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Analysis of Government Bonds Markets in Indonesia and Japan

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Preface

This dissertation titled "Analysis of Government Bonds Markets in Indonesia and Japan" is a compilation of papers produced during one year of research-studentship and three years of PhD course at Graduate School of Economics, Keio University, Japan. The research work reported in Chapter 2 has been published in *International Journal of Economic Policy in Emerging Economics*, Vol. 6, No. 3, pp. 254-268 under title "Foreign portfolio investment performance and investor's trading patterns: empirical study in Indonesian government bonds market". The paper described in Chapter 3 is forthcoming for publication in *Global Business and Economic Review* with title "Determining the Optimal Structure of Government Debt in Indonesia". Whereas, a version of Chapter 4 has been presented in *the* 14^{th} *Eurasia Business and Economic Society Conference* in Barcelona, 23-25 October 2014.

Over the past four years I have received support and encouragement from a great number of individuals. I would like to thanks my supervisor, Prof. Naoyuki Yoshino and my co-supervisor Prof. Sahoko Kaji, who has dedicated their time and enlightening knowledge to guide my rewarding journey in Keio University. Thanks to Prof. Ogaki, Prof. McKenzie, Umid Abidhadjaev, Christian Uduije, Farhad Taghizadeh Hesary, Nour Tauk, Ubaidillah Zuhdi, Nur Budi Mulyono and countless friends and colleagues who gave encouragement and inputs to improve my researches. Lastly, I would like to thanks MEXT-ASJA scholars, ADBI researchers and staffs, and Administrative staffs in Keio University for their support and assistance.

Japan, September 2014

I dedicate this dissertation to my beloved wife, Merry Martina,

to my angels, Chinira and Akira,

and to my parents, Lisol Hadiwijaya and Nurul Huriah.

Thank you for your warm love and wishes.

Table of Contents

Chapter 1

Introduction 1

Chapter 2

Foreign Portfolio Investment Performance and Investors' Trading Patterns: Empirical Study in Indonesian Government Bonds Market 5

2.1. Introduction 5

2.2. Literature Review 7

2.2.1. Herding behavior and feedback trading 7

2.2.2. Foreign Investors vs. Domestic Investors Performance 8

2.3. Investment Flow Data 10

2.4. Investment Patterns 11

2.5. Investor Performance 20

2.6. Concluding remark 24

Chapter 3

Determining the Optimal Structure of Government Debt in Indonesia 25

3.1. Introduction 25

3.2. Literature Review 28

3.2.1. Domestic Government Debt Sustainability 28

3.2.2. External Government Debt Sustainability 31

3.3. Government Debt Management in Indonesia 32

3.4. Development of the Model 35

3.4.1. General overview of the markets 35

3.4.2. Supply of Domestic and External Government Debts 37

3.4.3. Demand of Domestic Government Debts 41

3.4.3.1. Demand from Local investors 41

3.4.3.2. Demand from Foreign Investors 43

3.4.3.3. The Joint Demand for Domestic Government Debts 43

3.4.4. The role of Exchange Rates 44

3.5. Empirical Analysis 48

3.5.1. The data 48

3.5.2. The simulations 49

3.6. Concluding remarks 55

Appendix A 56

Chapter 4

The Optimal Structure of Japanese Government Bonds 57

4.1. Introduction 57

4.2. JGB characteristics 60

4.3. Model development 64

4.4. Simulation and Analysis 71

4.5. The role of the demand side 78

4.6. Concluding remarks 84

Appendix B 85

Chapter 5

Conclusion 87

Bibliography 94

Chapter 1

Introduction

Deficits in the primary balance have become a generic policy for triggering the economy and generating growth. Governments, especially in poor and developing countries, need higher amounts of investments to build public facilities and to satisfy their consumption and expenses compared to the tax revenues that could be attained. In many cases, raising the tax rate might cause resistances, both for political and economic reasons. Some governments choose a pragmatic way to solve this problem; they seek financial aids and issue public debts from domestic and foreign countries.

Indonesian government is one that pursued this common policy. Before the Asian financial crisis in mid-1997, Indonesian government accumulated external debts (debt that is denominated in foreign currencies) through bilateral and multilateral agreements. This practice is certainly risky since external debts are very vulnerable to the exchange rate shocks. When the crisis burst out, the debt services had multiplied over a short period along with the drastic depreciation of IDR against USD. Consequently, Indonesian economy was severely bled and it takes longer time to revive compare to other countries in Asia (Suhud, 2004). The Indonesian government took several actions in order to struggle out the crisis, including seeking soft loans from bilateral and international institutions, rescheduling the existing debts, privatizing its assets, and issuing domestic government bonds in order to bail out the collapsed banking system. During 1998-2000, the Indonesian government had issued in total IDR 643.8 Trillion of domestic government bonds. By the end of 2000, the bonds holders (which are the national banks who were bailed out by the government) started to trade these bonds to other investors, which remark the initiation of the domestic government bonds market.

Along with the improvement of Indonesian economy, the global confidence towards Indonesian domestic government bonds market was also increased. In early 2012, Fitch and Moody's have upgraded Indonesian sovereign credit rating into investment grade, which boosted the portfolio investment inflow into the government bonds market. The amount of domestic government bonds held by foreign investors by the mid 2012 is IDR 224.5trillion; 2.8 times of the amount in 2007. The foreign ownership share was also increased significantly. With total share about 29%, the foreign investors became the second largest group of government bonds holder after banks.

The greater involvement of foreign investors has caused anxiety among the other market participants. Foreign investors have been percept to be more sophisticated than local investors they have significant amount of liquidity, experience and expertise (Dvorak, 2005). These attributes often make them act as the leader of the market. At this position, foreign investors are having the opportunity to enjoy maximum return. Depart from this perception, I investigate the investment patterns and investment performance in the Indonesian goverment bonds market, which will be described in Chapter 2. This study suggests that foreign investors might have become market followers instead of leader during the analysis period. However, cumulatively, they enjoy the highest returns.

The result of investigation on foreign investor's behavior and performance in Chapter 2, led me to further question whether or not Indonesian government has manage its debt in sustainable manner. Currently Indonesian government maintains to issue two kinds of debts, i.e. domestic debt and external debt. Each type of debt has its own advantages and disadvantages. I develop a simple general equilibrium model to determine the optimal share for domestic and external government debts in Indonesia, which is described in Chapter 3. I emphasize the important role of Government debt's demand in forming the optimal structure of government debt. In addition, the back testing simulation suggests that the Indonesian government has to reduce the level of its external debt. Through a dynamic recursive simulation, it is suggested that, in the long run, the government must not hold any external debt while the Debt-to-GDP ratio is maintained at a level of 16%-17%.

Japanese Government Bond market is a perfect example of how a government could maintain a fully domestic debt. Moreover, it also becomes an interesting case due to anomaly in the relationship between its stock-of-debt and interest-rate. In Chapter 4 I propose a model that would determine the optimal share of types of JGBs in the government's debt portfolio. I equipped the model with sensitivity simulations to understand how these optimal proportions would change when certain variables changes. I found that the optimal proportion for fixed-rate, floating-rate, and inflation-indexed bonds depend on the risk appetite of the government; the government should pursue a different strategy depending on whether they are imposing risk averse or risk seeking policy. Further, it appears that the risk appetites of government and private sector were opposite to each other. In addition, the stability of the bonds market would also be affected by the wealth of the investors since there is a positive correlation between interest rates and the ownership of government bonds relative to other assets owned by investors.

While concluding remarks is provided at the end of each chapter to resume what have been done and found in respective chapters, the general conclusion of the dissertation is described in Chapter 5. This general conclusion will help readers to grasp the holistic idea of the dissertation in a continuous manner.

Chapter 2

Foreign Portfolio Investment Performance and Investors' Trading Patterns: Empirical Study in Indonesian Government Bonds Market

2.1. Introduction

The global confidence towards Indonesian economy has been increasing in the middle of recession that hit Europe and the U.S. recently. In early 2012, Fitch and Moody's have upgraded Indonesian sovereign credit rating into investment grade, which boosted the portfolio investment inflow into the market, including into the government bonds market.

The amount of domestic government bonds held by foreign investors by the mid 2012 is IDR 224.5trillion; 2.8 times of the amount in 2007. The foreign ownership share was also increased significantly. With total share about 29%, the foreign investors became the second largest group of government bonds holder after banks.

The greater involvement of the foreign investors means greater liquidity, which yields further development of the market as the it become broader and deeper (Levine and Zervos, 1996). Andritzky (2012) confirm that an increasing share of foreign investors is associated with lower yields, which is good for the government as it reduce the cost of borrowings. However, despite the positive effects, this situation raises concerns from other aspects. Foreign investors may have information advantages since they have significant amount of liquidity, experience and expertise (Dvorak, 2005). These attributes often make them act as the leader of the market. At this position, foreign investors are having the opportunity to enjoy maximum return. In addition, the asymmetric information between foreign investors and domestic investors may cause overreaction that generates huge volatility in the market (see Wang, 2007a). When most investors react on the same direction, herding behavior occurs. Volatility excessiveness caused by herding behavior might become a hazard for overall economy. This could encourage speculators riding the market and diminish the confidence of longer term investors.

In this chapter, I investigate the investment patterns and investment performance in the Indonesian goverment bonds market. As far as my concern, only few researchers conducted similar study, especially in Indonesian government bonds market. I compare foreign portfolio investments to other investor groups', i.e. banks, insurances, mutual funds, pension funds, and securities. The data set includes the accumulation of monthly market capitalization, both purchases and sales, of each investor group and market performance (represented by the returns of IGBX) from July 2004 until December 2010. The methodology used in finding the investment pattern is similar to the work of Kamesaka, Nofsinger and Kawakita (2003). This study suggests that foreign investors might have become market followers during the analysis period. This paper also shows that, cumulatively, foreign investors enjoy the highest return in Indonesian government bond market.

The rest of this paper is organized as follows: the next section reviews existing literature on herding behavior and feedback trading, and investors' performance. Section 3 is describing the data used in this paper. Each investor group's investment pattern and performance is explored in section 4 and 5 respectively. Lastly, concluding remarks appears in section 6.

2.2. Literature Review

2.2.1. Herding behavior and feedback trading

Herding behavior occurs when a group of investors making the same investment decision over a period of time (Nofsinger and Sias, 1999). This behavior may occurs due investors' psychology (Scharfstein and Stein, 2001; Bickhchandani and Sharma, 2001) or on rational motive following the same information (Nofsinger and Sias, 1999; Kamesaka et al, 2003). To some extent, some investors just mimic the action of other investors that is believed to have more information than the others (Dvorak, 2005). However, there will be a time lag between the leaders' action and the followers'. Sometimes the followers just overreact, leading to bubbles and crashes in the market (Lux 1995)

Kamesaka et al. (2003) stated that previous market return could give signal for determining the next action should be taken by the investors. This is also known as feedback trading.

There are two types of feedback trading, i.e. positive feedback trading and negative feedback trading. Positive feedback trading occurs if investments are made (withdrawn) after the market experienced positive (negative) returns in the past. Thus, positive feedback traders would expect that the market keep rallying up (down). In opposite, negative feedback trading occurs if investments are made (withdrawn) when the market experienced negative (positive) returns in the past. Thus, the negative feedback traders expect that the market has been saturated and could turn around to another direction in any time. Kim and Wei (1999) noted that positive feedback traders could destabilize the market since they would drive assets' price away from their fair value.

2.2.2. Foreign Investors vs. Domestic Investors Performance

Since the market liberalization in 2002, Indonesian government bonds market becomes one of attractive investment destination for foreign investors. The deterioration in risk-return characteristics of assets in the origin country might become a "push" factor that triggered the capital outflows from the developed markets (Montiel, 1998). On the other hand, there are also "pull" factors that attract foreign investors. Kim and Yang (2008) mentioned that there are at least three factors that boost capital inflows. i.e. economic fundamental, undervalued currency, and loosened regulatory. New information and communication technologies that enabled global investment and broadened opportunity to manage risk through diversified investment also fueled the trend (Kim and Yang, 2008). By regressing the returns in domestic markets, major mature markets, emerging markets, and US technology stocks on the net purchases of foreign investors, Richards (2004) found that "push" factors on average are at least as important as "pull" factors in explaining flows to these emerging markets.

Many believe that foreign investors perform better due their extensive liquidity, knowledge, experience, and expertise. Kamesaka and Wang (2004), using data from Indonesian stock market through 1996-2000, found that foreign investors buy stocks at better timing compared with domestic investors before the crisis period. However, Dvorak (2005) using data from the same market after the crisis period found that domestic investors earn higher profit than foreign investors. He argued that foreign investors are less patient in initiating and exercising their investment, that causing higher in bid and spread cost. In addition, domestic investors might be supplied with internal information that is not reachable by foreign investors. Brennan and Cao (1997) noted that such asymmetric information leads foreign investors to depend on previous market returns when investing in the emerging market. Investor's sophistication and trading experience totally eliminate the reluctance to realize losses. On the other hand, sophistication and trading experience reduce the propensity to realize gains by 37 per cent (Feng and Seasholes, 2005).

Wang (2007a) reported that trading between domestic and foreign investors increases market volatility, and foreign investors appear to be leading in the price adjustment process in Indonesian stock market. However, domestic investors appear to be the price leaders during the Asian crisis.

Related to the investment motive, using the data from Korean stock market, Kim and Wei (1999) found that foreign investors herd more significantly than their counterparts'. In addition, foreign institutional investors are always positive feedback traders, whereas domestic investors before the crisis were negative feedback (contrarian) traders but switch to be positive feedback traders during the crisis. The same result also reported by Kamesaka et al. (2003) in Japan stock market, Babu and Prabheesh (2008) in Indian Stock market, and Grinblatt and Keloharju (2000) in Finland stock market.

2.3. Investment Flow Data

The investment flow data of foreign portfolio investment and other investor groups' is described in Table 2.1. From the table, banks had the highest transaction amount both for purchasing and selling government bonds in the Indonesian Stock Exchange. This is understandable since it has the most members among the investor groups. The average amount for purchasing and selling are IDR 37,925.67 Billion and IDR 35,506.39 Billion respectively. The minimum purchasing amount was IDR 5,936.60 Billion in November 2005, while the maximum purchasing amount was occurred in May 2007 amounted IDR 112,540.39 Billion. The minimum selling amount was occurred in November 2005, amounted IDR 3,575.04 Billion. The maximum selling amount was amounted IDR 98,590.32 in May 2007.

Table 2.1. Descriptive statistic of investment flow data

(IDR Billion)	Buy				Sell			
	Average	Stdev	Min	Max	Average	Stdev	Min	Max
Foreign Investors	13.350,66	8.559,26	1.122,79	32.545,29	15.217,63	10.157,87	129,35	43.444,87
Banks	37.925,67	20.577,92	5.936,60	112.540,39	35.506,78	19.157,35	3.575,04	98.590,32
Insurance	844,76	804,70	110,14	6.437,64	1.119,79	853,53	106,59	6.985,73
Mutual Funds	3.253,57	3.001,11	276,56	14.048,41	3.239,86	2.207,52	174,17	10.996,72
Pension Funds	515,01	460,73	23,63	2.326,87	594,43	331,01	73,03	1.721,51
Securities	11.004,27	5.335,53	675,72	27.630,67	10.807,50	5.283,74	688,90	27.693,48

Pension funds had the lowest transaction amount during the sample period. They only averaged IDR 515.01 Billion in purchase and IDR 594.43 Billion in sales. The insurance companies had the most variation in transaction, the standard deviation about 95.26 per cent of its average purchasing amount and 76.22 per cent of the average selling amount. On the other side, securities had the least variation, with standard deviation about 48.49 per cent of average purchasing amount and 48.89 per cent of average selling amount.

Foreign investor comes second for average transaction amount. The average purchasing amount and selling amount were IDR 13,350.66 Billion and IDR 15, 217.63 respectively, both with moderate standard deviation. The minimum purchasing transaction was amounted IDR 1,122.79Billion in November 2005; while the maximum purchasing transaction was amounted IDR 32,545.29 Billion in August 2007. The minimum selling transaction was amounted IDR 129.35 Billion in November 2004 and the maximum selling transaction was occurred in June 2008 amounted IDR 43,444.87 Billion.

2.4. Investment Patterns

In order to investigate the investment patterns of foreign investors, as well as domestic investors as comparison, first the trade imbalance is measured by calculating the Net Investment Flows (NIF). The NIF will indicate whether foreign investors were net seller or net buyer during period *t*.

$$NIF_{i,t} = \frac{purchasing\ value_{i,t} - selling\ value_{i,t}}{purchasing\ value_{i,t} + selling\ value_{i,t}} \quad (2.1)$$

Large trade imbalances in either direction are indicators of market timing. Large net purchasing (selling) signals indicates that the investor group perceives the government bonds market is under- (over-)valued relative to the alternatives (Kamesaka et al., 2003). Table 2.2 summarizes the NIF of each investor group.

Table 2.2. Descriptive statistic of net investment flow data

NIF	Minimum	Maximum	Mean	Std. Deviation
Foreign Investors	-0.51	0.85	-0.037	0.21420
Bank	-0.15	0.25	.0318***	0.06668
Insurance	-0.80	0.74	-.1509***	0.31877
Mutual Funds	-0.52	0.62	-.0639***	0.21018
Pension Funds	-0.96	0.64	-.1589***	0.36517
Securities	-0.05	0.08	.0087***	0.02537

Note: *** Denotes significance in 1 per cent level

During the sample period, banks seems to be the highest net purchaser with average .0318; while, on the other side, pension funds become the highest net seller with average -.1589. Insurance, mutual funds, pension funds, and foreign investor share same characteristics, they all were net sellers with big variance of NIF. The likeliness of their characteristics indicates that they perceived no difference in market timing. However, there is no significance evidence for foreign investor.

Large imbalance also indicates herding behavior of investors (Kamesaka et al., 2003). Some investor groups might just following the action taken by foreign investors since they are perceived to have better information and experience. Thus, I propose a hypothesis

H0: The mean of NIFs of every investor group are equals

One-way ANOVA is used to test the hypothesis. The test yields that there are statistically significance differences among each group's NIF means. By using Tamhane Multiple Comparison test it can be conclude that there are no statistically significant difference between the mean of NIF for banks and securities. Likewise, there are no statistically sig-

Table 2.3. Result of ANOVA test

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2.473	5	.495	8.991	.000
Within Groups	25.419	462	.055		
Total	27.892	467			

Table 2.4. Tamhane multiple comparison test result

(I) Code	(J) Code	Mean Difference (I-J)	Std. Error	Sig.
Banks	Insurance	.18271*	.03687	.000
	Mutual Funds	.09568*	.02497	.003
	Foreign Investors	.06881	.02540	.114
	Pension Funds	.19067*	.04203	.000
	Securities	.02313	.00808	.074
Insurance	Banks	-.18271*	.03687	.000
	Mutual Funds	-.08703	.04323	.508
	Foreign Investors	-.11390	.04349	.138
	Pension Funds	.00796	.05488	1.000
	Securities	-.15957*	.03621	.000
Mutual Funds	Banks	-.09568*	.02497	.003
	Insurance	.08703	.04323	.508
	Foreign Investors	-.02687	.03398	1.000
	Pension Funds	.09499	.04771	.527
	Securities	-.07254*	.02397	.049
Foreign Investors	Banks	-.06881	.02540	.114
	Insurance	.11390	.04349	.138
	Mutual Funds	.02687	.03398	1.000
	Pension Funds	.12187	.04794	.169
	Securities	-.04567	.02442	.636
Pension Funds	Banks	-.19067*	.04203	.000
	Insurance	-.00796	.05488	1.000
	Mutual Funds	-.09499	.04771	.527
	Foreign Investors	-.12187	.04794	.169
	Securities	-.16754*	.04145	.002
Securities	Banks	-.02313	.00808	.074
	Insurance	.15957*	.03621	.000
	Mutual Funds	.07254*	.02397	.049
	Foreign Investors	.04567	.02442	.636
	Pension Funds	.16754*	.04145	.002

*. The mean difference is significant at the 0.05 level.

nificant difference between the mean of NIF for insurances, mutual funds, and pension funds. While, there are statistically significant difference between the mean of NIF for the two groups.

I also examine whether there are correlation of NIFs among investor groups and to their past trading (lagged up to 3 months). The result yields in Table 2.5. Except the negative correlation between banks and foreign investors, the other flows are weak or not correlated to each other. Relatively strong negative correlation between banks and foreign investors occurs

Table 2.5. NIF Correlations among Investor Groups

	Banks	Insurance	Mutual Funds	Foreigns	Pension Funds	Securities
Banks	1					
Insurance	0.001941	1				
Mutual Funds	-0.36834	-0.01958	1			
Foreigns	-0.63621	0.04679	0.04018	1		
Pension Funds	0.173872	0.44072	-0.16577	-0.0177	1	
Securities	-0.03186	-0.04145	-0.17382	-0.10253	-0.00791	1
Banks (t-1)	0.358424	-0.05289	-0.34054	-0.3414	0.155851	0.135435
Insurance (t-1)	0.026315	0.179007	-0.09421	0.120415	0.09591	-0.0433
Mutual Funds (t-1)	-0.18207	0.108168	0.360525	0.141072	-0.1427	-0.11958
Foreigns (t-1)	-0.17495	0.145393	0.014519	0.376184	-0.02074	-0.12185
Pension Funds (t-1)	-0.0085	0.136245	-0.28135	0.072015	0.404339	-0.03982
Securities (t-1)	-0.11674	0.037959	0.020855	0.0415	0.147754	-0.03423
Banks (t-2)	0.005707	-0.1208	0.036661	-0.05477	-0.21417	0.079249
Insurance (t-2)	0.086911	-0.01751	0.0035	-0.02618	-0.08248	0.075542
Mutual Funds (t-2)	-0.16094	-0.01751	0.345348	0.042922	-0.16194	-0.05005
Foreigns (t-2)	-0.22537	0.20754	0.0035	0.266904	0.193893	-0.01994
Pension Funds (t-2)	0.037986	-0.05692	-0.12415	-0.02618	0.171992	0.176176
Securities (t-2)	0.051841	-0.20275	-0.15671	0.018641	-0.08248	-0.03915
Banks (t-3)	0.096849	0.052406	-0.12861	-0.29969	-0.13945	0.042907
Insurance (t-3)	-0.06321	0.144776	0.142397	-0.13441	0.060922	-0.12302
Mutual Funds (t-3)	-0.04021	0.103943	0.277233	-0.007	0.126039	-0.12968
Foreigns (t-3)	-0.18451	-0.01937	0.110831	0.259114	0.064297	0.113084
Pension Funds (t-3)	0.018269	0.152069	-0.09609	-0.12711	0.274939	0.055258
Securities (t-3)	-0.01495	-0.03353	-0.14247	0.183777	-0.07954	-0.08139

since banks are the main counterparts of foreign investors, thus the action taken are usually opposites.

Nevertheless, as shown in Figure 2.1 (a) - (e), further examination through Cholesky impulse-response analysis shows that there is no immediate response of other investor groups' NIFs towards impulse from foreign investor's NIF. On the other hand, there is a measurable negative response of foreign investors' NIF towards impulse from bank's NIF (See Figure 2.1 (f)). This could be an indication that instead of becoming market initiator in the Indonesian Government Bond market, foreign investors have become market follower. This result is contrary to what have been suggested by Wang (2007b) in Indonesian stock market.

Theory suggests that investors could herd for rational reasons such as they are following the same information signals (Nofsinger and Sias, 1999; Kamesaka et al, 2003) or for irrational reasons like following fads (Bikhchandani et al., 1992). In order to determine whether the herding is rational or not, Nofsinger and Sias (1999) recommend examining the post herding market returns. A high return after buy-herding (or low return after sell-herding) indicates rational herding. While Kamesaka et al. (2003) suggest examining the pre-herding market returns to investigate the investment pattern.

I investigate whether feedback trading occurs in government bonds market by each investor group and also examine whether their behavior considered as rational herding or just following fads by estimating a simple bivariate VAR (p) model:

$$Y_t = \alpha + \sum_{j=1}^{p} \beta_j Y_{t-j} + \varepsilon_t \tag{2.2}$$

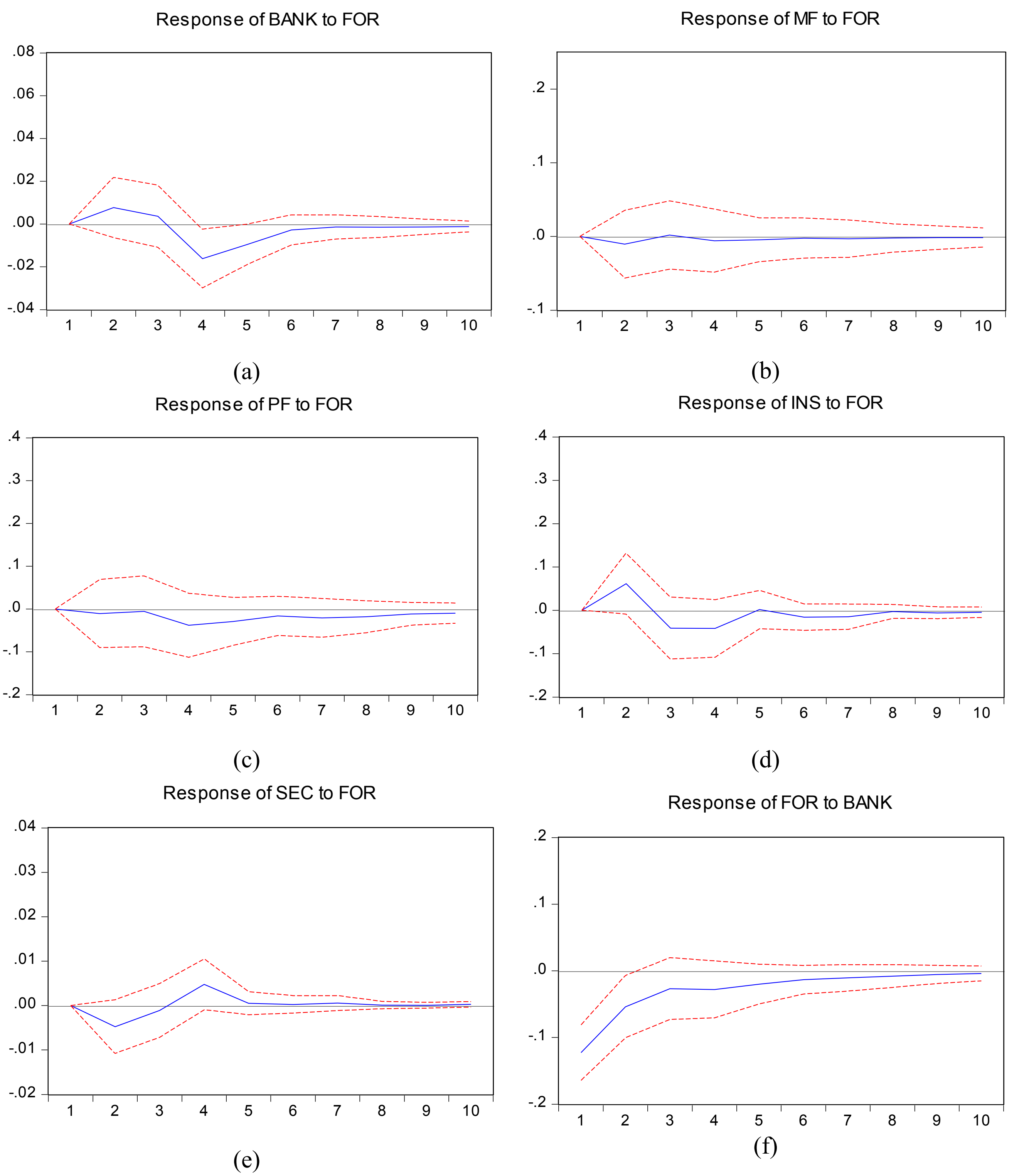

Figure 2.1. Cholesky Impulse-Response graph of dynamic behavior

Table 2.6. Vector Auto Regression Estimates

	BANK	IGBX		FOREIGN	IGBX		INSURANCE	IGBX
BANK(-1)	0.3317	0.1249	FOR(-1)	0.2644	0.0103	INS(-1)	0.1577	-0.0078
	[2.74032]	[1.52482]		[2.23669]	[0.41392]		[1.29900]	[-0.47494]
BANK(-2)	-0.1661	-0.1378	FOR(-2)	0.0958	0.0351	INS(-2)	-0.0832	-0.0240
	[-1.31951]	[-1.61750]		[0.79043]	[1.37676]		[-0.67667]	[-1.44600]
BANK(-3)	0.1777	-0.0085	FOR(-3)	0.1377	-0.0241	INS(-3)	0.1713	0.0028
	[1.50824]	[-0.10629]		[1.16979]	[-0.97579]		[1.47853]	[0.17678]
IGBX(-1)	-0.0113	-0.0769	IGBX(-1)	0.3028	-0.0428	IGBX(-1)	0.6553	-0.0541
	[-0.06179]	[-0.62328]		[0.52750]	[-0.35482]		[0.72619]	[-0.44442]
IGBX(-2)	-0.2143	-0.0513	IGBX(-2)	0.6939	-0.0769	IGBX(-2)	-0.4103	-0.0642
	[-1.20440]	[-0.42567]		[1.22329]	[-0.64534]		[-0.45964]	[-0.53234]
IGBX(-3)	-0.1428	-0.0813	IGBX(-3)	0.6445	-0.1454	IGBX(-3)	-0.4486	-0.1080
	[-0.79716]	[-0.67058]		[1.12782]	[-1.21074]		[-0.50480]	[-0.90021]
C	0.0273	0.0087	C	-0.0385	0.0095	C	-0.1283	0.0034
	[3.05962]	[1.43903]		[-1.56101]	[1.83117]		[-2.66410]	[0.52264]
R-squared	0.1511	0.0820	R-squared	0.1994	0.0629	R-squared	0.0703	0.0611
Adj. R-squared	0.0762	0.0010	Adj. R-squared	0.1287	-0.0198	Adj. R-squared	-0.0117	-0.0217
S.E. equation	0.0606	0.0410	S.E. equation	0.1972	0.0414	S.E. equation	0.3072	0.0415
F-statistic	2.0177	1.0124	F-statistic	2.8219	0.7609	F-statistic	0.8575	0.7378
Log likelihood		246.0080	Log likelihood		155.5539	Log likelihood		122.6000
AIC		-6.1869	AIC		-3.7748	AIC		-2.8960
SC		-5.7543	SC		-3.3422	SC		-2.4634

Table 2.6. Vector Auto Regression Estimates (cont.)

	MUTUAL FUND	**IGBX**		**PENSION FUND**	**IGBX**		**SECURITIES**	**IGBX**
MF(-1)	0.0952	-0.0391	PF(-1)	0.3259	0.0211	SEC(-1)	-0.0426	0.0017
	[0.77415]	[-1.41829]		[2.56808]	[1.34528]		[-0.35221]	[0.00863]
MF(-2)	0.1636	0.0042	PF(-2)	-0.0423	-0.0333	SEC(-2)	-0.0418	0.1377
	[1.40652]	[0.16233]		[-0.32108]	[-2.04835]		[-0.34677]	[0.71978]
MF(-3)	0.1663	0.0193	PF(-3)	0.3073	-0.0034	SEC(-3)	-0.0975	-0.1451
	[1.45113]	[0.75246]		[2.39269]	[-0.21548]		[-0.80455]	[-0.75507]
IGBX(-1)	-1.3592	-0.0975	IGBX(-1)	1.2377	-0.1069	IGBX(-1)	0.0429	-0.0471
	[-2.47582]	[-0.79279]		[1.16627]	[-0.81675]		[0.56636]	[-0.39141]
IGBX(-2)	-0.9024	-0.1455	IGBX(-2)	-0.9737	-0.0346	IGBX(-2)	-0.0460	-0.1075
	[-1.61742]	[-1.16459]		[-0.96263]	[-0.27709]		[-0.60977]	[-0.89768]
IGBX(-3)	-0.5232	-0.1485	IGBX(-3)	-1.1026	-0.0481	IGBX(-3)	0.0526	-0.1153
	[-0.92894]	[-1.17677]		[-1.09384]	[-0.38662]		[0.69211]	[-0.95636]
C	-0.0258	0.0081	C	-0.0698	0.0055	C	0.0094	0.0087
	[-1.08753]	[1.52130]		[-1.42548]	[0.91736]		[2.58436]	[1.51052]
R-squared	0.2646	0.0546	R-squared	0.2472	0.0955	R-squared	0.0273	0.0406
Adj. R-squared	0.1997	-0.0289	Adj. R-squared	0.1807	0.0157	Adj. R-squared	-0.0585	-0.0441
S.E. equation	0.1859	0.0416	S.E. equation	0.3301	0.0407	S.E. equation	0.0264	0.0419
F-statistic	4.0781	0.6540	F-statistic	3.7206	1.1964	F-statistic	0.3184	0.4791
Log likelihood		162.2699	Log likelihood		124.2089	Log likelihood		305.1530
AIC		-3.9539	AIC		-2.9389	AIC		-7.7641
SC		-3.5213	SC		-2.5063	SC		-7.3315

Where Y_t is a 2x1 vector of NIF and IGBX return, α is a 2x1 matrix of constants, β_j is a 3x2 matrix of parameters, Y_{t-j} is the 2x1 matrix of NIF and IGBX return for month lag j, and ε_t is the 2x1 error matrix. The results are shown in Table 2.6.

The examination yields that there is not enough evidence to determine whether these investors are feedback traders or not, except for mutual funds. Mutual funds seemed to be negative feedback traders since it shows negative correlation between the NIFs and lagged market returns. Banks', pension funds', and foreign investors' NIFs are positively correlated with their own lagged variable. Nevertheless, many other factors might be considered by these investors when making investment decision since the R^2 are very low.

Likewise, there is not enough evidence to determine whether the investors are rational traders or not, except for pension funds. There is a statistically significant negative correlation between pension funds' NIF and market return in the 2 months lag. This makes pension funds fall into irrational traders category based on Nofsinger and Sias' definition.

Divergence in investors' decision, due to broad range of investors consisted in the investor groups, may become the cause why it is hard to measure the investor patterns based on investor groups classification. In addition, unlike in the stock market, Indonesian government bonds are traded over the counter. It needs more effort to gather information about other parties' transaction activities, and thus for the aggregate market performance. There is no standardized settlement date after the transaction makes it harder to measure the fair price in the market. Therefore, investors tend to rely on other information, such like fundamental macroeconomics data and national and international issues, rather than market data.

2.5. Investor Performance

Kamesaka et al. (2003) have developed a method to measure cumulative value returns by evaluating the relative market timing ability of investor groups over the entire period. The formula of cumulative value returns described as follows:

$$R_{i,t} = \sum_{t=1}^{T} \left(Purchases_{i,t-1} - Sales_{i,t-1}\right) R_{m,t} \tag{2.3}$$

Where $R_{i,t}$ is the cumulative investment returns of investor group *i* at time *t* and $R_{m,t}$ is the market return at time *t*. The result is depicted in Figure 2.2.

From the graph, it can be seen that banks, securities, and foreign investors have positive cumulative return at the end of period, while mutual funds, pension funds, and insurance companies have negative cumulative return at the end of periods. It seems that banks and foreign investors negate each other along the period since they are the main counterparts to each other. Among the others, banks have a persistent growth from time to time, except for June 2007. It was the biggest shock that affected the cumulative return of banks and foreign investors entirely. On May 2007, banks aggressively bought the government bond due information of the improvements on Indonesian macroeconomics[1], while Foreign Investors sold their assets due the first hit of sub-prime mortgage crisis in the U.S. that bring losses to many financial institutions in several countries[2]. This condition was driving the market return dropped sharply. IGBX was loss more than 16 per cent of its value by the next month.

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[1] See Zetha and Tambunan (2007) report for Indonesian Chamber of Commerce, "Laporan Ekonomi Bulanan, Mei 2007"

[2] See Bianco (2008) report for CCH, "The Subprime Lending Crisis: Causes and Effects of the Mortgage Meltdown"

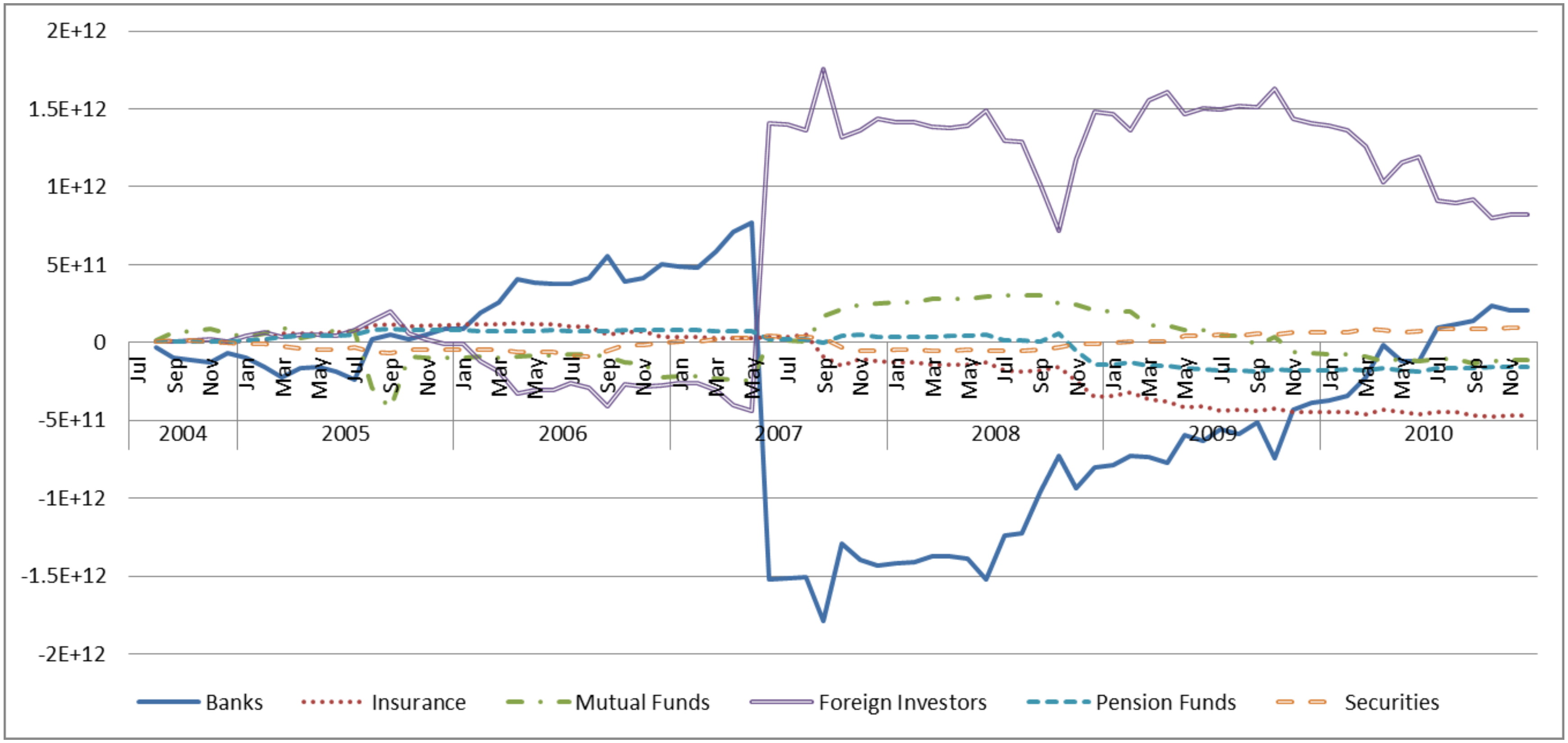


Figure 2.2. Cumulative investment returns from July 2004-December 2010

The second hit of sub-prime mortgage crisis occurred on October 2008, when several large-scale investment banking firms, such as Bearn Stearns, AIG, Lehman Brothers, and Citibank announced their bankruptcy. As foreign investors crowded out of government bonds market, the capital outflow reached IDR 12.17 Trillion during the crisis period. This amount mostly absorbed by banks, the Central Bank of Indonesia, and pension funds. Soon after the crisis, the market quickly rebound, put foreign investors left in loss position. However, foreign investors have regained their cumulative return in the next consecutive months.

Even though experiencing downtrend since the first sub-prime mortgage crisis in June 2007, foreign investors keep having the largest cumulative return along the sample period. This finding contrary to what have been suggested by Dvorak (2005) in Indonesian stock market that domestic investors do better than foreign investors since they have the information advantages. This finding also support the opinion that foreign investor gained the most returns against other investor groups.

What actually happened during those crisis periods? As shown in Table 2.7, in 2007, banks and pension funds were forced to sell all range of their assets. Mutual funds were reallocating their short term assets to the longer terms, while securities were redistributing their medium-short and long term assets to medium-long and short term assets. Insurance companies had the same strategy along with foreign investors, collecting the assets sold by other counterparts. While no significant return gained by insurance company for this strategy, the cumulative return of foreign investors was spiked 4 times of its initial. Regardless the small amount of investment done by insurance companies, they might be too early or too late in exercising the transaction. Interestingly, mutual funds also gained profit by 150 per cent for their strategy.

Table 2.7. Net Purchase of Investor Groups at Sub-Prime Mortgage Crisis I, June, 26-29 2007

(in Billion Rp)

	Banks	**Insurance**	**Mutual funds**	**Foreign**	**Pension Funds**	**Securities**
Long	(221)	1	139	516	(87)	(8)
Medium-Long	(26)	(3)	27	(19)	0	21
Medium-Short	(805)	29	(237)	1,072	(20)	(40)
Short	(438)	16	7	481	(89)	22
Total	**(1,490)**	**43**	**(64)**	**2,050**	**(195)**	**(4)**

The opposite occurs when the second sub-prime mortgage crisis was hit in October-November 2008. As shown in Table 2.8, the foreign investors fled their capital by more than 1.2 Trillion rupiah out of the market. Most of those bonds were collected by banks, pension funds, insurance companies, and also the Central Bank of Indonesia as the safety net of financial crisis. Mutual Funds were redistributing their portfolio to the longer terms while, on the other hand, Securities were selling their longer term bonds and purchasing shorter term bonds.

Table 2.8. Net Purchase of Investor Groups at Sub-Prime Mortgage Crisis II, 10 October- 26 November 2008 (in Billion Rp)

	Banks	**Insurance**	**Mutual Funds**	**Foreign**	**Pension Funds**	**Securities**
Long	517	528	102	(1556)	626	(282)
Medium-Long	55	(75)	276	(423)	125	(96)
Medium-Short	301	985	134	(4418)	883	56
Short	3855	763	(657)	(5768)	1348	49
Total	**4729**	**2202**	**(145)**	**(12165)**	**2981**	**(273)**

In this crisis period, only pension funds gained significant profit. This might be because investors had predicted the coming of the second hit. The market was trembled since early of the year. By the mid of 2008, foreign investors had started to make withdrawals. This worsened market condition that was already in bearish position. After reached its deepest bottom by the end November 2008, the market was quickly rebound in less than a month, and foreign investors regained their profit by the end of the year.

2.6. Concluding remark

This paper is purposed to determine the investment patterns of every investor group as well as measuring their investment performance in Indonesian government bonds market. From this study, there is indication that foreign investors have become market followers. There is no evidence to suggest whether foreign investors are positive feedback or negative feedback traders. Likewise, there is no evidence to determine whether they are rational or irrational traders. The various types and objectives of investors in the groups and the lack of transparency in the market are the potential causes why it is hard to determine investors' trading patterns.

During the sample period, banks, securities, and foreign investors have positive cumulative return at the end of period, while mutual funds, pension funds, and insurance companies have negative cumulative return. In addition, I found that foreign investors earn the largest cumulative return along the sample period. This finding supports the opinion that foreign investor gained the most returns against other investor groups.

Chapter 3

Determining the Optimal Structure of Government Debt in Indonesia

3.1. Introduction

Deficits in the primary balance have become a generic policy for triggering the economy and generating growth. Governments, especially in poor and developing countries, need higher amounts of investments to build public facilities and to satisfy their consumption and expenses compared to the tax revenues that could be attained. Barro (1999) mentioned that the government should run budget deficits at times of temporarily high public outlays. Moreover, the budget deficits should be high at times of temporary economic distress and low (typically negative) in good times. In many cases, raising the tax rate might cause resistances, both for political and economic reasons. Some governments choose a pragmatic way to solve this problem; they seek financial aids and issue public debts from domestic and foreign countries.

In the past, many poor and developing countries have received grants and soft-loans from developed countries and international fund institutions to finance their primary gaps. However, many economists have criticized this practice. They argued that these aids are not effective for triggering the economic development in poor and developing countries; this is indicated by the poor growth record of the grantee countries (Loser, 2004). On the other hand, many believe that there is no such thing as a free lunch; there are economic and political motives behind external aids and debts (Makmun, 2005).

Recently, there is a tendency for switching the external debts into domestic debts in many developing countries. This policy could reduce the government exposure to interest rates and currency risks. In addition, it could also reduce the dependency on external assistance and on external shocks (Arnone and Presbitero, 2008). Nevertheless, there also risks embedded in the domestic debts issuance. Compared to external debts, domestic debts tend to have higher rates and short-maturity[3]. Higher interest rates imply higher debt services, which aggravate fiscal imbalances and decrease the government's ability to sustain debts. In addition, they eventually lead to a fall in the real demand for government bonds, due to the increase in default risk (Akemann and Kanczuk, 2002). Alternatively, sovereigns that are switching from external to domestic debts could be trading a currency mismatch for a maturity mismatch

[3] However, investors might assumed that domestic and external debt rates are indifferent since, as mentioned by Barro (1999), the extra premium required on domestically denominated issues (even if indexed) may justify the extra riskiness of the foreign currency debt.

since few of them are able to issue long-term domestic debts at a reasonable interest rate (Panizza, 2008).

Muhdi (2007) found that emphasizing domestic debts as a financing resource had an implication to crowd out private investments. Panizza (2008) explained that this happened because institutional investors and banks were absorbing "too much" government debt. In addition, he also mentioned that there are political reasons that may make domestic debts more difficult to restructure. For some sovereigns, the problem is more fundamental. They are not able to raise the amount needed from domestic sources due to lack of liquidity and saving. Hence, they enter the international capital market since it can provide a large amount of funds without crowding out lending to private sectors or recurring to inflationary finance. However, these countries could not issue the debts in their own currency in this market; they have to borrow in foreign currency. This is also known as “original sin” (Panizza, 2008; Muhdi, 2007).

Debt’s sustainability has been a central issue in government’s fiscal policy. Unsustainable debt was one of the main causes why the economic recovery was so slow in Indonesia compare to other countries impacted by the Asian financial crisis in 1998 (Suhud, 2004), and has triggered the sovereign debt crisis in the Eurozone in 2012. Some economists believe that the structure of the government debt (which is associated with its holder) is one of the keys for a sustainable debt. For example, Tokuoka (2010) explained that the large pool of household savings and the stable domestic institutional investor base has contributed to keeping yields steady despite the abundant stock of government debt in Japan.

Because of these pros and cons of the domestic and external debts issuance and the important role of the structure of government debt in order to maintain its sustainability, it is tempting to investigate the optimal share of domestic and external debts in the government debt's portfolio. The terminology of external debts refers to debt that is denominated in foreign currencies; in this chapter, all external debts are converted into the US dollar denomination.

I develop a simple general equilibrium model to determine the optimal share for domestic and external government debts in Indonesia. I emphasize the important role of Government debt's demand in forming the optimal structure of government debt. In addition, the back testing simulation suggests that the Indonesian government has to reduce the level of its external debt. Through a dynamic recursive simulation, it is suggested that, in the long run, the government must not hold any external debt while the Debt-to-GDP ratio is maintained at a level of 16%-17%.

The rest of this paper is structured as follows: in the next section, I review the existing literature about domestic and external government debt's sustainability. Third section will disscuss the government debt management in Indonesia. The development of the model will be discussed in the fourth section. Section 5 will discuss the empirical evidence in Indonesia. Lastly, the concluding remarks will appear in section 6.

3.2. Literature Review

3.2.1. Domestic Government Debt Sustainability

One of the many important questions that should be asked when a government decides to issue public debt is "Can the government afford to maintain it?", or in other terms, is the debt sustainable or not? The study of government's fiscal sustainability, especially concerning the sustainability of its debt, has flourished in the past decade. IMF (2006) defined debt sustainability as "*a situation in which a borrower is expected to be able to continue servicing its debt without an unrealistically large correction to the balance of income and expenditure*". However, there is no exact parameter to measure a sustainable debt. Some economists just set a threshold that serves as warning indicator, while other economists set a dynamic parameter that depends on the economic situation at that moment.

Maybe the most famous debt's threshold is stated in the Maastricht Treaty by the European Council. This treaty is arranged to establish the criteria for European Union member states to enter the third stage of European Economic and Monetary Union (EMU) and adopt the euro as their currency. One of the criteria in the treaty is to maintain the ratio of gross government-debt-to-GDP and not allow it to exceed 60% at the end of the preceding fiscal year. Even if the target cannot be achieved due to specific conditions, the ratio must have sufficiently diminished and must be approaching the reference value at a satisfactory pace. Other thresholds are stated by Aiyagar and McGrattan (1997). Using the U.S. economics data, they reached the conclusion that the optimal debt ratio is 2/3 of the country's GDP.

Other economists set the parameterization of debt's sustainability to depend on the Debt-to-GDP ratio. The current debt would be considered as sustainable when its present value of the debt-to-GDP ratio converges to zero; this parameterization is also known as the inter-temporal budget constraint. Based on this constraint, Bohn (1998) suggests the government improve its primary balance on an increase in the levels of Debt/GDP ratio, by either reducing government spending or increasing tax revenue.

According to Akyuz (2007), an inter-temporal budget constraint is often formulated with respect to conditions for solvency, which requires that the present discounted value of future primary budget balances should at least be equal to the value of outstanding debt. This constraint implies that a sovereign that is able to run a larger primary surplus, can have a higher initial stock of debt while maintaining long-term sustainability. Alternatively, a country that is growing fast can run a lower primary surplus for a given stock of debt and interest rate. Other implications include that the public sector cannot be a debtor, and the private sector cannot be a creditor, in present-value terms. That is to say, any debt incurred should eventually be fully payable. This would require the government to constantly increase taxes and reduce spending on goods and services. In addition, the theoretical concept of sustainability based on solvency is problematic because it does not impose specific constraints on debts and deficits at any point in time. Since current deficits are collateralized by surpluses in some distant future, any level of debts and deficits could be compatible with the present-value budget constraint. On the other hand, both the underlying economic conditions, as reflected by the growth adjusted interest rate, and the fiscal policy stances vary over time and are highly uncertain.

Another approach is a static budget constraint which is when the public sector is able to finance its current expenditures with its revenues and new borrowing, and meet or rollover its maturing liabilities, that is, if liquidity is not constrained (Akyuz, 2007). This parameter would depend on the demand of the market. Yoshino and Mizoguchi (2012) mentioned that a huge demand from local investors has led the Japanese government bond market to a different fate than the Greek's. This approach, to our knowledge, is less explored in the debt sustainability study, and is being pursued in constructing the model in this paper.

3.2.2. External Government Debt Sustainability

The formal definition of the external government debts sustainability is *"the ability of a country to meet the current and future external obligations without running into arrears, recourse to debt-rescheduling and eventually a drastic balance-of-payments adjustment"* (Akyuz, 2007). Like in domestic debts sustainability, there is no exact parameter that guides us on how to measure the external debts sustainability. For example, IMF (2002) considers an external debt ratio of 40% as a useful benchmark, however many economists relate the external debts sustainability with the levels of trade surplus.

The amount of trade surplus desired is not directly linked to policy, but influenced by a host of variables operating on imports and exports, particularly the exchange rate and the rate of growth (Akyuz, 2007). Fisher (1933, in Muhdi, 2007) propounded a paradox regarding the external debts sustainability: the heavily indebted countries are trapped in a net transfer problem – that is when debt services are higher than new debts - while at the same time they are experiencing depreciation in unit value and in terms of trade of their export commodities. The unit value and terms of trade of export commodities can be depreciated as the foreign reserves are exhausted due to high debt services (Suhud, 2004). In fact, increasing external debt itself will potentially depreciate the local currency, thus the total redemption will increase (Muhdi, 2007).

Another characteristic of external debts is that they are subject to the shock of external events. An external event will result in an increase in borrowing costs and capital outflow (Loser, 2004). Creditors are less willing to roll over loans when there is an expectation that the debtor will be unable to repay in the future (Ferucci and Penalver, 2003). At the extreme cases, debt overhang is followed by massive capital flight as investors' confidence is eroded

(Muhdi, 2007). However, sudden stops in lending or rolling over debt do not always signal solvency problems. Investor behavior and risk appetites tend to vary over time without any significant change in the economic fundamentals. Furthermore, a country's experience of default on its debt in the past and the nature of its government and institutions also play a significant role in influencing the investor's confidence (Akyuz, 2007)

Despite these drawbacks, the preference for domestic debts issuance is not always superior to external debts issuance. As shown by Arnone and Presbitero (2008), the ex-post evaluation of the sustainability condition of 14 heavily indebted poor countries shows that the inclusion of domestic debts makes the evolution of debts not always sustainable while the results obtained by looking exclusively at the external public debts do.

3.3. Government Debt Management in Indonesia

Indonesia is one of the countries most severely impacted by the financial crisis in mid-1997, in South East Asia. One of the factors that made it hard to struggle out of the crisis was the increase of accumulative government debts (Suhud, 2004). These government debts especially took the form of external debts, which are denominated in foreign currency. As the IDR was depreciated drastically against USD, the debt services had multiplied over a short period. The Indonesian government took several actions in response, including seeking soft loans from bilateral and international institutions, rescheduling the existing debts, privatizing its assets, and issuing domestic government bonds in order to bail out the collapsed banking system. During 1998-2000, the Indonesian government had issued in total IDR 643.8 Trillion of domestic government bonds. By the end of 2000, the bonds holders (which are the national banks who were bailed out by the government) started to trade these bonds to other investors, which initiated the development of a domestic government bonds market.

In 2002, the Indonesian government issued the Government's Bond Act No. 24/2002, which contains the government's objective of bonds management and other general concerns related to government bond issuance. It is elaborated in more specific terms in the Minister of Finance Decree No.447/KMK.06/2005, which stated: "*The objectives of debt management are (1) To finance the gap in primary balance and to maintain fiscal sustainability which is in line with the macroeconomic condition, and within the lowest cost, (2) To increase the prudence in debt management in order to minimize the risks embedded, (3) To be persistent with all of the scheduled plans and estimated costs*". These objectives are then translated into several actions, i.e. (1) Maintaining the debt issuance below 1% of GDP, (2) Prioritizing the issuance of domestic debts and maintaining the external debts in a balanced proportion in order to reduce the crowding out effect in the local market, (3) Issuing debts with longer maturities and continuously rearranging the maturity profile through buyback and debt-switch in order to mitigate the refinancing risk. Furthermore, it seems as beneficial to also establish a debt management office under the Ministry of Finance to monitor the debts' development and to implement strategies for sustaining debts. The government, after implementing the latter, has started to manage its debts more professionally.

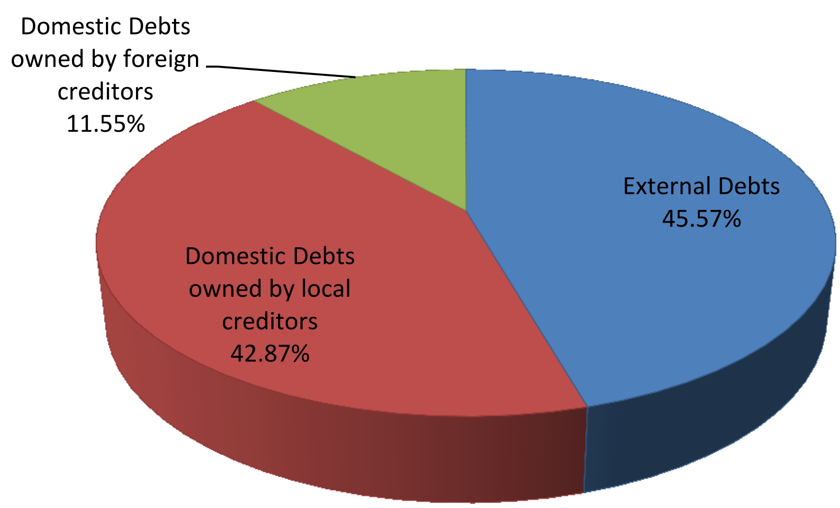
While the domestic debts market still continues to develop, it has recently become the main source to cover the primary deficit in Indonesia. The government tried to reduce new borrowings sourced from external debt. However, there are still abundant stocks of external debts in the go vernment's liabilities. Currently, the proportion between domestic and external debts is almost equal.

Table 3.9. Statistics of Indonesian government debts (in Trillion IDR)

	2008	2009	2010	2011
Primary Balance Surplus/Deficit	-4.12	-88.62	-133.75	-124.66
Domestic Debt Sources Net flows	46.73	52.45	66.29	90.24
Stock of Domestic Non-Tradable Debt			0.17	0.81
Stock of Domestic Tradable Debt	783.86	836.31	902.43	992.03
External Debt Sources Net flows	200.6	-98.54	20.07	37.04
Stock of External Non-Tradable Debt	730.25	611.2	612.45	615.83
Stock of External Tradable Debt	122.64	143.15	161.97	195.63

Source: Debt Management Office, Indonesian Ministry of Finance (2012)

Foreign investors overwhelmed local investors in the Indonesian government debts market. Foreign investors' ownership reached more than 57% from the total outstanding debts. To some extent, this is worrisome because this figure is closer to that of the Greek market, rather than the level of Japanese sustainable debt (Yoshino and Mizoguchi, 2012). Prasetyo (2013) commented upon the advantages and disadvantages of having an extensive involvement of



Source: Debt Management Office, Indonesian Ministry of Finance
Figure 3.1. Government Debts Ownership by May 2012.

foreign investors in the market. On the bright side, one of the advantages includes greater liquidity that enabled the government to develop the market. However, this also might be hazardous for the economy due to high volatility brought by foreign investors' behavior, especially during crisis periods.

3.4. Development of the Model

3.4.1. General overview of the markets

Naturally, local investors would avoid investing in the external debt market due to the additional currency risk. In addition, the interest rate offered in the external debt market is relatively low compared to the domestic debt. Therefore, I assume that local investors are only investing in the domestic government debts. Demand in the domestic debt market is forming an upward slope since the quantity of debt demanded will increase as the interest rate increase. The domestic debt's interest rate (r^d) is endogenously determined as when the market is cleared.

On the other hand, foreign investors have the privilege to invest in both domestic and external government debts market as the interest disparity offsets the currency risk. Prasetyo (2013) mentioned that foreign investors in the Indonesian government debt market are having the flexibility in allocating and withdrawing their investment, in other words, the demand that is sourced from foreign investors are very elastic. In this model, I make an extreme assumption that the demand in the external debts market is perfectly elastic. Thus, the external debts' interest rate (r^f) is considered as an exogenous variable.

The supply for both domestic and external government debt is solely determined by the government. One of the main considerations for the government in determining the amount of government debt is the budget constraint of its primary balance. As it needs the debt to cover the deficit in the primary balance, it would accept debt at any given interest rate. This makes the supply for both domestic and external government debts perfectly inelastic.

Both markets are linked from both from the perspective of both demand and supply. From demand point of view, with no restriction for the foreign investors to put their investment into the domestic market, domestic and external debts have become substitutes. From supply point of view, the government determines the optimal proportion between the domestic and external debt issuance, thus any decision made on one market will naturally affect the other market.

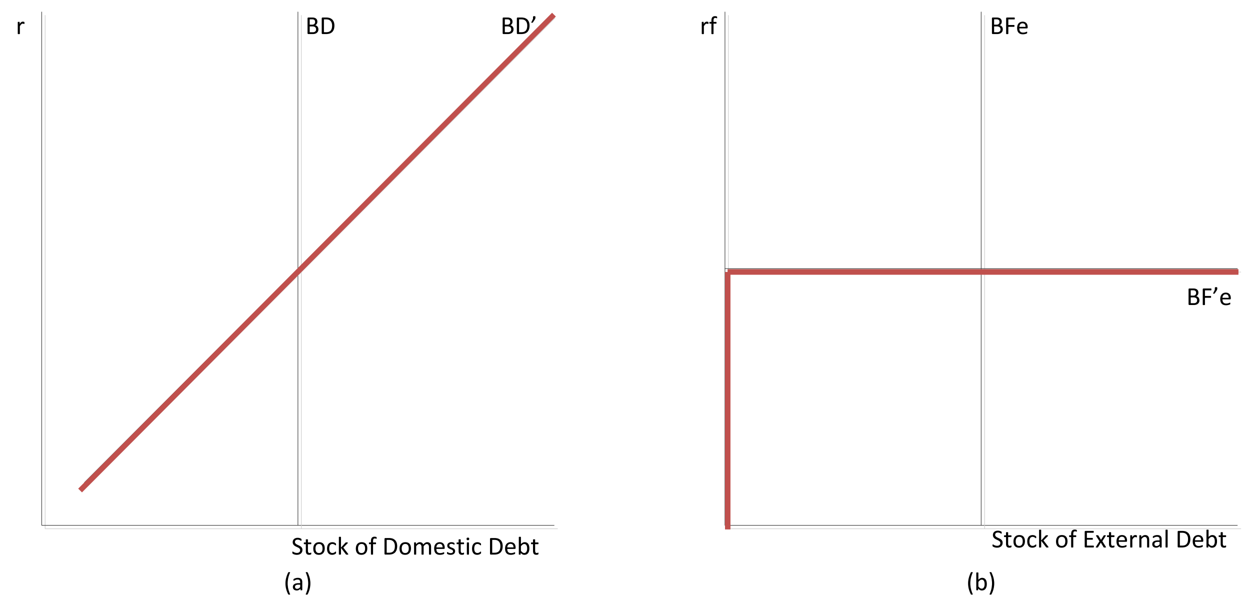


Figure 3.2. (a) the Domestic government debt market and (b) the External government debt market.

3.4.2. Supply of Domestic and External Government Debts

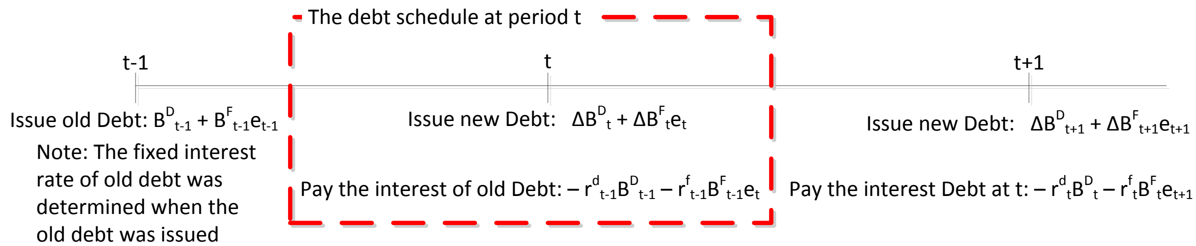


Figure 3.3. Government debt schedule

Government revenues comes from tax, which is equal to domestic income (Y) multiplied by tax rate (τ), and raising new debts, which come from domestic debts (ΔB_t^D) and external debts (ΔB_t^F). On the other hand, the government has to spend its expenditure (G) and has to pay the interest payment of previous debts. The government has to pay the interest on the entire outstanding debt. Therefore, the interest rates are exposed to the stock of government debt instead of to the new borrowings.

$$\tau Y_t + \Delta B_t^D + \Delta B_t^F e_t = G_t + r_{t-1}^d B_{t-1}^D + r_{t-1}^f B_{t-1}^F e_t \tag{3.1}$$

Where r^d denotes the interest rate for domestic borrowings, r^f denotes the interest rate for external borrowings, B^D denotes the stock of domestic government debt, and B^F denotes the foreign government debt.

In Indonesia, most of the government debts are fix-rate for both domestic and external. It means that the interest rate to be paid at the end of an observed period is determined at the beginning of the period. Thus, I use the notation r^d_{t-1} and r^f_{t-1} to denote the previously-determined-interest-rates in the government budget constraint (see figure 3.2 for illustration). Since the external debts are made in foreign currency, they have to be multiplied by the current exchange rate (e).

Note that new borrowings are basically the differences between current level and the previous level of stock of debts.

$$\Delta B_t^D = B_t^D - B_{t-1}^D \tag{3.2.a}$$

$$\Delta B_t^F = B_t^F - B_{t-1}^F \tag{3.2.b}$$

Therefore, equation (3.1) can be rewritten as following:

$$\tau Y_t + B_t^D + B_t^F e_t = G_t + \left(1 + r_{t-1}^d\right) B_{t-1}^D + \left(1 + r_{t-1}^f\right) B_{t-1}^F e_t \tag{3.3}$$

Many economists assume that the government debts would be perfectly rolled over into the next period (Ferruci and Penalver, 2003; Penalver and Thwaites, 2006). However, this assumption is not applicable in reality. *Ceteris paribus*, the stock of debt would naturally increase as the debt services are integrated in the new debts issuance. These accumulative debts would raise a general concern towards the debt sustainability in the long run. For developing countries, such as Indonesia, debt services are the ultimate source of the foreign reserves' outflows. Indonesian government spending is less likely to act as a stimulus for the economic growth due to the fact that the debt-service-to-revenue ratio is very high (Makmun, 2005; Suhud, 2004). Thus, the government's objective function is not only to minimize the interest payments in the future, but also to minimize the new borrowings. The relationship between new borrowings and stock of debts in equation (3.2.a) and equation (3.2.b) indicates that the government could achieve the objective by minimizing the stock of domestic and foreign debt.

$$\min_{B_t^D, B_t^F} B_t^D - B_{t-1}^D + (B_t^F - B_{t-1}^F)e_t + r_t^d B_t^D + r_t^f B_t^F E(e_{t+1}) \tag{3.4}$$

Subject to equation (3.3)

The constrained objective function in equation (3.4) above can be converted into unconstrained function as following:

$$\mathcal{L}_{B_t^D, B_t^F, \lambda} = -B_t^D + B_{t-1}^D - (B_t^F - B_{t-1}^F)e_t - r_t^d B_t^D - r_t^f B_t^F E(e_{t+1}) \tag{3.5}$$
$$- \lambda\left(\tau Y_t + B_t^D + B_t^F e_t - G_t - \left(1 + r_{t-1}^d\right)B_{t-1}^D - \left(1 + r_{t-1}^f\right)B_{t-1}^F e_t\right)$$

Deriving the unconstrained function with respect to B_t^D, B_t^F, and λ gives us the necessary condition for the optimisation problem.

$$\frac{\delta \mathcal{L}}{\delta B_t^D} = -\left(1 + r_t^d\right) - \lambda = 0 \tag{3.6}$$

$$\frac{\delta \mathcal{L}}{\delta B_t^F} = -e_t - r_t^f\ E(e_{t+1}) - \lambda e_t = 0 \tag{3.7}$$

$$\frac{\delta \mathcal{L}}{\delta \lambda} = \tau Y_t + B_t^D + B_t^F e_t - G_t - \left(1 + r_{t-1}^d\right)B_{t-1}^D - \left(1 + r_{t-1}^f\right)B_{t-1}^F e_t = 0 \tag{3.8}$$

Equation (3.6) and (3.7) imply that the necessary condition for solving such an optimization problem is reached when $\lambda = -\left(1 + r_t^d\right) = -\left(1 + r_t^f \frac{E(e_{t+1})}{e_t}\right)$. However, no sufficient condition could be found as no stationary point can be obtained. It is common to assume that the government determines the structure of its debts arbitrarily due to this sufficiency matter. However, I propose that the optimal proportion between the two kinds of debts could be pursued by following market demand.

Further, by substituting equation (3.6) and (3.7), we get:

$$r_t^d = r_t^f \frac{E(e_{t+1})}{e_t} \tag{3.9}$$

Equation (3.9) gives the insight that, supposing that the exchange rate is expected to be fixed, then the government should manage the proportion of domestic and external debts, thus domestic debts' interest rate should be equal to the external debts'. Therefore, the determination of expected exchange rates has become critical. There are several methods in estimating the expected value of a variable. In this paper I use an "adaptive expectation" approach. In this approach, the expectation of future exchange rates reflects the expected exchange rate in the present, and an "error-adjustment" term, which is the gap of expected value of exchange rate and the actual value in the present time.

$$E(e_{t+1}) = E_{t-1}(e_t) + \zeta\big(e_t - E_{t-1}(e_t)\big) \tag{3.10}$$

Where ζ denotes the subjective preference of the importance of the error adjustment. Rearranging equation (3.10) yields:

$$E(e_{t+1}) = \zeta e_t + (1-\zeta)E_{t-1}(e_t) \tag{3.11}$$

By rearranging equation (3.9) and taking it backward for one period, we could obtain the expected exchange rate function at the present time.

$$E_{t-1}(e_t) = \frac{r_{t-1}^{d}}{r_{t-1}^{f}} e_{t-1} \tag{3.12}$$

By substituting equation (3.12) into equation (3.11), the expected exchange rate is then formulated as:

$$E(e_{t+1}) = \zeta e_t + (1-\zeta)\frac{r_{t-1}^{d}}{r_{t-1}^{f}} e_{t-1} \tag{3.13}$$

Up to this point, the optimal value at which domestic and external debts should be maintained by the government have not been determined. Except the external government debts interest rate, all variables are endogenously determined in the market. Therefore, in order to determine what the optimal level of debts that should be maintained by the government are, we should look at the demand of the markets.

3.4.3. Demand of Domestic Government Debts

3.4.3.1. Demand from Local investors

From the infamous IS-LM model, it is understood that the financial wealth (*W*) is the summation of the amount of distributed money (*M*) and the stock of government debts (*B*). By using this relationship, we can obtain the demand for government debts.

$$B_t^{D1} = W_t - M_t \tag{3.14}$$

There are many instruments in the money market in which investors could put their money. In fact, risk averse investors are always comparing the returns of the assets, given the risks. In 1988, Bernanke and Blinder proposed the extended IS-LM curve by including bank loans in the asset market. They believed that bank loans are having an important role in the monetary transmission mechanism as banks serve as financial intermediaries for households and firms. Changes in the loan market and money market would affect the demand for government debt due the restriction of financial wealth. They called this model as CC-LM model, or also known as IS-MP-BL model. Departing from the CC-LM model, I include deposit interest rate as the next best assets against the returns of government debts. Thus, I expand the function of the demand of local investors for domestic government debts as follows:

$$B_t^{D1} = \alpha_0 + \alpha_1\left(r_t^d - r_t^{dep}\right) + \alpha_2 W_t + \epsilon_r \tag{3.15}$$

Taking into account the expansion of the financial wealth function derived in the Appendix, equation (3.15) can expanded into:

$$B_t^{D1} = \alpha_0 + \alpha_1\left(r_t^d - r_t^{dep}\right) + \alpha_2(W_{t-1} + \omega_0 + \omega_1 G_t + \omega_2 r_t^d + \omega_3 e_t + \epsilon_W) + \epsilon_r \tag{3.16}$$

The reduced form for demand of local investors for domestic government debts becomes:

$$B_t^{D1} = \hat{\alpha}_0 + \hat{\alpha}_1 r_t^d + \hat{\alpha}_2 r_t^{dep} + \hat{\alpha}_3 W_{t-1} + \hat{\alpha}_4 G_t + \hat{\alpha}_5 e_t + \hat{\epsilon}_r \tag{3.17}$$

Where:

$\hat{\alpha}_0 = \alpha_0 + \alpha_2\omega_0$ $\hat{\alpha}_3 = \alpha_2$ $\hat{\epsilon}_r = \epsilon_r + \alpha_2\epsilon_W$

$\hat{\alpha}_1 = \alpha_1 + \alpha_2\omega_2$ $\hat{\alpha}_4 = \alpha_2\omega_1$

$\hat{\alpha}_2 = -\alpha_1$ $\hat{\alpha}_5 = \alpha_2\omega_3$

3.4.3.2. Demand from Foreign Investors

Similar to local investors, foreign investors also consider the opportunity cost of investing in government debts. I include the risk-free interest rate in the U.S. (r^{US}) as the next best asset that can be obtained by foreign investors. Since the investment is made in local currency denomination, then the risk-free interest rate should be adjusted by the exchange rate. Suppose r* is the adjusted risk-free interest rate, the relationship between r* and r^{US} can be explained by the interest parity function.

$$r_t^* = r_t^{US} + \frac{E(e_{t+1}) - e_t}{e_t} \tag{3.18}$$

The demand of foreign investors, then, is formulated as:

$$B_t^{D2} = \beta_0 + \beta_1 \left(r_t^d - r_t^{US} - \frac{E(e_{t+1}) - e_t}{e_t} \right) + \epsilon_{r_t^f} \tag{3.19}$$

By substituting equation (3.13), we obtain:

$$B_t^{D2} = \beta_0 + \beta_1 \left((1-\zeta) + r_t^d - r_t^{US} - \frac{(1-\zeta)E_{t-1}(e_t)}{e_t} \right) + \epsilon_{r_t^f} \tag{3.20}$$

3.4.3.3. The Joint Demand for Domestic Government Debts

We could obtain the joint demand for domestic government debt by summing the demand from local investors and foreign investors.

$$B_t^{Dd} = B_t^{D1} + B_t^{D2} \tag{3.21}$$

$$B_t^{Dd} = \gamma_0 + \gamma_1 r_t^d + \gamma_2 r_t^{dep} + \gamma_3 r_t^{US} + \gamma_4 G_t + \gamma_5 W_{t-1} + \gamma_6 e_t + \gamma_7 \frac{(1-\zeta)E_{t-1}(e_t)}{e_t} + \epsilon_{B^D} \tag{3.22}$$

Where

$\gamma_0 = \hat{\alpha}_0 + \beta_0 + \beta_1(1-\zeta)$ $\quad \gamma_3 = -\beta_1$ $\quad \gamma_6 = \hat{\alpha}_5$

$\gamma_1 = \hat{\alpha}_1 + \beta_1$ $\quad \gamma_4 = \hat{\alpha}_4$ $\quad \gamma_7 = -\beta_1$

$\gamma_2 = \hat{\alpha}_2$ $\quad \gamma_5 = \hat{\alpha}_3$ $\quad \epsilon_{B^D} = \hat{\epsilon}_r + \epsilon_{r_t^f}$

3.4.4. The role of Exchange Rates

The exchange rate plays an important role as the external debt is made in a foreign currency denomination. Once attained, the external debt will be converted into domestic currency to fund some parts of government spending. Then it will be converted back into the respective foreign currency denomination when it is due. This way, government's decisions in determining the level of external debt also affects the value of exchange rate.

In the foreign currency market, the stock of foreign currency is supplied from exports and capital inflow, whereas the demand for the foreign currency is determined by imports and capital outflow. The value of exports and imports is a function of exchange rate. Capital inflow comes from the new external debt, whereas the capital outflow is the amount of existing external debt to be paid plus its interest. Mathematically, this is explained by equation (3.23) and (3.24).

$$Q_{e,t}^s = Ex_t + B_t^F e_t = x_0 + x_1 e_t + B_t^F e_t + \epsilon_X \tag{3.23}$$

$$Q_{e,t}^d = Im_t + \left(1 + r_{t-1}^f\right) B_{t-1}^F e_t = m_0 + m_1 e_t + \left(1 + r_{t-1}^f\right) B_{t-1}^F e_t + \epsilon_{Im} \tag{3.24}$$

At the equilibrium, the value of exchange rate is formulated as:

$$e_t = \frac{m_0 - x_0 + \epsilon_{Im} - \epsilon_X}{\left(B_t^F - \left(1 + r_{t-1}^f\right) B_{t-1}^F - m_1 + x_1\right)} \tag{3.25}$$

3.4.5. The Optimal Amount of Domestic and External Government Debts

At equilibrium, the amount of domestic government debt supplied by the government is equal to the amount demanded combined, as shown below:

$$B_t^{Ds} = B_t^{Dd} = B_t^D \tag{3.26}$$

$$B_t^D = \gamma_0 + \gamma_1 r_t^d + \gamma_2 r_t^{dep} + \gamma_3 r_t^{US} + \gamma_4 G_t + \gamma_5 W_{t-1} + \gamma_6 e_t + \gamma_7 \frac{(1-\zeta)E_{t-1}(e_t)}{e_t} + \epsilon_{B^D} \tag{3.27}$$

Substituting equation (9) into equation (27) yields:

$$B_t^D = \gamma_0 + \gamma_1 r_t^f \zeta + \gamma_2 r_t^{dep} + \gamma_3 r_t^{US} + \gamma_4 G_t + \gamma_5 W_{t-1} + \gamma_6 e_t + \left(\gamma_7 + \gamma_1 r_t^f\right) \frac{(1-\zeta)E_{t-1}(e_t)}{e_t} + \epsilon_{B^D} \tag{3.28}$$

As can be seen in equation (3.28), the optimal amount of domestic government debt depends on the value of foreign exchange rate, which is a function of the stock of external government debt. Therefore, we have to solve the optimal amount of external government debt in advance. As dictated by the government budget function in equation (3.3), the external government debt is the residual funds needed by the government to cover its budget deficit after raising the debts internally. we rewrite equation (3.3) below:

$$B_t^F e_t = G_t + \left(1 + r_{t-1}^d\right) B_{t-1}^D + \left(1 + r_{t-1}^f\right) B_{t-1}^F e_t - \tau Y_t - B_t^D \tag{3.29}$$

The government's domestic debts' interest rate is associated with a risk-free rate as the government is backing-up the debt service obligation. Taking into account the infamous Keynesian aggregate expenditure, the domestic income could be converted into a reduced form as follow:

$$Y_t = \varphi_0 + \varphi_1 G_t + \varphi_2 r_t^d + \varphi_3 e_t + \epsilon_Y \tag{3.30}$$

Substituting equation (3.9), (3.25), (3.28) and (3.30) into equation (3.29) we found that the optimal external debts is the root of a quadratic function of interacting variables.

$$B_t^F = \frac{-h \pm \sqrt{h^2 - 4gi}}{2g} \tag{3.31}$$

Where:

$$a = (1 - \tau\varphi_1 - \gamma_4)G_t + \left(1 + r_{t-1}^d\right)B_{t-1}^D - \tau(\varphi_0 + \epsilon_Y) - \gamma_0 - (\gamma_1 + \tau\varphi_2)r_t^f\zeta - \gamma_2 r_t^{dep} - \gamma_3 r_t^{US} - \gamma_5 W_{t-1} - \epsilon_{B^D}$$

$$b = x_0 - m_0 + \epsilon_X - \epsilon_{Im}$$

$$c = \left(1 + r_{t-1}^f\right)B_{t-1}^F - \gamma_6 - \tau\varphi_3$$

$$d = \left(\gamma_7 + \gamma_1 r_t^f + \tau\varphi_2 r_t^f\right)(1 - \zeta)E_{t-1}(e_t)$$

$$f = \left(1 + r_{t-1}^f\right)B_{t-1}^F - x_1 + m_1$$

$$g = d$$

$$h = ab + b^2 + 2df$$

$$i = -(b^2c + abf + df^2)$$

$$h^2 - 4gi \geq 0$$

As indicated in equation (3.31), there are two possible solutions for obtaining the optimal external government debts. However, the government still has to manage the smoothness of the change of its external debt level to keep sustainability. Moreover, drastic surges – both for addition or reduction of stock of debts – are often hard to manage or even unattainable. Even though the demand for external government debt is very elastic, drastic increase in external government debt would also require an increase on the interest rate. In addition, it would strengthen the exchange rate, which would hamper the export-products competitiveness. It would also be inefficient since the government has restricted resources to manage the abundant incoming fund. On the other hand, drastic reductions of external debt would require huge usage of foreign reserves for repayment. It would also weaken the exchange rate, which will increase the price of imported products. Either would be bad for the overall economy.

Suppose that B_t^{F1} is the solution to one root and B_t^{F2} is the solution to the other root, the government's decision would be as following:

$$B_t^F = \begin{cases} B_t^{F1}, \left|B_t^{F1} - B_{t-1}^F\right| \leq \left|B_t^{F2} - B_{t-1}^F\right| \\ B_t^{F2}, \left|B_t^{F1} - B_{t-1}^F\right| \geq \left|B_t^{F2} - B_{t-1}^F\right| \end{cases} \quad (3.32)$$

The government will choose B_t^{F1} if the absolute difference of B_t^{F1} to the previous stock of debt is lower than the absolute difference of B_t^{F2} to the previous stock of debt. The government will choose B_t^{F2} if the opposite situation occurs.

Since there is no non-negativity constraint involved in the solution, it is possible to obtain a negative value for the stock of external government debt. This negative value would simply be referred to as loans to foreign countries instead of external debt.

3.5. Empirical Analysis

3.5.1. The data

We conducted an empirical analysis on the Indonesian government debt market to support the theoretical framework described in the previous section. I gathered the annual data of domestic government debts, the average domestic debts interest rate, the average external debts interest rate and the average T-Bill interest rate in US, GDP, IDR/USD exchange rate, exports and imports. I assumed that the subjective preference of the importance of the error adjustment is equal to 0.5, while the tax rate was assumed to be fixed at 10%. The statistical summary of the data is shown in table 3.2.

Table 3.10. Statistical summary of the data

	Units	Min	Max	Mean	Std Deviation
$\mathbf{B^D}$	(Trillion IDR)	648.75	992.03	756.06	120.37
$\mathbf{r^d}$	%	6.00	50.67	19.65	7.35
$\mathbf{r^f}$	%	1.10	5.01	2.70	1.26
$\mathbf{r^{US}}$	%	1.07	6.26	3.00	1.91
Y	(Trillion IDR)	102.68	6422.92	1675.58	1851.01
E	IDR/USD	149.58	10389.94	3512.82	3851.38
Ex	(Trillion IDR)	0.08	1580.82	288.86	449.39
Im	(Trillion IDR)	0.14	1475.83	251.27	401.45

Source: Debt Management Office - Indonesian Ministry of Finance and World Bank (2012)

Domestic government debts, exports, imports, and GDP were regressed with respective independent variables to obtain the coefficients needed for calculating the optimal stock of domestic and external debts. The results are shown in table 3.3.

Table 3.11. Statistical coefficient of regressions

	Domestic Debt	Income	Export	Import
Constant	6.785E+14	1.896E+13	-1.540E+14	-1.257E+14
	(11.955) ***	(.232)	(-1.534)	(-1.235)
r^d	5.216E+13	-3.671E+14		
	(.163)	(-1.007)		
r^{dep}	6.000E+12			
	(2.573)			
r^{US}	-5.399E+14			
	(-3.217) *			
G	.167	10.026		
	(1.347)	(44.999) ***		
W(-1)	.032			
	(3.817) *			
E	-1.229E+10	5.675E+10	1.136E+11	9.735E+10
	(-2.163)	(6.387) ***	(7.752) ***	(6.557) ***
0.5*E(e)/e	-1.171E+13			
	(-3.044) *			
R^2	1	0.997	0.723	0.651

Note: * Significant in 10% significance level
*** Significant in 1% significance level

By using the coefficients shown in table 3.3, we could see that the components c and f in equation (3.31) are positive-definite while component d is a negative-definite function. However, due to external shock on income (ϵ_Y), exports (ϵ_X), imports (ϵ_{Im}), and demand on domestic government debt (ϵ_{B^D}), it is hard to determine the direction component a, b, g, h and i in equation (3.31) will take.

3.5.2. The simulations

We conducted two kinds of simulations, back-testing and recursive dynamic simulation, in order to comprehend the optimal level of domestic and external government debts in Indonesia. Back-testing simulation was conducted for a 2004-2011 sampling period. Given the model derived in section 3.4 and the coefficients described in table 3.3, I inserted the actual values of exogenous and lagged variables to calculate the optimal level of domestic and external government debts for the respective years. From this simulation, it can be seen that the actual level of external government debt is higher than the optimal level for every year in the sampling period. While the actual level of domestic government debt is almost as high as the optimal level.

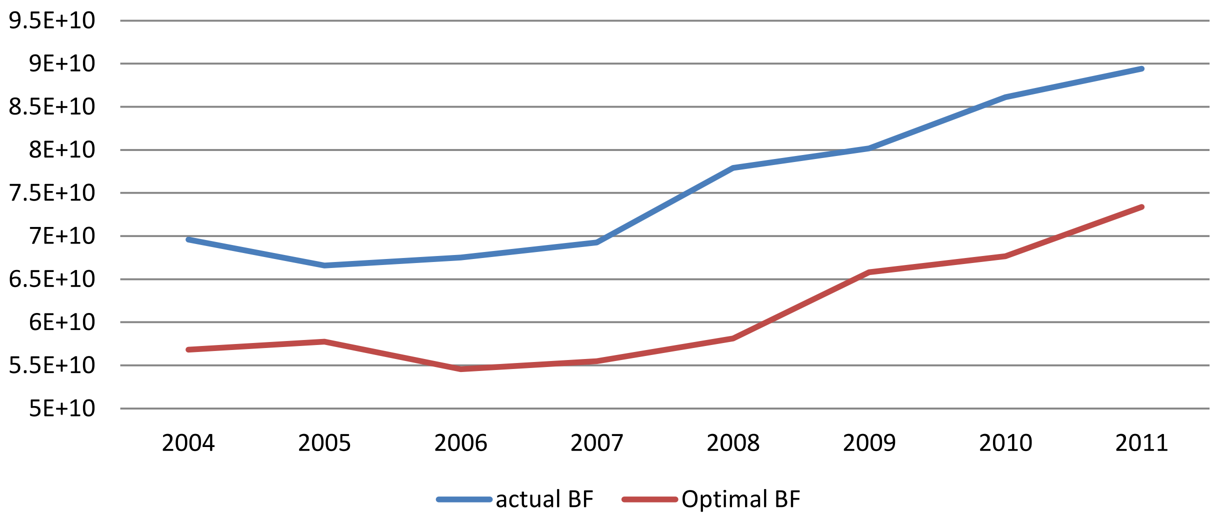


Figure 3.4. Comparison between optimal level of external government debt and the actual level

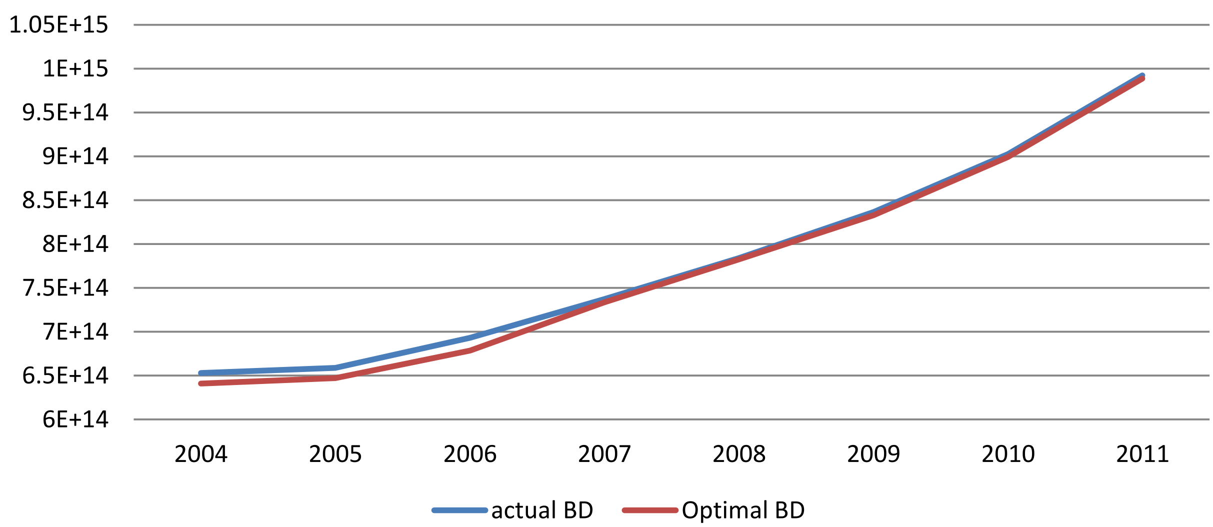


Figure 3.5. Comparison between optimal level of domestic government debt and the actual level

At a deeper analysis, I comprehend that household wealth plays a significant role in shaping the demand of the government debts. As household wealth increases at a rapid pace, the government is allowed to increase the amount of domestic debt; thus reducing the proportion of external debt. The Indonesian government should have maintained the domestic debts 1.15 to 1.54 times that of the external debts during the sampling period.

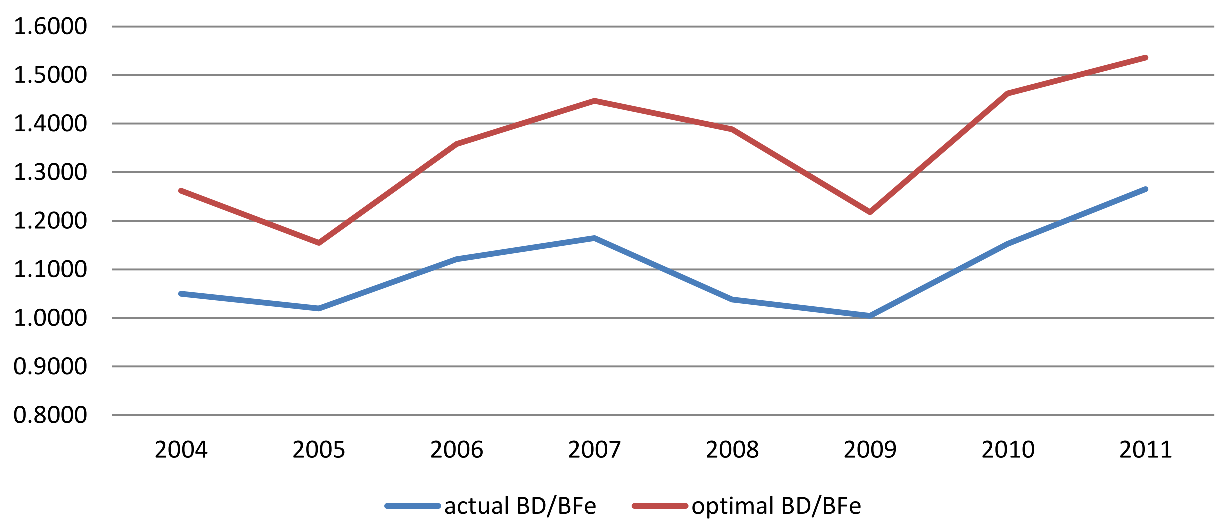


Figure 3.6. Comparison between optimal ratios of domestic-to-external debts to the actual level

We also conducted a recursive dynamic simulation to estimate the optimal value of domestic and external government in the forthcoming years. Firstly, in order to conduct this simulation, some initial conditions and stochastic parameters had to be calibrated. Actual data of Indonesian Government debts in 2011 were used for the initial conditions as shown in table 3.4. For the forthcoming years, government spending and household wealth were assumed to be growing at a rate of 7%. Stochastic estimation was applied to measure exogenous variables and error terms. The parameters of the stochastic estimation are taken, based on the performance in the past 5 years. These parameters are shown in table 3.5.

The optimal debt calculations were conducted multiple times for each period. In each period, the stochastic parameters were generated randomly, following a normal distribution. I took the average results as the base for the next calculations, thus it would be a bootstrapping process. While there is no non-negativity constraint was imposed in the model, I enabled such constraint in the simulation since I would like to focus on the government's debts instead of government's lending[4].

Table 3.4. Initial condition for recursive dynamic simulation

Coefficients	Value
G_0	6.67E+14
$B^D{}_0$	9.92E+14
$B^F{}_0$	8.94E+10
r_0	6.61%
$r^f{}_0$	1.74%
e_0	8770.43
W_0	1.31E+16

Table 3.5. Parameters for stochastic estimation

Variables	Average	σ
r^f	1.74%	0.90%
r^{dep}	5.80%	0.10%
ϵ_{B^D}	-1.94E+12	1.03E+13
ϵ_X	3.17E+14	4.22E+14
ϵ_{Im}	3.14E+14	4.39E+14
ϵ_Y	8.73E+14	1.79E+15

From the simulation, it can be seen that the optimal stock of external government debt keeps decreasing, even goes to zero at the 8th period. This means that the Indonesian government shall not hold external debt for long. On the contrary, the domestic government debt is allowed to increase gradually. The debt-to-GDP ratio will decrease as the stock of external debt decreases. However, it will converge to the 16%-17% level.

Even though it is advisable for the Indonesian government to drastically reduce its external debt, in reality it would be hard to implement. Despite the commitment penalty that is charged upon cancellations, the government must also wisely manage the national foreign

[4] The government should pursue different objective once it serve as lender, i.e. maximizing the revenue from the loan instead of minimizing the debt service.

Figure 3.7. Recursive dynamic simulation for external government debt

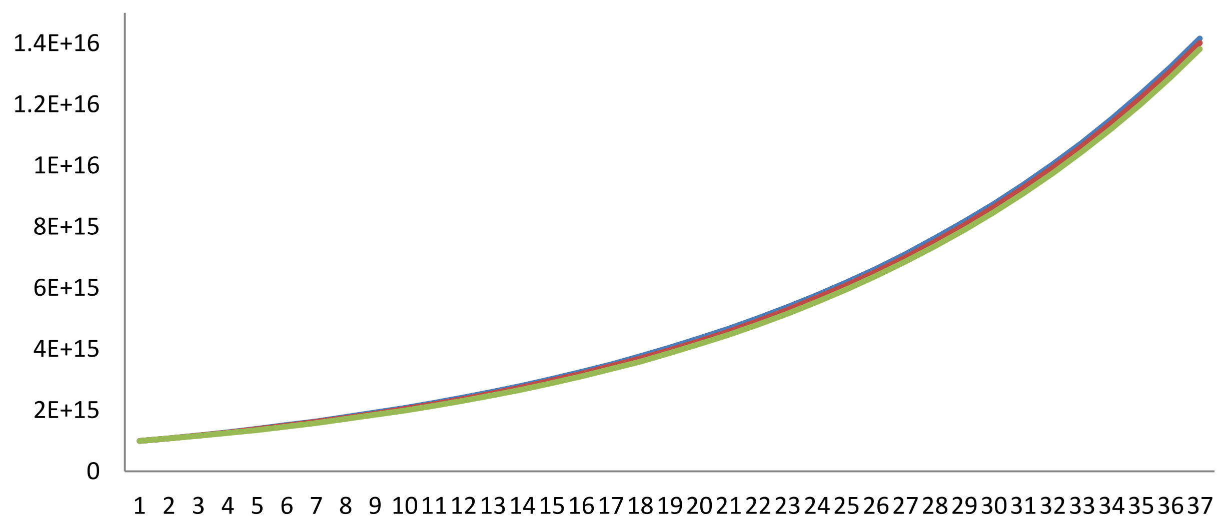


Figure 3.8. Recursive dynamic simulation for domestic government debt

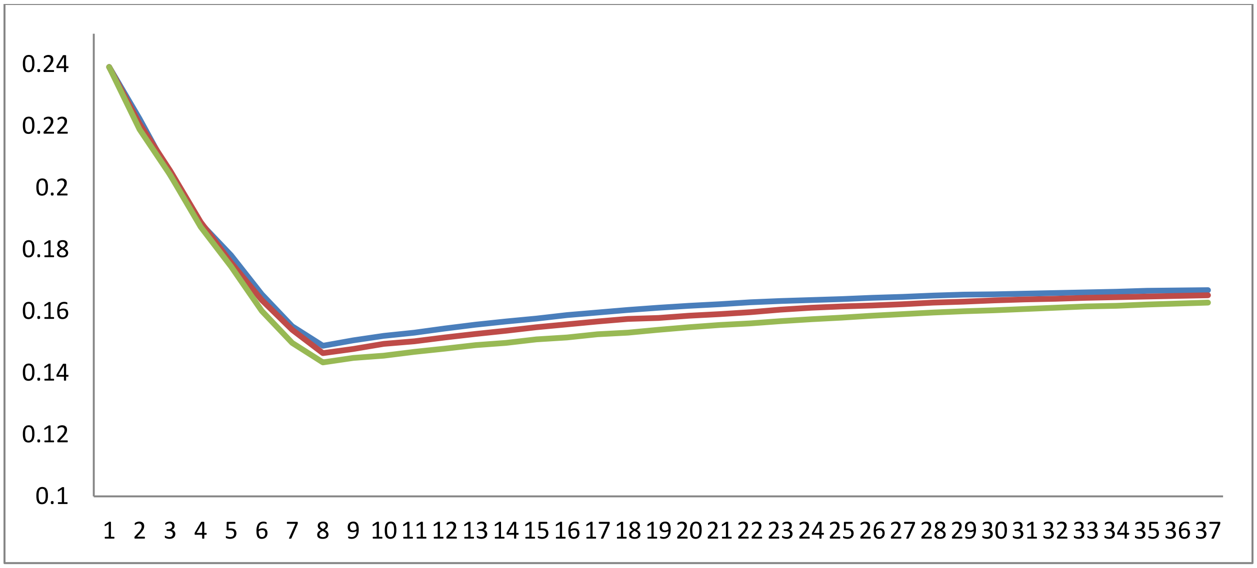


Figure 3.9. Recursive dynamic simulation for debt-to-GDP ratio

reserves for repaying the external debt. Moreover, the issuance of external debt is still needed to avoid crowding out effect in the domestic markets.

The Indonesian government has committed to reduce the stock of external debt that is sourced from bilateral and multilateral loans. The strategy to reduce the external debt is described in the Minister of Finance Decree No. 37/KMK.08/2013: (1) Reinforce the limitation of external non-tradable debts, (2) Evaluate the project performance in the past as the base for new (project based) external debt agreements, (3) Prioritize low-interest loans and reduce/eliminate the contingency component, (4) Utilize an early debt repayment offer if it is profitable, as well as considering the cancellation of the debt that has a low absorption. In the future, the Indonesian government will prioritize the issuance of domestic debts and tradable external debts that have more flexibility.

3.6. Concluding remarks

This paper aimed to determine the optimal proportion for domestic and external government debts in Indonesia. I developed a simple general equilibrium model that emphasizes the important role of demand in forming the optimal structure of government debts. I derive the CC-LM model and foreign investors' opportunity cost factor in determining the demand of domestic government debts, while assuming the interest rate for external government debt is exogenous. With respect to supply, I set the government objective as to minimize the interest payment and also the new issued debts. I found that the optimal supply of domestic debt is a function of the deposits interest rate, household wealth, external debt interest rate, foreign interest rate, government spending, and exchange rate. In addition, the external debt's supply is a factor of a quadratic function of inter-related variables. Furthermore, I found that both domestic and external government debt markets are linked to both demand and supply.

By using the data from the Indonesian government bond's market, the back testing simulation results suggest that the government has to reduce its level of external debt, while it is allowed to increase the amount of domestic government bonds at the current level. I found that household wealth plays a significant role in shaping the demand of government debts. As household wealth increases at a rapid pace, the government is allowed to increase the amount of domestic debt, thus reducing the proportion of external debt. The dynamic simulation results offer evidence to suggest that the Indonesian government should decrease the level of its external debt significantly so that it reaches zero at the 8th period. Along with the reduction of the external government debt, the Debt-to-GDP ratio will decrease. The debt-to-GDP ratio shall be maintained at the 16%-17% level in the long term.

Appendix A

Household wealth is the accumulation of the previous wealth plus private savings (S), while private saving is the residual of income after consumption and taxes.

$$W_t = W_{t-1} + S_t \tag{A.1}$$

$$S_t = (1-\tau)Y_t - C_t \tag{A.2}$$

In Keynesian terms, consumption is described as marginal propensity to consume (c_1), multiplied by income plus some autonomous consumption (c_0).

$$C_t = c_0 + c_1 Y_t + \epsilon_c \tag{A.3}$$

Substituting equation (A.2), (A.3) and (30), I obtain the reduced form of the wealth function

$$W_t = W_{t-1} + (1-\tau-c_1)\big(\varphi_0 + \varphi_1 G_t + \varphi_2 r_t^d + \varphi_3 e_t + \epsilon_Y\big) - c_0 - \epsilon_c \tag{A.4}$$

$$W_t = W_{t-1} + \omega_0 + \omega_1 G_t + \omega_2 r_t^d + \omega_3 e_t + \epsilon_W \tag{A.5}$$

Where

$\omega_0 = (1-\tau-c_1)\varphi_0 - c_0$ $\quad\omega_2 = (1-\tau-c_1)\varphi_2$ $\quad\epsilon_W = (1-\tau-c_1)\epsilon_Y - \epsilon_c$

$\omega_1 = (1-\tau-c_1)\varphi_1$ $\quad\omega_3 = (1-\tau-c_1)\varphi_3$

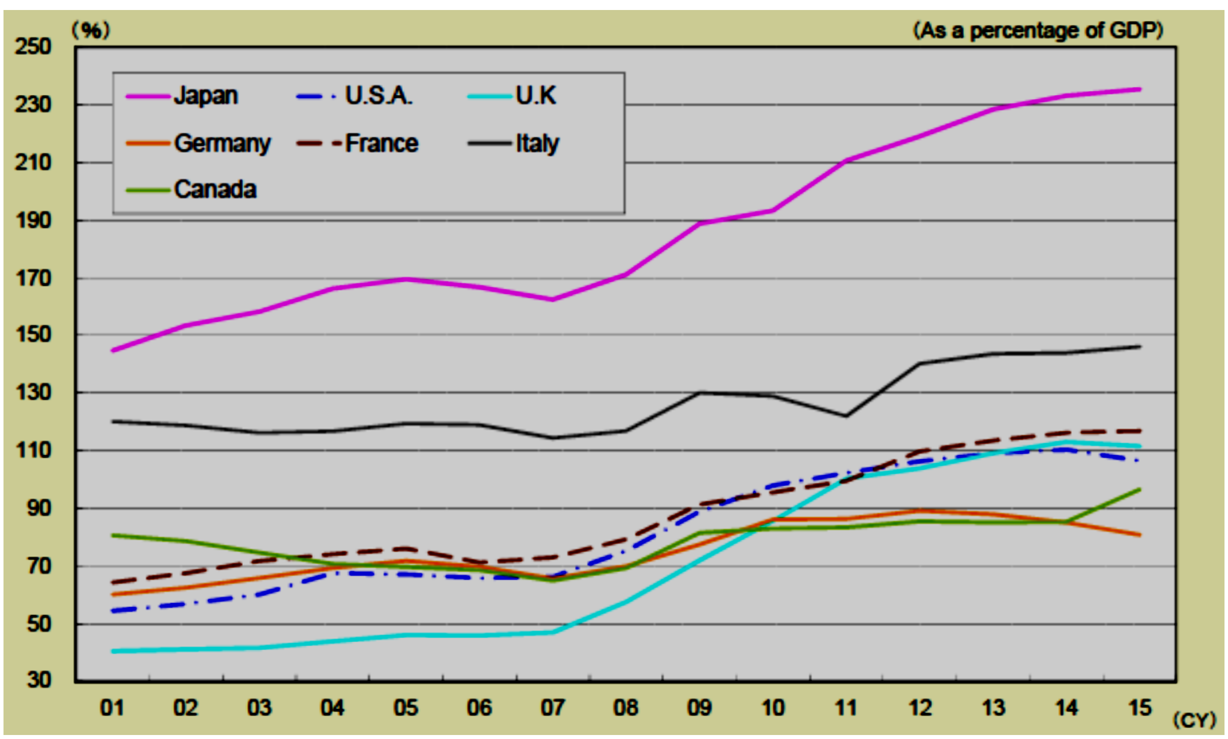
Chapter 4

The optimal structure of Japanese Government Bonds

4.1. Introduction

Japan has gone to uncharted areas in terms of Government Bonds' development. The outstanding amount of Japanese Government Bonds (JGB) is projected to be around 240% of its GDP by January 2014, the highest among OECD countries. This situation has raised concern about the sustainability of JGB. Many economists that study JGB market, including Ihori et al. (2001), Kato (2002), McNelis & Yoshino (2012), Sakuragawa & Hosono (2011), Hoshi & Ito (2014), Horioka et al. (2013) and Kameda (2014), agree that such a high amount of debt might be unsustainable.

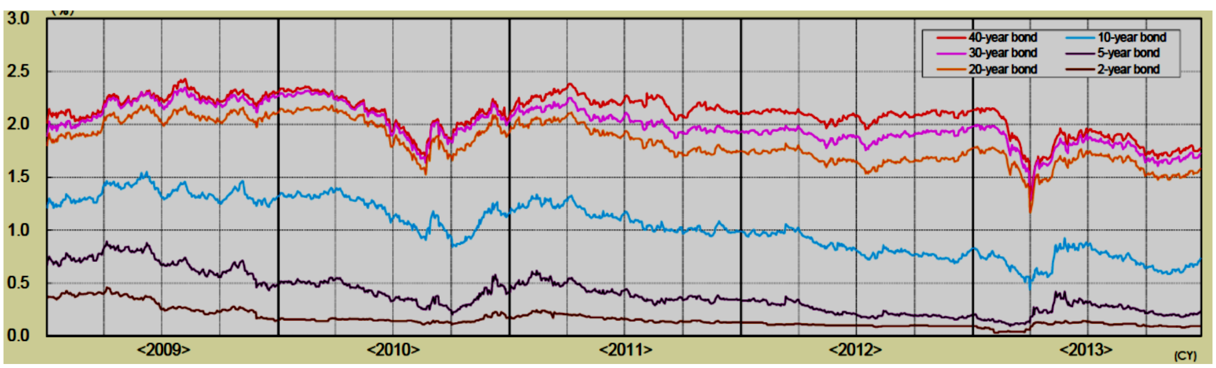
Despite the worrisome figure of Debt-to-GDP ratio, the JGB's interest rate seemed to be steady at low level. The short-term interest rate ranged between 0% and 0.5 % in the last 5 years, while the long term interest rate yields below 2% in 2013. This is unusual since theoretically, with such high outlays of debt, the cost of borrowing will skyrocket; it could even lead to default in many cases. Akram & Das (2014) mentioned that the low level of JGB yield is a product of several entangled causes, i.e. BOJ monetary policy, deflationary pressure, tepid growth, and monetary sovereignty. Hoshi & Ito (2014) argue that the stability of the JGB's interest rate was collateralized by the high assets of private sectors. On the same stream, Fincke & Geiner (2011) explained that when the data was focused on net debt instead of gross debt, there was evidence of sustainability of JGB. However, the rapid aging of the Japanese population may bring a grim outlook for stability in the future since it means a pro-



Source: Ministry of Finance – Japan, 2013

Figure 4.1 Comparison of current and projected Japanese Government's Debt-to-GDP ratio to other OECD countries 2001-2015 jected decline of household savings that were underlying private assets (Horioka et al., 2013).

Some solutions have been proposed to solve this problem. Batini et al. (2005) suggested to pace up the productivity growth and reducing the primary budget deficit. By assuming that the productivity growth increases 0.5% of GDP per year while the Japanese government reduces the primary budget deficit of 0.25% of GDP per year, they claimed that the Debt-to-GDP ratio could be reduced by 36.8% over 15 years. Some other economists suggested that in order to reduce the primary budget deficit, the government has to increase the tax rate. The suggested nominal percentage, however, is varied due to a different approach in conducting their study, namely: 20% (Imrohoglu et al., 2013; Hoshi & Ito, 2013), 21% (Sakuragawa & Hosono, 2011), and 30% (Hansen & Imrohoglu, 2013). Others focused on reducing the government expenditure through pension reforms (Yoshino, 2012; Imrohoglu et al., 2013) and increasing the productivity rate through female labor force participation (Imrohoglu et al., 2013).



Source: Ministry of Finance – Japan, 2013

Figure 4.2 Historical Yields of JGB for various maturities within 2009-2013 periods

There are also other approaches to keep the JGB stable and sustainable. McNelis & Yoshino (2012) employed an exchange-rule for the monetary policy into their simulation. They claimed it would considerably moderate the instability induced by a rising risk premium. Doi et al. (2006) suggest that the Japanese government must apply an upper limit of stock of JGB. Prasetyo & Yoshino (2013) explained that managing an optimal structure of bond types would also be effective in order to achieve the overall debt sustainability. Through a simulation on Indonesian government debt market, they estimated that by reducing the amount of external debt the debt-to-GDP ratio would be steady at 17% in the long run.

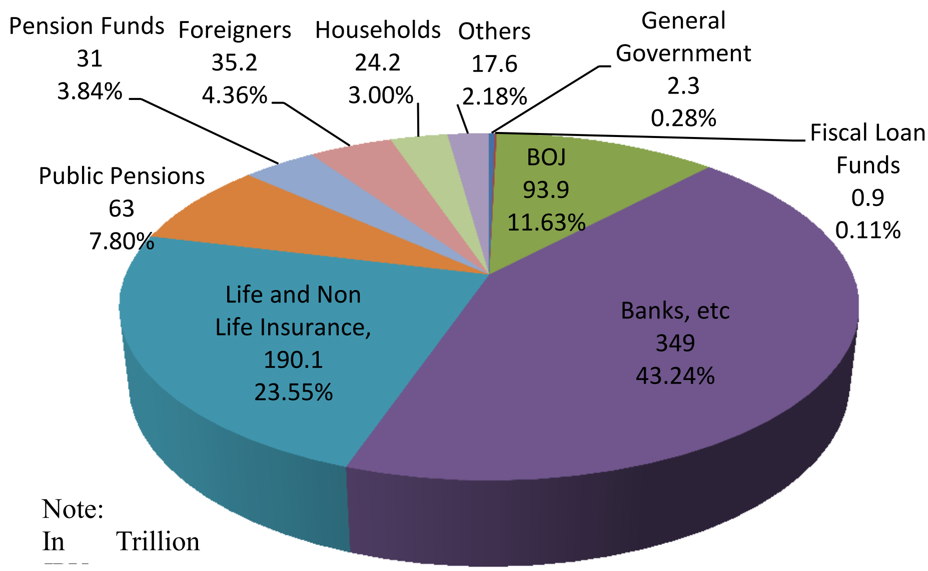
The latest approach will also be employed in this paper. I will derive a model to obtain the optimal proportion of JGB types in order to minimize the cost of borrowings. In addition, I also adjust the derived model with the deterministic risks embedded in each type of JGB. Through sensitivity simulations, I found that the optimal proportion for fixed-rate, floating-rate, and inflation-indexed bonds depend on the risk appetite of the government; the government should pursue a different strategy depending on whether they are imposing risk averse or risk seeking policy. Further, It appears that the risk appetites of government and private sector are always opposite to each other. In addition, the stability of the bonds market would also be affected by the wealth of the investors since there is a positive correlation between interest rates and the ownership of government bonds relative to other assets owned by investors.

4.2. JGB characteristics

Doi and Ihori (in Yoshino, et al., 2004) presented a good historical description about the JGB. Traditionally, the Japanese government has followed a balanced budget policy. The balanced budget was maintained until 1965, when national bonds were first issued in the postwar period. The gap between government expenditure and tax revenue, which corresponds roughly to fiscal deficit, began to expand rapidly at the outbreak of the first oil shock in 1973.

The stock of debt has been increasing ever since; the accumulation growth even paced up after the burst of economic bubble in 1991.

The JGB is only issued in Yen denomination. This makes it easier for the government to manage the risk embedded in the bonds since they are not exposed to exchange rate fluctuation. By 2013, most of JGB ownership (about 70.63%) was held by private sectors, e.g. Banks, Insurance Companies, Pension Funds, etc. BOJ and Public sectors holds about 19.82% of the JGB, while households and foreigners owned 3% and 4.36% respectively.



Source: Ministry of Finance – Japan, 2013

Figure 4.3 The share of JGB's ownership in 2013

Currently, Japanese government issues four types of bonds, i.e. Fixed-rate bonds, Floating-rate bonds, Inflation-indexed bonds, and Zero coupon bonds. As reflected in the name, Fixed-rate bonds give coupons which rates are fixed from the auction dates until redemption dates[5]. Fixed-rate bonds were diversified to 6 different types of maturities, i.e. 2,

[5] In Japan, the auction methods are varies by the type of securities and participants. Please see "Debt Management Report 2013" page 45, issued by Financial bureau, Ministry of Finance – Japan for more details.

5, 10, 20, 30, and 40 years long. Besides the common fixed-rate bonds, Japanese government also issues retail fixed-rate bonds with maturities of 3 and 5 years.

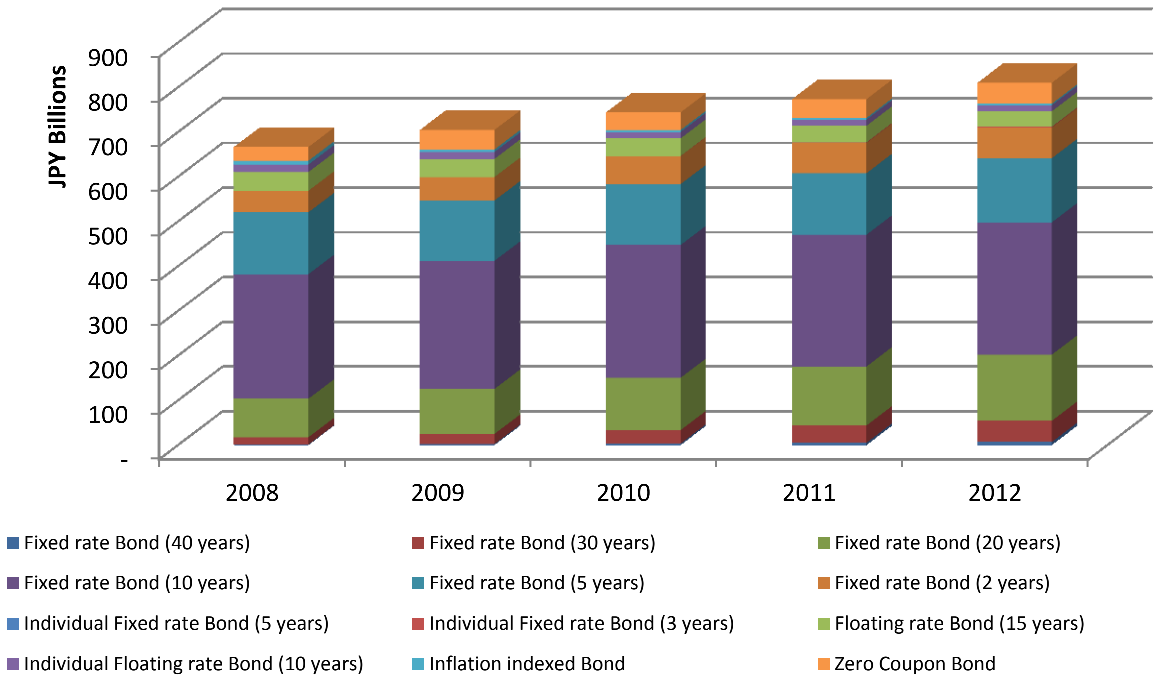
Floating-rate bonds' coupon rates are varied along with the change of reference rates. Reference rate is the compound yield of the average accepted bid of the 10-year Fixed-rate JGB auction, which is held 6 months before the coupon payment month. The rate is rounded off the yield to 2 decimal places. The formula to calculate the coupon rates of Floating-rate bonds is as follows:

$$Coupon\,rate \;=\; reference\,rate - \alpha \tag{4.1}$$

α is an adjustment value that is set in the morning of the auction day and stays constant until maturity. Coupon rates have floor protection (the lowest coupon rate is 0%), and are paid semi-annually. The Japanese government issues two types of Floating-rate bonds, i.e. common floating-rate bonds with 15 years maturity, and retail floating-rate bonds with 10 years maturity.

The Inflation-indexed bonds were introduced to protect the investors from the inflation shock. The principal value of Inflation-indexed bonds is adjusted by change in CPI, thus the interest payment changed proportionally. It is issued at 10 years maturity and paid semi-annually. The formula for calculating the interest of inflation indexed bonds is as follows:

$$Semiannual\ interest = facevalue \times \frac{CPI\ at\ payment}{CPI\ at\ issue} \times coupon\,rate \times \frac{1}{2} \tag{4.2}$$



Source: Ministry of Finance – Japan, 2013

Figure 4.4 The development of JGB based on types 2008-2012

The CPI adjustment in equation 4.2 is also known as indexation coefficient. The Inflation-indexed bond was firstly introduced in March 2004. After a long issuance suspension since October 2008, the Japanese government re-introduced the Inflation-indexed bonds with additional features in 2013. The principal amount of the inflation-indexed bonds is now guaranteed at maturity (deflation floor). In a case where the indexation coefficient falls below 1 at maturity, the bonds will be redeemed at the face value.

The last type of JGB is Zero coupon bonds, also known as Treasury bills. It is a typical discounted bonds that were issued at a price lower than its face value, with the face value repaid at the time of maturity. The Zero coupon bonds have a very short maturity, i.e. less than 1 year, thereby I exclude them from the developed model as it took yearly inter-temporal period.

4.3. Model development

Issuing new bonds is a natural consequence of holding a deficit budget policy. Therefore, government budget becomes the main constraint for any government objective to manage its debt. The government revenue comes from tax which is equal to domestic income (Y) multiplied by tax rate (τ), and raising new bonds, which issued in terms of fixed rate bonds (ΔB_t^{GFx}), floating rate bonds (ΔB_t^{GFl}), and inflation indexed bonds (ΔB_t^{GI}). On the other side, the government allocates its expenditure to provide public goods and services at G_t. In addition, the government is obliged to pay the interest of previous debts. Since the interest rate of the fixed-rate and inflation-indexed bonds have been determined early at the issuance date, I denote both interest rate at previous time period, i.e. r_{t-1}^{Fx} and r_{t-1}^{I} for previously-determined fixed-interest-rate and inflation-indexed-interest-rate respectively. The floating-rate bond is paid according to the current nominal interest rate, denoted by r_t^{Fl}.

As explained in Appendix B, the investors of JGB would measure their return in real term – that is adjusting the nominal income with inflation rate. Therefore, in order to match with investors' expectation and to obtain proper shares of JGB, the government should also consider real interest rate instead of nominal rate in the optimization objective. The fixed rate and floating rate bonds' interest rate is subtracted by the current inflation rate, while the inflation indexed bonds' rate would be fixed at its nominal value in real term.

Currently, the Japanese government imposes a deflation floor to protect the investors from losing their investment. However, for simplicity, I do not include such policy in our model. The government budget constraint is then formulated as:

$$\tau Y_t + \Delta B_t^{GFx} + \Delta B_t^{GFl} + \Delta B_t^{GI} = G_t + (r_{t-1}^{Fx} - i_t)B_{t-1}^{GFx} + \left(r_t^{Fl} - i_t\right)B_{t-1}^{GFl} + r_{t-1}^{I} B_{t-1}^{GI} \quad (4.3)$$

As shown in equation 4.3, new borrowings are flow variables whereas the interest payment must be done for the entire stock of bonds. These different forms of government bond in the model can be easily solved by converting the flow variables into stock variables through these relationships:

$$\Delta B_t^{GFx} = B_t^{GFx} - B_{t-1}^{GFx} \quad (4.4.a)$$

$$\Delta B_t^{GFl} = B_t^{GFl} - B_{t-1}^{GFl} \quad (4.4.b)$$

$$\Delta B_t^{GI} = B_t^{GI} - B_{t-1}^{GI} \quad (4.4.c)$$

Further, I take these variables into rational terms by dividing the current stock of each type of bonds with government deficit.

$$\zeta_t = \frac{B_t^{GFx}}{X_t + G_t - \tau Y_t} \quad (4.5.a)$$

$$\eta_t = \frac{B_t^{GFl}}{X_t + G_t - \tau Y_t} \quad (4.5.b)$$

$$\theta_t = \frac{B_t^{GI}}{X_t + G_t - \tau Y_t} \tag{4.5.c}$$

$$\zeta_t + \eta_t + \theta_t = 1 \tag{4.5.d}$$

ζ_t, η_t, and θ_t denote the proportion of fixed-rate, floating-rate, and inflation-indexed bonds to the entire government debts at current period. Whereas X_t denotes the current real debt service, which consists of both the interest payment and the previous face value of government bonds.

$$X_t = (1 + r_{t-1}^{Fx} - i_t)B_{t-1}^{GFx} + (1 + r_t^{Fl} - i_t)B_{t-1}^{GFl} + (1 + r_{t-1}^{I})B_{t-1}^{GI} \tag{4.6}$$

According to the "Debt Management Report 2013" issued by Japanese Ministry of Finance, there are two objectives in managing JGB, i.e. (1) to ensure stable and smooth issuance of JGB, and (2) to minimize the medium- to long-term financing cost. I take the first objective of Japanese Ministry of Finance as another constraint in addition to the government budget constraint. In order to reduce the stock of JGB in the future, the expected stock of JGB in the future must not exceed the current debt level. Thus:

$$E(B_{t+1}^{GFx}) + E\left(B_{t+1}^{GFl}\right) + E(B_{t+1}^{GI}) \leq B_t^{GFx} + B_t^{GFl} + B_t^{GI} \tag{4.7.a}$$

$$E(X_{t+1}) + E(G_{t+1}) - \tau E(Y_{t+1}) \leq X_t - (\tau - g)Y_t \tag{4.7.b}$$

Let the expected income in the future is equal to the current income multiplied by growth rate.

$$E(Y_{t+1}) = \big(1 + E(\kappa_{t+1})\big)Y_t \tag{4.8}$$

Divide both hand side in with Y_t equation 4.7.b can be rewritten as:

$$\chi_{t+1} \leq \frac{\Big(\chi_t + g_t - E\big(g_{t+1}\big)\Big)\big(1 + E(\kappa_{t+1})\big)}{\chi_t + g_t - \tau} \tag{4.9}$$

Where

$$\chi_{t+1} = \big(1 + r_t^{Fx} - E(i_{t+1})\big)\zeta_t + \Big(1 + E(r_{t+1}^{Fl}) - E(i_{t+1})\Big)\eta_t + (1 + r_t^{I})\theta_t \tag{4.10}$$

g_t and $E(g_{t+1})$ denote the government expenditure per GDP at time t and expected government per GDP at t+1 respectively.

The government objective function is to minimize the debt service will be bored by the government in the future as well as the risk embedded to the portfolio at current period. Here I assume that the government is price taker, thus it only optimize the objective function with respect to the bonds' shares and take the interest rate as given variable.

$$\min_{\zeta_t,\eta_t,\theta_t} E(Z) = \big(1 + r_t^{Fx} - E(i_{t+1})\big)\zeta_t + \Big(1 + E(r_{t+1}^{Fl}) - E(i_{t+1})\Big)\eta_t + (1 + r_t^{I})\theta_t \tag{4.11}$$

$$+ \frac{w}{2}\Big({\zeta_t}^2\sigma_I^2 + \big(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\big){\eta_t}^2 + 2\zeta_t\eta_t\big(\sigma_{Fl,I} + \sigma_I^2\big)\Big)$$

Subject to equation 4.5.d and 4.9

Where σ_{Fl}^2 and σ_I^2 denotes variance of errors in measuring the expectation of floating-rate and inflation rate respectively. $\sigma_{Fl,I}$ measures the covariance of those two errors, while w denotes the risk appetite of the Japanese government. A positive sign on the risk appetite indicates the government is more risk averse whereas a negative sign indicates that the government tends to be a risk seeker.

The Karush-Kuhn-Tucker (KKT) necessary conditions for objective function in equation 4.11 are described as follows:

$$\frac{\partial L}{\partial \zeta_t} = -\left(1 + r_t^{Fx} - E(i_{t+1})\right) - w\left(\zeta_t \sigma_I^2 + \eta_t\left(\sigma_{Fl,I} + \sigma_I^2\right)\right) + \lambda_1 + \lambda_2\left(1 + r_t^{Fx} - E(i_{t+1})\right) = 0 \quad (4.12.a)$$

$$\frac{\partial L}{\partial \eta_t} = -\left(1 + E\left(r_{t+1}^{Fl}\right) - E(i_{t+1})\right) - w\left(\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right)\eta_t + \zeta_t\left(\sigma_{Fl,I} + \sigma_I^2\right)\right) + \lambda_1 + \lambda_2\left(1 + E\left(r_{t+1}^{Fl}\right) - E(i_{t+1})\right) = 0 \quad (4.12.b)$$

$$\frac{\partial L}{\partial \theta_t} = -(1 + r_t^I) + \lambda_1 + \lambda_2(1 + r_t^I) = 0 \quad (4.12.c)$$

$$\frac{\partial L}{\partial \lambda_1} = \zeta_t + \eta_t + \theta_t - 1 = 0 \quad (4.12.d)$$

$$\frac{\partial L}{\partial \lambda_2} = -\left(1 + r_t^{Fx} - E(i_{t+1})\right)\zeta_t - \left(1 + E\left(r_{t+1}^{Fl}\right) - E(i_{t+1})\right)\eta_t - (1 + r_t^I)\theta_t + \frac{\left(\chi_t + g_t - E(g_{t+1})\right)\left(1 + E(\kappa_{t+1})\right)}{\chi_t + g_t - \tau} = 0 \quad (4.12.e)$$

$$\lambda_2\left(-\left(1+r_t^{Fx}-E(i_{t+1})\right)\zeta_t-\left(1+E\left(r_{t+1}^{Fl}\right)-E(i_{t+1})\right)\eta_t-(1+r_t^I)\theta_t + \frac{(\chi_t+g_t-E(g_{t+1}))(1+E(\kappa_{t+1}))}{\chi_t+g_t-\tau}\right)=0 \tag{4.12.f}$$

As indicated in equation 4.12.f above, the optimized variables could lie beyond the constraint's boundary. In this case, if $\lambda_2 = 0$ then ζ_t, η_t, and θ_t lie within the constraint range. The optimal value of ζ_t, η_t, and θ_t are then formulated as:

$$\zeta_t{}^* = \frac{\left(r_t^I + E(i_{t+1})\right)\left(\sigma_{Fl}^2 - 3\sigma_{Fl,I}\right) - r_t^{Fx}\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) + E\left(r_{t+1}^{Fl}\right)\left(\sigma_{Fl,I} + \sigma_I^2\right)}{w\left(\sigma_I^2\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) - \left(\sigma_{Fl,I} + \sigma_I^2\right)^2\right)} \tag{4.13.a}$$

$$\eta_t{}^* = \frac{-\left(r_t^I + E(i_{t+1})\right)\sigma_{Fl,I} + r_t^{Fx}\left(\sigma_{Fl,I} + \sigma_I^2\right) - E\left(r_{t+1}^{Fl}\right)\sigma_I^2}{w\left(\sigma_I^2\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) - \left(\sigma_{Fl,I} + \sigma_I^2\right)^2\right)} \tag{4.13.b}$$

$$\theta_t{}^* = 1 - \frac{\left(r_t^I + E(i_{t+1})\right)\left(\sigma_{Fl}^2 - 2\sigma_{Fl,I}\right) + r_t^{Fx}\left(3\sigma_{Fl,I} - \sigma_{Fl}^2\right) + E\left(r_{t+1}^{Fl}\right)\sigma_{Fl,I}}{w\left(\sigma_I^2\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) - \left(\sigma_{Fl,I} + \sigma_I^2\right)^2\right)} \tag{4.13.c}$$

On the other hand, if $\lambda_2 \neq 0$, the inequal constraint in KKT conditions will be treated as equal constraint. Thus it can be solved with the Lagrangian method and the optimized variables would lie on the constraint's boundary. The optimal value of ζ_t, η_t, and θ_t are then formulated as:

$$\zeta_t^{**} = \frac{\left(\frac{(\chi_t + g_t - E(g_{t+1}))(1+E(\kappa_{t+1}))}{\chi_t + g_t - \tau} - (1+r_t^I)\right)\begin{pmatrix} \left(r_t^I + E(i_{t+1})\right)(\sigma_{Fl}^2 - 3\sigma_{Fl,I}) \\ +E\left(r_{t+1}^{Fl}\right)(\sigma_{Fl,I} + \sigma_I^2) \\ -r_t^{Fx}(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}) \end{pmatrix}}{\begin{pmatrix} (r_t^{Fx} - E(i_{t+1}) - r_t^I)\begin{pmatrix} (r_t^I + E(i_{t+1}))(\sigma_{Fl}^2 - 3\sigma_{Fl,I}) + E\left(r_{t+1}^{Fl}\right)(\sigma_{Fl,I} + \sigma_I^2) \\ -r_t^{Fx}(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}) \end{pmatrix} \\ +\left(E\left(r_{t+1}^{Fl}\right) - E(i_{t+1}) - r_t^I\right)\begin{pmatrix} -(r_t^I + E(i_{t+1}))\sigma_{Fl,I} \\ +r_t^{Fx}(\sigma_{Fl,I} + \sigma_I^2) - E\left(r_{t+1}^{Fl}\right)\sigma_I^2 \end{pmatrix} \end{pmatrix}} \tag{4.14.a}$$

$$\eta_t^{**} = \frac{\left(\frac{(\chi_t + g_t - E(g_{t+1}))(1+E(\kappa_{t+1}))}{\chi_t + g_t - \tau} - (1+r_t^I)\right)\begin{pmatrix} -\left(r_t^I + E(i_{t+1})\right)\sigma_{Fl,I} \\ +r_t^{Fx}(\sigma_{Fl,I} + \sigma_I^2) \\ -E\left(r_{t+1}^{Fl}\right)\sigma_I^2 \end{pmatrix}}{\begin{pmatrix} (r_t^{Fx} - E(i_{t+1}) - r_t^I)\begin{pmatrix} (r_t^I + E(i_{t+1}))(\sigma_{Fl}^2 - 3\sigma_{Fl,I}) + E\left(r_{t+1}^{Fl}\right)(\sigma_{Fl,I} + \sigma_I^2) \\ -r_t^{Fx}(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}) \end{pmatrix} \\ +\left(E\left(r_{t+1}^{Fl}\right) - E(i_{t+1}) - r_t^I\right)\begin{pmatrix} -(r_t^I + E(i_{t+1}))\sigma_{Fl,I} \\ +r_t^{Fx}(\sigma_{Fl,I} + \sigma_I^2) - E\left(r_{t+1}^{Fl}\right)\sigma_I^2 \end{pmatrix} \end{pmatrix}} \tag{4.14.b}$$

$$\theta_t^{**} = 1 - \frac{\left(\frac{(\chi_t + g_t - E(g_{t+1}))(1+E(\kappa_{t+1}))}{\chi_t + g_t - \tau} - (1+r_t^I)\right)\begin{pmatrix} \left(r_t^I + E(i_t)\right)(\sigma_{Fl}^2 - 2\sigma_{Fl,I}) \\ +E\left(r_{t+1}^{Fl}\right)\sigma_{Fl,I} \\ +r_t^{Fx}(3\sigma_{Fl,I} - \sigma_{Fl}^2) \end{pmatrix}}{\begin{pmatrix} (r_t^{Fx} - E(i_{t+1}) - r_t^I)\begin{pmatrix} (r_t^I + E(i_{t+1}))(\sigma_{Fl}^2 - 3\sigma_{Fl,I}) + E\left(r_{t+1}^{Fl}\right)(\sigma_{Fl,I} + \sigma_I^2) \\ -r_t^{Fx}(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}) \end{pmatrix} \\ +\left(E\left(r_{t+1}^{Fl}\right) - E(i_{t+1}) - r_t^I\right)\begin{pmatrix} -(r_t^I + E(i_{t+1}))\sigma_{Fl,I} \\ +r_t^{Fx}(\sigma_{Fl,I} + \sigma_I^2) - E\left(r_{t+1}^{Fl}\right)\sigma_I^2 \end{pmatrix} \end{pmatrix}} \tag{4.14.c}$$

Please note that as there is no non-negativity constraint imposed in the model, it is allowed for ζ_t, η_t, and θ_t to have negative values. Negative values on the optimized bonds shares mean that the government is allowed to invest the excess amount of budget deficit in assets that give returns as much as offered by the respective bonds[6].

4.4. Simulation and Analysis

I conducted a sensitivity simulation in order to understand the characteristics of the model. First of all I set some parameters and exogenous variables as bases for the simulation. These parameters are following conditions in JGB market in early 2013. The fixed-interest rate and the inflation-indexed-interest rate were taken from Japanese MOF data on the latest coupon rate for 10-years fixed bond and inflation indexed bond, which equal to 0.06% and 1.2% respectively.

Table 4.1 Parameters calibration for sensitivity analysis of the supply side

Parameter	Value
σ_{Fl}	0.0146
σ_{I}	0.0404
$\sigma_{Fl,I}$	8.19E-05
τ	0.2783
$g_t = E(g_{t+1})$	0.3852

I hold some assumptions to determine the value of Expected floating-interest-rate, Expected inflation rate and Expected growth rate. The Expected floating-interest-rate is the average of computed-yield-curve value on 15-years-maturity bonds range from 1991-2013, equal to 2.6%. The expected inflation rate is set at 2% as targeted under PM Abe administration. The Expected growth rate was also set at the same level, i.e. 2% as I assumed the aggregate supply curve is unit elastic.

6 This can be viewed as the opposite of short-selling in the portfolio management.

Holding these parameters and assumptions, the results obtained by assuming $\lambda_2 \neq 0$ seemed quite peculiar and impossible to achieve; it yields of ζ_t, η_t, and $\theta_t$are equals to 3.49, -3.61., and -1.12 respectively. It seems that the set of optimized variables lies beyond the boundary. From equation 13.a, 13.b, and 13.c derived above, I understand that the optimal proportion for fixed-rate, floating-rate, and inflation-indexed bonds depend on the risk appetite of the government. Hence, I simulate varied values to measure the government's risk appetite.

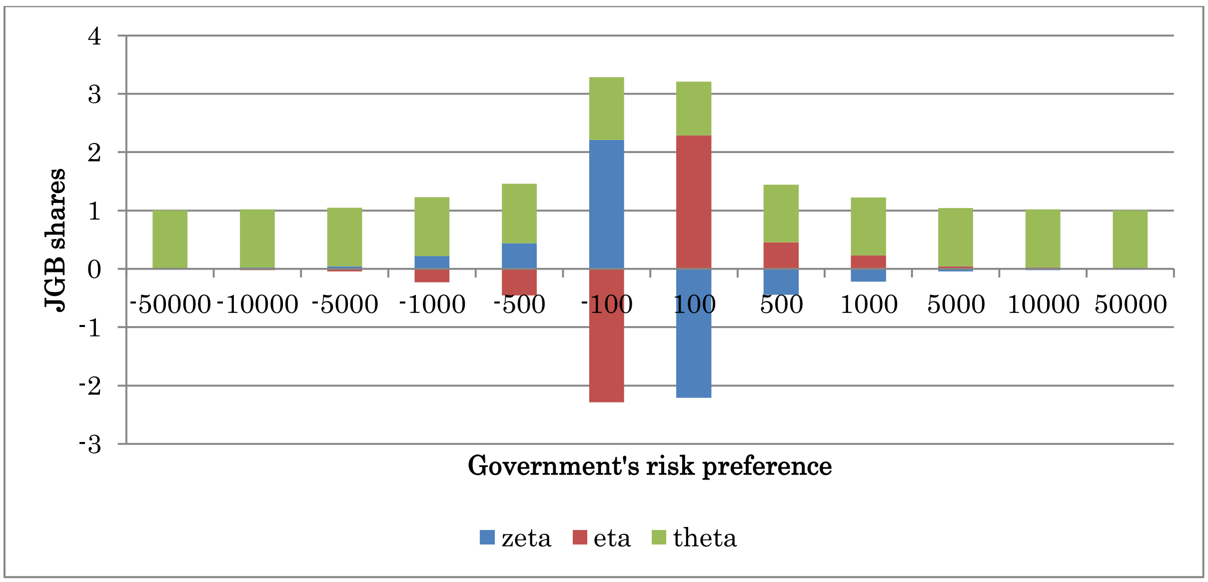


Figure 4.5 The calculated optimal share for various level of government's risk preference

As can be seen in figure 4.5, when the government imposes a risk-averse policy, the government issues more floating rate bonds and invests the excess amount of budget deficit into assets that give returns as much as offered by fixed rate bonds. On the other hand, a risk-seeker government would like to borrow fixed rate bonds and invest in assets that have similar characteristics with floating rate bonds. Interestingly, the government would like to issue almost the same amount of inflation rate bonds in any level of risk appetites. The more emphasis put into the risk appetite in either direction, the government would likely to decrease the share of other type of bonds, leaving the inflation rate bonds remained in the portfolio. This can be explained by equation 4.15.a to 4.15.c below. The limit of ζ_t* and η_t* as w goes to infinity is 0, while the limit of θ_t* is 1.

$$\lim_{w\to\infty} \zeta_t^{\ *} = 0 \tag{4.15.a}$$

$$\lim_{w\to\infty} \eta_t^{\ *} = 0 \tag{4.15.b}$$

$$\lim_{w\to\infty} \theta_t^{\ *} = 1 \tag{4.15.c}$$

Next I analyzed the effect of changes in r_t^{Fx}, r_t^I, $E\left(r_{t+1}^{Fl}\right)$, and $E(i_{t+1})$ to ζ_t, η_t, θ_t, and overall objective function E(Z). The mathematical functions are described in equation 4.16.a to 4.16.m.

$$\frac{d\zeta_t}{dr_t^{Fx}} = \frac{-\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right)}{w\left(\sigma_I^2\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) - \left(\sigma_{Fl,I} + \sigma_I^2\right)^2\right)} \tag{4.16.a}$$

$$\frac{d\eta_t}{dr_t^{Fx}} = \frac{\left(\sigma_{Fl,I} + \sigma_I^2\right)}{w\left(\sigma_I^2\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) - \left(\sigma_{Fl,I} + \sigma_I^2\right)^2\right)} \tag{4.16.b}$$

$$\frac{d\theta_t}{dr_t^{Fx}} = \frac{-\left(3\sigma_{Fl,I} - \sigma_{Fl}^2\right)}{w\left(\sigma_I^2\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) - \left(\sigma_{Fl,I} + \sigma_I^2\right)^2\right)} \tag{4.16.c}$$

$$\begin{aligned} \frac{dE(Z)}{dr_t^{Fx}} &= \left(1 + r_t^{Fx} - E(i_{t+1})\right)\frac{d\zeta_t}{dr_t^{Fx}} + \zeta_t + \left(1 + E\left(r_{t+1}^{Fl}\right) - E(i_{t+1})\right)\frac{d\eta_t}{dr_t^{Fx}} + (1 + r_t^I)\frac{d\theta_t}{dr_t^{Fx}} \\ &+ w\left(\zeta_t \frac{d\zeta_t}{dr_t^{Fx}}\sigma_I^2 + \left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right)\eta_t \frac{d\eta_t}{dr_t^{Fx}} + \left(\zeta_t \frac{d\eta_t}{dr_t^{Fx}} + \eta_t \frac{d\zeta_t}{dr_t^{Fx}}\right)\left(\sigma_{Fl,I} + \sigma_I^2\right)\right) \end{aligned} \tag{4.16.d}$$

$$\frac{d\zeta_t}{dE\left(r_{t+1}^{Fl}\right)} = \frac{\left(\sigma_{Fl,I} + \sigma_I^2\right)}{w\left(\sigma_I^2\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) - \left(\sigma_{Fl,I} + \sigma_I^2\right)^2\right)} \tag{4.16.e}$$

$$\frac{d\eta_t}{dE\left(r_{t+1}^{Fl}\right)} = \frac{-\sigma_I^2}{w\left(\sigma_I^2\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) - \left(\sigma_{Fl,I} + \sigma_I^2\right)^2\right)} \tag{4.16.f}$$

$$\frac{d\theta_t}{dE\left(r_{t+1}^{Fl}\right)} = \frac{-\sigma_{Fl,I}}{w\left(\sigma_I^2\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) - \left(\sigma_{Fl,I} + \sigma_I^2\right)^2\right)} \tag{4.16.g}$$

$$\begin{aligned}\frac{dE(Z)}{dE\left(r_{t+1}^{Fl}\right)} = {} & \left(1 + r_t^{Fx} - E(i_{t+1})\right)\frac{d\zeta_t}{dE\left(r_{t+1}^{Fl}\right)} + \left(1 + E\left(r_{t+1}^{Fl}\right) - E(i_{t+1})\right)\frac{d\eta_t}{dE\left(r_{t+1}^{Fl}\right)} + \eta_t \\ & + (1 + r_t^I)\frac{d\theta_t}{dE\left(r_{t+1}^{Fl}\right)} \\ & + w\left(\begin{array}{c}\zeta_t \frac{d\zeta_t}{dE\left(r_{t+1}^{Fl}\right)}\sigma_I^2 + \left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right)\eta_t \frac{d\eta_t}{dE\left(r_{t+1}^{Fl}\right)} \\ + \left(\zeta_t \frac{d\eta_t}{dE\left(r_{t+1}^{Fl}\right)} + \eta_t \frac{d\zeta_t}{dE\left(r_{t+1}^{Fl}\right)}\right)\left(\sigma_{Fl,I} + \sigma_I^2\right)\end{array}\right)\end{aligned} \tag{4.16.h}$$

$$\frac{d\zeta_t}{dr_t^I} = \frac{d\zeta_t}{dE(i_{t+1})} = \frac{\left(\sigma_{Fl}^2 - 3\sigma_{Fl,I}\right)}{w\left(\sigma_I^2\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) - \left(\sigma_{Fl,I} + \sigma_I^2\right)^2\right)} \tag{4.16.i}$$

$$\frac{d\eta_t}{dr_t^I} = \frac{d\eta_t}{dE(i_{t+1})} = \frac{-\sigma_{Fl,I}}{w\left(\sigma_I^2\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) - \left(\sigma_{Fl,I} + \sigma_I^2\right)^2\right)} \tag{4.16.j}$$

$$\frac{d\theta_t}{dr_t^I} = \frac{d\theta_t}{dE(i_{t+1})} = \frac{-\left(\sigma_{Fl}^2 - 2\sigma_{Fl,I}\right)}{w\left(\sigma_I^2\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) - \left(\sigma_{Fl,I} + \sigma_I^2\right)^2\right)} \tag{4.16.k}$$

$$\begin{aligned}& \frac{dE(Z)}{dr_t^I} \\ & = \left(1 + r_t^{Fx} - E(i_{t+1})\right)\frac{d\zeta_t}{dr_t^I} + \left(1 + E\left(r_{t+1}^{Fl}\right) - E(i_{t+1})\right)\frac{d\eta_t}{dr_t^I} + (1 + r_t^I)\frac{d\theta_t}{dr_t^I} + \theta_t \\ & + w\left(\zeta_t \frac{d\zeta_t}{dr_t^I}\sigma_I^2 + \left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right)\eta_t \frac{d\eta_t}{dr_t^I} + \left(\zeta_t \frac{d\eta_t}{dr_t^I} + \eta_t \frac{d\zeta_t}{dr_t^I}\right)\left(\sigma_{Fl,I} + \sigma_I^2\right)\right)\end{aligned} \tag{4.16.l}$$

$$\frac{dE(Z)}{dE(i_{t+1})} = \left(1 + r_t^{Fx} - E(i_{t+1})\right)\frac{d\zeta_t}{dE(i_{t+1})} - \zeta_t + \left(1 + E\left(r_{t+1}^{Fl}\right) - E(i_{t+1})\right)\frac{d\eta_t}{dE(i_{t+1})}$$
$$- \eta_t + (1 + r_t^I)\frac{d\theta_t}{dE(i_{t+1})}$$
$$+ w\left(\begin{array}{c}\zeta_t \frac{d\zeta_t}{dE(i_{t+1})}\sigma_I^2 + \left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right)\eta_t \frac{d\eta_t}{dE(i_{t+1})} \\ + \left(\zeta_t \frac{d\eta_t}{dE(i_{t+1})} + \eta_t \frac{d\zeta_t}{dE(i_{t+1})}\right)\left(\sigma_{Fl,I} + \sigma_I^2\right)\end{array}\right) \quad (4.16.m)$$

While, ceteris paribus, changes in the optimal JGB shares would be constant with respect to changes in interest rates and expected inflation rate, the changes of E(Z) would be dynamic and non-linear. Thus I conducted a sensitivity simulation – by adding shocks to the observed variables while keeping the other variables still – to observe the behavior of E(Z). By manipulating the model in equation 4.13.a to 4.13.c – given the parameters and assumptions and by using the current share of JGB, I found that the Japanese government has different values of risk preferences for different type of JGB. However, since the optimal share solutions only allow one value of risk preference to be applied in all type of JGB, I assign the weighted average of calculated risk preferences as the value of government risk preference in this sensitivity simulation, which is equal to -442. This value indicates that, given the parameters and assumptions, the government pursues risk seeking policy.

Table 4.2 Sensitivity analysis for changes in fixed-rate interest

	base-5%	base-1%	base	base+1%	base+5%
w	-442	-442	-442	-442	-442
r_t^{Fx}	-4.94%	-0.94%	0.06%	1.06%	5.06%
ζ_t	148.81%	69.75%	49.98%	30.22%	-48.85%
η_t	-152.44%	-71.88%	-51.73%	-31.59%	48.97%
θ_t	103.63%	102.13%	101.75%	101.38%	99.88%
$E(Z)$	-1.19751	-1.07964	-1.06007	-1.04445	-1.02156

Table 4.3 Sensitivity analysis for changes in expected floating-rate interest

	base-5%	base-1%	base	base+1%	base+5%
W	-442	-442	-442	-442	-442
$E\left(r_{t+1}^{Fl}\right)$	-2.40%	1.60%	2.60%	3.60%	8.60%
ζ_t	-50.72%	29.84%	49.98%	70.12%	170.83%
η_t	44.18%	-32.55%	-51.73%	-70.92%	-166.83%
θ_t	106.55%	102.71%	101.75%	100.79%	96.00%
$E(Z)$	-1.15331	-1.07104	-1.06007	-1.05294	-1.07491

Table 4.4 Sensitivity analysis for changes in inflation-indexed interest

	base-5%	base-1%	base	base+1%	base+5%
w	-442	-442	-442	-442	-442
r_t^I	-3.80%	0.20%	1.20%	2.20%	6.20%
ζ_t	51.86%	50.36%	49.98%	49.61%	48.11%
η_t	-46.94%	-50.78%	-51.73%	-52.69%	-56.53%
θ_t	95.08%	100.42%	101.75%	103.09%	108.42%
$E(Z)$	-0.87844	-1.02321	-1.06007	-1.09719	-1.24836

Table 4.5 Sensitivity analysis for changes in expected inflation

	base-5%	base-1%	base	base+1%	base+5%
w	-442	-442	-442	-442	-442
$E(i_{t+1})$	-3%	0.01	2%	3%	0.07
ζ_t	51.86%	50.36%	49.98%	49.61%	48.11%
η_t	-46.94%	-50.78%	-51.73%	-52.69%	-56.53%
θ_t	95.08%	100.42%	101.75%	103.09%	108.42%
$E(Z)$	-0.92352	-1.03329	-1.06007	-1.08658	-1.18994

As shown in table 4.2 to 4.5, The government would like to borrow more inflation indexed bonds. In the fixed bonds market, the government would likely to act as bonds issuer. While on the other hand, it would rather invest on assets that give similar risk and return with the floating bonds.

In table 4.2, The government would likely to decrease its share of fixed bonds should there any positive shocks in the fixed rate interest rate. The government would even to take an opposite stance when the shock quite big. On the other hand, it would increase the share of fixed rate bonds when the negative shocks happen. Similarly, the government would decrease the share of floating rate bonds when the fixed interest rate increases, and would increase the share of floating rate bonds when the fixed interest rate decreases. Meanwhile, the value of theta would increase along with the decrease of fixed interest rate. While pursuing risk seeking policy would result negative value of E(Z), the trend would be positive as the fixed rate increases.

In table 4.3, it is shown that the government would increase the share of fixed rate bonds and floating rate bonds along with the increase of expected floating rate. While theta would increase as the expected floating rate increases. The behavior of E(Z) would form an inverted U-curve. It is declining as the expected floating rate declines. Whereas it increases when there is small positive shock of expected floating rate, but then declines as the shock get bigger.

The behavior of the optimal shares of JGB would be similar with respect to changes in inflation indexed rate and the expected inflation rate. Regardless the signs, there are positive correlations between zeta and inflation indexed rate as well as with the expected inflation rate. Similarly, there are positive correlations between theta and inflation indexed rate as well as the expected inflation rate. On contrary, there are negative correlations between eta and inflation indexed rate and the expected inflation rate. Whereas, E(Z) would increase along with the decrease of inflation indexed rate and the expected inflation rate.

4.5. The role of the demand side

While the government is aiming to minimize the cost of borrowing, ultimately, the stability and sustainability of the government bonds market would also depend on liquidity and readiness of the demand side. With objectives totally opposite to the government, the demand of JGB would be dependent on Total Assets of the private sector and its risk preference (see Appendix B).

The equilibrium interest rates turn to be endogenous variables in the JGB markets as the result of the interaction of the supply side from the government and the demand side from the investors. In each market clearing condition, the endogenous fixed rate bonds' interest and inflation-indexed rate bond's interest is formulated as shown in equation 4.17 and 4.18 respectively.

$$r_t^{Fx*} = \frac{\left(b_{13}\left({b_2}^2 - \sigma_I^2\right)c_1 - b_{10}c_4\right)E(r_{t+1}^R) + (c_1c_6 + c_3c_4)E(r_{t+1}^{Fl})}{(c_2c_4 + c_1c_5)} \tag{4.17}$$

$$r_t^{I*} = \frac{\left(c_2b_{13}\left({b_2}^2 - \sigma_I^2\right) + c_5b_{10}\right)E(r_{t+1}^R) + (c_2c_6 - c_3c_5)E(r_{t+1}^{Fl}) - (c_2c_4 + c_1c_5)E(i_{t+1})}{(c_2c_4 + c_1c_5)} \tag{4.18}$$

Where

$$b_1 = \left(\sigma_R^2 + \sigma_I^2 - 2\sigma_{R,I}\right) \tag{4.19.a}$$

$$b_2 = \left(\sigma_{R,I} - \sigma_I^2\right) \tag{4.19.b}$$

$$b_3 = \left(\sigma_{R,Fl} - \sigma_{R,I} - \sigma_{Fl,I} + \sigma_I^2\right) \tag{4.19.c}$$

$$b_4 = \left(\sigma_{Fl,I} - \sigma_I^2\right) \tag{4.19.d}$$

$$b_5 = \left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) \quad (4.19.e)$$

$$b_6 = (b_2 b_3 - b_1 b_4)^2 - \left({b_2}^2 - \sigma_I^2\right)\left({b_3}^2 - b_1 b_5\right) \quad (4.19.f)$$

$$b_7 = \left(\left(b_3 {b_2}^2 - b_3 \sigma_I^2\right)(b_1 b_2 b_4 - b_3 \sigma_I^2) + b_6 \sigma_I^2 + {b_2}^2 b_3 - b_1 b_2 b_4\right) \quad (4.19.g)$$

$$b_8 = b_1(b_2 b_6 + b_2 b_3 - b_1 b_4) \quad (4.19.h)$$

$$b_9 = b_1\left({b_2}^2 - \sigma_I^2\right)(b_1 b_2 b_4 - b_3 \sigma_I^2) \quad (4.19.i)$$

$$b_{10} = \left(b_2 b_6 - b_2(b_2 b_3 - b_1 b_4)^2 + b_3\left({b_2}^2 - \sigma_I^2\right)(b_2 b_3 - b_1 b_4)\right) \quad (4.19.j)$$

$$b_{11} = b_1((b_2 b_3 - b_1 b_4)^2 - b_6) \quad (4.19.k)$$

$$b_{12} = \left(b_{15}(b_2 b_3 - b_1 b_4)\right) \quad (4.19.l)$$

$$b_{13} = (\sigma_I^2 b_3 - b_1 b_2 b_4) \quad (4.19.m)$$

$$b_{14} = b_1(b_2 b_3 - b_1 b_4) \quad (4.19.n)$$

$$b_{15} = b_1\left({b_2}^2 - \sigma_I^2\right) \quad (4.19.o)$$

$$c_1 = \left(\left(\sigma_{Fl}^2 - 3\sigma_{Fl,I}\right)d + b_{10} + b_{11} - b_{12}\right) \quad (4.19.p)$$

$$c_2 = \left(\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right)d + b_{11}\right) \quad (4.19.q)$$

$$c_3 = \left(b_{12} + \sigma_{Fl,I} + \sigma_I^2\right)d \quad (4.19.r)$$

$$c_4 = \left((b_{13} - b_{14} + b_{15})\left({b_2}^2 - \sigma_I^2\right) - \sigma_{Fl,I} d\right) \quad (4.19.s)$$

$$c_5 = \left(\left(\sigma_{Fl,I} + \sigma_I^2\right)d + b_{14}\left({b_2}^2 - \sigma_I^2\right)\right) \quad (4.19.t)$$

$$c_6 = \left(b_{15}\left({b_2}^2 - \sigma_I^2\right) + \sigma_I^2 d\right) \quad (4.19.u)$$

$$d = \frac{v\left({b_2}^2 - \sigma_I^2\right) b_6 (X_t + G_t - \tau Y_t)}{w\left(\sigma_I^2\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) - \left(\sigma_{Fl,I} + \sigma_I^2\right)^2\right) A_t^B} \quad (4.19.v)$$

v and ϕ denote the private sector's risk appetite and share of total government securities over the total assets of the private sector respectively. A positive value of v means that the investor is a risk averse. On contrary, a negative value of v indicates that the investor is a risk seeker.

While it is important for determining the equilibrium values in the market, these investors' risk preferences were unknown and might be varied across bonds type and maturities. I performed simulations to observe the value of r_t^{Fx*} and r_t^{I*} for various risk preferences of the private sector. I set the government's risk appetites at -442 for similar reason as explained in section 4.4. Other calibrations for performing the simulation are shown in table 4.6.

Table 4.6 Parameters and Exogenous variables calibration for sensitivity analysis of the demand side

Parameter and Exogenous variables	Value
r_{t-1}^{Fx}	0.0006
$E_{t-1}(r_t^{Fl}) = E(r_{t+1}^{Fl})$	0.0260
r_{t-1}^{I}	0.0120
$E(r_{t+1}^{R})$	0.0528
σ_{Fl}	0.0146
σ_I	0.0404
σ_R	0.0270
$\sigma_{Fl,I}$	8.19E-05
$\sigma_{I,R}$	0.0008
$\sigma_{Fl,R}$	0.0001
$E(i_{t+1})$	0.0200
ϕ	0.1682

As mentioned before, since there are no zero bound constraints for the optimal shares, the optimal shares could be negative. Negative shares can be interpreted as investments for government, or borrowings for the private sectors. However, since there are only two agents in the market, the government and private sector must have opposite stances in each market. Cases that both government and private sector both act as purchasers or bonds issuers should be neglected. Therefore, I would only focus to cases that fulfill $\frac{\beta_t}{\zeta_t} > 0$, $\frac{\gamma_t}{\eta_t} > 0$, and $\frac{\delta_t}{\theta_t} > 0$ simultaneously.

Implementing this restriction, I found that the private sector would be risk averse when the government is risk seeker. The possible range or private sector's risk preferences given the parameters and assumptions are v > 58. As depicted in figure 4.6 and 4.7 both the government and private sector would decrease the share of fixed rate bonds and increase the share of inflation indexed bonds as the investors become more risk averse. This would yield uncertain outcome of the interest rates. However, simulation shows that both r_t^{Fx*} and r_t^{I*} would slightly increase as private sector's risk preference increases in Figure 4.8.

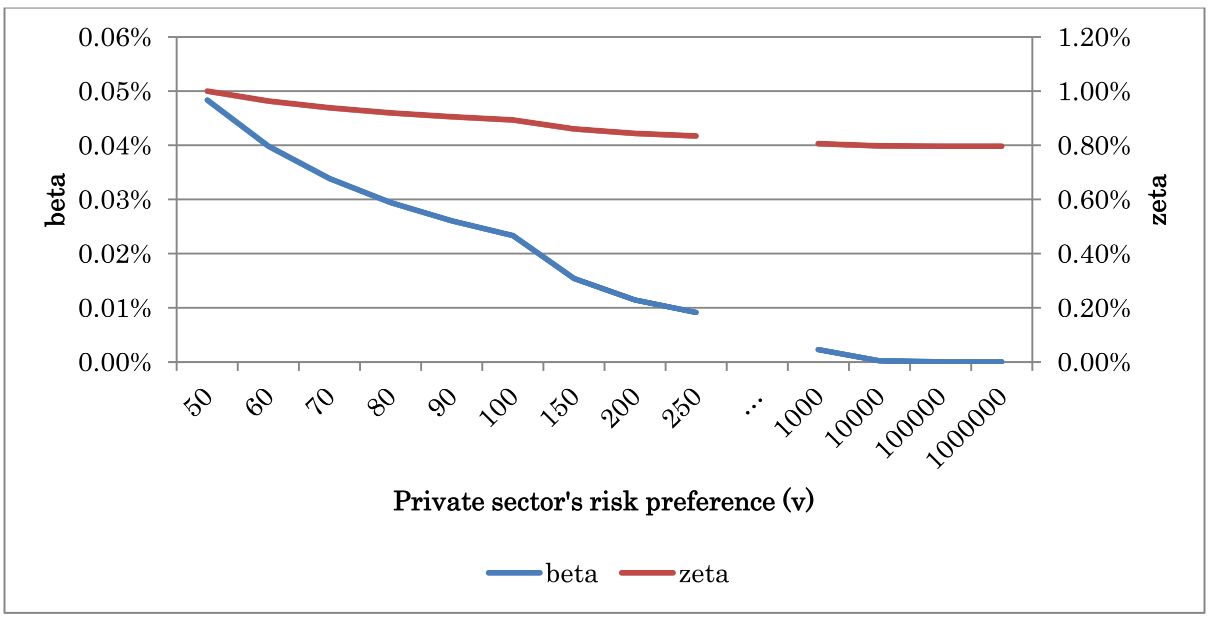


Figure 4.6 The behavior of shares of fixed rate bonds for various values of private risk preferences when the government is risk seeker

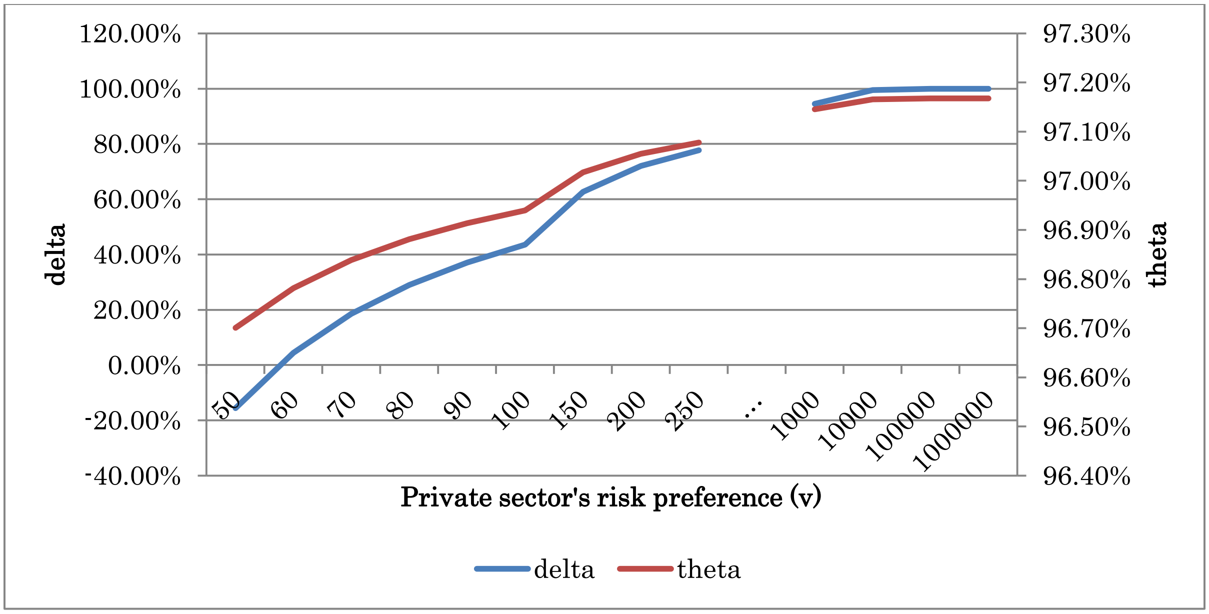


Figure 4.7 The behavior of shares of inflation indexed bonds for various values of private risk preferences when the government is risk seeker

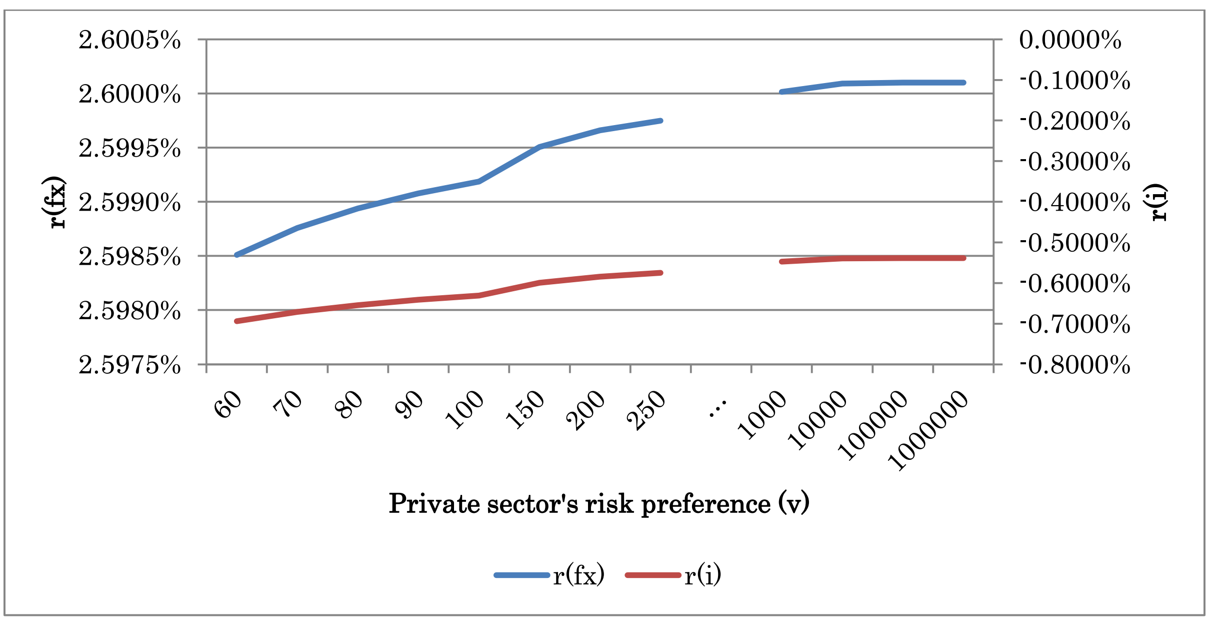


Figure 4.8 The behavior of fixed bonds interest rate and inflation indexed bonds interest rate for various values of private risk preferences when the government is risk seeker

Next, I would like to investigate the impact of changes of total-government-bonds-to-total-assets ratio on r_t^{Fx*} and r_t^{I*}. As mentioned above, in conducting this analysis I assume that the government and private sector are taking opposite stances to each other. I set values equal to 60 for the private sector's risk appetite. This value is the weighted average of calculated private sector's risk appetites given the parameters and assumptions. Whereas for government's risk preference I assign value equal to -442. As shown in figure 4.10, both r_t^{Fx*} and r_t^{I*}will increase as the ownership of government bonds increases relative to other assets. This could be caused by one of these two reasons: (1) the bond ownership is increasing while the total assets of the private sector is decreasing, or increasing at slower rate, or (2) the private sector might lower their bond ownership, but the total assets is also decreasing even faster. This also implies that a steady (or even decreasing) level of total-government-bonds-to-total-assets ratio would cause sustainable government bonds in terms of a steady cost of borrowing. This would explain why the interest rate keeps steady in the JGB market.

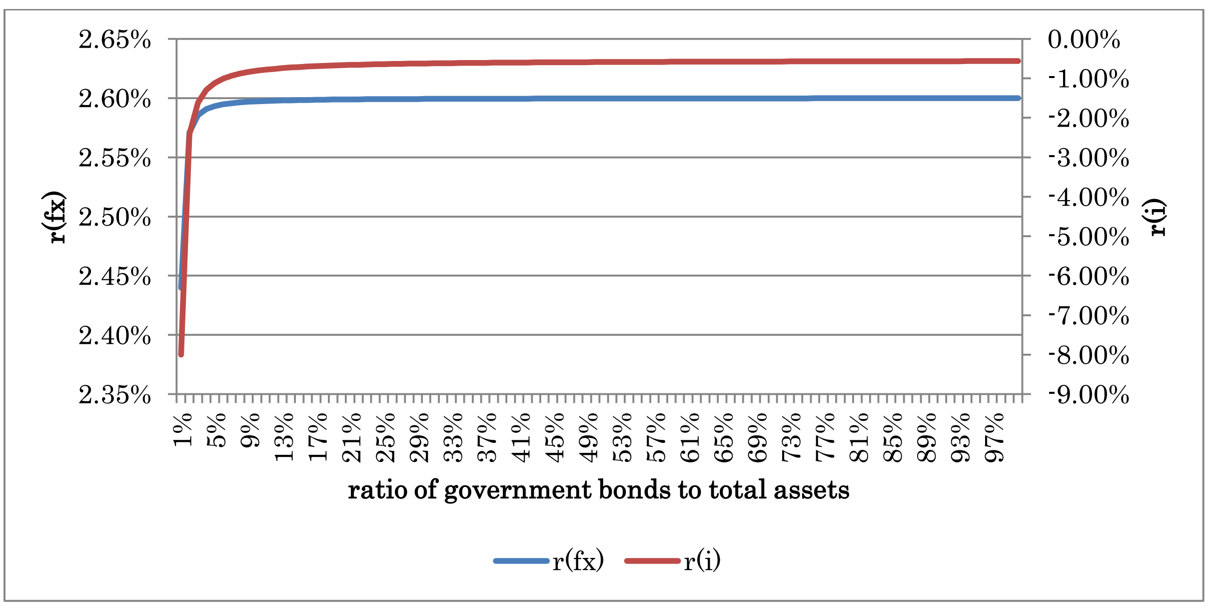


Figure 4.3 r_t^{Fx*} and r_t^{I*} behavior towards changes in Share of Total government securities over Total Assets

4.6. Concluding remark

The Japanese government is currently suffering from high outlays of debt. Despite the worrisome figure of Debt-to-GDP ratio, the JGB's interest rate seemed to be steady at a low level. The challenge faced by the Japanese government is then how to keep the low cost borrowing while mitigating the risk simultaneously.

In order to diversify their risks and to attract a wider range of investors, the Japanese government issued four types of bonds, i.e. Zero coupon bonds, Fixed-rate bonds, Floating-rate bonds, and Inflation-indexed bonds. I developed a simple equilibrium model to obtain the optimal proportion of each type of JGB. With the objective of minimizing the cost of borrowing, I included deterministic risks embedded in each type of JGB in the model development. In this model I exclude Zero coupon bonds for simplicity.

I equipped the model with sensitivity simulations to understand how the optimal proportion of JGB would change when certain variables changes. Given some strict parameters I found that the optimal proportion for fixed-rate, floating-rate, and inflation-indexed bonds depend on the risk appetite of the government. I also found that the government should pursue a different strategy depending on whether they are imposing risk averse or risk seeking policy.
Take into account the investor's behavior on the demand side, given the parameters and assumptions, it appears that the risk appetites of government and private sector were opposite to each other. In addition, the stability of the bonds market would also be affected by the wealth of the investors since there is a positive correlation between interest rates and the ownership of government bonds relative to other assets owned by investors.

Appendix B

Suppose that Total Assets of private sectors (A_t^B) is distributed into fixed rate bonds (B_t^{BFx}), floating rate bonds (B_t^{BFl}), inflation-indexed bonds (B_t^{BI}), and real assets (RA_t^B). The private sector's budget then is described as:

$$A_t^B = RA_t^B + B_t^{BFl} + B_t^{BFx} + B_t^{BI} \tag{B.1}$$

Let α_t, β_t, γ_t, and δ_t be the current share of Real Assets, Fixed-rate bonds, Floating rate bonds, and Inflation-indexed bonds respectively, equation B.1 then could be rewritten as

$$\alpha_t + \beta_t + \gamma_t + \delta_t = 1 \tag{B.2}$$

The Private sector's objective function is to maximize its expected real return from the assets as well as minimizing the risk. Mathematically it is described as

$$\max_{\alpha_t, \beta_t, \gamma_t, \delta_t} U = E(r_{t+1}^B) - \frac{v}{2}\sigma_B^2 \tag{B.3}$$

Subject to equation A.2, whereas

$$E(r_{t+1}^B) = a_t\left(1 + E(r_{t+1}^R) - E(i_{t+1})\right) + \beta_t\left(1 + r_t^{Fx} - E(i_{t+1})\right) + \gamma_t\left(1 + E(r_{t+1}^{Fl}) - E(i_{t+1})\right) + \delta_t(1 + r_t^I) \tag{B.4}$$

$$\sigma_B^2 = a_t^{\,2}\left(\sigma_R^2 + \sigma_I^2 - 2\sigma_{R,I}\right) + \beta_t^{\,2}\sigma_I^2 + \gamma_t^{\,2}\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) + 2a_t\beta_t\left(\sigma_{R,I} - \sigma_I^2\right) + 2a_t\gamma_t\left(\sigma_{R,Fl} - \sigma_{R,I} - \sigma_{Fl,I} + \sigma_I^2\right) + 2\beta_t\gamma_t\left(\sigma_{Fl,I} - \sigma_I^2\right) \tag{B.5}$$

v denotes the risk preference of the private sector.

Satisfying the necessary conditions, where $\frac{\partial U}{\partial \alpha_t} = 0$, $\frac{\partial U}{\partial \beta_t} = 0$, $\frac{\partial U}{\partial \gamma_t} = 0$, $\frac{\partial U}{\partial \delta_t} = 0$, $\frac{\partial U}{\partial \lambda} = 0$, I obtained the optimal share of Real Assets, Fixed-rate bonds, Floating rate bonds, and Inflation-indexed bonds for the private sector as follows:

$$\alpha_t{}^* = \frac{\left(-b_7 E(r_{t+1}^R) + b_8 r_t^{Fx} + b_9 E(r_{t+1}^{Fl}) + (b_7 - b_8 - b_9)(E(i_{t+1}) + r_t^I)\right)}{v b_1 \left(b_2{}^2 - \sigma_I^2\right) b_6} \quad \text{B.6}$$

$$\beta_t{}^* = \frac{\left(b_{10} E(r_{t+1}^R) + b_{11} r_t^{Fx} - b_{12} E(r_{t+1}^{Fl}) - (b_{10} + b_{11} - b_{12})(E(i_{t+1}) + r_t^I)\right)}{v \left(b_2{}^2 - \sigma_I^2\right) b_6} \quad \text{B.7}$$

$$\gamma_t{}^* = \frac{\left(b_{13} E(r_{t+1}^R) - b_{14} r_t^{Fx} + b_{15} E(r_{t+1}^{Fl}) - (b_{13} - b_{14} + b_{15})(E(i_{t+1}) + r_t^I)\right)}{v b_6} \quad \text{B.8}$$

$$\delta_t{}^* = 1 - \frac{\begin{pmatrix} (b_1 b_{10} + b_{15} b_{13} - b_7) E(r_{t+1}^R) + (b_1 b_{11} + b_8 - b_{14} b_{15}) r_t^{Fx} \\ +\left(b_9 + b_{15}{}^2 - b_1 b_{12}\right) E(r_{t+1}^{Fl}) \\ + \begin{pmatrix} (b_7 - b_8 - b_9) - b_1(b_{10} + b_{11} - b_{12}) \\ -b_{15}(b_{13} - b_{14} + b_{15}) \end{pmatrix} (E(i_{t+1}) + r_t^I) \end{pmatrix}}{v b_1 \left(b_2{}^2 - \sigma_I^2\right) b_6} \quad \text{B.9}$$

Chapter 5

Conclusion

This dissertation consists of three essays that study about investor's behavior and optimal structure in Indonesian and Japanese government bonds market. Each of which were presented in Chapter 2, Chapter 3, and Chapter 4 of this dissertation book.

In the first study, I investigated the investment patterns and investment performance in the Indonesian goverment bonds market. I compared foreign portfolio investments to other investor groups', i.e. banks, insurances, mutual funds, pension funds, and securities. The data set includes the accumulation of monthly market capitalization, both purchases and sales, of each investor group and market performance (represented by the returns of IGBX) from July 2004 until December 2010.

I examined if herding behavior exists among investor groups. By using ANOVA and Tamhane Multiple Comparison Test it can be conclude that banks and securities tend to be in the same trade patterns while insurances, mutual funds, and pension funds were forming another trade patterns. In addition, the trade patterns of those two groups seemed to be opposite to each other. further examination through Cholesky impulse-response analysis shows that there is a measurable negative response of foreign investors' NIF towards impulse from bank's NIF. This could be an indication that in the Indonesian Government Bond market foreign investors have become market follower instead of market leader.

Through a simple bivariate VAR (p) model, I also investigated whether feedback trading occurs in government bonds market by each investor group while simultaneously examine whether their behavior considered as rational herding or just following fads. The examination yields that there is not enough evidence to determine whether these investors are feedback traders or not, except for mutual funds. Mutual funds seemed to be negative feedback traders since it shows negative correlation between the NIFs and lagged market returns. Banks', pension funds', and foreign investors' NIFs are positively correlated with their own lagged variable. Nevertheless, many other factors might be considered by these investors when making investment decision since the R^2 are very low. Likewise, there is not enough evidence to determine whether the investors are rational traders or not, except for pension funds. There is a statistically significant negative correlation between pension funds' NIF and market return in the 2 months lag. This makes pension funds fall into irrational traders category based on Nofsinger and Sias' definition.

Analysis on investors' portfolio performance in the past yields that banks, securities, and foreign investors have positive cumulative return at the end of period, while mutual funds, pension funds, and insurance companies have negative cumulative return at the end of periods. It seems that banks and foreign investors negate each other along the period since they are the main counterparts to each other. In addition, even though experiencing downtrend since the first sub-prime mortgage crisis in June 2007, foreign investors keep having the largest cumulative return along the sample period.

The finding in the second chapter does not surprising since widespread perception that foreign investors may have information advantages since they have significant amount of liquidity, experience and expertise in Indonesian Government Bond market. Along with the fact that foreign ownership is very large in terms of general government debt in Indonesia, this finding may unveil the hazard of greater involvement of foreign investors for two reasons. First, as suggested by Wang (2007), greater foreign investors involvement associated with greater volatility and risk in the market. Second, there might be negative feedback to the economy since there is no certainty that profits earned by foreign investors were re-invested back into Indonesia.

Further, while Indonesian government is developing domestic government debt market to reduce exchange rate risk, still maintains abundant amount of external debts. I developed a simple general equilibrium model to determine the optimal share these two kinds of debts. I set government's objective function is to minimize the interest payments in the future and the new borrowings at present as well. I found no specific optimal amount of debt shall be issued by Indonesian government. The government should arrange the share of domestic and external debt thus interest rates must satisfy condition below:

$$r_t^d = r_t^f \frac{E(e_{t+1})}{e_t} \tag{5.1}$$

Involving the demand side would be necessary to get the optimal structure of government debt. While assuming the demand for external debt is perfectly elastic, I employed a Keynesian approach to develop the demand for domestic debt. In equilibrium, the equation for the optimal share of domestic and external debt is described as follows:

$$B_t^D = \gamma_0 + \gamma_1 r_t^f \zeta + \gamma_2 r_t^{dep} + \gamma_3 r_t^{US} + \gamma_4 G_t + \gamma_5 W_{t-1} + \gamma_6 e_t + \left(\gamma_7 + \gamma_1 r_t^f\right) \frac{(1-\zeta) E_{t-1}(e_t)}{e_t} + \epsilon_{B^D} \tag{5.2}$$

$$B_t^F = \frac{-h \pm \sqrt{h^2 - 4gi}}{2g} \tag{5.3}$$

In addition, I also run some simulations to understand the behavior of the optimal debts. The back testing simulation suggests that the Indonesian government has to reduce the level of its external debt. Through a dynamic recursive simulation, it is suggested that, in the long run, the government must not hold any external debt while the Debt-to-GDP ratio is maintained at a level of 16%-17%.

Japanese Government Bond market is a perfect example of how a government could maintain a fully domestic debt. Despite the worrisome figure of Debt-to-GDP ratio, the JGB’s interest rate seemed to be steady at low level. In order to diversify their risks and to attract a wider range of investors, the Japanese government issued four types of bonds, i.e. Zero coupon bonds, Fixed-rate bonds, Floating-rate bonds, and Inflation-indexed bonds. In Chapter 4, I developed a simple equilibrium model to obtain the optimal proportion of each type of JGB. With the objective of minimizing the cost of borrowing, I included deterministic risks embedded in each type of JGB in the model development.

There are two sets of possible share combinations of JGB types. The first set does not include government risk appetite in the equation whereas the second combination depends on government risk appetite. From sensitivity analysis simulation, I found that the first equations set yields very peculiar result. Therefore, the second equations set were the most probable model to be pursued. The equations in the second set are described as follows:

$$\zeta_t{}^* = \frac{\left(r_t^I + E(i_{t+1})\right)\left(\sigma_{Fl}^2 - 3\sigma_{Fl,I}\right) - r_t^{Fx}\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) + E\left(r_{t+1}^{Fl}\right)\left(\sigma_{Fl,I} + \sigma_I^2\right)}{w\left(\sigma_I^2\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) - \left(\sigma_{Fl,I} + \sigma_I^2\right)^2\right)} \quad (5.4.a)$$

$$\eta_t{}^* = \frac{-\left(r_t^I + E(i_{t+1})\right)\sigma_{Fl,I} + r_t^{Fx}\left(\sigma_{Fl,I} + \sigma_I^2\right) - E\left(r_{t+1}^{Fl}\right)\sigma_I^2}{w\left(\sigma_I^2\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) - \left(\sigma_{Fl,I} + \sigma_I^2\right)^2\right)} \quad (5.4.b)$$

$$\theta_t{}^* = 1 - \frac{\left(r_t^I + E(i_{t+1})\right)\left(\sigma_{Fl}^2 - 2\sigma_{Fl,I}\right) + r_t^{Fx}\left(3\sigma_{Fl,I} - \sigma_{Fl}^2\right) + E\left(r_{t+1}^{Fl}\right)\sigma_{Fl,I}}{w\left(\sigma_I^2\left(\sigma_{Fl}^2 + \sigma_I^2 - 2\sigma_{Fl,I}\right) - \left(\sigma_{Fl,I} + \sigma_I^2\right)^2\right)} \quad (5.4.c)$$

I found that the optimal proportion for fixed-rate, floating-rate, and inflation-indexed bonds depend on the risk appetite of the government. I also found that the government should pursue a different strategy depending on whether they are imposing risk averse or risk seeking policy. Taking into account the investor's behavior on the demand side, given the parameters and assumptions, it appears that the risk appetites of government and private sector were opposite to each other In addition, the stability of the bonds market would also be affected by the wealth of the investors since there is a positive correlation between interest rates and the ownership of government bonds relative to other assets owned by investors.

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