Foreign Debt and The Gold Standard:

Comparing Russian and Japanese Experience in Late XIX Century

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Abstract

The following work will examine risk premiums on government debt issued by Russian and Japanese governments in the late XIX century (1870-1890) and will attempt to provide a comprehensive account of certain features, dynamics and underlying causes of the premiums, as well as to compare these attributes for both securities. The study will then focus on the introduction of the gold standard by both countries in 1897 and on its effect on risk premiums on government debt present in the market at that time. Since the effects on Russian and Japanese debt were cardinally different, I will attempt to hypothesize on the causes of this difference and will claim that they were largely caused by the differences in "credit rating" of the debt prior to the introduction of the gold standard, that is, by different liquidity and default risk, as well as by asymmetric information.

Introduction

The period of time commonly referred to as the "classic era" of the gold standard (late XIX to early XX centuries), as well as the standard itself, it's causes, and implications, have received much attention in academic literature and have been the focus of a considerable amount of research in the past. Most studies which deal with introduction of the gold standard, attempt to evaluate this measure as merely a tool of monetary policy: it's implications on inflation and therefore on investment and international trade. Many aim to reconcile chain of events and account for economic factors which lead to its introduction. Only few address its effects on government debt and foreign borrowing.[1] This topic thus seems relatively under researched and is therefore appealing.

In the late XIX century Russia and Japan, both rapidly developing and industrializing nations, frequently resorted to foreign borrowing in order to finance a number of domestic expenditures such as railroad construction, and other needs of domestic industry. These loans were placed in a number of markets, although in this paper I will only consider government bonds traded in London. This period in economic history is characterized by the almost unprecedented integration of world financial markets and very little barriers to capital mobility; therefore it would not be unreasonable to assume that conditions under which these bonds were traded in London would prevail elsewhere. Russian debt, for example, was truly global in nature and was traded in London, Paris, Amsterdam, Vienna, Berlin and New York.[2]

Japan shortly before the gold standard

After 250 years of isolation from the outside world and Tokugawa Shogun dictatorship, Japan was "forced open" in 1853-54 and was found in a "curious state of things": gold was rated as $8^{1/2}$:1 of silver, and the "early arrivals" took prompt advantage of the large differential which existed between this and the world price of metals, which ultimately resulted in Japan being "stripped out of her

[1] For example, see N. Sussman, Y. Yafeh "Institutions, Reforms, and Country Risk: Lessons from Japanese Government Debt in the Meiji Era", Journal of Economic History, Vol. 60, No. 2 (June 2000).

[2] See "Financial Innovation and Russian Government Debt" by Andrey Ukhov, Yale International Centre for Finance, Working Paper 03-20, 2003.

gold coins and bullion" in just few years.[3] The existing coinage was theoretically bimetallic, but practically monometallic: in 1871 gold 20-yen piece containing 462.96 grains of pure gold along with 1 yen coin were adopted, along with circulating silver. The issues of depreciated paper, however, prevented gold from circulating.[4] One major problem therefore faced by the ministry of finance at a time was the fluctuation of domestic silver currency in relation to gold currencies of countries, with which Japan carried between 70% and 80% of its trade (Laughlin (1897)). Moreover, the need for cheap foreign loans required to satisfy domestic demand for capital after Japanese military triumph over China was even more crucial.

Russia shortly before the gold standard

Russia's foreign indebtedness and paper currency regime had their beginnings under the reign of Catherine II, during which the country made its advent as a great power. To maintain this position considerable strain was imposed on the Treasury. The largely natural resource based economy with widespread poverty among common people did not generate enough taxation, which caused chronic budget deficits and induced recourse to the printing press and even further foreign borrowing at that time. It was the currency reform of 1839-1843 under Nicholas I which somewhat took inflation under control by introducing credit ruble freely convertible into silver. Nevertheless the Turkish war forced the government to the further production of unconvertible currency. Inflation for the decade of 1879-1888 is estimated to average to about 38%, with deviations of +/- 30%.[5] Unstable currency therefore adversely affected foreign trade, investments and made obtaining foreign loans more expensive due to inflation risk premium sought by foreign investors.

The gold standard

Both countries introduced the gold standard in 1897 which unarguably had a significant impact on Japanese and Russian economies by reducing inflation, facilitating international trade and creating an influx of foreign investment as well as sustained industrial growth.[6] Its effect on government bonds, however, was not so straightforward: both governments' debt was traded at certain risk premia, which is defined as the yield differential between that of security in question and any other virtually risk-free asset. Sussman and Yafeh (2000) provide in-depth empirical analysis of effects of institutional reforms and risk on risk premia on Japanese government bonds versus British Consols between 1870 and 1914 using their monthly data series collected from the London Times. Out of only few events which appear to be statistically significant at 5% level in Sussman and Yafeh regression,[7] the introduction of the gold standard in Japan had a major effect on spreads on government bonds: interest rate differentials[8] halved in a very short time.[9]

[3] Quotations and silver/gold price ratio taken from "Report on the Adoption of Gold Standard in Japan" by Count Matsukata Masayoshi; Ernest Foxwell, The Economic Journal, Vol. 10, No. 38 (June 1900), pages 232-245.

[4] See "The Gold Standard in Japan" by Laurence Laughlin, The Journal of Political Economy, Vol. 5, No. 3 (June 1897).

[5] Summary of Russian history and paper money inflation estimates are based on "Russian Financial Policy and the Gold Standard at the End of the Nineteenth Century", Olga Crisp, The Economic History Review, New Series, Vol. 6, No.2 (1953).

[6] See "Russian Monetary Policy and Industrialization" by Paul Gregory, Joel Sailors, The Journal of Economic History, Vol. 36, No. 4 (Dec. 1976), pp. 836-851

[7] Refer to next section for summary of Sussman and Yafeh (2000) paper.

[8] In Sussman and Yafeh (2000) paper interest-rate differential is yield on Japanese Government bonds vs British Consols

[9] Less than one year (1897).

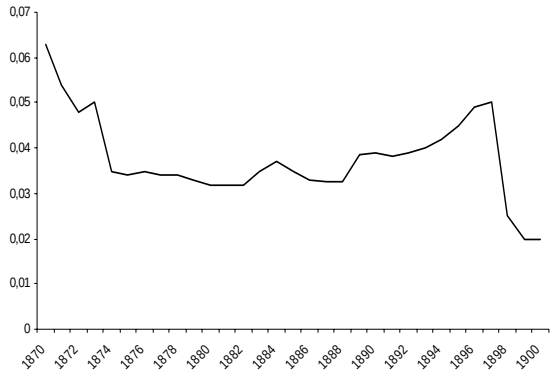

Figure 1
Risk Premium on Japanese Government Debt vs British Consoles, 1 year frequency.
(Data from Sussman and Yafeh(2000))

It is remarkable, that although the 1897 introduction of the gold standard in Japan had such a tremendous effect on risk premia, the Russian gold standard, introduced the same year by Count Whitte, had virtually no effect on spreads on Russian bonds.[10] In subsequent sections I will propose a hypothesis and use a modeling approach to explain the striking difference. This is seen as the main contribution of this paper.

Margin of Research

A number of researches have been relied upon in compilation of this paper. Sussman and Yafeh (2000) present an invaluable study of the effects of institutional reforms on Japanese government debt traded in London between 1870 and 1914. The authors conclude that the only institutional change which positively affected Japan's "credit rating" was the adoption of the gold standard. Their research also suggests that only gold standard had a *long term* statistically significant effect on Japanese risk premia and on volumes of foreign debt. The data used by the authors on prices and yields of Japanese government bonds was collected from The London Times with monthly frequency using actual coupon rates and closing prices reported at the end of each month. Data on British Consols comes from NBER's Macroeconomic History dataset. Yields were calculated as a ratio of interest payments to market price, and then a regression was specified to test statistical significance of known historical events, such as military treaties, institutional changes, agrarian reforms and of course, introduction of the gold standard, on the risk premium associated with government foreign debt. The regression was specified as follows:

$$\ln RP_t = \beta_0 + \beta_1 \ln RP_{t-1} + \beta_2 \Delta \ln RP_{t-1} + \beta_3 \Delta \ln RP_{t-2} + \beta_4 TREND + \beta_5 EVENT_{long} + \beta_6 EVENT_{short}$$

Therefore taking into consideration lagging and trend effects of risk premia and introducing dummy variables $EVENT_{long}$, which took the value of zero at all times prior to the event and the value of one at all times after, and $EVENT_{short,}$ which took the value of one at a time of the event. This regression was run for all data in an eighteen month window around the month of the event studied. In their findings, Sussman and Yafeh report that in the short run, only the agrarian reform of 1873, the introduction of yen notes convertible to silver (1885), the gold standard of 1897, the British-Japanese treaty of 1902 and the Russian surrender in port Arthur in 1905 managed to noticeably impress British investors and therefore had statistically significant effects on risk premia on government bonds at the 5% level, with gold standard having the largest effect. The authors also provide time series on ratios of

[10] Traded in London. As mentioned earlier, this is assumed to be representative of all other markets. Also, for co-movement of Japanese government debt yields and yields on similar securities of other countries see Sussman and Yafeh "The Gold Standard, the Cost of Foreign Debt, and Capital Market Integration: historical Evidence from Japanese Government Debt" (In French), Economie Internationale 78, no.2 (1999), pages 85-105.

capital flows to government revenues and of foreign debt to total debt. Remarkably, after the introduction of gold standard in 1897, the ratio of foreign debt to total government debt has climbed steadily and approximately tripled by 1910. This suggests that after Japan became a "golden" country, obtaining foreign credit must have became cheaper and easier. The paper then attempts to analyze perceptions and overall awareness of London investors in regard to institutional change in Japan and compare it to other related agendas: analysis and classification of a large number of articles on Japan in the London Times from 1871 to 1899 shows that issues such as "internal instability and wars" were the most talked about, followed by "commerce and economics" and "foreign relations". "Institutions and reforms" received by far the least coverage, with at most seven articles on the subject in one given year (1892) and more commonly, nothing written at all. This seems to support Sussman and Yafeh' empirical findings of the fact that reforms and institutional change had little effect on investors in London, whereas gold standard certainly did.

Another source which has been considered in preparation of this paper is the "Report on the Adoption of Gold Standard in Japan" published in 1900 by Count Matsukata Masayoshi, then Japanese minister of finance. The report begins with a brief overview of political tensions in the mid-nineteenth century in Japan and reconciles the chain of events which led to revolution. After the revolution there was no centralized alteration of the national currency, and local princes often resorted to private minting and debasements to satisfy the economy's demand for money and possibly to collect seniorage. At the same time the practice of printing out local private unconvertible paper money was wide-spread, and caused even more confusion. In late 1869 a decision to adopt monometallism was taken, and a year later the Osaka mint was coining silver. The decision to introduce bimetallism by minting gold coin along with silver came in 1871, but increasing issues of paper money promptly drove gold out of circulation[11], leaving Japan monometallic again. This is echoed in Laurence Laughlin's "The Gold Standard in Japan" Journal of Political Economy article in 1897. The Matsukata report stresses out succeeding failure of the Japanese government to introduce paper currency into circulation due to Japanese people doubting the legitimacy of paper money. It seems that only after Matsukata's appointment as a finance minister in 1881, did speedy redemption of unconvertible notes take effect. "Instead of issuing unconvertible paper when there was a deficit in revenue, Treasury Bills were substituted, redeemable out of the revenue of the year of issue". This policy along with "strict attention to business" resulted in Japanese government running a budget surplus, half of which "was devoted to the retirement of paper money, while the other half was added to the reserve fund with the object of securing specie from abroad". Chartering of Bank of Japan followed in 1882. In a meantime, "by the end of 1883 some 20 million yen of paper were redeemed and public confidence reviving, paper rose to par with silver in 1883". Therefore Japanese public finances and national currency seemed to start to recover. The reasons for "coin reform" of 1897 still existed, however, as outlined in Chapter II of the book, and included rapidly depreciating silver, fluctuating exchange rates in regard to gold currencies of other countries and high price of foreign borrowing.[12] "..Japan became *de-facto* silver country".

[11] This is reasonable considering Gresham's law which claims that inferior money will always draw good one out of circulation.

[12] All quotes from Laughlin 1897, p.239 in "The Economic Journal".

Paul Gregory's "The Russian Balance of Payments, the Gold Standard, and Monetary Policy: A Historical example of Foreign Capital Movements" (1979)[13] has also proven valuable in my research. Gregory presents calculations of foreign investment into Russia as a major recipient of foreign capital between 1881 and 1913 and concludes that "following convertibility [influx of foreign investment into Russia] was much more substantial than the early estimates suggested and that the Russian growth rate was raised by about 0.5 percent annually as a consequence of the gold standard" (Gregory, 1979). He also estimates that the cost of acquiring gold reserves to establish convertibility amounted to one third of Russia's borrowing abroad. However, according to the author, the benefits of increased rates of output growth certainly outweighed the costs. The net foreign investment was estimated indirectly by looking at the current account balance, since by definition these must equate. His study of averages of annual data broken down into pre- and post- gold standard sets reveal striking increases in net foreign investments in Russia: "for the period 1885 to 1897 [investment] was 43 million rubles; for the period 1897 to 1913 the corresponding figure was 191 million" (Gregory, 1979).

The main utilization of Gregory's work, however, will be used to support my claim that differences in effects of Japanese and Russian gold standard on both countries' debt were largely due to different awareness and expectations of foreign investments. In the next section I will address this topic in more detail.

[13] Journal of Economic History, Vol. 39, No. 2, June 1979, pages 379-400.

Causes of differing effects of the gold standard on Russian and Japanese government bonds

Before I attempt to speculate upon causes of difference in effects of gold standard on risk premiums associated with Russian and Japanese government foreign debt, it is important to examine factors which cause and mechanisms which control risk premiums in the market.

Preliminaries

It is generally acknowledged[14] that asset demand is determined by factors such as lifetime wealth[15], expected return[16], risk[17] and liquidity[18]. Therefore, increases in lifetime wealth, expected return or liquidity of security in question relative to other assets will increase demand for that asset, whereas an increase in risk will be negatively correlated with asset demand. These general principles of theory of asset demand hold as long as ceteris paribus assumption is not violated. These results are summarized in Table 1 below:

[14] For example, refer to "The Economics of Money, Banking and Financial Markets", 2nd Canadian edition, by Mishkin and Serletis, 2005, Pearson Education Canada Inc.

[15] In most models of intertemporal choice, for example in that presented in "Macroeconomics" by Stephen D. Williamson, 2002, Pearson Education Inc., marginal utility of consumption is assumed diminishing, therefore saving (investment) is an upward-sloping function of income.

[16] Since increased interest rate (return) on an asset makes current consumption relatively more expansive compared to future consumption.

[17] Since it lowers expected return of investment: ER = (1-risk of default)*Return if not defaulted.

[18] Since economic agents are assumed to discount the future, time spent converting asset into cash is costly.

Variable	Change in Variable	Change in Investment Demand
Wealth	↑	↑
Relative expected return	↑	↑
Relative risk	↑	↓
Relative liquidity	↑	↑

Table 1

The Model

The simplest way to model risk differentials proposed in financial economics literature is to examine the determination of interest rates in the market using investment demand, investment supply and a market clearing condition. In this model I will consider one-year discount bonds which make no coupon payments, but pay the bearer a fixed amount, V, at the end of the period. Omitting coupon payments and multi-period discounting will greatly simplify analysis but will still allow the model to capture all important aspects of the problem in question. The interest rate on such bonds equals the expected return and can be expressed as follows:

$$i = \frac{V - P}{P} \quad (1)$$

where i = interest rate, V = face value of the bond and P = price. This formula therefore matches each value of interest rate to some particular value of price and vice versa. For example, a bond with face value of $100 and current price of $90 will have an interest rate of

$$i = \frac{100 - 90}{90} = 0.111, \text{ or } 11\%.$$

Note that keeping face value and other factors which affect asset demand constant, an increase in price decreases interest rate, which is also the expected return. But as mentioned earlier, investment demand is positively correlated with expected return on assets; therefore demand for bonds must be a downward-sloping function of price (and upward-sloping function of interest rate). Similar logic can be used to derive the investment supply curve. Holding face value and other factors constant, an increase in price reduces interest rate, which makes obtaining loans cheaper. Income and substitution effects work in the same direction on a borrower and the supply of bonds should increase. A simple market clearing condition pins down equilibrium quantity, price and interest rate on bonds. Changes in wealth, relative expected return of an asset compared to other assets, changes in relative risk and liquidity will shift the demand curve and cause equilibrium price, quantity and interest rate to change. Figure 2 below illustrates this framework: the x-axis represents the quantity of bonds, the y-axis represents the price and *i* (interest rate) axis represents corresponding interest rate. Note, however, since interest rate and price are inversely related, the interest rate axis is increasing from top to bottom, Bd indicates bond

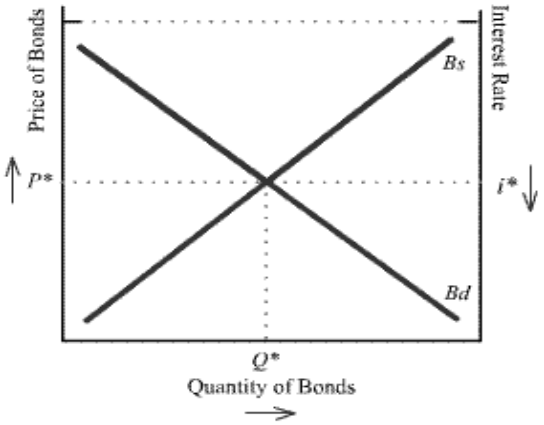

Figure 2
Bond market: determination of equilibrium quantity, price and interest rate.

demand curve, Bs indicates the bond supply curve. *P**, *i** and *Q** are equilibrium price, interest and quantity respectively. Arrows show the direction of the axis. From Figure 2 it is evident that increase in bond demand due to increase in wealth, for example, will shift the Bd curve to the right causing *Q* – equilibrium quantity and *P* – equilibrium price of bonds to rise, and *i* – interest rate to fall.

This can be extended to the two-security case to study the formation of risk premia in the market: consider otherwise equal Bond1 with non-zero risk of default and Bond0, which is virtually risk-free asset. If, initially, Bond1 was risk-free, Bond1 and Bond0 would trade at the same price *P*1* and would bare same interest rate *i*1*. Suppose that some economic event causes positive default risk to be associated with Bond1. That would make Bond1 relatively more risky compared to Bond0, and Bond0 would become relatively less risky compared to Bond1. As outlined in Table 1, that would cause a decrease in demand for Bond1 and increase in demand for Bond0: demand curves for both bonds would shift from *Bd1* to *Bd2*. For Bond1 this will reduce the quantity demanded from *Q**1 to *Q*2*, reduce the price from *P*1* to *P*2* and will increase interest rate from *i*1* to *i*2*. The opposite will happen to Bond0: demand will increase, price will increase and interest rate associated with it will drop. This motion is illustrated on Figure 3 below:

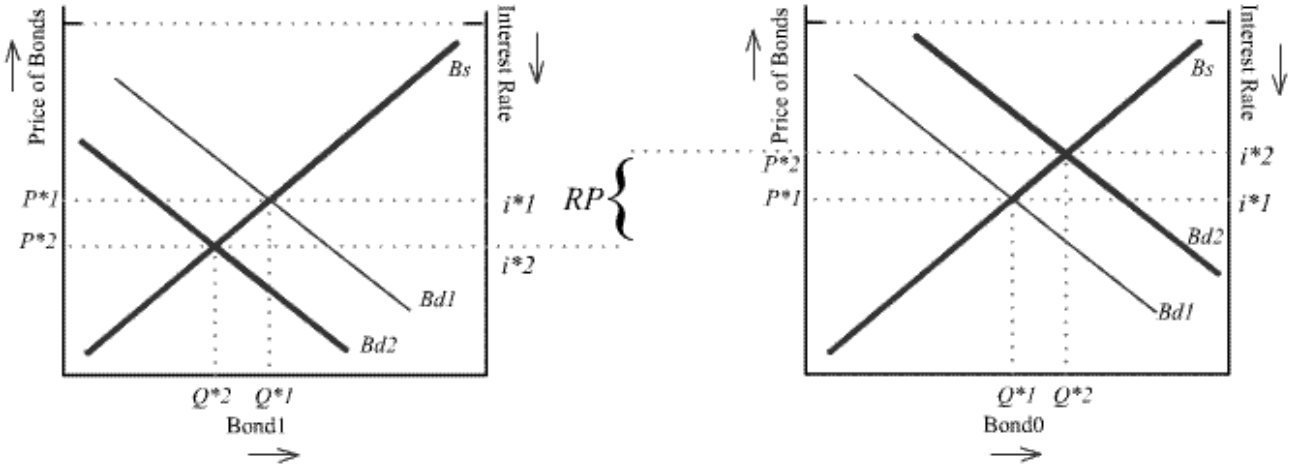

Figure 3.
Formation of Risk Premium in the market.

As a result, a differential between return on Bond1 and Bond0 will form, labeled RP (for Risk Premium) on the graph.[19]

Application to explaining different effects on risk premiums associated with government debt

I propose explaining differences in effects of gold standard on risk premiums associated with Russian and Japanese government debt along similar lines. We need to consider several important characteristics of these bonds shortly before gold standard was announced. Prior to 1897, Russian debt had considerably higher "credit rating" than Japanese: the debt was much more liquid and had a lower risk of default associated with it.

Difference in liquidity

As far as liquidity of Russian debt is concerned, firstly, Russian debt was truly global, circulating in London, Paris, Amsterdam, Vienna, Berlin and New York. These cities were historically the hubs of commercial activity in Europe and North America, and therefore allowed holders of Russian bonds to relatively easily convert his assets into cash in a number of popular places. Secondly, the interest on Russian bonds was paid in different currencies of various countries where it circulated. That too contributed greatly to very high liquidity of Russian debt since it increased the size and national composition of prospective bond holders. Thirdly, the Imperial Bank of Russia gave an option of interest to be paid in gold as opposed to currency. This equally contributed to higher liquidity of Russian bonds as well to lower risk, as it insured bond holders from possible costs of inflation. Support for above claims can be found in announcement posted in London Times by Imperial Bank of Russia in 1883:[20]

> The Imperial Bank announces the forthcoming issue of the 12th series of 4 per cent. Short-dated Imperial Treasury Bonds to the amount of twenty million rubles payable on 19th May next.
>
> …
>
> The interest on the Rente will be paid in Russia in gold or credit notes, at the current rate, in Berlin in Imperial marks, in Paris in francs, in Amsterdam in Dutch florins and in London in sterling.

Japanese government debt on the contrary seemed to be mainly issued and circulated in London; denominated in sterling, with interest payable only in British currency. The following announcement from London Times[21] supports this:

> Imperial Government of Japan. Customs Loan for £1,000,000. In bonds bearer for £100, £500 and £1,000 each, bearing interest at 9 per cent. per annum from 1st of August, 1870 (the installments meanwhile bearing 6 per cent.), payable half-yearly in London.

Difference in risk of default

Default risk is the probability that issuer of the bond will not repay risk premium or principle, or both on his loan, or will restructure or attempt to re-negotiate the conditions of loan. In the eyes of British investors of that time, events like military successes, for example could have had significant impact on debt capacity of the country and reduce default risk. Gold reserves, however, were the most observable, quantifiable and therefore reliable measure of country's ability to repay loans at that time. From mid-nineteenth to late twentieth centuries Russia had one of word's largest gold reserves in possession: its financial administrators followed a policy of gold accumulation for a significant period

[19] Numerical examples and further extension of this model can be found in the appendix.

[20] *London Times*, 3rd December 1883.

[21] *London Times*, 26 April 1870, p.8

of time well before the gold standard was introduced. Production of gold was also on the increase, and these two facts seem to have been well known to international public. The London Times[22] reports Russian gold production to be 3rd highest in the world in 1883:

> Production of Gold And Silver - … By far the largest producer was America – viz., gold, $34,700,000; silver, $43,000,000; followed in descending scale by Australia – gold, $31,127,515, silver only $227,125. Russia – gold, $28,551,028; silver $473,519…

Astonishingly, Japan is mentioned a bit lower in the very same "rating" of gold and silver producers and occupies the last place in the world. Based on this I feel it is more than reasonable to assume that British investors associated considerably greater risk of default with Japanese bonds compared to Russian, shortly before the gold standard was introduced.

Decomposing effects

Based on the above we can infer that introduction of the gold standard in Russia by Count Whitte did not pass any new messages to economic agents in London which would affect the determinants of asset demand outlined in Table 1. It did not make Russian debt more liquid as it was already payable in gold as almost any other major currency at that time, nor did it radically signal that Russian debt became lest risky, since Russian vast gold reserves and leading production was well known beforehand. Introduction of the gold standard in Russia therefore did not affect demand for Russian government bonds. On the contrary, when the gold standard was introduced in Japan it signaled the possession of significant gold reserves by Japan, which was required to ensure convertibility and adherence to its new standard. That immediately signaled lower risk of default associated with Japanese debt than previously anticipated. That alone is sufficient to conclude that demand for Japanese bonds must have increased "overnight". However it is worth adding that the gold standard increased the liquidity of Japanese debt. At the least of these were bonds, interest on which was also payable in yen, since yen now was freely convertible into gold, one of the most liquid assets of all time. The difference in the effect of the gold standard on risk premia on Russian and Japanese government debt is therefore explained by the immediate shift in demand for Japanese bonds after the introduction of the gold standard and the absence of any significant effect on demand for Russian government bonds after the gold standard. This is illustrated in Figures 4 and 5 below.

As mentioned earlier, demand for relatively more liquid and less risky Japanese bonds increased from Bd1 to Bd2, increasing quantity demanded from Q*1 to Q*2, increasing price from P*1 to P*2, and lowering interest rate from i*1 to i*2. Similarly, relative to Japanese government bonds, British Consols became relatively less liquid and relatively more risky, therefore their demand decreased from Bd1 to Bd2, reducing equilibrium price and quantity and increasing equilibrium interest rate. The motions together result in the reduction of risk premia on Japanese bonds from RP1 to RP2.[23] Note that the increase in quantity demanded of Japanese bonds is entirely consistent with observations presented in the Sussman and Yafeh (2000) paper: relatively shortly after the introduction of the gold standard, share of

[22] *London Times*, 3rd February 1883, p. 10

[23] Note that even if demand for Consols didn't decrease, increase in demand for Japanese bonds would still reduce risk premium.

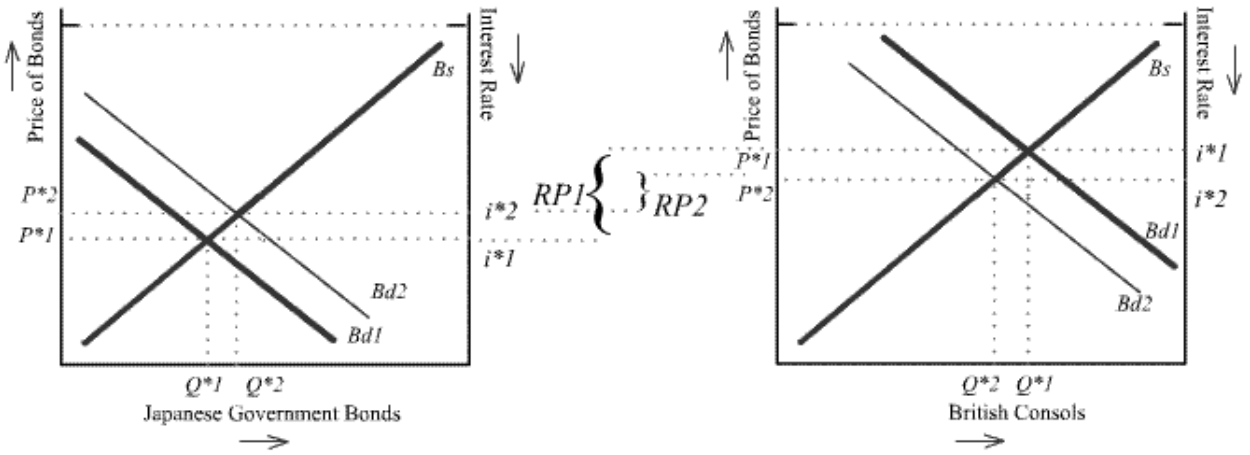

Figure 4.
Effect of introduction of gold standard on risk premiums on Japanese government bonds in 1897.

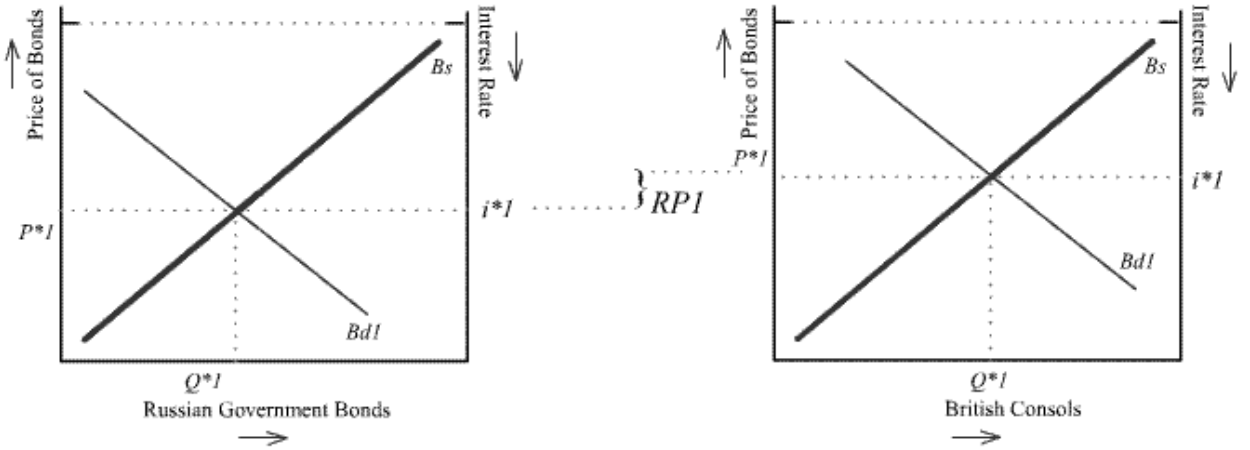

Figure 5
Effect of introduction of gold standard on risk premiums on Russian government bonds in 1897.

foreign debt in total Japanese government debt tripled.

The earlier proposition that the Russian gold standard had no effect on demand for Russian bonds and therefore on risk premia is illustrated in Figure 5 above.

Other factors explaining different effects
Another observation explains why upon announcement of the gold standard, risk premia on Japanese government bonds dropped dramatically while similar news had almost no effect on Russian government debt, lies in expectations about the gold standard at that time. According to the theory of rational expectations, if British investors are aware of or believe the Japanese governments' intention to introduce the gold standard, the market will adjust before the standard is introduced, and there will be no sudden drop in risk premia associated with it. A study of British press from that period reveals, however, that news

of Japanese becoming a "golden country" was not expected. Once again referring to London Times:[24]

> The House of Representatives by a vote of 151 to 96 have just passed a Bill providing for the adoption of gold monometallism. It cannot be said that the measure was preceded by thorough discussion, or by any general consent of popular intelligence and will. Four years ago, indeed, a commission was appointed by the Japanese Government to investigate the problem of metals, and, after deliberations extending over 22 months, a majority of commissioners recorded their opinion that the adoption of the gold standard would be advantageous, but that the time for such step had not arrived. Scarcely any attention was paid by the nation at large to that decision. Very few people noticed even what the decision had been. The vernacular press hardly allured to it, and the general feeling had been that the subject belonged wholly to the field of academical discussion. Much surprise was felt, therefore, when some of the leading journals announced about a month ago that the cabinet seriously contemplated the introduction of the gold standard.

Conclusion

In this paper I attempted to investigate causes of differences of effects of gold standard introduced by Russia and Japan in 1897 on risk premiums associated with foreign debt of both countries, which seem to be mainly attributed to the following: increase in "credit rating" of Japanese government bonds due to gold standard; no effect of gold standard on "credit rating" of Russian government bonds, as well as to unexpected appearance of news on Japanese gold standard. Experiments with the model of asset price and risk premium determination seem to strongly support these findings.

[24] *London Times,* 10th of May 1897, p.4

APPENDIX

To give a numerical example of equilibrium solution to the model outlined in this paper, consider the following two-variable demand and supply functions:

$$\begin{matrix} P = a - bQ_d \\ P = c + dQ_s \end{matrix} \text{ or } \begin{matrix} bQ_d + P = a \\ -dQ_s + P = c \end{matrix}.$$

Using market clearing condition (Q_d=Q_s), writing these in matrix notation and row-reducing gives the following solutions:

$$\left(\begin{array}{cc|c} b & 1 & a \\ -d & 1 & c \end{array}\right) \sim \left(\begin{array}{cc|c} 1 & \frac{1}{b} & \frac{a}{b} \\ -d & 1 & c \end{array}\right) \sim \left(\begin{array}{cc|c} 1 & \frac{1}{b} & \frac{a}{b} \\ 0 & \frac{b+d}{b} & c+\frac{da}{b} \end{array}\right) \sim \left(\begin{array}{cc|c} 1 & \frac{1}{b} & \frac{a}{b} \\ 0 & 1 & \left(c+\frac{da}{b}\right)\left(\frac{b}{b+d}\right) \end{array}\right) \sim$$

$$\sim \left(\begin{array}{cc|c} 1 & 0 & \frac{a}{b} - \frac{\left(c+\frac{da}{b}\right)\left(\frac{b}{b+d}\right)}{b} \\ 0 & 1 & \left(c+\frac{da}{b}\right)\left(\frac{b}{b+d}\right) \end{array}\right)$$

That is, in equilibrium, $Q_d = Q_s = \frac{a}{b} - \frac{\left(c+\frac{da}{b}\right)\left(\frac{b}{b+d}\right)}{b}$, $P = \frac{\left(c+\frac{da}{b}\right)\left(\frac{b}{b+d}\right)}{b}$.

Therefore, from equation (1) introduced on page 6: $i = \frac{V-P}{P} = \frac{V}{P} - 1 = \frac{Vb}{\left(c+\frac{da}{b}\right)\left(\frac{b}{b+d}\right)} - 1$.

Note that using exact same steps we can introduce a market for second "risk-free" security and derive general expression for interest rate associated with it. Subtracting first interest rate from second will give general expression for interest rate differential.

Using similar techniques this model can be extended to account for other factors which influence investment demand and supply. For example, we can introduce households' income *I,* or risk of default *R* into investment demand function:

$$\begin{matrix} P = a - bQ_d + I - R \\ P = c + dQ_s \end{matrix} \text{ or } \begin{matrix} bQ_d + P = a + I - R \\ -dQ_s + P = c \end{matrix}.$$

This gives the following coefficient matrix, which can be row-reduced to identity to obtain expressions for equilibrium prices and quantities, now accounting for income and risk of default:

$$\left(\begin{array}{cc|c} b & 1 & a+I-R \\ -d & 1 & c \end{array}\right).$$

Varying *I* and/or *R* will cause parallel shifts in investment demand curve and will change equilibrium interest rate and therefore risk premium in two security case. Since these calculations are trivial and will follow same steps as above, they are outside of the scope of this paper.

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