



The sovereign property of foreign reserve investment in China: A CVaR approach[☆]

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ABSTRACT

This paper investigates the role of foreign exchange reserve investment to hedge overall macroeconomic risks. Different from usual micro profit-maximizing purpose, the investment with macro objective is unique in the field of foreign reserve investment. We propose a framework of mean-variance-CVaR (conditional value at risk) model to capture the features of such investment and calculate the optimal allocation of foreign reserves in China. We use Cornish–Fisher method to calculate CVaR and adopt quasi-Newton algorithm to solve the optimization problem. Two scenarios are compared in the paper: the usual micro profit-maximizing portfolio and the sovereign portfolio hedging macro risks. We find that hedging the overall macro risks and lower the overall volatility of the economy through foreign reserve investment is possible under certain risk constraints.

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1. Introduction

Fueled in part by large current account surpluses, high levels of foreign direct investment, and inflows of capital from overseas investors betting on appreciation of RMB in the near future, China's foreign reserves grew rapidly from the 1990s onward, reaching \$3.2 trillion by the end of 2011.

Rapid growth in the size of foreign reserves challenges China about her reserve management skills. All along, safety and liquidity are the priority considered and the vast majority of foreign reserves are used to purchase foreign government bonds (especially US bonds) with high liquidity and low yields. However, with the accumulation of foreign reserves, its size has far exceeded the reasonable level with precautionary demand, leading to large amount of excess reserves. In this case, if China continues to invest excess reserves to bonds with low return, the cost of holding foreign reserves will rise. According to Rodrik (2006), the social cost of foreign reserves held by developing countries is about 1% of GDP. Zhang and Zhang (2007) estimated that the opportunity cost of China's foreign reserves was RMB 1.09 trillion in 2006, accounting for 5% of GDP. Therefore, how to actively manage tradeoff between return and risk for the huge amount of foreign reserve assets in a more frequently changing and volatile global financial environment becomes a subject of heated debates.

A key question is what investment strategy should be adopted. Some point out that the investment strategy for excess reserves should be the same as ordinary mutual funds or government pension fund, controlling the risk while improving the overall return of assets through diversification in international financial markets. Others argue that the excess foreign reserves should be invested in line with the state's overall development strategies. For example, some propose to use the excess reserves to buy gold, oil, minerals and other scarce resources. Others propose to use reserves to buy foreign patents, advanced technology and equipments for upgrading their domestic industrial production. In recent literatures, some researchers mention the concept of 'hedge' when discussing asset allocation for foreign reserves. Caballero and Panageas (2004) suggest that adding richer hedging instruments to the portfolios held by central banks can significantly improve the efficiency of the anti-sudden stop mechanism. The optimal use of options and futures on the S&P 100's implied volatility index (VIX) increases the expected reserves available during sudden stops by as much as 40 percent. In order to smooth revenues and maximize long-term welfare for oil exporting countries, Gintschel and Scherer (2008) develop a framework for partially hedging the market risk of oil reserves through appropriately allocating financial assets for Sovereign Wealth Funds.

China is facing lots of external risks, such as raw material price fluctuation, declining demand from major trading partners, potential capital withdrawal (sudden stop), etc. Once these latent risks realize, the economy will fluctuate in a large extent. Among these risk factors, some are counter-cyclically fluctuating with macro economy. For example, the iron ore price's large rise could increase production cost, hindering country's economic development. Larger US exports to China may slow down China's economic growth rate by narrowing China's net exports. If China can construct a portfolio consisting of

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those financial and physical assets counter-cyclically related with China's macroeconomic risks with excess reserves, the economy would grow more steadily and avoid excessive volatility. Several researches focused on hedging macroeconomic risks, or stabilizing macroeconomic volatility. Mei and Li (2008) adopted the Mean-Variance model to derive an optimal portfolio while taking GDP volatility into account. However, traditional Mean-Variance model may not be sufficient when financial crisis hits.

Since foreign reserves are mainly accumulated for the use during currency crisis, we need a good risk measure taking into account the small-probability event like crisis. While traditional risk measure Value at Risk (VaR) has undesirable theoretical properties (it is not subadditive, as shown, for example, in Acerbi and Tasche (2002) and thus fails to reward diversification), Conditional Value-at-Risk (CVaR) is gaining more popularity. CVaR has attractive theoretical properties: it controls the magnitude of losses beyond VaR and it is coherent (see e.g. Acerbi and Tasche, 2002; Artzner et al., 1999; Flug, 2000; Rockafeller and Uryasev, 2002). In addition, CVaR is easy to optimize.

Regarding the application of CVaR in the field of foreign reserve investment, we may form three-objective model consisting of mean, variance and CVaR. The Mean-Variance-CVaR model is multi-objective: mean and variance represent usual average return and risks at normal times while CVaR measures average loss under the extreme circumstance like financial crises. Roman et al. (2007) adopts a similar approach

but does not provide economic explanation of local optimal solutions. The Monte Carlo method for simulation has been proposed under the assumption of normal distribution, but simulation methods are still not clearly explained in the case of non-normal distribution.

Drawing on the literature of Mean-Variance, Mean-CVaR, Mean-VaR models, and the Mean-Variance-CVaR model, we optimize the investment of China's foreign reserves by choosing different tolerance levels of minimum required expected return and maximum expected losses. In the study, we will select different CVaR values (corresponding to the different reserve management requirements), and compute the optimal investment frontier for China's foreign reserves under different preferences. We adopt quasi-Newton algorithm optimization with Cornish–Fisher expansion. We also analyze the foreign reserves investment in the scenarios that reserves are either treated as a usual investment tool or as a hedging mechanism of macroeconomic risks. We also compare our optimal portfolio with the actual historical one. Our results show that it is possible to hedge the overall macroeconomic risks with well-selected assets.

2. The model

In this section, we lay out different model settings and describe the methods to optimize them.

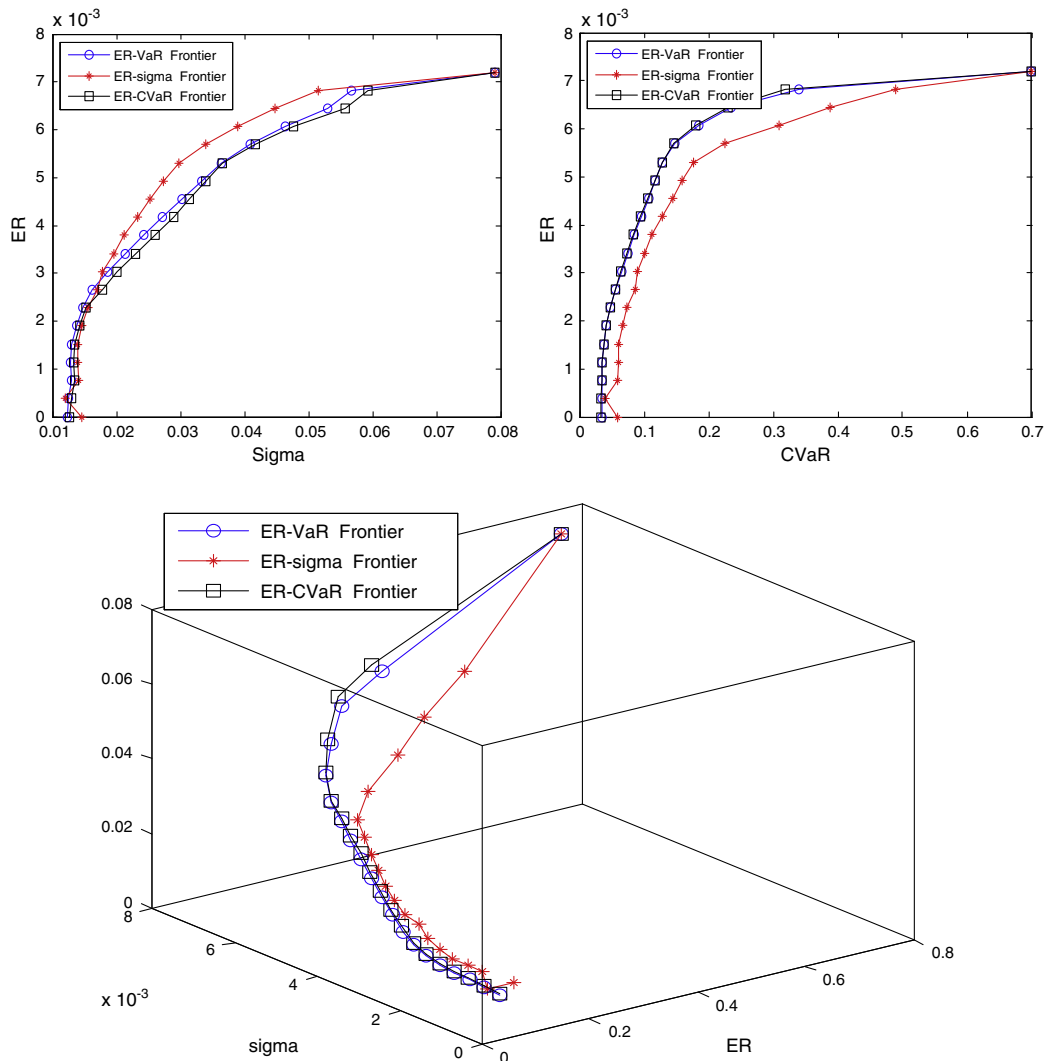


Fig. 1. Simulated local efficient frontiers.

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