that the current monetary regime is Bretton Woods revisited. Instead of Europe recovering by importing capital from the US it is Asia. Of course the dollar is not pegged

as in BW, but many Asian economies stabilize the value of their currencies with respect to the dollar, notably China. We know that the willingness of China to export savings to the US prevents interest rates from rising here – think of the two-country model of interest determination. The question is why is China willing to persist in this behavior? DFG provide a theory and that is why it is worth considering.

As Eichengreen summarizes the story:

> Today, like 40 years ago, the international system is composed of a core and a periphery. The core has the exorbitant privilege of issuing the currency used as international reserves and a tendency to live beyond its means. The periphery, which still has a way to go in catching up to the core, is committed to export-led growth based on the maintenance of an undervalued exchange rate, a corollary of which is its massive accumulation of low-yielding international reserves issued by and denominated in the currency of the center country. In the 1960s, the core was the United States and the periphery was Europe and Japan, many developing countries not yet having been fully integrated into the international system. Now, with the spread of globalization, there is a new periphery, the emerging markets of Asia and Latin America, but the same old core, the United States, with the same tendency to live beyond its means.

As DFG put it:

> Underpinning our view of this global reality are two basic phenomena that we expect to continue into the foreseeable future. First, about fifteen years ago, hundreds of millions of underemployed workers joined the world's market economies. They had no capital to speak of. But they had a desire to work in industry and to get rich. We might expect that an increase in the supply

of labor would drive real interest rates up, but this labor came with an enormous savings rate and a dead financial system that had served them in the past as a capital destroyer, as it does to this day.

This helps us understand why they peg the yuan and keep it undervalued, but why hold so much assets in dollars? The key is the underdeveloped financial system in China. The problem for China is how to mobilize its existing enormous domestic savings given its underdeveloped financial system. This is a problem inherited from communism. A serious constraint on development is the lack of a domestic financial system capable of channeling these savings into productive capital, of proper technology, and management skills.

DFG argue that the Chinese development strategy has two prongs:

- It wants to move workers from an unproductive pool to produce positive marginal product in the industrial sector. The pool of potentially disruptive excess labor is reduced. The larger the size of this pool the greater the political cost to the government. The government wants to reduce this pool quickly...but faces increasing foreign economic and political costs that increase with the speed of employment from the pool.

- The government wants the capital stock accumulated as the pool of .labor is absorbed into the industrial! sector to be efficient:at the end of the transition period; the capital stock should be capable. when combined with domestic labor paid the world real wage, of producing goods going forward that are competitive with those produced in other countries.

Export-led growth creates a quality control – prevents another Great Leap Forward disaster. To get export markets open, a part of the policy has
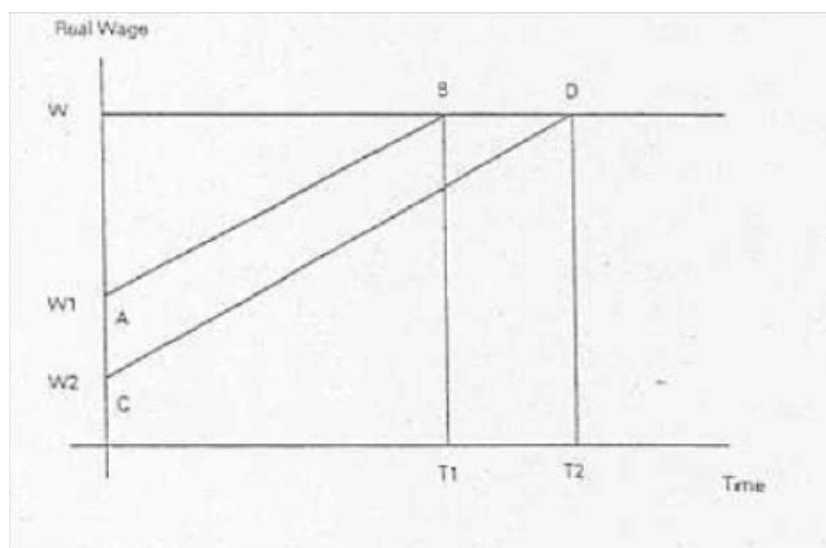
Figure 15: Optimal Adjustment in the DFG Model

been to offer a large incentive to potential foreign and domestic industrial exporters in the form of low dollar wages and the expectation that wages will rise only slowly toward world levels.

DGF think of this as an exhaustible resource problem, with the exhaustible resource being the pool of surplus labor in the countryside. China has to shift this labor to higher-productivity manufacturing. This takes time. To accomplish this it needs to keep the manufacturing wage below the world level to attract FDI and keep markets open. The key problem is to absorb the labor before the real wage reaches the world level. Once it is there, then manufacturing will not be able to absorb more excess. So wages must start out low. Indeed, this provides an incentive for foreign capital to invest in China. Moreover, by investing its surplus in the US it provides some of the benefits to US residents who have an incentive to keep markets open (to fight those arguing to close them). This yields figure

This explains why China has an undervalued real exchange rate now, and how it will adjust over time. All fine, but why the net export of capital? Here

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DFG argue it is a form of collateral for FDI. Asian emerging markets do not need net foreign savings but they do need efficient financial intermediation. By holding large dollar assets China provides collateral against expropriation. It is a means of gaining credibility. So China gets FDI (and know-how) plus financial intermediation that it cannot provide domestically. The price for this is that it forgoes some consumption or investment by holding wealth abroad. But given the high savings rates in China this cost can be easily born.

But won't the surpluses lead to increased money growth and real exchange appreciation? Won't this erode the advantage of the low value of the yuan? Here China has the advantage of being able to sterilize at relatively low cost, due to heavy restrictions on the capital account. In most countries, it would be hard to sterilize sufficiently. But China is financially repressed and has capital controls.

- suppressing the real exchange rate requires another instrument, in China's case the real interest rate

The one issue with this theory is the magnitude. The dollar assets held are almost ten times FDI.[37]

Will this last?

Note that in BW period the US had positive net savings; the current account was positive. We exported capital rather than importing it. Now we are a net debtor. Why does this matter?

To sustain the system foreign investors have to hold increasing amounts of dollar assets. But they may worry that the value of the dollar will decline. This could cause them to switch out of dollars. Notice, that unlike the BW period there is an alternative currency: the euro. The fear is that a switch in

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[37]There is one major problem with the "offshore" intermediation argument: it doesn't work after the end of 2002. In 2003 and 2004, there was no net flow of private capital out of China available to fund inward investment into China. The flow of funds went in the other direction.

the composition of reserves could cause a big capital loss. Clearly, as of now, foreign central banks appear willing to bear the risk of large capital losses to keep their exports growing. But given that dollar depreciation is required for US adjustment this may change. The question then is how long can this scenario persist?

- The original Bretton Woods system required the US to maintain the dollar's parity to gold. This, in principle, protected the long-term value of the rest of the world's dollar reserves. Bretton Woods two provides the United States with access to far more financing from dollar reserve accumulation than was ever available in the initial Bretton system, but fails to impose any limits on US policy. The implication is that the US can be irresponsible, which as we know was a key problem in the interwar period.

10   Monetary Approach to the Balance of Payments

This is not a bad place to consider the monetary approach to the Balance of Payments During Bretton Woods economies had fixed exchange rates and low capital mobility. The monetary approach works well in this setting. We know most of the parts. One is PPP. The second is the *no-sterilization* assumption.

What is non-sterilization? This means that the Central Bank does not offset the effects of reserve flows on the domestic money supply. To understand this it is useful to think of a simple version of the central bank's balance sheet:

assets	*liabilities*
Foreign reserves (IR)	Currency in circulation
Domestic securities (DS)	Bank reserves

Because assets must equal liabilities, we can note that the assets of the central bank, $IR + DS$ sum to equal to the monetary base (MB) (or high-powered money).[38] Note that the money stock is equal to the product of the monetary base and the money multiplier, μ:

$$M = \mu MB = \mu(IR + DS) \tag{14}$$

Now let us consider what happens when the Federal Reserve purchases foreign exchange with dollars. There are four cases to consider:

1. purchase from home-country banks: in this case alongside the increase in IR is an increase in bank reserves.

2. purchase from home-country non-bank residents: in this case, residents would receive payment in the form of currency in circulation.

3. purchase from foreign banks or central banks : in these cases currency in circulation rises immediately if the payment is made in cash.

4. purchase from foreign banks or central banks via changes in the foreign bank's deposit at the Fed. In this case, once the bank uses this deposit to purchase some interest-bearing security from a domestic bank, bank reserves will rise.

The key point, in any case, is that reserve transactions must result in simultaneous changes in the money base. This makes the stock of money endogenous. If foreign reserves are increasing so is the domestic money stock, and vice versa. Non-sterilization means that

$$\Delta M = \mu \Delta MB = \mu \Delta IR \tag{15}$$

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[38] Recall that the definition of the monetary base is the sum of currency in circulation and bank reserves.

Sterilization, on the other hand means that the Central Bank offsets the reserve change with an open market operation, i.e.,

$$\Delta DS = -\Delta IR \tag{16}$$

If (16) holds then clearly changes in international reserves have no impact on the monetary base. If the non-sterilization assumption holds it does.

Given this the monetary approach follows relatively easily. First we assume a quantity-theory like relation for money demand:

$$M^d = kPY \tag{17}$$

where k is the inverse of velocity. How are money balances adjusted? By hoarding (saving in excess of investment) or dishoarding, H. It is assumed that this can only take place through changes in money balances (this is the monetary approach, after all). We suppose that hoarding is a function of the difference between the desired and actual money stock:

$$H = \delta(M^d - M) \tag{18}$$

which can be re-written using equation (17) as

$$H = \delta(kPY - M) \tag{19}$$

You can think of this as a stock adjustment theory of cash balances. Here δ measures the speed of adjustment.

We can think of H as the change in the stock of money in any period. But under the non-sterilization assumption (15) we know that $\Delta M = \mu \Delta IR$. So this implies that
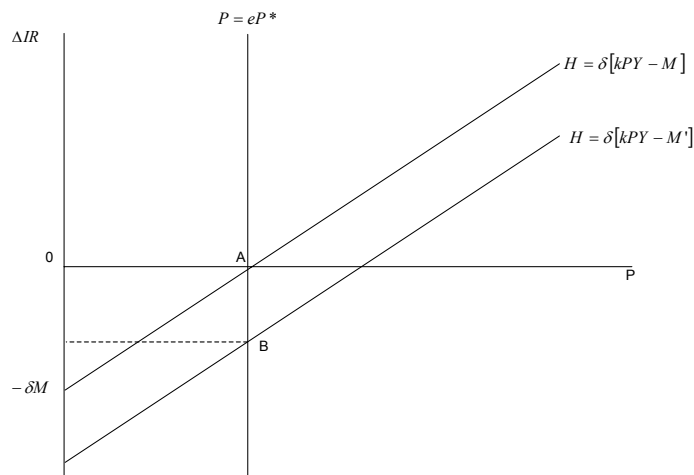
$$H = \Delta IR = \delta kPY - \delta M \tag{20}$$

Figure 16: Monetary Expansion

since we assume PPP, we could re-write (20) as

$$H = \Delta IR = \delta k e P^* Y - \delta M \tag{21}$$

What does (20) or (21) imply? Notice that from PPP the price level is given. So if output is given (by full employment, say) then any discrepancy between money demand and money supply will lead to changes in the balance of payments (ΔIR). We can map this in figure 16:We start at point A. Let the money stock rise to M'. Since the price level is given there is a Balance of Payments deficit at point B. This causes the money stock to fall and we return to point A.

What if the exchange rate changes? A devaluation of the currency increased e. This shifts the PPP line to the right, causing $\Delta IR > 0$. This must cause domestic money creation and a this restores equilibrium to the Balance of Payments at the higher price level. So the impact effect of the devaluation is to improve the Balance of Payments, but the long-run effect is just a rise in the price level.

What happens in this model if income rises? Notice that this would rotate the H function so it is steeper. At the initial price level there would be a Balance of Payments surplus. The surplus countries would face inflationary pressure. This is opposite to the reaction to a rise in income that is caused by increased spending. This usually leads to a deterioration in the Balance of Payments due to increased imports. This case is interesting because during Bretton Woods Germany and Japan grew faster than the US and accumulated reserves (they sterilized them). Perhaps something similar occurs today in China or Taiwan.

Of course we may not consider PPP to hold, or prices to be flexible. Then we can use the *IS-LM* model. The trade balance is a negative function of the level of income. So a monetary expansion shifts the LM curve to the right. This causes $\Delta IR < 0$, which shifts the LM back to its original position. The prediction is similar as before about what happens to the balance of payments. The difference, however, is that now it is income that is adjusting, and the impact effect is $\Delta Y > 0$ and $\Delta IR < 0$.

You can think of this as exactly the specie-flow mechanism at the beginning of this lecture. The only difference is that now it is not gold that is flowing but claims to gold – the international reserves held in dollars. The system reduced exchange rate uncertainty, but at the expense of tying the world price level to the worldwide growth of dollar liabilities. When these grew to high, the row was faced with either importing inflation or turning in the dollars for gold. Since US supplies were limited this led to the unilateral end of the system in 1973, and to floating rates.