Economists have long been curious about China’s conservatism with regard to managing its foreign exchange reserves, which exceeded the $2 trillion mark in early 2009. Usually, having more funds means that one can afford to take more risk, but China has managed its huge foreign exchange reserves cautiously, hoarding much of its reserves in relatively safe, but low-yield Treasury bonds, while investing only a small fraction into sovereign wealth funds, whose expected returns are more promising, but riskier. This has led many economists to conclude that China has managed its reserves sub-optimally. But by conducting simulations, I quantify the nature of China’s dual challenge of achieving decent investment returns while maintaining optimal consumption levels. These simulations are based on previous analyses of university endowments, which share some key similarities with China’s foreign exchange reserves. The results suggest that China may be vulnerable to short-term and long-term negative shocks to its foreign exchange reserves. In the end, I conclude that owing to its need to minimize risk, China’s conservative approach to managing its reserves, although counterintuitive to many economists, is fundamentally rational.

Keywords: asset allocation, consumption, foreign exchange reserves, optimization, sovereign wealth funds

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1. Introduction

Ever since embarking on economic reforms in the late seventies and early eighties, China’s economy has experienced an average of 10 percent growth per annum. Fuelled in part by large annual current account trade surpluses, high levels of foreign direct investment, and inflows of cash from overseas investors who anticipate that the Chinese government will appreciate the yuan in the near future, China’s foreign reserves grew rapidly from the 1990s onward, reaching the $2 trillion mark by January 2009.

This figure is not an accounting trick. It represents real money ($2,000,000,000,000) that the Chinese could potentially use to buy not just bonds, but also stocks, houses, land, and all sorts of assets. This development has led to its fair share of controversy, as speculation abounds as to how China intends to manage this wealth. To this end, Harvard economist Kenneth Rogoff once remarked at a 2003 IMF conference: “It is one thing to save for a rainy day, but a trillion dollars in reserves accumulation looks more like building Noah’s Ark.”

As Nugee (2002) points out, currency reserves constitute a major national asset for many nations. In 2007, China’s foreign exchange reserves amounted to 47.1 percent of GDP. From the standpoint of preserving this asset, the management of foreign exchange reserves is an important task for almost all governments. But because the reserves play a role in other elements of national economic policy, the management of currency reserves assumes a doubly important role, because poor management of the reserves can cause economic damage beyond the losses suffered on the assets themselves.

China’s large foreign currency reserves allow it to stabilize the foreign exchange rates to provide for a more favorable economic environment. However, there are costs in
maintaining such large reserves. Fluctuations in currency values often result in gains and losses in the purchasing power of the reserves. For example, China holds huge U.S. dollar-denominated assets, but the U.S. dollar has been weakening on the exchange markets in recent years, resulting in a relative loss of wealth. In addition to fluctuations in exchange rates, the purchasing power of currency often decreases due to inflation. Moreover, there is also the opportunity cost of holding large currency reserves: they could have been invested in higher yielding assets.

In recent decades, China has chosen to recycle much of its vast export earnings by buying relatively safe assets, such as U.S. Treasury bonds. As of September 2008, China surpassed Japan as the largest foreign holder of U.S. Treasury bonds. This has served to finance the U.S. deficit, help keep U.S. interest rates low, and given U.S. consumers greater power to buy exports. Treasury bonds are generally regarded as relatively stable and safe investments, and in the aftermath of the subprime meltdown, they are generally considered even safer than triple-A bonds. However, this safety comes at a price: Treasury bonds usually offer low returns, which are often insufficient to offset the exchange rate and inflation risks posed to the currency reserves. Therefore, partly in response to the low returns on Treasury bonds, China has, in recent years, sought to build and expand its sovereign wealth funds.

1.2 What are sovereign wealth funds?

A sovereign wealth fund, according to the U.S. Treasury Department, is a government investment vehicle funded by foreign exchange assets and managed separately from the official reserves of the monetary authorities. In principle, sovereign
wealth funds look abroad for higher returns and asset diversification, which would in turn improve the efficiency of global asset allocation. In this sense, investing reserves in sovereign wealth funds can be broadly construed as an investment alternative to buying Treasury bonds.

Globally, sovereign wealth funds have grown in size and significance over the past 10 years, and are projected to grow even more (Martin, 2003). This development has become a concern in both economic and political circles in the U.S. (McCormick, 2008). In 2007, *Forbes* magazine listed Ho Ching, CEO of a Singaporean sovereign wealth fund, as the 3rd most powerful woman in the world, ahead of prominent political figures such as Condoleezza Rice, Hillary Clinton, and Queen Elizabeth II.

Today, total sovereign wealth fund assets are currently estimated at about $3 trillion, and Morgan Stanley economist Stephen Jen writes that sovereign wealth funds are “projected to hold nearly $12 trillion in assets by 2015” and are likely to “surpass the size of the world’s total official reserves within five years.” As a result, sovereign wealth funds have emerged as important investors of global equity and are attracting increasing world attention (Kimmitt, 2008).

Yet, although sovereign wealth funds have existed since the early 1950s, China has only recently established sovereign wealth funds on a large-scale. In 2003, the Central Huijin Investment Company Limited (CHI) was established by the Department of Finance with a paid-in-capital of $45 billion. In 2007, China launched the China Investment Corporation (CIC), a sovereign wealth fund with $200 billion in capital, to make long-term investments in search of higher returns.
Despite the size of China’s sovereign wealth fund holdings, few economists have analyzed these closely due to their generally low transparency and the fact that they have traditionally restricted themselves to investing in only several dozen companies, which limits the range of quantitative studies that can be made.

In addition, sovereign wealth funds may enjoy fewer investment opportunities due to their size. A sovereign wealth fund with many billions to invest, but with limited personnel to oversee investments, may be unable to effectively invest small amounts, such as a few millions dollars, in small, but potentially profitable low-capitalization companies. Instead, the sovereign wealth fund may have to invest larger amounts (i.e., billions of dollars) in high-capitalization companies, and these investments may not always be superior to low-capitalization alternatives.

Moreover, because sovereign wealth fund investments are typically large-sized and their purchases often become public information relatively quickly, it is not so easy for them to time the market. Potentially profitable short-term sales are unavailable to sovereign wealth funds, forcing them to restrict themselves to long-term holdings. In this sense, the China Investment Corporation, with $200 billion to spend, does face some drawbacks due to its size. In many senses, the China Investment Corporation’s situation can be seen as a variant of diseconomies of scale.

1.3 China’s dual dilemma

China’s management of its foreign exchange reserves can be understood as making tradeoffs between two competing objectives. On one hand, China faces the continual short-term challenge of making steady, sustainable payouts from the reserves
for economic purposes (i.e., the goal of consumption). On the other hand, China also faces the long-term challenge of maximizing the returns and total size of its reserves (i.e., the goal of return maximization).

China uses foreign exchange reserves for a variety of consumption purposes. This money is sometimes used to pay off debt and other foreign liabilities. It is used for government expenditure overseas. It may be used as a tool for China’s monetary or exchange rate policy. It can also be used in emergencies and times of disaster, such as during the 2008 Sichuan earthquake. Moreover, the reserves serve as a formal backing for China’s currency. For these reasons and many more, China occasionally makes payouts from its reserves.

China’s foreign exchange reserves also represent funds for potential investment, and one of China’s priorities to keep the reserves growing while avoiding unnecessary risks that might lead to major losses. Naturally, this goal of return maximization conflicts with the goal of consumption.

1.4 Context

The problem with analyzing China’s dual dilemma is that it is part of a bigger puzzle. Just as a Russian stacking doll consists of dolls of increasing sizes placed one inside the other, so the Chinese sovereign wealth funds are only one small segment of a larger entity, the foreign exchange reserves, which are in turn only a small part of an even larger entity, the Chinese economy.

It is beyond the scope of this paper to draw conclusions about China’s $2 trillion reserves in the context of China’s entire economy. Rather, this paper will study China’s $2 trillion reserves as an independent economic entity. This is a humble approach whose
simplifying benefits should be recognized alongside its inherent limitations. In this paper, any conclusions drawn about China’s management of the reserves must be qualified, given that the full context of China’s larger economic situation remains important, but is outside the scope of this study.

Broadly speaking, three main issues come into consideration: 1) how China’s $200 billion sovereign wealth fund is managed; 2) how the sovereign wealth fund fits into the management of China’s $2 trillion foreign exchange reserves; and 3) how the foreign exchange reserves fit into the management of China’s $20+ trillion economy and assets as a whole. My paper focuses on the second point, but all three are worth mentioning.

The first issue, how China’s $200 billion sovereign wealth fund is managed, is difficult to analyze with the current data available. This is not just because the China Investment Corporation’s activities often lack transparency, but more importantly, that it is currently investing in only a few dozen companies and does not plan to invest in more than fifty. This limits the quality and range of quantitative analysis that can be done on the sovereign wealth fund’s investments. With limited data available, it is much more difficult to conduct standard regressions. Although non-parametric tests may be employed, they may not yield quality results in this particular area of research.

The second issue, how China’s $2 trillion foreign exchange reserves are managed, is economically more significant than how the individual sovereign wealth fund is managed. Moreover, given the relative abundance of literature and the greater availability of data on foreign exchange reserves, it is more plausible to analyze China’s multi-trillion dollar reserves, with analysis of sovereign wealth funds playing a
supporting rather than a lead role. Indeed, the focus of this paper is primarily on the $2
trillion question.

The third issue, the question of China’s $20+ trillion economy and assets, is even
larger than the question of the foreign exchange reserves. There are limitations to the
analysis of the foreign exchange reserves, in part because this money represents only a
small piece of a larger economic picture.

China’s refusal to consume heavily from its reserves might seem irrational until
we consider the larger context of China’s economy. Every year, trillions of dollars worth
of output are produced and exchanged. Most of what China produces is consumed
domestically. Viewed in this context, China’s reserves, although large, still represent only
a small fraction of the nation’s total wealth. Therefore, although this paper studies
China’s management of its foreign exchange reserves as an independent entity, future
studies may wish to consider the larger economy in drawing conclusions about whether
China’s management of the reserves (or the sovereign wealth funds) is optimal.
2. Literature Review

China’s management of its foreign exchange reserves is unique mainly because of the size of this fund. But other multi-billion dollar entities—retirement funds, private investment funds, and university endowments—have been studied before. If China’s situation shares similarities with other economic entities, it may become easier to analyze. Moreover, studying these other entities sheds light on the nature of China’s situation. Any framework for analyzing China’s foreign exchange reserves must take into consideration China’s twin goals of consumption and return maximization. In my view, neither problem should be studied in isolation; they are two sides of the same coin.

In this section, I do three things. In Part 2.1, I discuss the scarcity of relevant economic literature in my area of research: China’s investment and consumption of its foreign exchange reserves. In Part 2.2, I discuss the shortcomings of existing relevant literature and literature in related fields in order to glean for ideas and to point out certain features in those papers that influence my eventual approach to this study. Finally, in Part 2.3, I discuss related literature, primarily in university endowment portfolio management, that I build on for my eventual analysis.

2.1 Literature on China’s foreign exchange reserves management is scarce

Foreign exchange reserves

Few formal economic studies have been performed on how foreign exchange reserves are related to Treasury bonds, sovereign wealth funds, and consumption. While foreign exchange reserves have been extensively studied by many economists, most notably by McKinnon (2003), the interplay between foreign exchange reserves and their
various consumption and investment uses have generally eluded detailed quantitative analysis by economists until the past two years.

By and large, most economists writing about foreign exchange reserves have chosen to focus on other questions. For example, Hviding, Nowak, and Ricci (2004) examine how the level of reserves relates to exchange rate policy, while Liu (2007) explores how reserves should be allocated among different currencies such as dollars, pounds, and yen. But although these questions are interesting, they relate to issues that are peripheral to my research. Unfortunately, most of the existing literature on foreign exchange reserves focuses on the traditional macroeconomic aspects—i.e., how the foreign exchange reserves relate to issues like economic growth, inflation, exchange rate policy, and so on. Rather than take a traditional macroeconomic approach, I analyze the reserves from the standpoint of financial economics—of optimizing and maximizing returns and payouts from a $2 trillion currency fund. In my view, the financial economics approach offers a useful alternative perspective for analyzing the purposes and features of China’s foreign exchange reserves.

**Sovereign wealth funds**

Until recently, few economists have written academic papers dealing with sovereign wealth funds, let alone the optimal scale of sovereign wealth funds in the context of managing foreign exchange reserves. Although these funds have existed in various forms since the 1950s and have been widely covered by the press in the West (Portman, 2008) and in Asia (Wang, 2007), the term “sovereign wealth fund” was itself coined only recently by Razanov (2005).
Given the relatively thin coverage of formal economic literature surrounding sovereign wealth funds in general, economists who attempt to directly study sovereign wealth funds have few precedents to rely on and must often find ways to deal with the problem of scarce data. For example, Fotak and Megginson’s (2008) paper on the financial impact of sovereign wealth fund investments seems to face this problem. Its main limitation is that it is not easy to collect comprehensive data sets on individual sovereign wealth funds due to the frequent lack of transparency surrounding sovereign wealth fund investments. Fotak and Megginson attempt to get around this problem by pooling together data on all sovereign wealth fund investments from many countries, which yields a data set large enough to conduct regressions. But sovereign wealth funds tend to differ widely across countries. Therefore, in a sense, pooling the data across different sovereign wealth funds is roughly analogous to mixing apples with oranges.

Another attempt was made by Chhaochharia and Laeven (2008) who recently found that sovereign wealth funds tended to invest more heavily in countries that shared similar cultures, suggesting their investment rules are not entirely driven by profit maximizing objectives. They also found that share prices of companies that receive sovereign fund investments tend to rise in the short term, but decline in the longer term.

Chhaochharia and Laeven gathered data from twelve sovereign wealth funds, but they also had to rely on pooling the data in order to help draw some of their conclusions. Once again, due to the heterogeneous nature of sovereign wealth funds, with some being very transparent and open about their portfolios and others less so, I am not confident that every conclusion gained from pooling the data will necessarily lead to groundbreaking economic insights. To study sovereign wealth funds effectively, one must study them
individually, especially the less-transparent ones in China and the Arab countries. However, more data is needed on these sovereign wealth funds, and it may take many years before such data becomes available.

2.2 Shortcomings of related literature

The problem of absolute returns versus risk distributions

However, three Chinese economists recently wrote an interesting and relevant paper, one seeking to find the optimal scale and allocation of foreign exchange reserves into consumption and savings in China’s context. I consider Zhang, Wei, and Yue’s (2008) paper to be a bold attempt to analyze the relationship between China’s foreign exchange reserve earnings and its expenditures in consumption and savings (i.e., sovereign wealth funds). It is one of very few papers to analyze this particular topic, and the authors deserve credit for looking at it.

However, the Chinese paper contains a number of shortcomings. For this particular sub-section, I introduce some parts of the Chinese paper in order to critique it and offer alternative perspectives that shape my eventual approach.

Due to the thin economic literature in this particular field of inquiry, Zhang, Wei, and Yue (2008) borrow tools from other economic studies. In particular, the authors employ part of the precautionary savings model from Deaton (1991) with reference to mathematical models from Tauchen (1986) to characterize China’s optimization problem. Their project is based on a publication by Arrau and Claessen (1992). The model outlined by Zhang, Wei, and Yue attempts to balance China’s foreign exchange earnings with its
consumption, with the remainder (savings) all going into sovereign wealth funds and Treasury bonds.

The authors employ a model to predict the nation’s future reserve earnings. Building on a model first developed by Wang (2003), the authors argue that China’s foreign exchange reserves grow according to an AR (1) pattern. Making long-term projections about the future is difficult. However, some degree of prediction is interesting from an economic standpoint. Specifically, they offer the following model:

\[ \Delta \log(y_t) = a \Delta \log(y_{t-1}) + b + \epsilon_i \]  \hspace{1cm} (1)

where \( y_t \) represents the foreign exchange earnings of period \( t \), \( t \) is represented in one month units, and \( \epsilon_i \sim N(0, \sigma_{\log(y)}) \). Using data from China’s State Administration of Foreign Exchange (SAFE) dating from 1993 to 2008, I use the existing data and their method to do conduct some estimations:

**AR (1) regression results on foreign exchange earnings**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. error</th>
<th>T-statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>0.011913</td>
<td>0.002097</td>
<td>5.680261</td>
<td>5.04E-08</td>
</tr>
<tr>
<td>A</td>
<td>0.506825</td>
<td>0.062781</td>
<td>8.072919</td>
<td>7.99E-14</td>
</tr>
</tbody>
</table>

- R square 0.257422
- Adjusted R square 0.253472
- S.E. of regression 0.020208
- F-statistic 0.997861
- Durbin-Watson statistic 2.228675

The regression result shows that the t-values are statistically significant and the R-square is reasonably-sized. The AR (1) value is less than 1, meaning that the AR (1)
procedure is balanced. Also, the Durbin-Watson value is close to 2, meaning that the presence of autocorrelation is small. Therefore this model, for all its limitations, is fairly effective at simulating and predicting the process of foreign exchange earnings.

Using this model, I generate simulations for China’s projected foreign exchange reserve levels. One possible simulation looks like the following:

<table>
<thead>
<tr>
<th>Year</th>
<th>USD (billions)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reserves (historical)</td>
</tr>
<tr>
<td>1993</td>
<td>0.5</td>
</tr>
<tr>
<td>1995</td>
<td>1.0</td>
</tr>
<tr>
<td>1997</td>
<td>2.0</td>
</tr>
<tr>
<td>1999</td>
<td>3.0</td>
</tr>
<tr>
<td>2001</td>
<td>4.0</td>
</tr>
<tr>
<td>2003</td>
<td>5.0</td>
</tr>
<tr>
<td>2005</td>
<td>6.0</td>
</tr>
<tr>
<td>2007</td>
<td>7.0</td>
</tr>
<tr>
<td>2009</td>
<td>8.0</td>
</tr>
<tr>
<td>2011</td>
<td>9.0</td>
</tr>
<tr>
<td>2013</td>
<td>10.0</td>
</tr>
<tr>
<td>2015</td>
<td>11.0</td>
</tr>
</tbody>
</table>

Under this particular prediction, one can expect China’s foreign exchange reserves, with some fluctuations, to triple to around $6 trillion by around 2015. Although this sounds like a lot of money, it is not a wild estimate when considered in the context of China’s population—perhaps $5,000 per citizen, approximately equal to China’s 2008 GDP per capita (PPP)—and sounds relatively reasonable for a large industrial nation. Moreover, considering that China’s GDP, assuming it grows at 10 percent a year, is expected to double every seven years, it may be plausible for China’s foreign exchange reserves to triple in size if its GDP doubles.

To be clear, there are limitations to this predictive model. One such objection is that the model seems to predict future reserve earnings based on past earnings, a relationship that may not necessarily hold. Another problem with this model could be the
possibility of omitted variable bias, which is a common problem in single-regressor models. Perhaps, to ameliorate this bias, one might consider adding at least one more regressor to this model, one that is correlated with \( \Delta \log (y_{t-1}) \), and which is a determinant of \( \Delta \log (y_t) \).

However, my main problem with this model is not that it is inaccurate, but that its simulations—given as absolute figures—do not reveal a full picture. The model predicts that the Chinese foreign exchange reserves will grow to at least $6 trillion, but this is an absolute figure that does not give us enough information. I am more interested in understanding the distributional, not absolute, returns on the foreign exchange reserves. In my mind, I prefer to model the relative probabilities of the foreign exchange reserves losing (or gaining) money, rather than on the projected absolute size of the fund.

My rationale for taking this stance is that people generally tend to be risk averse. For a big nation like China, with the welfare of 1.3 billion people at stake, I believe that while rising reserves are desirable, it is the distribution of risk probabilities that matter the most. For example, even if the reserves are expected to grow to $6 trillion within a decade under a certain investment strategy, I doubt that the Chinese government would be willing to pursue that strategy if it carried a 50 percent risk of huge losses, since such a large risk might expose millions to poverty or even hunger. China’s foreign exchange reserves are likely to be managed with a high degree of caution and risk aversion, unlike private investment funds that may be more tolerant of risk-taking.

Thus, from the standpoint of this paper, I find it useful to make the assumption that the Chinese government, like many economic actors, is risk-averse. Therefore, I
focus not on absolute returns, but on a distribution of returns that is closely connected to risk probabilities.

*The Finite Period Problem in Consumption*

Returning to the Chinese paper by Zhang, Wei, and Yue (2008), the authors employ another model to predict Chinese behavior with regard to the management of the foreign exchange reserves. The model is based on the notion that the individual country faces choices and constraints on its expenditure. Once again, I offer my take on the plus and minus points of this approach, from which I gain some insights and ideas.

Under the model, due to fluctuations in earnings from international trade and the borrowing constraint and the low returns from the risk-free assets, such as Treasury bonds, the central bank or government has an incentive to save to smooth earnings fluctuations. The central bank or government transfers some foreign exchange earnings to sovereign wealth fund in a bid to make excess returns that can be used for a rainy day.

According to the Chinese paper, the government maximizes the expected value of a function of the control variable, saving, subject to budget and borrowing constraints.

\[
\text{max } E \sum_{t=1}^{n} \beta^{t-1} u(c_t) \quad \text{(2)}
\]

s.t.

\[
w_{t+1} = (1+r)(w_t + y_t - c_t) \quad \text{(3)}
\]

\[
w_t \geq 0, \quad t = 1, \ldots, n \quad \text{(4)}
\]

where:

- \(u(\cdot)\): Instantaneous utility function, assumed to be increasing, strictly concave, and differentiable, i.e., \(u' > 0, \quad u'' < 0\).
- \(n\): Number of months.
• \( c_t \): Consumption in period \( t \).
• \( y_t \): Foreign exchange earnings in period \( t \).
• \( w_t \): Total value of sovereign wealth fund’s assets in period \( t \).
• \( \beta \): Time preference factor, \( 0 < \beta < 1 \).
• \( r \): Return rate of sovereign wealth fund asset, assumed to be a constant, i.e., the return rate of risk-free asset.

The model assumes that foreign exchange earnings follow an AR (1) process (outlined in Part 3.1) and that the utility function is as follows:

\[
u(c_t) = \frac{c_t^{1-\alpha}}{1-\alpha}
\]

(5)

Where \( \alpha \) is the relative risk aversion parameter, and the value of \( \alpha \) would be higher as the degree of risk aversion becomes higher. This is a constant relative risk aversion function, a common utility function that has many useful properties.

In the Chinese paper, the authors then employ “typical procedures” to solve this dynamic programming problem, which yields the following Euler equation:

\[
u'(c_t) = \max \{(y_t + w_t)^{-\alpha}, r\beta E[u'(c_{t+1})]\}
\]

(6)

That is, the optimal consumption decision makes the marginal utility of the current consumption equal to the discount value of marginal utility of the consumption in the next period, when the budget constraint is not binding. The term on the left refers to the situation where China consumes all its income and savings in a particular period. The term on the right refers to a “normal” situation where they consume in accordance with their marginal utility. In their paper, the Chinese economists choose values of \( \alpha = 0.5 \) and
\[ \beta = 0.9 \] based on “experiences.” After that, they conduct some simulations and come up with some conclusions about the optimal consumption and savings (i.e., size of sovereign wealth fund).

The authors’ value of \[ \beta = 0.9 \] per month is too low (i.e., the discount rate is overly high) because each time period \( t \) represents only a short period of 30-odd days. If this model is employed in future studies, a much smaller discount factor, perhaps \( \beta = 0.999 \), would probably be more appropriate. When I ran some simulations using a similar approach to the Chinese paper, I got results that resembled the following:

![Size of Chinese Reserves](image)

Basically, the simulation tells us that under this particular model, it would have been optimal for China to consume none of its foreign reserves until 2004, after which it should start spending heavily.

Several things can be said about this model’s strengths. It proposes a framework in which the reserves can be divided into different segments, such as consumption and savings. The idea of having an optimization process, taking risk aversion into account, is useful to this analysis.
That being said, the model and paper has a major weakness. I call it the “retirement fund” fallacy.

A retirement fund is a pool of money that is saved up over a number of years with the intention of consuming everything. This assumption—that everything saved and invested must be eventually consumed—works fine in the context of analyzing retirement funds. But in my opinion, it is not analogous to China’s foreign exchange reserves.

Fundamentally, I disagree with the assumptions surrounding consumption in this model. In equation (2), the model assumes that maximizing the utility of consumption is the end goal. In real-life terms, this is roughly equivalent to assuming that the Chinese government intends for all its foreign reserves to be eventually consumed. Given that the reserves represent only a small fraction of the multi-trillion dollar Chinese economy, of which the lion’s share is already consumed, this assumption of consumption is a strong assumption to make since it may not be true that every cent of the reserves are meant for consumption. Indeed, one might even argue given the economic context, it is entirely rational and optimal to save at least a large fraction of the reserves.

In addition, the assumption of consumption leads to a problem with the model’s finite planning horizon. No matter how many years the model takes into consideration (i.e., no matter how big $n$ is), the fact that the years are finite means that every cent of the reserves must be consumed by the final period, since you get no utility from having anything left over after the final period. This idea of a finite planning horizon makes sense if we’re talking about an individual smoothing his consumption over a life expectancy of eighty years. But it makes very little sense in the context of China, a country that arguably has a longer, perhaps near-infinite, time horizon. The authors of the
Chinese paper, aware of this problem, calculated that this assumption created a few distortions in the earlier periods, but had greater influence in the last five to ten years of the analysis. Therefore, their solution was to exclude the later periods (which I also did when generating the simulation above). But the number of excluded periods is an arbitrary number, and its selection influences consumption levels in earlier periods.

Although consumption is an important reason for China having foreign exchange reserves, it is not the only reason. Unlike a retirement fund, China’s foreign exchange reserves are meant not just for consumption, but also for their own intrinsic expansion.

The Problem of Maximizing Returns Alone

On the opposite side of the spectrum is another approach, where economists seek ways to maximize just one’s investment returns while ignoring consumption. The goal of maximizing returns and increasing the size of one’s fund has been long studied by economists. Looking through a standard finance textbook, such as Bodie, Kane, and Marcus (5th ed., 2003), one might consider a common set of functions often employed by financial theorists, which consists of the following:

\[ U = \mathbb{E}(r) - 0.005A\sigma^2 \]  \hspace{1cm} (7)

\[ \sigma^2 = w_i^2\sigma_i^2 + w_s^2\sigma_s^2 + 2w_iw_s\text{Cov}(r_i,r_s) \]  \hspace{1cm} (8)

where:

- \( \mathbb{E}(r) \): Expected return
- \( \sigma^2 \): Variance of the returns
- \( A \): Index of risk aversion
- \( t \): Represents investment T (i.e., Treasury bonds).
• s: Represents investment S (i.e., sovereign wealth fund).
• w: Represents weight (from 0 to 1) placed on investment choices

The above equations are consistent with the notion that utility is enhanced by higher expected returns and diminished by higher risk. The foreign exchange reserve managers’ degree of risk aversion influences the extent to which volatility lowers utility.

Using the above model and similar ones, economists have often analyzed the ways in which private investment firms from Berkshire Hathaway to Legg Mason have sought to maximize their size and returns. The usefulness of this model is that it recognizes the interplay between returns on investment, which is seen as a plus, and volatility, which is seen as a negative. This model is useful in terms of considering the issue of return maximization.

Unfortunately, it doesn’t take into account the issue of consumption. This assumption—that maximizing returns is the only thing that matters, and that we don’t consider consumption—might work fine when analyzing private investment funds, which may only make occasional payouts for consumption. However, it is a poor paradigm to adopt when analyzing China’s foreign exchange reserves, whose consumption levels play an integral role in their purpose and function.

In previous drafts of this paper, doing some calculations, I came across several scenarios where China’s foreign exchange reserves could have grown to $16 trillion by 2015. However, that figure represents a theoretical fiction because they occur in the absence of consumption. In reality, the Chinese foreign exchange reserves are meant not
just to be maximized, but also to be consumed. And consumption plays an intrinsic and systemic role in the operation of the reserves.

### 2.3 Settling on a model: the university endowment fund analogy

If China’s foreign exchange reserves are closely analogous to neither retirement funds nor private investment funds, what else might they bear a resemblance to? In my view, university endowment funds face a situation that is similar in many useful respects to China’s foreign exchange reserve situation.

Although university endowments have not been as heavily analyzed as retirement funds or private investment funds, there is a substantial literature on them. Brown, Garlappi, and Tiu (2007) investigate the role of asset allocation on the performance of university endowment funds, and conclude that university endowments in their data set held remarkably similar levels of asset allocation.

A more recent paper Basch (2008) uses simulations to analyze the quantitative implications of university endowments’ “dual dilemma” of having to balance regular short-term payouts with the long-term goal of growing the endowment.

From Basch’s analysis, university endowment funds—like China’s foreign exchange reserves—face the twin challenges of balancing consumption with return maximization. Unlike retirement funds, in which all savings and investments are expected to be consumed, university endowment funds generally aim to preserve and expand their capital indefinitely. In the words of David Swensen, Chief Investment Officer of Yale’s endowment, university endowments have a “time horizon measured in centuries.” Although a university endowment may make occasional payouts to the
university every few months, these payouts tend to be relatively small compared to the overall size of the endowment. This means that university endowments may take consumption as a consideration, but do not necessarily seek to spend all their capital within a short period of time. This consideration is analogous to the management of China’s foreign exchange reserves, which makes occasional payouts for consumption, but also has the goal of maintaining and expanding itself over a long time horizon.

Basch (2008) also uses an additional, interesting method of analysis, one that I will be employing for this paper. Instead of choosing utility functions on consumption and investment, which are useful for creating simulations that predict absolute outcomes (i.e., a fund is expected to grow to $X million in Y years), Basch’s paper focuses instead on analyzing the risk probabilities of possible investment strategies (i.e., a fund has a W percent chance of growing to $X million in Y years, but has a Z percent chance of shrinking by V percent). I find Basch’s analysis of university endowment funds useful in this respect, and his idea plays a key role in the next section of this paper.
3. Risk Analysis of Foreign Exchange Reserves Management

From the above observations, I believe that my analysis must take two factors into account:

1. The analysis should be based on a risk-averse framework, one based on avoidance of major losses.

2. The analysis must take into consideration China’s dual dilemma of balancing consumption with return maximization.

The essence of the following policy simulations is to quantify the probable performance of China’s foreign exchange reserves under different investment strategies and levels of consumption.

Consider the consumption problem. China’s foreign exchange reserves, although substantial, faces a difficult dilemma. If consumption rates are kept low to reduce the probability of short-term losses (and maximize the probability of growth) on the reserves, this low spending rate will lead to lower average annual support for China’s economic policies. However, if consumption rates are kept high in order to maximize support for China’s economic policies, the probability of short-term losses on the reserves would be much greater since more is being taken out.

On the flip side, China also faces the investment problem. If it invests its foreign exchange reserves too cautiously, it may face low returns. However, if it invests too ambitiously, it may risk losing a lot of money even though its expected returns may be higher, making it difficult to provide critical funding for China’s future economic needs.

In this section, I conduct five policy simulations—each analyzing a different possible investment situation—in order to quantify the nature of the dilemma facing
China’s foreign exchange reserves. These simulations are used to analyze the relative probabilities of China losing a significant fraction (i.e., 25, 40, or 50 percent) of its reserves within a specified time period (10 or 40 years) at various levels of consumption (ranging from 1 to 7 percent per annum). I also include calculations of the expected size of China’s currency fund under each investment strategy at each level of consumption at the end of a 40-year period. The simulations are as follows:

Simulation A: China invests ambitiously, investing 100 percent of its funds in a risky, but promising portfolio (similar to that used by Yale University’s endowment).

Simulation B: China invests conservatively, investing 85 percent of its funds in relatively safe Treasury bonds and 15 percent in risky sovereign wealth funds (using the returns on Treasury inflation-protected securities and Norway’s sovereign wealth fund as benchmarks)

Simulation C: China invests ambitiously like in Simulation A, with additional foreign exchange earnings added to the total reserves (at a rate of 2.5 percent per year).

Simulation D: China invests conservatively, like in Simulation B, with additional foreign exchange earnings added to the total reserves (at a rate of 2.5 percent per year).

Simulation E: China invests using a “mixed strategy” for the management of China’s foreign exchange reserves, with 70 percent of its funds in Treasury bonds and 30 percent in well-managed sovereign wealth funds (using the Yale endowment as a proxy for a well-managed sovereign wealth fund), with additional foreign exchange earnings added to the total reserves (at a rate of 2.5 percent per year).
Simulation A: China invests ambitiously, like an Ivy League endowment fund

Borrowing an idea from Basch (2008), I employ Monte Carlo simulations to provide illustrations and quantitative results. The simulations are created by factoring in expected investment return and risk portfolio into the analysis. For these simulations, I assume that the consumption percentage remains constant. For example, a fund with a 5 percent consumption rate will always consume 5 percent of the available funds each year. I also assume that annual returns are real (corrected for inflation) and that the numbers follow a normal probability distribution.

Consider the situation where China invests ambitiously, like a multi-billion dollar Ivy League endowment fund. I consider the gold standard of college endowment investing to be that of Yale University and David Swensen. Over the past decade, Swensen was remarkably successful in enlarging Yale’s endowment, which grew by $16 billion, more than 17% per annum on average.

Swensen’s investment strategy is famously called the “Yale Model,” and is described in his 2000 book, *Pioneering Portfolio Management*. At bottom, its most revolutionary insight was the idea that to maximize returns, it pays better to invest in illiquid assets than liquid ones. This is because liquid assets, which can be readily converted to cash, generally offer lower returns than illiquid assets, which offer higher returns to compensate for the fact that they cannot be easily converted. In China’s case, the equivalent of adopting a Swensen strategy might be to invest less in Treasury bonds or stocks, which tend to be liquid, and to instead invest heavily in comparatively illiquid assets like houses, land, factories, and farms.
What would happen if China adopted an investment strategy similar to Swensen’s? For this simulation, I borrow data from the 2007 university report of The Yale Endowment. According to the report, the “target mix of assets” produces an expected long-term real growth rate of 6.3 percent with a risk (standard deviation) of 12.4 percent. I choose to accept these estimates, given the endowment’s past track record of success in making previous estimates, as well as its previous successes over the past two decades. Although there is a possibility that this projection may be slightly optimistic, since most fund managers may consider Yale’s projections to overestimate expected returns and underestimate volatility, I feel that for the purposes of this paper, an optimistic estimate works better than a conservative one, since I’m trying to analyze a best-case scenario for China’s foreign exchange reserves being fully managed in the Yale Model-Swensen style, which I consider an example of successful, high-stakes endowment investing.

The results of this simulation can be seen on the following page. In interpreting the results, one should remember the dual dilemma faced by China’s foreign exchange reserve managers: to preserve the size and purchasing power of the fund over the long term, versus providing stable and steady levels of consumption income for China’s economic needs.
Table A

*China Invests Ambitiously, Ivy-League Endowment Style*

Simulations of foreign exchange reserves with expected annual return = 6.3% and standard deviation = 12.4%

<table>
<thead>
<tr>
<th>Consumption spending (%)</th>
<th>1.0%</th>
<th>1.5%</th>
<th>2.0%</th>
<th>2.5%</th>
<th>3.0%</th>
<th>3.5%</th>
<th>4.0%</th>
<th>4.5%</th>
<th>5.0%</th>
<th>5.5%</th>
<th>6.0%</th>
<th>6.5%</th>
<th>7.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chance of reserves losing over 25% of value over 10 years</td>
<td>7.9%</td>
<td>8.8%</td>
<td>9.8%</td>
<td>10.9%</td>
<td>12.1%</td>
<td>13.6%</td>
<td>15.2%</td>
<td>17.1%</td>
<td>19.2%</td>
<td>21.7%</td>
<td>24.4%</td>
<td>27.5%</td>
<td>30.9%</td>
</tr>
<tr>
<td>Chance of reserves losing over 40% of value over 10 years</td>
<td>5.1%</td>
<td>5.6%</td>
<td>6.1%</td>
<td>6.7%</td>
<td>7.4%</td>
<td>8.2%</td>
<td>9.2%</td>
<td>10.2%</td>
<td>11.4%</td>
<td>12.8%</td>
<td>14.3%</td>
<td>16.1%</td>
<td>18.2%</td>
</tr>
<tr>
<td>Chance of reserves losing over 50% of value over 10 years</td>
<td>3.7%</td>
<td>4.0%</td>
<td>4.3%</td>
<td>4.7%</td>
<td>5.2%</td>
<td>5.7%</td>
<td>6.2%</td>
<td>6.9%</td>
<td>7.6%</td>
<td>8.5%</td>
<td>9.5%</td>
<td>10.6%</td>
<td>11.9%</td>
</tr>
<tr>
<td>Chance of reserves losing over 25% of value over 40 years</td>
<td>12.4%</td>
<td>13.0%</td>
<td>13.6%</td>
<td>14.5%</td>
<td>15.5%</td>
<td>16.9%</td>
<td>18.7%</td>
<td>21.0%</td>
<td>24.1%</td>
<td>28.1%</td>
<td>33.5%</td>
<td>40.6%</td>
<td>49.7%</td>
</tr>
<tr>
<td>Chance of reserves losing over 40% of value over 40 years</td>
<td>11.9%</td>
<td>12.3%</td>
<td>12.9%</td>
<td>13.5%</td>
<td>14.3%</td>
<td>15.3%</td>
<td>16.7%</td>
<td>18.4%</td>
<td>20.6%</td>
<td>23.6%</td>
<td>27.5%</td>
<td>32.8%</td>
<td>39.7%</td>
</tr>
<tr>
<td>Chance of reserves losing over 50% of value over 40 years</td>
<td>11.6%</td>
<td>12.0%</td>
<td>12.4%</td>
<td>12.9%</td>
<td>13.5%</td>
<td>14.4%</td>
<td>15.4%</td>
<td>16.8%</td>
<td>18.5%</td>
<td>20.9%</td>
<td>23.9%</td>
<td>27.9%</td>
<td>33.3%</td>
</tr>
<tr>
<td>Expected currency reserves at the end of 40 years ($ bil)</td>
<td>15,782</td>
<td>13,046</td>
<td>10,775</td>
<td>8,890</td>
<td>7,329</td>
<td>6,036</td>
<td>4,967</td>
<td>4,083</td>
<td>3,353</td>
<td>2,751</td>
<td>2,255</td>
<td>1,846</td>
<td>1,510</td>
</tr>
</tbody>
</table>

**Color**

- Greater than 20 percent
- Between 10 and 20 percent
- Between 0 and 10 percent
- Zero percent
The results of Simulation A suggest that China can’t afford to adopt a risky investment strategy with regard to managing its foreign exchange reserves. Even under the rosy scenario where China’s foreign exchange reserves are expected to achieve Swensen-like returns, the risk of a major shrinkage in the Chinese reserves is too high.

To make things clearer in a visual way, I have added colors to the table. The red areas represent the “danger zones,” where China’s foreign exchange reserves face a greater than 20 percent chance of major shrinkage. The yellow areas represent the “moderate risk zones” where China’s foreign exchange reserves might shrink between 10 and 20 percent. Finally, the green areas represent comparatively “low risk zones” where China’s foreign reserves stand a less than 10 percent chance of shrinking.

As one can see in the table, adopting a Swensen strategy means that China risks landing into a large number of red zones over the next four decades, especially if it fails to keep its consumption spending low. The relatively safe green zones are small and do not extend to the 40-year periods. This means that over the long term, the chances of China’s foreign exchange reserves shrinking is unacceptably high.

Consider the implications of some of the numbers. A modest 4.5 percent spending rate means that China bears a huge risk of losing a quarter of its reserves within ten years—about 17 percent. This is roughly the odds of getting killed while playing Russian roulette with a six-shooter with one chamber lethally loaded.

Moreover, the numbers do not dramatically improve even if China behaves conservatively with respect to consumption. For even if China consumes only one percent of its reserves annually—an unrealistically low spending estimate—it will still face double-digit chances of losing half its reserves within 40 years. Indeed, China could
spend zero of its reserves on consumption and still face double-digit chances of losing
significant amounts of money at the end of four decades, let alone a century.

The issue of large rewards is a tempting one. For if China could somehow keep its
consumption to one percent and invest in the Swensen style with its expected results,
China’s foreign exchange reserves would be expected to grow to almost $16 trillion in
forty years, on the strength of its internal returns alone.

However, this strategy is not likely to be practical, given that China’s foreign
exchange reserves face a different situation from university endowments. These reserves
represent the country’s main avenue for paying off debts to foreigners, conducting
overseas expenditures, and pursuing monetary and exchange rate policies. The loss of a
quarter of the foreign exchange reserves at any point in time could potentially cripple
China’s ability to defend its currency, pay off debts, or respond to a national disaster. To
the Chinese government, which plans in terms of decades and half-centuries, the
downside of facing a double-digit risk of a major shrinkage in the reserves far outweighs
the upside of massive theoretical gains.

Simulation B: China invests conservatively (using a portfolio similar to real life)

The Yale Model may work well for university endowments, but it may be a poor
strategy to adopt for managing a national currency reserve responsible for the welfare of
millions. Hence, I offer a second simulation as a rough estimate of China’s current
investment behavior.

Although the specific asset allocation of China’s foreign exchange reserves is a
state secret, economists have a fairly good idea of what the proportions are. It is widely
known that China keeps most of its reserves in safe assets like Treasury bonds, and only a small fraction in the riskier sovereign wealth funds. Given that the Chinese foreign exchange reserves total about $2 trillion and the newly formed sovereign wealth fund, the China Investment Corporation, has capital of only $200 billion (ten percent of the $2 trillion), I assume that in total, safe assets with expected returns and volatility akin to Treasury bonds make up 85 percent of China’s portfolio, while risky assets like the sovereign wealth funds make up only 15 percent of the portfolio.

I use Norway’s Global Pension Fund, a transparent and well-known sovereign wealth fund, as a proxy for China’s sovereign wealth fund. My reasons for employing the Norwegian fund is because its returns tend to be modest, unlike the spectacular double-digit returns earned by other sovereign wealth funds like Singapore’s Temasek Holdings or the Government of Singapore Investment Corporation (GIC). I prefer to make the conservative assumption that because China’s sovereign wealth funds are relatively new, they get only modest expected returns given their relative lack of experience.

For the expected return on its investments, I use the Norwegian sovereign wealth fund’s average real performance over the past twelve years, which is 4.67 percent. I also calculate the standard deviation of these returns, which is 6.04 percent. Although past returns and volatility are not necessarily perfect indicators of future expected returns and volatility, they offer useful estimates as a general rule of thumb, and financial theorists often use these numbers as second-best guesses in the absence of a superior method.

To estimate the expected return on China’s safe assets and Treasury bonds, I use returns on Treasury Inflation-Protected Securities (TIPS). My reason for using TIPS is that they offer a modest estimate of real post-inflation returns. In contrast, I do not use the
returns on Treasury bonds (10-year) because I find that even after taking inflation into account, their returns tend to be relatively high at more than 3 percent. For this simulation, I borrow a figure from Girola (2006). This paper uses historical data from the 2006 edition of Ibbotson’s “Stocks, Bonds, Bills, and Inflation” yearbook. After computing forward rates and assuming a risky future, Girola’s paper predicts that the long-run (50 years) real expected return on a portfolio consisting entirely of TIPS is just 2.25 percent per annum.

For the purposes of this paper, I assume that the TIPS are risk-free, using New York University finance professor Aswath Damodaran’s definition of a risk-free asset as one that has no default risk or reinvestment risk. Although some economists have argued otherwise, for the purposes of this exercise, I assume that the TIPS are risk-free, given the general strength of the U.S. economy, the insulation of TIPS from virtually all inflation risk, and the assumption that the U.S. government does not default on its debts.

Combining the above numbers using Equation (7) of Part 2.2b, and assuming no correlation between the sovereign funds and the Treasury bonds, I get an expected annual return of 2.62 percent and a modest standard deviation of just 0.9 percent on the Chinese foreign exchange reserves.

With these numbers, I conduct a second simulation, shown on the next page:
Table B

*China Invests Conservatively (85% in Treasury bonds, 15% in sovereign wealth funds)*

Simulations of foreign exchange reserves with expected annual return = 2.62% and standard deviation = 0.9%

<table>
<thead>
<tr>
<th>Consumption spending (%)</th>
<th>1.0%</th>
<th>1.5%</th>
<th>2.0%</th>
<th>2.5%</th>
<th>3.0%</th>
<th>3.5%</th>
<th>4.0%</th>
<th>4.5%</th>
<th>5.0%</th>
<th>5.5%</th>
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<th>6.5%</th>
<th>7.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chance of reserves losing over 25% of value over 10 years</td>
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<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.1%</td>
<td>5.4%</td>
<td>56.4%</td>
<td>97.9%</td>
<td>100.0%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>Chance of reserves losing over 40% of value over 10 years</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
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<td>0.0%</td>
<td>0.0%</td>
<td>1.6%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chance of reserves losing over 50% of value over 10 years</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
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<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chance of reserves losing over 25% of value over 40 years</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>1.3%</td>
<td>88.4%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>Chance of reserves losing over 40% of value over 40 years</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.5%</td>
<td>79.1%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>Chance of reserves losing over 50% of value over 40 years</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>1.2%</td>
<td>88.5%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>Expected currency reserves at the end of 40 years ($ bil)</td>
<td>3,804</td>
<td>3,123</td>
<td>2,561</td>
<td>2,098</td>
<td>1,717</td>
<td>1,404</td>
<td>1,147</td>
<td>936</td>
<td>763</td>
<td>621</td>
<td>505</td>
<td>411</td>
<td>333</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Color</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Greater than 20 percent</td>
</tr>
<tr>
<td></td>
<td>Between 10 and 20 percent</td>
</tr>
<tr>
<td></td>
<td>Between 0 and 10 percent</td>
</tr>
<tr>
<td>Blue</td>
<td>Zero percent</td>
</tr>
</tbody>
</table>
Compare Table B to that of the previous simulation, Table A.

Notice that in Table B, the red area seems to have expanded slightly. But most of the green areas and all of the yellow areas are gone, and have been replaced by a huge swath of blue. These blue areas represent “zero-risk zones,” areas where the risk of major losses on China’s foreign exchange reserves are so low that when rounded off to one decimal point, they can be considered to have essentially zero risk.

Consider some of the numbers. Under this simulation, China could safely commit to consuming 3 percent of its funds annually with almost no risk of major losses over four decades (as opposed to double-digit risk of major losses under Strategy A). Moreover, if the Chinese government felt that saving more was in the national interest, they could cut consumption below this 3 percent level to encourage the reserves to grow at a faster rate—with zero risk of big losses and chances for trillion-dollar gains. Knowing that consumption above the 3 percent level leads to sharply-increasing levels of risk (note how some of the green areas are right next to red ones), it is easier for the Chinese government to calibrate its consumption for the long run using this strategy than the previous one in Table A. The low volatility of returns makes it easier to plan consumption under this simulation, and the Chinese government can do quite well by sticking to the simple rule of not consuming a higher percentage than its return.

There is also one additional point. Within a ten-year period, China can afford to consume at a high 7 percent rate (consumption) in case of an emergency, without major risk of losing more than half its funds. This suggests that during short periods of tough economic times (such as this one) it is possible for China to finance short bursts of heavy spending, which may fit in with China’s overall macroeconomic needs.
Simulations C and D: The “buffer effect” of additional foreign exchange earnings

Thus far, in the above simulations, I have been assuming that China’s foreign exchange reserves would remain stuck at the $2 trillion mark. I consider it useful and valid to assume that in managing China’s foreign exchange reserves, the existing fund should stand on its own by using its internal investment returns to finance consumption.

But one issue has not been raised: the effect of additional foreign exchange earnings on the total foreign exchange reserves. Additional foreign exchange earnings, which are gained by China’s trade and industry rather than by returns on investments, represent an exogenous addition to China’s foreign exchange reserves.

Introducing the additional foreign exchange earnings is useful because it offers a small reflection of what reality might look like. Arguably, no matter how risky or safe China’s investments are, the presence of this additional income serves to further insulate China’s consumption from drastic drops during occasional periods of poor investment returns from the existing, “old” reserves.

First, I would like to reintroduce the Yale Model. Assume that China readopts the risky Swensen strategy of Simulation A, with high expected returns and volatility, except that this time, we assume that extra foreign exchange earnings add 2.5 percent to the reserves annually. Wouldn’t the combination of extra foreign exchange earnings plus the high expected returns of the Swensen strategy yield returns that are both high and safe?

The answer to this question is important because many economists argue that China’s high foreign exchange earnings enable it to take more risks in the hope of higher returns. Again, I conduct a simulation, and the results are shown on the next page:
China Invests Ambitiously, Ivy-League Endowment Style, and earns an extra 2.5% in exogenous reserve earnings every year

Table C

Simulations of foreign exchange reserves with expected annual return = 6.3% and standard deviation = 12.4%

<table>
<thead>
<tr>
<th>Consumption spending (%)</th>
<th>1.0%</th>
<th>1.5%</th>
<th>2.0%</th>
<th>2.5%</th>
<th>3.0%</th>
<th>3.5%</th>
<th>4.0%</th>
<th>4.5%</th>
<th>5.0%</th>
<th>5.5%</th>
<th>6.0%</th>
<th>6.5%</th>
<th>7.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chance of reserves losing over 25% of value over 10 years</td>
<td>5.0%</td>
<td>5.4%</td>
<td>5.9%</td>
<td>6.5%</td>
<td>7.2%</td>
<td>7.9%</td>
<td>8.8%</td>
<td>9.8%</td>
<td>10.9%</td>
<td>12.1%</td>
<td>13.6%</td>
<td>15.2%</td>
<td>17.1%</td>
</tr>
<tr>
<td>Chance of reserves losing over 40% of value over 10 years</td>
<td>3.4%</td>
<td>3.6%</td>
<td>3.9%</td>
<td>4.3%</td>
<td>4.7%</td>
<td>5.1%</td>
<td>5.6%</td>
<td>6.1%</td>
<td>6.7%</td>
<td>7.4%</td>
<td>8.2%</td>
<td>9.2%</td>
<td>10.2%</td>
</tr>
<tr>
<td>Chance of reserves losing over 50% of value over 10 years</td>
<td>2.6%</td>
<td>2.7%</td>
<td>2.9%</td>
<td>3.2%</td>
<td>3.4%</td>
<td>3.7%</td>
<td>4.0%</td>
<td>4.3%</td>
<td>4.7%</td>
<td>5.2%</td>
<td>5.7%</td>
<td>6.7%</td>
<td>6.9%</td>
</tr>
<tr>
<td>Chance of reserves losing over 25% of value over 40 years</td>
<td>11.0%</td>
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<td>11.4%</td>
<td>11.7%</td>
<td>12.0%</td>
<td>12.4%</td>
<td>13.0%</td>
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<td>15.5%</td>
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<td>11.3%</td>
<td>11.6%</td>
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<td>12.3%</td>
<td>12.9%</td>
<td>13.5%</td>
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<td>15.3%</td>
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<td>18.4%</td>
</tr>
<tr>
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<td>10.7%</td>
<td>10.8%</td>
<td>10.9%</td>
<td>11.1%</td>
<td>11.3%</td>
<td>11.6%</td>
<td>12.0%</td>
<td>12.4%</td>
<td>12.9%</td>
<td>13.5%</td>
<td>14.4%</td>
<td>15.4%</td>
<td>16.8%</td>
</tr>
<tr>
<td>Expected currency reserves at the end of 40 years ($ bil)</td>
<td>40,344</td>
<td>22,498</td>
<td>27,789</td>
<td>23,034</td>
<td>19,075</td>
<td>15,782</td>
<td>13,046</td>
<td>10,775</td>
<td>8,890</td>
<td>7,329</td>
<td>6,036</td>
<td>4,967</td>
<td>4,083</td>
</tr>
</tbody>
</table>

Color Risk
Greater than 20 percent
Between 10 and 20 percent
Between 0 and 10 percent
Zero percent
Compared to Table A, we see that in Table C, many of the red areas have been replaced by yellow ones, i.e., the extra foreign exchange earnings do increase the safety of the reserves. This was to be expected.

However, the real comparison should not be between Tables A and C, but between Tables B and C. We want to know if an ambitious investment style (Table C) combined with the effect of the additional foreign exchange earnings, is inherently less risky than adopting a conservative investment style (Table B) without the benefit of any additional foreign exchange earnings.

The answer is no. Even if China’s investment performance imitates the successful Yale Model, the combined effect of this fine performance plus the additional exchange earnings is still risky. Under this simulation, China could limit its consumption to just one percent and still face a double-digit risk of losing half of its reserves within two generations. Reducing consumption may help insulate China against major losses within the next ten years, but it wouldn’t greatly reduce the risk of major long-term losses.

In analyzing the tables, the fact that the red area in Table B is larger than that of Table C is unimportant. The central issue at stake is the idea of choice. Under the cautious investment strategy, China can virtually eliminate the probability of major losses by choosing to keep consumption below 3 percent. In contrast, under the more ambitious investment strategy, China faces double-digit risk of major losses on its reserves regardless of its choice of consumption pattern.

In short, the cautious investment strategy allows China greater control over its destiny. And if we go one step further and consider combining the conservative strategy with the additional foreign exchange earnings, we get the next simulation:
China Invests Conservatively (85% in Treasury bonds, 15% in sovereign wealth funds) and earns an extra 2.5% in exogenous reserve earnings every year

Simulations of foreign exchange reserves with expected annual return = 2.62% and standard deviation = 0.9%

<table>
<thead>
<tr>
<th>Consumption spending (%)</th>
<th>1.0%</th>
<th>1.5%</th>
<th>2.0%</th>
<th>2.5%</th>
<th>3.0%</th>
<th>3.5%</th>
<th>4.0%</th>
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<th>7.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chance of reserves losing over 25% of value over 10 years</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
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<td>0.0%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Chance of reserves losing over 40% of value over 10 years</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
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</tr>
<tr>
<td>Chance of reserves losing over 50% of value over 10 years</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
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<td>0.0%</td>
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<td>0.0%</td>
</tr>
<tr>
<td>Chance of reserves losing over 25% of value over 40 years</td>
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<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>1.3%</td>
<td>88.4%</td>
<td>100.0%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>Chance of reserves losing over 40% of value over 40 years</td>
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<td>0.0%</td>
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<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>79.1%</td>
<td>100.0%</td>
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<td>Chance of reserves losing over 50% of value over 40 years</td>
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<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>1.2%</td>
<td>88.5%</td>
<td></td>
</tr>
<tr>
<td>Expected currency reserves at the end of 40 years ($ bil)</td>
<td>10,055</td>
<td>8,294</td>
<td>6,835</td>
<td>5,627</td>
<td>4,629</td>
<td>3,804</td>
<td>3,123</td>
<td>2,561</td>
<td>2,098</td>
<td>1,717</td>
<td>1,404</td>
<td>1,147</td>
<td>936</td>
</tr>
</tbody>
</table>

Color Risk
Greater than 20 percent
Between 10 and 20 percent
Between 0 and 10 percent
Zero percent
Table D is essentially a sea of blue with only a few small spots of red and green. Under this simulation, if China combines a conservative investment strategy alongside modest annual foreign exchange earnings, it could consume at almost any reasonable rate with little risk to its foreign exchange reserves.

To substantiate this argument, consider the situation where China adopts the conservative portfolio (expected annual return of 2.62 percent, standard deviation of 0.9 percent) and that it spends 5 percent of its fund annually. If we now assume that China’s foreign exchange earnings amount to a very modest 2.5 percent per annum, we find that China essentially faces zero risk of major losses within the next four decades. In other words, China could adopt a strong spending rate while being able to maintain its wealth at current levels, at the very least.

To bolster this point, I offer an additional calculation. If China consumes at a 5 percent rate annually over the next two hundred years, its odds of losing a quarter of its reserves rises to a trivial 0.1 percent, while the odds of losing 40 or 50 percent of the reserves remains zero percent, correct to one decimal place.

With the addition of the exogenous foreign exchange earnings, the probabilities that China’s foreign exchange reserves will increase their spending power increases dramatically. The median expectation is that the foreign exchange reserves would balloon to $4 trillion in four decades even with a conservative 2.5 percent external earnings rate. However, the central argument here is that the additional earnings play the primary role of “buffering” China’s consumption against unexpected shocks to its investment returns. Just as a person’s regular paycheck helps insulate him against investment losses, so China’s foreign exchange earnings help protect it from the volatility of its investments.
Simulation E: A Proposed “Mixed Strategy” for investing China’s Forex Reserves

Thus far, I have shown that, given China’s low appetite for risk, it is unlikely that China would invest all its reserves in the style of the Yale Model, in spite of its potentially lucrative returns. I have also shown that China’s existing conservative management strategy, although low-yield, is a logical and safe strategy in preserving China’s foreign exchange reserves while enabling consistent levels of consumption.

However, China is a country that is constantly reforming. Although its sovereign wealth fund managers are relatively inexperienced, it is arguable that within the next decade, the funds could become better-managed. This is especially because China’s sovereign wealth fund has been studying successful funds in other countries, such as Singapore. Moreover, with 1.3 billion people, China could conceivably find many talented economists and analysts to optimize the nation’s investments.

For the next simulation, I assume that China’s sovereign wealth fund managers eventually become skilled enough to invest like David Swensen and achieve Yale Model-esque returns of 6.3 percent and volatility of 12.4 percent. I also assume that Treasury Inflation-Protected Securities (TIPS) continue to pay out a risk-free rate of 2.25 percent.

Given these numbers, I offer a possible investment strategy for managing China’s foreign exchange reserves. If China invests 30 percent of its funds in sovereign wealth funds (up from 15 percent in Table D) and the remaining 70 percent of its funds in Treasury bonds (whose returns are proxied by the TIPS), I compute a combined annual expected return of 3.47 percent on the reserves, with a standard deviation of 3.72 percent.

If China earns these returns, plus an additional external 2.5 percent rate of foreign exchange earnings, we end up with the simulation in the next table:
Table E

*China Invests 70% in Treasury bonds, 30% in well-invested sovereign wealth funds, and earns an extra 2.5% in exogenous reserve earnings every year*

Simulations of foreign exchange reserves with expected annual return = 3.47% and standard deviation = 3.72%

<table>
<thead>
<tr>
<th>Consumption spending (%)</th>
<th>1.0%</th>
<th>1.5%</th>
<th>2.0%</th>
<th>2.5%</th>
<th>3.0%</th>
<th>3.5%</th>
<th>4.0%</th>
<th>4.5%</th>
<th>5.0%</th>
<th>5.5%</th>
<th>6.0%</th>
<th>6.5%</th>
<th>7.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chance of reserves losing over 25% of value over 10 years</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.3%</td>
<td>0.8%</td>
<td>1.8%</td>
<td>3.8%</td>
<td>7.6%</td>
<td>14.4%</td>
<td></td>
</tr>
<tr>
<td>Chance of reserves losing over 40% of value over 10 years</td>
<td>0.0%</td>
<td>0.0%</td>
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<td>0.5%</td>
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</tr>
<tr>
<td>Chance of reserves losing over 50% of value over 10 years</td>
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</tr>
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<td>Chance of reserves losing over 25% of value over 40 years</td>
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<td>0.1%</td>
<td>0.3%</td>
<td>0.7%</td>
<td>1.9%</td>
<td>5.5%</td>
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<td>95.2%</td>
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<td>0.1%</td>
<td>0.1%</td>
<td>0.2%</td>
<td>0.6%</td>
<td>1.7%</td>
<td>4.8%</td>
<td>13.8%</td>
<td>35.1%</td>
<td>68.6%</td>
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<td>0.0%</td>
<td>0.0%</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.3%</td>
<td>0.6%</td>
<td>1.8%</td>
<td>5.3%</td>
<td>15.2%</td>
<td>38.0%</td>
</tr>
<tr>
<td>Expected currency reserves at the end of 40 years ($ bil)</td>
<td>11,478</td>
<td>9,474</td>
<td>7,812</td>
<td>6,436</td>
<td>5,297</td>
<td>4,356</td>
<td>3,578</td>
<td>2,937</td>
<td>2,408</td>
<td>1,972</td>
<td>1,614</td>
<td>1,319</td>
<td>1,077</td>
</tr>
</tbody>
</table>

**Color**
- Greater than 20 percent
- Between 10 and 20 percent
- Between 0 and 10 percent
- Zero percent
Compare Table E to Table D. Notice that although the risky red area remains the same size as before, some of the blue areas have been replaced by green ones. However, most of the green areas represent trivial levels of risk (i.e., a fraction of a percent), which is almost akin to the zero-percent risk offered by the blue areas. This suggests that if China’s sovereign wealth funds eventually become skilled at investing, China could conceivably invest 30 percent of its foreign exchange reserves in sovereign wealth funds and achieve higher overall returns while maintaining extremely low levels of risk.

Moreover, looking at Table E, China could afford to consume 5 percent of its reserves annually with virtually no risk of losing large sums of money within a decade, and with only low single-digit risk over four decades. This represents only a marginal increase in risk over the simulation in Table D.

If the model in Table E is accurate, China could still calibrate its consumption carefully to maintain low levels of risk to the foreign exchange reserves while enjoying much higher returns. Under the new investment strategy, where 30 percent of the reserves are plowed into well-managed sovereign wealth funds, if China consumes 2.5 percent or less of its reserves annually, it could expect to see its reserves grow by about $1 trillion more than under the conservative investment strategy over 40 years.

Indeed, I suspect that China’s management of its foreign exchange reserves is gradually moving from the conservative strategy of Table D to the slightly more ambitious strategy of Table E. Ten years ago, China’s foreign exchange reserves were still small and its sovereign wealth funds insignificant. But today, with U.S. shares selling cheaply, U.S. debt paying low returns, and Chinese reserves growing strongly, China can arguably afford to expand its sovereign wealth funds to seek more ambitious returns.
4. Implications

My risk analysis focuses on analyzing percentage changes rather than the absolute dollar size of the foreign exchange reserves. Using the insight that government currency reserves may share some broadly similar characteristics with university endowment funds, this paper offers a different economic reasoning for why China might choose to invest its foreign exchange reserves conservatively even though it has $2 trillion available.

Intuitively, some economists might argue that given the size of its reserves, China can afford to take huge risks with all its money in pursuit of more exciting gains. However, this paper suggests that China’s foreign exchange reserves are surprisingly vulnerable to risk. If all of China’s foreign exchange reserves are invested in sovereign wealth funds, the foreign exchange reserve managers would be taking unacceptably high levels of risk that may lead to great losses, even if the managers of China’s sovereign wealth funds could invest as skillfully as the famous David Swensen.

This finding does not undermine traditional financial economic beliefs about investing large sums of foreign exchange reserves; rather, it adds a possible additional consideration. Its basic idea is that the distribution of risk, not just the absolute expected returns, is an important factor when thinking about the management of foreign exchange reserves. In studying firms and funds, traditional economists often think in terms of maximizing the “size of the pie.” This paper does not necessarily challenge that belief, but instead suggests that an additional framework is needed, where risk-averse economic agents (including risk-averse government agencies) might take risk probability assessments into account. This insight should not be overlooked. Research suggests that
the Chinese currency reserve managers may adopt a very risk-averse approach because its
government and people are particularly unforgiving of losses (Dean, Areddy, Ng, 2009).
Therefore, including risk assessment probabilities can help to shed more light on this
complicated economic phenomenon.

From a financial economics perspective, there is also a strong logic behind my
paper’s findings. China’s large appetite for buying safe assets like Treasury bonds, as
opposed to investing most of its money in sovereign wealth funds, may be partly due to
China’s difficulty in finding profitable investment opportunities outside Treasury bonds.
Smaller funds like the Stanford, Yale, or Harvard endowments may each have between
$20 and $40 billion to invest, which means that their average purchases might represent
only a fraction of the profitable investment opportunities available. In contrast, China
may find it difficult to find profitable investments for $200 billion worth of funds, let
alone $2 trillion. Rather, it would be far easier (and safer) to buy government securities,
particularly from the United States, whose huge appetite for debt is likely to reach new
heights because of projected trillion-dollar deficits under President Obama.

5. Conclusion

Overall, the issue of China’s foreign exchange reserves raises serious questions.
First, there’s the problem of managing the existing stock of trillions of dollars. Second,
there’s the complicating fact that there’s also a flow: the reserves are expected to grow by
hundreds of billions of dollars every year. And how this wealth is handled raises
economic questions.
Economists have often wondered why China, despite the size of its foreign exchange reserves, has generally chosen to invest the reserves conservatively by putting most of the funds back into Treasury bonds, rather than investing more heavily in riskier assets. However, this observation must be understood in the context of the challenge faced by those who manage China’s foreign exchange reserves. On one hand, they have the duty to preserve and enhance the size of the reserves over the long haul. On the other hand, they also face the continual, recurring challenge of having to provide funds for the nation’s consumption: to pay off debts, promote monetary and exchange rate policies, and finance other forms of spending. These twin challenges represent China’s dual dilemma, and may be understood in the context of probabilistic assessments of returns, consumption, and external earnings.

“Know thy enemy, know thyself, in a thousand battles, a thousand victories,” wrote Sun Tzu. Arguably, China’s leaders seem to know themselves. With a short history of free-market reforms and a financial sector in its infancy, China’s leaders seem to believe that their financial managers are still too inexperienced to be entrusted with the bulk of the national currency reserves. Therefore, they instead seem to be sticking to the cautious, tried-and-true virtue of saving heavily and lending to America in pursuit of low, but safe gains. And in doing so, they may well have a point. For if this paper’s insights are correct, China’s conservative approach to managing its foreign exchange reserves, although counterintuitive to many economists, is fundamentally rational.
5. Appendix

Possible limitations of analysis and assumptions

My paper offers a simplified picture of a complex reality, and these simplifications are worth mentioning.

For example, in the simulations, I assumed that China’s Treasury bond investments (as represented by TIPS) are risk-free. While useful, this assumption may not always hold, because even if China can insulate itself from inflation risk, it is much more difficult to shield itself from exchange rate risk. Simply put, there is always the risk that China’s dollar-denominated assets may decline in value. Arguably, it is partly because of the exchange rate risk that China seeks to find better investments outside U.S. Treasury bonds and through sovereign wealth funds.

In this paper, I have also assumed that China’s safe assets are composed of Treasury bonds (represented by TIPS), because these form the bulk of China’s purchases. This assumption was useful and convenient when making calculations about the risk probabilities in Part 3 of this paper. In reality, it is worth mentioning that China also buys securities not just of varying maturities and returns, but also securities from other nations, albeit in much smaller quantities. Moreover, China may one day decide to shift away from its heavy purchases of U.S. debt, in favor of buying debt from other countries that offer higher returns. To a certain extent, investing in a range of global securities enables China to reduce its exchange rate risk. The diversification effect of these other global securities is an interesting question for future papers.

In real life, there are fluctuations in the rate at which the reserves are consumed, fluctuations in the rate of return on investments, as well as fluctuations in the rate at
which extra foreign exchange earnings are added to the reserves. For the purposes of this paper, I have simplified the process by assuming that consumption, expected returns, and the foreign exchange earnings are roughly fixed percentages. In reality, we find that all these things shift from year to year. China’s $585 billion stimulus package in 2009, for example, involved consumption (i.e., cashing in) on some of the excess foreign exchange reserves, and represents a much higher consumption rate than say, in 2007, when China’s economic situation was far less uncertain.

In this paper, I have also assumed that China’s foreign exchange reserves may be managed as an economic entity in an economically optimal way. This is generally a useful assumption to make in the context of an economics paper. Economists may wish to consider, however, that there are political considerations that may affect China’s ability to manage its reserves in a perfectly economical manner. For example, in a 2008 Amadan International report titled “The Creation of the China Investment Corporation,” the paper suggested that China’s sovereign wealth fund was created under very difficult political circumstances, in a volatile environment where various Chinese ministries and the central bank were vying for influence. The man who was eventually selected to become chairman of the China Investment Corporation was not a CEO or an ex-analyst, but a former naval officer, State Council member, and official in China’s Ministry of Finance. Although China’s goal may be to maximize its returns, the complex relationship between its various government ministries and bureaucracies may hinder its economic aims.

For the purposes of this paper, I have made assumptions about the inherent volatility and riskiness of sovereign wealth funds as an investment. This consideration is rooted in the idea that sovereign wealth funds face, in addition to the traditional goal of
maximizing returns, other obligations and situations that private funds do not often face. For example, given that the China Investment Corporation has $200 billion to invest, but is only planning to invest in about 50 companies, this represents a relatively narrow and imperfectly diversified portfolio. Moreover, sovereign wealth funds may often be restrained by political considerations, not only by their own political leaders, but also by the governments of countries that they are trying to invest in. These considerations suggest that in comparison to Treasury bonds, sovereign wealth funds represent a risky and volatile sort of investment.

This consideration of the riskiness of sovereign wealth funds is often reflected in literature, both economic and non-economic. For example, law professors Gilson and Milhaupt (2008) give a good analysis of sovereign wealth funds in their paper, which provides some useful insights about the legal restraints and considerations surrounding sovereign wealth funds—features that contribute to their inherent riskiness and volatility.

This legal paper makes a clear analysis of most of the issues, pros, and cons surrounding sovereign wealth fund investments. They also offer a good explanation of some of the data collected (i.e., why China’s sovereign wealth fund holdings of U.S. companies tend to be in smaller percentages than their holdings of Chinese and other non-U.S. companies). The authors point out that the U.S. has legal procedures to deter sovereign wealth fund deals that may be detrimental to national security. For example, the Committee on Foreign Investment in the United States (known as “CFIUS”) is authorized to review all notices of pending foreign acquisitions of control over U.S. companies. The CFIUS can also recommend to the President that specific transactions be blocked because they pose a threat to national security. As a result of legal restrictions
such as this, sovereign wealth funds must generally restrict themselves to buying small, non-controlling stakes in companies, preferably below the legal limit (around 10%) that would trigger a CFIUS investigation. At the same time, the authors also recognize that sovereign wealth funds may have different goals from private funds, and that these factors may skew decision-making and investment choices.

China established its sovereign wealth funds partly to seek higher returns, and partly because the reserve assets depreciate continuously due to the weakening U.S. dollar. Yet, despite the drawbacks of keeping most of its reserves in Treasury bonds, China has traditionally continued this strategy and will likely continue on this path in the near future. Ultimately, on a practical level, it is very difficult for a Chinese sovereign wealth fund—constrained by not just financial motives, but possibly non-financial ones as well—to find suitable and profitable investments for the billions that it is entrusted with investing. In most arenas of economic life, the public sector is considered less efficient than the private sector, and fund management may be no exception.

Economics, at bottom, is the study of scarcity—i.e., how people seek to optimize their use of scarce resources. But it is much more difficult to answer the question of how people apply economic principles in situations of extreme abundance rather than scarcity. An insight into how China manages its growing reserves—especially its employment of sovereign wealth funds—will shed light on how economic principles might apply to situations where one is dealing not with the problem of scarcity, but the problem of abundance. If a man has only $2,000 in his pocket, he may have to make hard economic choices about whether investing in stocks or bonds might be optimal. But if the man has $2 trillion, his need to make economically optimal decisions might be less urgent.
Managing wealth of this magnitude is a complicated, and one question that has not been mentioned in this paper, but which economists might want to tackle in a future paper, is whether China manages (or is capable of managing) this huge pool of money in an economically-efficient way. To this end, I think that prominent economists may do well to further explore this interesting but relatively unexplored corner of the economic universe.
References


