

An Examination of the Financial and Economic Impact US Exchange Rate
Volatility Has on Fixed Income Securities for Chinese Investors

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Abstract: This paper analyzes the impact US dollar/ Chinese Yuan exchange rates have on Chinese Investors in US Government Bonds. We examine wealth and income effects to Chinese investors directly related to exchange rate risk. This study investigates the dual impact interest rate and exchange rate risks have on bond pricing and overall investment return to bondholders. The results of this investigation show that exchange rate risk may magnify gains and losses to Chinese investors in US government bonds to a much greater extent than with interest rate movements. This paper provides insights into both the income and wealth effects of exchange rates on Chinese investment in US Government Bonds.

Introduction: Analysis of the Motivations for US Government Bond Investment and the Impact Exchange Rates Have on Real Income and Bond Pricing

US Government Bond investors seek to obtain an investment return that will preserve principal and at the same time generate income and capital appreciation commensurate with the risks of lending money. The investor purchases a bond on the belief that they will be better off sometime in the future from their investment. As noted in Irving Fisher's book, The Theory of Interest, "Capital wealth is merely the means to the end called income, while capital value (which is the sense in which the term capital is ordinarily used by interest theorists) is merely the capitalization of expected income."¹ When an investor exchanges their savings for bond investment, it is with the expectation that the goods and services that can be obtained later are significantly greater than what could be acquired today using those same funds. Although bond income and appreciation are stated by the market in nominal terms, it is the real rate of return based on what an investor can purchase with a bond's cash flows that determines its value to the owner. Consequently, a bond's worth to the investor is directly tied to the purchasing price of the currency in which the cash flows are stated. For US Government Bond investors the stability of the dollar relative to the currency in which purchases are to be made in the future is a significant factor motivating investment.

The real value of US Government Bonds to the Chinese investor will depend on the movement of both interest and exchange rates over the holding period. The price of the bond will move inversely to market rates of interest in the US. Since the interest rate on a US Government Bond is fixed at the time of issue, lower market interest rates in the future will drive up the bond price causing capital appreciation. Conversely, higher market interest rates will reduce bond prices and produce capital depreciation. Another motivation for Chinese investment in US Government bonds is the differential between US and Chinese interest rates. *Ceteris paribus*, if the interest rate on US Government Bonds is higher than rates on comparable Chinese Bonds, the Chinese

¹ Irving Fisher, The Theory of Interest: As Determined by Impatience to Spend Income, and Opportunity to Invest it, (New York: Augustus M. Kelley, 1970), p. 61.

investor may secure greater income in the US investment. However, this perspective is predicated on the US Dollar/Chinese Yuan exchange remaining stable. If the US Dollar/Chinese Yuan rates change over a Chinese investor's holding period, the real rate of return on US Government bonds will change dramatically. A decline in the US dollar would mean that the value of the cash flows stated in Chinese Yuan is reduced in real terms. Under such circumstances, the Chinese investor would be left buying goods and services with less Chinese currency than what was anticipated when the US Government Bonds were originally purchased. The reduction in Chinese purchasing power from holding US Government Bonds would reduce the investment motivations for buying or retaining these securities.

Long-term, changes in the US Dollar/Chinese Yuan exchange rate will eventually impact interest rates between the two countries. Irving Fisher when discussing the time preference for fixed income investment noted this relationship between current interest rates and forward exchange and interest rate movements.² Today's US interest rate is based on expectations of both future US interest and currency exchange rates between the US and China, for the Chinese investor. If due to a decline in the US Dollar/Chinese Yuan exchange rate, Chinese investors expect an erosion of purchasing power when holding US Government bonds, they will require a higher rate of interest on these US securities to compensate for the additional price risk. Conversely, a strengthening of the US Dollar against the Chinese Yuan may lead to expectations of greater purchasing power when converting interest income and maturity value on US Government bonds, thereby reducing the need higher interest rates to compensate for adverse exchange rate movement.

Review of the Literature Related to the Impact Interest and Exchange Rate Movements have on Bond Income and Pricing

Literature related to the impact interest and exchange rates have on bond income and pricing may be divided according to a focus on either macro or microeconomic perspectives associated with rate changes. The paper, "Expectations and Exchange Rate Dynamics," by Rodiger Dornbusch develops a static macroeconomic framework for examining the fluctuation of exchange rates in relation to a rational expectations theory of interest rate determination.³ Domestic and foreign currencies are assumed to be perfect substitutes with domestic interest rates moving according to investor expectations about domestic currency changes in correspondence to their foreign currency counterparts. If the domestic currency is expected to depreciate, interest rates on assets denominated in the domestic currency will rise against those interest rates stated on assets of the appreciating foreign currency. In disequilibrium, as the prices of the domestic assets decline and interest rates move up, foreign investors are presented

² Irving Fisher, *op. cit.*, pp. 68-71.

³ Rudiger Dornbusch, "Expectations and Exchange Rate Dynamics," *The Journal of Political Economy*, Vol. 84, No. 6(December 1976), pp. 1161-1176.

with the opportunity to move foreign currency funds into the higher yielding domestic assets.⁴ This arbitrage process leads to long run equilibrium at a higher interest rate on domestic assets. The paper also considers the impact domestic monetary expansion may have on exchange and interest rate movements. The author shows that monetary expansion will initially reduced interest rates and create an anticipation of exchange rate depreciation in the domestic currency leading to reduced interest in domestic asset purchases by foreigners. Ultimately, the lower demand for these assets leads to higher interest rates and lower prices on domestic assets at a new equilibrium level.⁵

A paper by Rudolfo Manuelli and James Peck, “Exchange Rate: Volatility in an Equilibrium Asset Pricing Model,” develops a two period stochastic model of exchange rate determination with unrestricted access to capital and currency markets. Based on their findings exchange rate volatility is unrelated to welfare considerations in terms of equilibrium allocations in both the foreign and domestic economic when rates change.⁶ The Manuelli and Peck model considers an objective function based on current utility based on consumption in period 1 with expected utility based on conditional on information about consumption in the future period 2. Within the pure exchange economy there is no production, however, there is a S vector of endowments that defines a stochastic process over a compact [closed and bounded] set. Consumers choose the level of current consumption and the level of future consumption, as well as, the amount of foreign and domestic currency to be held into the next period. All equilibria involve no net trade of goods between countries, and as a consequence there is a rational expectations equilibrium which clears the market at a fixed set of prices, consumption levels and exchange rate.⁷ Under this model, a change in the rate of exchange will set up arbitrage possibilities that lead to a convergence of prices and consumption in both companies regardless of initial endowments and money supply positions.⁸

One of the first papers to explore diversification and exchange rate risk, “Exchange risk and international diversification in bond and equity portfolios,” by Evi Kaplanis and Stephen M. Schaefer, published in 1991, finds that when exchange rate variability is large, risk reduction opportunities may be significant for international diversified portfolios that hedge currency risk. The authors claim that with great variation, exchange risk becomes even more important when managing a bond portfolio because the size and degree of currency risk may be reduced to a much greater extent through diversification. Kaplanis and Schaefer show that for bonds and equities, internationally diversified portfolios that do not hedge currency risk may be riskier than similar domestic portfolios that attempt to diversify away exchange rate risk.⁹

⁴ Dornbusch, *op.cit.*, pp. 1162-1166.

⁵ Dornbusch, *op.cit.*, pp. 1168-1170.

⁶ [Rodolfo E. Manuelli, and James Peck, “Exchange Rate Volatility in an Equilibrium Asset Pricing Model,” *International Economic Review*, Vol. 31, No. 3\(August 1990\), pp. 559-574..](#)

⁷ [Manuelli and Peck, *op. cit.*, pp. 562-565.](#)

⁸ [Manuelli and Peck, *op. cit.*, pp. 572-573.](#)

⁹ Kaplanis, Evi and Schaefer, Stephen M., “Exchange risk and international diversification in bond and equity portfolios,” *Journal of Economics and Business*, Volume 43, Issue 4, November 1991, Pages 287-307.

An article appearing in 1992 entitled, “Linking the International Bond Investment Decision to Hedging,” by Yoav Benari, using 1974-85 data, provides some evidence that a close relationship may exist between the relative returns on US and foreign bonds with variations in exchange rates. Benari mentions that when inflation increases more rapidly in the US economy than abroad, US bonds will underperform foreign bonds; and this finding remains true when the foreign bond returns are measured in the local currency. When translating those returns into US dollars after exchange rates have incorporated inflation rate movements, the foreign bonds produce a better return than their US bond counterparts.¹⁰

The paper, “Equilibrium Asset Prices and Exchange Rates,” by Fernando Zapatero examines the role exchange rate and interest rate movements play in equilibrium pricing of domestic and foreign equities markets.¹¹ Zapatero extends Benari’s work in establishing a connection between exchange rates and bond returns, to develop a dynamic model relating exchange rates to the value of financial assets. Using a two-country, two good model framework, the Zapatero examines a dynamic model of the financial market that includes interest rates, asset prices, and exchange rates as endogenous rather than an exogenous components.¹² Each country produces one good, and the production process is stochastic with a utility function being derived out of consumption of the two goods generated from the two country system. The objective function maximizes an investor’s life-time utility from consuming those goods.¹³ Within this model, the representative investor in country D will deploy funds in one of three categories: (a) the risky asset of home country D, (b) the risky asset of country F or the risk-free asset of country F. Zapatero finds that the rate of appreciation in currency exchange consists of the change in the real interest rate plus a stochastic term consisting of the covariance of world wealth and the rate of exchange. Consequently, there is no stable relationship between real exchange rates and the differential of real interest rates, which appears to be a deviation from interest rate parity.¹⁴ The paper concludes by using the model to show exchange rate volatility may be explained by changes occurring in the stock markets of the two countries.¹⁵ It would appear that uncertainty with respect to exchange rate fluctuation between two country currencies motivates investors to purchase or sell equity positions in the domestic or foreign markets based on arbitrage possibilities.

The article entitled, “The Exchange-Rate Risk Exposure of Asset Returns,” by Edward Chow, Wayne Lee and Michael Solt seeks to explain the microeconomic long term impact exchange rate variations have on stock and bond returns to US investors using Federal Reserve and

¹⁰ Benari, Yoav, “linking the International Bond Investment Decision to Hedging,” *Financial Analysts Journal*, Vol. 48, No. 5 (Sep. - Oct., 1992), pp. 55-63.

¹¹ Fernando Zapatero, “Equilibrium Asset Prices and Exchange Rates,” *Journal of Economic Dynamics and Control*, Vol. 19(1995), pp. 787-811.

¹² Zapatero, *op. cit.*, p. 788.

¹³ Zapatero, *ibid.*, pp. 789-790.

¹⁴ Zapatero, *ibid.*, pp. 798-801.

¹⁵ Zapatero, *ibid.*, p. 806.

Compustat data over the period from March 1977 to December 1989.¹⁶ The authors found that changes in real exchange rates are important in explaining changes in expected returns on bonds on stocks, but the impact effects are different. Bond returns are responsive to both short and long term exchange rates alterations due largely to changes in interest rates on these securities. Exchange rate changes for stocks tend to impact cash flow and interest rates which are offsetting in the short term, but complimentary over long horizons.¹⁷ The results of their econometric study show an inverse relationship between the dollar exchange rate and the returns on stocks and bonds, with a weaker dollar producing lower bond and stock returns. The focus of this investigation was to determine how exchange risk might impact stock and bond returns to American corporations and investors using a mixed autoregressive-OLS model with bootstrap simulation.¹⁸

The 2004 article by Delroy M. Hunter and David P. Simon, “Benefits of International Bond Diversification” examines whether US investors holding a well diversified domestic fixed income and equity portfolio can gain incremental diversification benefits from investing in international government bonds. Using the mean-variance spanning test for ten-year UK, German and Japanese government bonds for the recent period of 1992-2002, the authors show that there are some benefits for US investors, but only if currency risk is hedged. Their findings also support the view that the benefits of international diversification, when currency risks are hedged, are not diminished during periods of weakness or increased volatility in US or foreign bond markets.¹⁹

The paper “International bond diversification strategies: the impact of currency, country, and credit risk,” by Mats Hansson, Eva Liljebloom and Anders Löflund, finds that international diversification among government bonds may not necessarily yield significant diversification benefits. The authors use mean-variance spanning and intersection tests, restricted for short sales, for currency hedged and un-hedged internationally developed market government bonds to test the benefits of diversification. Their results show that international corporate bonds which were hedged for currency variation offered only limited diversification benefits.²⁰

The 2010 article, “Asset Prices, Exchange Rates and the Current Account,” by Marcel Fratzscher, Luciana Juvenal, and Lucio Sarno, published in The European Economic Review, examines the relationship asset prices and exchange rates play in determining US trade balances.²¹ This investigation seeks to address policy issues related to how changes in the US

¹⁶ Edward H. Chow, Wayne Y. Lee, and Michael E. Solt, “The Exchange-Rate Risk Exposure of Asset Returns,” The Journal of Business, Vol. 70, No. 1 (January 1997), pp. 105-123.

¹⁷ Chow, Lee, and Solt, op.cit., p. 122.

¹⁸ Chow, Lee and Solt, op.cit., pp. 114-122.

¹⁹ Hunter, Delroy M. and Simon, David P., “Benefits of International Bond Diversification,” The Journal of Fixed Income, Vol. 13, March 2004, pp. 57-72.

²⁰ Hansson, Mats, Liljebloom, Eva and Löflund, Anders, “International bond diversification strategies: the impact of currency, country, and credit risk,” The European Journal of Finance, Vol.15, No.5-6, July-September 2009, pp.555-583.

²¹ Marcel Fratzscher, Luciana Juvenal, and Lucio Sarno, “Asset Prices, Exchange Rates and the Current Account,” European Economic Review, Vol 54(2010), pp. 643-658.

exchange rate, housing prices and equity market shocks impact the US trade account. The authors incorporate a new methodology using a Bayesian VAR model to examine how, and to what degree asset prices and exchange rates influence the US trade balances. Using quarterly data from 1974 to 2008 on trade balances, exchange rates, housing prices and equity prices for G7 countries, the model shows that an appreciation in the US exchange rate may produce a small decrease in US interest rates relative to other countries.²² In addition, a change in equity prices has a more persistent and significant impact on the US trade balance in a fashion comparable to a change in the US exchange rate.²³ On the basis of their findings, equity market shocks, as well as, housing price shocks have been major determinants of US current trade account balances. According to their model, real exchange rate shocks have been less relevant in explaining US trade balance movements than asset or housing prices. On the basis of these findings, the authors conclude that large exchange rate movements may not necessarily be key in adjusting today's large US current trade account imbalances.²⁴

Analysis of Historical US and Chinese Currency Rate Changes and Their Impact on US Government Bond Pricing and Returns to Chinese Investors

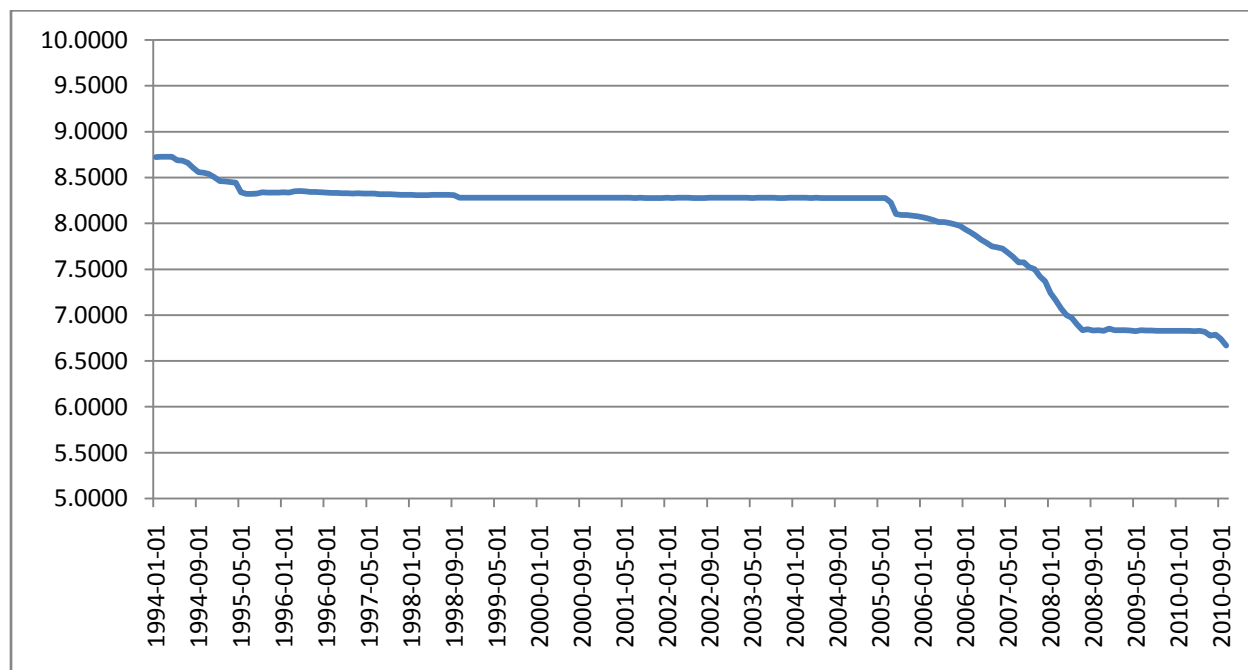
Analysis of US Dollar/Chinese Yuan exchange rate movements shows distinct differences between the periods from 1994 to 2002 versus 2002 to 2010. Figure 1 provides a graph of exchange rates over these two timeframes highlighting rate reductions from 1994 to 2010. Descriptive statistical tests were performed on exchange rate data comparing time periods consisting of 101 monthly observations from January 1, 1994 to May 1, 2005 and another from June 1, 2005 to October 1, 2010. Table 1 gives the results of a difference of two means tests on the average exchange rate for each of the two groups of observations. The null hypothesis that the group means are equal is rejected in favor of a difference in means at the .01 level. Table 2 offers findings related to the test of equality of variances between the two groups of exchange rates. According to Table 1, the US Dollar/Chinese Yuan exchange rates were significantly lower in the period from June 2005 to October 2010. In addition, based on the findings in Table 2, there was significantly greater variation in the US Dollar/Chinese Yuan exchange rate from June 2005 to October 2010 in comparison to the earlier period from January 1994 to May 2002. Consequently, a Chinese investor holding US securities denominated in American dollars would have incurred greater exchange losses and higher volatility in security value during the June 2005 to October 2010 time frame than in the holding period from January 1994 to May 2002.

²² Fratzscher, Juvenal, and Sarno, *op.cit.*, p. 650.

²³ Fratzscher, Juvenal, and Sarno, *ibid.*, p. 651.

²⁴ Fratzscher, Juvenal, and Sarno, *ibid.*, p. 657.

Figure 1: US Dollar/ Chinese Yuan Exchange Rates
January 1, 1994 to October 1, 2010



Source: Federal Reserve District Bank of St. Louis, Economic Research Data – FRED,
<http://www.stlouisfed.org/>

Table 1: Difference of Two Means Test
 H_0 : Group Means are Equal

	<u>Group 1: 1/1/94 to 5/1/2002</u>	<u>Group 2: 6/1/2002 to 10/1/2010</u>
Mean	8.346788	7.674475
Variance	0.013905	0.388809
Observations	101	101
Pearson Correlation Coefficient		.545292
Hypothesized Mean Difference		0
Degrees of Freedom		100
t-statistic		11.89735
Prob(T<=t) one tail test		3.65E-21
Significant at the .01 level		

Table 2: Difference of Two Means Test
 H_0 : Group Variances are Equal

	<u>Group 1: 1/1/94 to 5/1/2002</u>	<u>Group 2: 6/1/2002 to 10/1/2010</u>
Mean	8.346788	7.674475
Variance	0.013905	0.388809
Observations	101	101
Pooled Variance	0.201357	
Hypothesized Mean Difference	0	
Degrees of Freedom	200	
t-statistic	10.64716	
Prob(T<=t) one tail test	1.46E-21	
Significant at .01 level		

Table 3, provides an analysis of the impact interest rate movements have on U.S. government bond pricing using financial information on a 5% 2037 US Treasury bond from January 1, 2008 to September 15, 2010. Table 3 considers a Chinese investor's return from holding this US treasury issue in US dollars exclusive of exchange between American and Chinese currencies. Similar investigations using US government bond data for differing time periods could be performed using this spreadsheet. Bond prices for this security changed as the result of variation in market rates of interest. For the one year period for September 15, 2009 to 2010, interest yield to maturity declined 56.13 basis points. Consequently, this treasury security increased in value \$10.0313 [122.2813-112.25] per \$100 of face amount due to this interest rate decline. A more precise way to measuring the alteration on bond pricing due to changes in market rates of interest is to consider interest elasticity²⁵. For this particular timeframe the interest elasticity is:

$$\% \Delta \text{Price} / \% \Delta \text{Interest Rate} = \frac{[122.2813 - 112.25] / 112.25}{[.04243 - .036817] / .04243} = -.675537 \text{ or } -68\%$$

In contrast for the longer period January 1, 2008 to September 15, 2010 the interest yield to maturity increased 84.58 basis points and the treasury security decreased in value \$19.625 [122.2813-141.9063] per \$100 of face amount. The effect of these interest rate changes is an increase in wealth to the Chinese investor from September 15 2009 to 2010, against a decrease over the longer period from January 1, 2008 to September 15, 2010. For the longer holding period the interest elasticity is:

$$\% \Delta \text{Price} / \% \Delta \text{Interest Rate} = \frac{[122.2813 - 141.9063] / 141.9063}{[.028359 - .036817] / .028359} = -.463694 \text{ or } -46\%$$

²⁵ Brealey, Richard A., Myers, Stewart, Allen, Franklin, "Principles of Corporate Finance," 8th edition, 2006, p.632-641

In this particular case, the longer term Chinese investor incurs a loss on the bond from the rise in interest rates over a 21 month holding period, whereas, the shorter term Chinese investor obtains a slight gain from a drop in interest rates from September 2009 to 2010. Under the one year scenario, the Chinese investor generates an 8.94% return on investment from a 56.13 basis point reduction in market interest rates. With the second scenario, the Chinese investor generates a negative 13.83% return from a larger 84.58 basis point rise in interest rates. Even though the first scenario has greater interest elasticity, in this case market changes in interest rate is a third less than under the second scenario [i.e., 56.13 versus 84.58 basis points].

Table 3
Analysis of Interest Rate Risk on the Pricing and
Investor Return on a US Treasury Bond

Bond to be Analyzed:

<u>Date</u>		<u>Cpn</u> <u>Rate</u>	<u>Maturity</u> <u>Date</u>	<u>Asked</u> <u>Price</u>	<u>Asked</u> <u>Yld to Maturity</u>
1/1/2008	US Treasury Bond	5.0%	5/15/2037	141.9063	2.83590%
9/15/2009	US Treasury Bond	5.0%	5/15/2037	112.25	4.24300%
9/14/2010	US Treasury Bond	5.0%	5/15/2037	122.2813	3.68170%

Years to Maturity: 27

No. Semi-Annual Periods: 54

From Sept. 15th 2009 to September 15th 2010, market interest rates decreased
[4.24300% - 3.68170%] 0.56130% or 56.13 Basis points

From January 1, 2008 to September 15th 2010, market interest rates increased
[2.8359% - 3.68170%] 0.84580% or 84.5800 Basis points

**Case 1: Purchase of US Government Bond in 2009 followed by a Sale One Year Later
in 2010 on September 15th**

Analysis of a Chinese Investor's Return Denominated in US Dollars from a
Change in Interest Rates

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ONE YEAR SCENARIO:

Assume that an American purchased \$100 million of these bonds at 112.25 on	\$
9/15/2009 for: $[112.25 \times 10] \times \$100 \text{ million} / \$1,000 =$	112,250,000
Interest rates decline and the Chinese investor sells these bonds on	\$
9/15/2010 for: $[122.2813 \times 10] \times \$100 \text{ million} / \$1,000 =$	122,281,250
	\$
Producing a Capital Gain on the Sale of:	10,031,250

The American Investor's Rate of Return from this transaction is:
 $[\$10,031,250/\$112,250,000] = 8.94\%$

Case 2: Purchase of US Government Bond in January 1, 2008 followed by a Sale on September 15, 2010

Analysis of a Chinese Investor's Return Denominated in US Dollars from a
 Change in Interest Rates

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TWO YEAR SCENARIO:

Assume that an American purchased \$100 million of these bonds at 141.9063 on	
for: $[141.9063 \times 10] \times \100	
1/1/2008 million/\$1,000 =	141,906.25
Interest rates decline and the American investor sells these bonds on	
for: $[122.2813 \times 10] \times \100	
9/15/2010 million/\$1,000 =	122,281.25
Producing a Capital Loss on the Sale of:	-19,625.00
The Chinese Investor's Rate of Return from this transaction is:	
$[-\$19,625,000/\$141,906250] =$	-13.83%

Table 4, provides an examination of the impact US Dollar/Chinese Yuan exchange rates have on the rate of return to the Chinese Investor for the 5% 2037 US Treasury bond under consideration. For the shorter holding period from September 15, 2009 to 2010, the declining exchange rate reduced the Chinese investor's rate of return from 8.94% to 7.55%, about 139 basis points. Under the longer scenario from January 1, 2008 to September 15, 2010, the greater decline in exchange caused the Chinese investor's rate of return to go from -13.83% to -20.36% about 653 basis points. The effect of a decline in exchange rates over the period from 2008 to 2010 was to increase Chinese losses from this US Treasury bond purchase in a nonlinear fashion. A decline in the US Dollar against the Chinese Yuan results in the loss in the overall value of the Chinese investor's position in US Treasury bonds, and that reduction may be far greater than any gain from the decline in interest rates over an investment period. On the other hand, should the US Dollar appreciate against the Chinese currency, the gain from holding US Treasury securities may also prove greater than any increase due to lower interest rates going forward.

Table 4
Analysis of Exchange Rate Risk on the Chinese Investor's
Rate of Return on a US Treasury Bond

Bond to be Analyzed:

Date		Cpn Rate	Maturity Date	Asked Price	Asked Yld to Maturity	Rate US=>Yuan
1/1/2008	US Treasury Bond	5.0%	5/15/2037	141.9063	2.83590%	7.2946
9/15/2009	US Treasury Bond	5.0%	5/15/2037	112.25	4.24300%	6.8289
9/14/2010	US Treasury Bond	5.0%	5/15/2037	122.2813	3.68170%	6.74217

Years to Maturity: 27

No. Semi-Annual Periods: 54

Case 1: Purchase of US Government Bond in 2009 followed by a Sale One Year Later in 2010 on September

15th

Assume that a Chinese investor purchased \$100 million of these bonds at

112.25 on 9/15/2009: $[112.25 \times 10] \times \$100 \text{ million} / \$1,000 =$ \$ 112,250

However in order to do so, this Chinese investor must convert Chinese Yuan into dollars to effect the transaction

Exchange Rate on 9/15/2009

1 US Dollar converts into: 6.8289 Chinese Yuan

Consequently, US Government Bonds cost the Chinese Investor:

\$112,250,000 x 6.8289 Chinese Yuan = 766,544 Yuan

With the decline in US interest rates the Chinese Investor sells the bonds on

9/15/2010 for: $[122.2813 \times 10] \times \$100 \text{ million} / \$1,000 =$ \$ 122,281

The US Dollars from the Sale of the bonds will be at 824441 Yuan

a rate of 6.74217 Yuan to the US Dollar

Consequently, the capital gain to the Chinese investor is: 57,896.95 Yuan

The Chinese Investor's Rate of Return on this One Year

Transaction is: 57,896/766,544 Yuan or 7.55%

Case 2: Purchase of US Government Bond in January 1, 2008 followed by a Sale on September 15, 2010

Assume that a Chinese investor purchased \$100 million of these bonds at 141.9063 on 1/1/2008: $[141.9063 \times 10] \times \$100 \text{ million}/\$1,000 = \$ 141,906$
 However in order to do so, this Chinese investor must convert Chinese Yuan into dollars to effect the transaction.

Exchange Rate on 1/1/2008

1 US Dollar converts into: Chinese
7.2946 Yuan

Consequently, US Government Bonds cost the Chinese Investor:

$\$141,906250 \times 7.2946 \text{ Chinese Yuan} = 1,035,149 \text{ Yuan}$

With the increase in US interest rates the Chinese Investor sells the bonds on

for: $[122.2813 \times 10] \times \$100 \text{ million}/\$1,000$
 9/15/2010 = \$ 122,281

However, the dollars need to be translated in Chinese Yuan, and the Exchange Rate on 9/15/2010 is:

1 US Dollar converts into: Chinese
6.74217 Yuan

So, the proceeds from the sale of the bonds would be:

$\$122,281,250 \times 6.74217 \text{ Chinese Yuan or: } 824,441 \text{ Yuan}$

The Chinese Investor's Capital Loss in Yuan would be: 210,708.36 Yuan

The Chinese Investor's Rate of Return on this

Transaction would be: $210,708,355.94/1,035,149,331 = -20.36\%$

Note: The Chinese Investor's lower return is greater than that of the US investor because the US dollar has declined in relation to the Chinese Yuan so that when the US Treasury bonds are sold, they carry less value in Yuan.

Conclusion: Exchange rate risk will magnify investment returns to a foreign investor positively if the currency in which the fixed income security is denominated increases relative to the investor's home currency or negatively if the opposite case occurs.

Another way to gauge the impact exchange rate movements have on the price of a bond is to calculate exchange rate elasticities under these two scenarios. In the first case, the exchange rate elasticity is:

$\% \Delta \text{Price [in Chinese Yuan]} / \% \Delta \text{Exchange Rate} =$

$$\frac{[112.25 \times 6.8289 - 122.2813 \times 6.74217] / [112.25 \times 6.8289]}{[6.8289 - 6.74217] / 6.8289} = .97 \text{ or } 97\%$$

In contrast, the exchange rate elasticity for the second scenario is:

$\% \Delta \text{Price [in Chinese Yuan]} / \% \Delta \text{Exchange Rate} =$

$$\frac{[141.9063 \times 7.2946 - 122.2813 \times 6.74217] / [141.9063 \times 7.2946]}{[7.2946 - 6.74217] / 7.2946} = 3.547881 \text{ or } 355\%$$

The price elasticity on a Chinese investor's US Bond holding is 3 and half times larger with the drop in the US Dollar/Chinese Yuan exchange rate under scenario 2, as opposed to 1.

A third method for examining the impact exchange rates have on bond pricing may be to consider interest rate parity.²⁶ Interest rate parity assumes a linear relationship between exchange and interest rates, such that changes in exchange will cause adjustments in interest rates to allow investors to receive an equivalent return whether they invest at home or abroad. This relationship is defined as:

$$\frac{\text{Forward exchange rate}}{\text{Spot exchange rate}} = \frac{[1 + r_h]}{[1 + r_f]}$$

Where r_h represents the home market rate of interest and r_f denotes the equivalent foreign country rate of interest based on the rate of exchange in currencies. Consequently,

$$r_f = \left\{ \frac{\text{Spot exchange rate}}{\text{Forward exchange rate}} \times [1 + r_h] \right\} - 1$$

Under scenario 1, the equivalent market interest rate on a Chinese bond having comparable default, liquidity and maturity risk would have to be:

$$r_f = [6.8289 / 6.74217] \times [1 + .04243] - 1 = .059055 \text{ or } 5.9\%$$

For scenario 2, the equivalent market interest rate on a Chinese bond having comparable default, liquidity, and maturity risk would have to be:

$$r_f = [7.2946 / 6.74217] \times [1 + .028359] = .112619 \text{ or } 11.3\%$$

²⁶ Eugene F. Brigham, and Michael C. Ehrhardt, Financial Management Theory and Practice, 12th Edition, (New York: Southwestern Publishing, 2008), pp. 943-945.

This result would appear to indicate that the larger decline in exchange from scenario 1 to 2 contributes to a near doubling of the equivalent rate of interest needed on a Chinese bond to compensate for currency risk.

A Brief Examination of Currency and Interest Rate Fluctuations for the US Economy using Static Macroeconomic Analysis

While the main purpose of this paper is to evaluate the microeconomic consequences of currency exchange fluctuation of the US Dollar/ Chinese Yuan on US denominated treasury bonds held by Chinese investors, the larger issue may be what the Chinese reaction to such bond pricing has on the US economy. In an effort to explore such a broader concern, this section utilizes a closed, static macroeconomic model involving IS-LM analysis incorporating extensions with a foreign sector and balance of payments component to analyze what a decline in the US Dollar/Chinese Yuan might do to the US economy.²⁷ Granted a static model may not offer the exact results for interest rates, employment, inflation or productivity as with a dynamic framework with respect to currency fluctuation, but it should suffice to indicate perhaps the direction of economic movements might be from a dollar decline.

Consider the general GNP identity:

$$\text{GNP} = Y = C + I + G + (X - M) = C + S + T + R_f$$

Where, the left-hand side represents expenditures of national income in the form of GNP, and the right-hand side denotes how income earned in production is allocated.

$C[y - t(y), A/P]$ and consumption is positively related to disposable income $\{y - t(y)\}$ with y as the level of income, and t the applicable tax rate; and directly related to real balances or wealth $\{A/P\}$ with A being the nominal value of assets held and P the nominal price level. In this instance the level of consumption will be inversely related to prices, as increases in nominal prices will reduce real wealth [i.e., A/P leaving A fixed] thereby diminishing funds available for consumption.

More concisely,

$$\frac{\partial C}{\partial y} > 0; \frac{\partial C}{\partial t} < 0; ; \frac{\partial C}{\partial P} < 0.$$

Investment, $I = I(r, y)$ where the level of investment is inversely related to the interest rate r , and positively correlated to the amount of income y , so consequently,

²⁷ William H. Branson, Macroeconomic Theory and Policy, (New York: Harper and Row, Publishers, 1972), pp. 297-318.

$$\frac{\partial I}{\partial y} > 0; \text{ and } \frac{\partial I}{\partial r} < 0.$$

G the level of government spending is an exogenous policy variable dependent on strategies for assuring economic growth, employment and monetary stability.

X is the level of exports out of the US such that,

$X = x(P^{US}, P^{US}/P^C = P^e)$ where exports will increase from both a reduction in US domestic pricing of goods to overseas markets, and a decrease in the exchange rate [$P^{US}/P^C = P^e$, with the US Dollar declining against the Chinese Yuan] causing US goods to be priced less than domestic Chinese products. Thus,

$$\frac{\partial X}{\partial P^{US}} < 0; \text{ and } \frac{\partial X}{\partial P^e} < 0.$$

$M = m(P^{US}, P^e)$ where US imports are directly related to both P^{US} and P^e , so that higher prices on US domestic goods stimulate sales and imports of Chinese goods in the US, and the strengthening of the exchange rate P^e causes the prices on Chinese products to get cheaper thereby increasing imports. Consequently,

$$\frac{\partial M}{\partial P^{US}} > 0; \text{ and } \frac{\partial M}{\partial P^e} > 0.$$

The savings function, S depends directly on the rate of interest r, and the level of disposable income [$y - t(y)$] and indirectly on the level of real assets [$A/P = a$], so that,

$$S = S(r, y - t(y), a) \text{ and,}$$

$$\frac{\partial S}{\partial r} > 0; \frac{\partial S}{\partial y} > 0; \frac{\partial S}{\partial t} < 0; \frac{\partial S}{\partial a} < 0.$$

Both T, US tax revenues and R_f transfer payments to foreign citizens are exogenous policy variables that will depend on strategies for economic growth, employment and monetary stability.

Liquidity preference and money supply relationships are specified by,

$$\frac{M(r)}{P} = m(r, y) = l(r) + k(y), \text{ denoting the speculative and transactions motivation for holding money.}$$

Speculative demand for money $l(r)$ is indirectly related to the interest rate r, such that higher interest rates reduce those seeking financing where as lower market interest rates encourage borrowing. On the other hand a positive relationship exists for transactions

demand, so that as income increases, the demand for money within the production process increases.

The balance of payments surplus or deficit consists of,

$$\text{Net exports: } X - M = x(P^{\text{US}}, P^e) - m(P^{\text{US}}, P^e)$$

Minus net private capital outflow: $F = F(r)$ such that higher interest rates(r) stimulate greater Chinese investment in US treasury bonds [i.e., negative capital outflows] reducing F , such that $F'(r) < 0$,

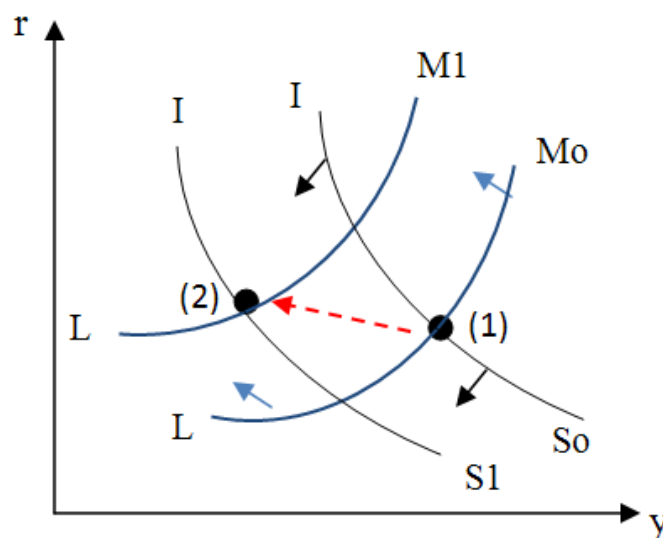
Minus R_f which consist of government transfer payments to US citizens overseas, which in this case would be China, so

$$B = [x(P^{\text{US}}, P^e) - m(P^{\text{US}}, P^e)] - F(r) - R_f$$

For purposes of this model, R_f is considered to be negligible given the modest presence of US citizens in China who might be receiving US government assistance. Consequently, the balance of payments lines is determined by variations in, the pricing of US goods P^{US} , the exchange rate P^e , and the US interest rate r .

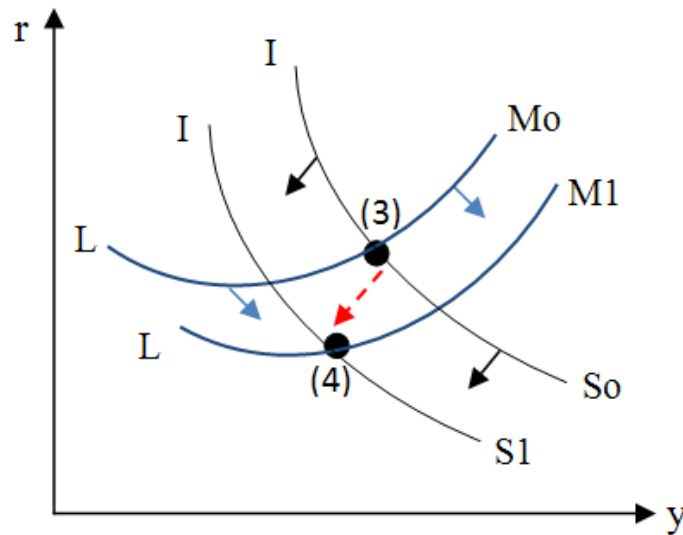
Within the IS-LM framework, an increase in American prices P^{US} [i.e. inflation] reduces real balances (A/P^{US}), lowering consumption (c), decreasing savings(s), shifting the IS curve to the left. On the other hand, as prices increase, $P^{\text{US}} \uparrow$ long term, interest rates will move up with increases in the inflation premium causing the LM curve to move up and to the left. Under such circumstances long term equilibrium is likely to occur at a higher interest rate, but lower level of aggregate income [Figure 2: (1) \rightarrow (2).]

Figure 2: IS-LM Equilibrium With Increase in P^{US}



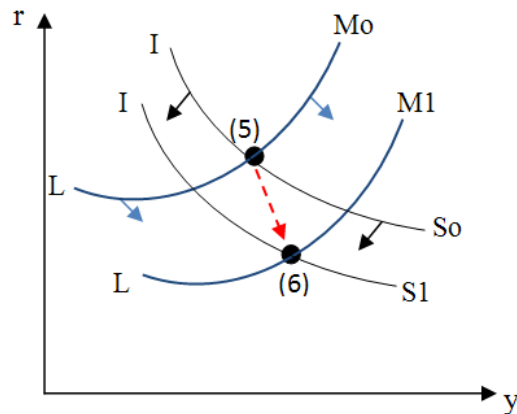
Alterations in the exchange rate P^e will impact net exports $X-M$, thereby shifting the IS schedule relative to the cost of US goods in China, based on exchange. If the exchange rate, P^e increases, causing US goods to be expensive, and Chinese products to appear cheaper, then net exports would decline, generating a trade deficit and the IS line would move to the left. In terms of liquidity preference, a higher exchange rate would be favorable to Chinese investment in US treasury bonds so initially the LM curve would shift out and to the right leading to an equilibrium position with lower income and interest rates [Figure 3: (3)→(4)].

Figure 3: Initial IS-LM Equilibrium with Increase in P^e



However, this equilibrium may depend upon the stability of US currency in relation to Chinese holdings of US government bonds. With a long-term build-up of trade deficits, more US currency will be housed in China, shifting control of US monetary aggregates overseas. With the trade imbalance continuing to contribute to lower income and employment, the Federal Reserve seek to monetize the growing debt causing the LM curve to shift out a sizeable resulting in lower interest rates, but a higher level of equilibrium income. As long as Chinese investors buy US treasury bonds this equilibrium may continue to stay in place. [Figure 4: (5) → (6)].

Figure 4: Longer Run IS-LM Equilibrium with Increases in P^e



Ultimately, should the Chinese investor seek to reduce their holdings in US treasury bonds, US dollars will be taken out of circulation [reducing the money supply], the price of the bonds will be bid up, and interest rates will increase. This type of action would be similar to a Federal Reserve open market operation whereby the Fed sells bonds into the market. The only difference being that this open market operation could be for a long time. Viewed from another perspective, the LM curve will shift up and to the left leading to higher long term interest rates and lower income in the US economy. [Figure 5: (7)→(8).]

A recent 2009 article by Cline and Williamson makes the argument that the US Dollar is overvalued relative to the Chinese Yuan based on projections of Chinese trade surpluses.²⁸ The authors note that these US external trade imbalances may be more important because of China's concern in regards to whether they wish to continue to increase their US Treasury holdings.²⁹ Chinese holdings of US Treasury debt reached \$2.85 trillion at the end of 2010³⁰. On his most recent visit to the US, Chinese President Hu showed little interest in wanting to alter their exchange rate policy noting the connection between rates and US trade imbalances.³¹ The preceding analysis indicates that international, macro-economic effects may represent legitimate concerns for both the US and China when dealing with exchange rate and trade imbalances.

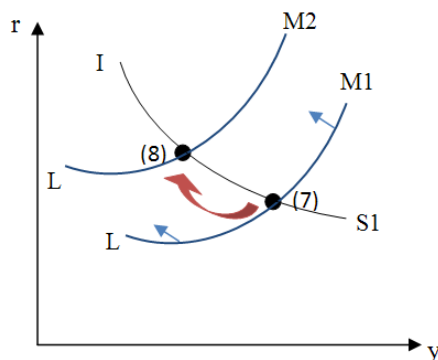
²⁸ Cline, William R. and Williamson, John, "Equilibrium Exchange Rates: Dollar Overvaluation, Renminbi Undervaluation," Jun 18, 2009, walstreetpit.com, 3/26/2011.

²⁹ Cline and Williamson, op.cit., 2009

³⁰ Browne, Andrew, "China's President Lays Groundwork for Obama Talks," The wall Street Journal, World News, Jan 17, 2011

³¹ Browne, op.cit., 2011

Figure: 5 New Long-Term Equilibrium Based on Chinese US Treasury Bond Sales



The results of the preceding IS-LM closed, static analysis provides some indication that changes in US Dollar/Chinese Yuan exchange rate will have dramatic, long-term effects on the US economy. Although a strengthening of the Chinese Yuan against the US Dollar may provide a temporary increase in income and better employment within the US economy, the long term result may be higher interest rates, lower income and employment. It should also be noted that even with a reduction in P^e , the advantages to the US economy could be neutralized by Chinese selling US bonds into the open market, something they would be motivated to do given the reduction in the value of their holdings. Consequently, these findings appear to favor the development of US policies that would promote a gradual reduction in the US Dollar/Chinese Yuan exchange rate, ironically something that has been occurring since 1994 [Figure 1] even though US government recently has argued for large decreases in the exchange rate between US and Chinese currencies.

Conclusions and Policy Implications of the Impact Interest and Exchange Rates Have on Long term Chinese Investment in US Government Bonds

For the long term Chinese investor in US Government bonds, fluctuation in both market interest and currency exchange rates may significantly impact overall investment return from owning these securities. Based on this investigation, if interest rates were to increase with a strengthening of the Chinese Yuan against the dollar, the rate of return on US Government bonds would decline and in some circumstances produce significant capital loss to Chinese investors in terms of their own currency. From 1994 to 2010, the US Dollar/Chinese Yuan exchange rate has been declining. However, this decline has not been even over time. For the earlier period from January 1994 to May 2002, the US dollar while declining against the Chinese currency, it did so at a slower rate that in the later time frame from June 2002 to October 2010. A micro-economic analysis of the impact declining US Dollar/Chinese Yuan exchange has on US Treasury bond prices indicates continued reductions in the US dollar against the Chinese home currency may result in further investment loss to long-term Chinese investors. An economically rational investor is unlikely to continue to lose large sums of money in a security that has generated negative returns for a long period of time with little provision for improvement. In such a situation, a prudent investor may sell the money losing holding in favor of investments

such as physical assets or financial securities in countries with stronger currencies, in an effort to obtain a more stable store of value over time. Large sales of US Government securities would lead to a reduction in bond prices, along with an increase in interest rates across the market. Temporarily the reduction in bond prices would further reduce Chinese investor returns on their US Government bond holdings as they transferred funds from US denominated securities into other investments. Such short term losses could accelerate Chinese investor interest in further unloading US Treasury bond holdings. This investigation shows that suggestions for China to peg their currency at a higher level to the US dollar need to be tempered with recognition of the impact exchange rates have on Chinese investment returns. While the reduction of the US Dollar/Chinese Yuan may create a climate for better sale of US exports to China over time, Chinese investors will incur losses from their US Treasury holdings from alteration of exchange. These investment losses may motivate Chinese to sell US Treasury securities causing declines in bond prices, and increases in interest rates in the US capital market. Higher interest rates may prove counterproductive to US economic recovery, as US businesses facing higher borrowing costs may reduce capital outlays. The results of this study provides some evidence that US Dollar/Chinese Yuan currency exchange policy needs to consider not only trade balance issues, but also the interests of Chinese investors who hold considerable positions in US Government bonds. The later view is important not only from the standpoint of maintaining Chinese interest in US Government bond investment, but also the objective of maintaining stability of the US Government bond market.

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