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Balance Sheet Approach for Fiscal Sustainability in Indonesia

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ABSTRACT

This paper models fiscal sustainability in Indonesia using the measure of liabilities-to-asset ratio (LAR), a simple measure of a country's balanced-sheet. It uses the approach of conditional value-at-risk (VaR), assuming normal or t distributions, to define the risky level. The conditional standard deviation in the conditional VaR is modeled using a univariate generalized autoregressive heteroscedasticity (GARCH) family model. The conditional mean equation is modeled using a simple autoregressive equation. Using quarterly data from 1990 to 2014, the paper finds that the autoregressive term significantly influences the conditional mean of LAR. It also finds that both ARCH and GARCH terms significantly influence the conditional variance. Applying the conditional variance to calculate conditional VaR with 95% confidence level, and comparing the result with the actual LAR, it finds that there are no violations occurred during the period of estimation. This means that the fiscal sustainability in Indonesia is deemed safe. The violation occurs using the confidence level of 90% only.

Keywords: Fiscal Sustainability, Liabilities-to-Asset Ratio, Univariate Generalized Autoregressive Heteroscedasticity, Conditional Value-at-Risk
JEL Classifications: H62, H63, H81

1. INTRODUCTION

Fiscal sustainability has become an important international issue following the more turbulence international economies which had created various shocks endangering fiscal sustainability (European Commission, 2012 for various country cases of fiscal sustainability investigation). This issue is also crucial in lower level of economies, such as provinces and districts levels.

Atiyas (1995) mentioned that the failure in fiscal policy indicates a failure of fiscal governance. The inability of the state to resolve problems of cooperation between political actors also influence such failure. Brondolo et al. (2001) investigate administration reform and fiscal adjustment in Indonesia. They find that Indonesia initiated an economic reform program in 2000 to achieve high economic growth, maintaining inflation, and achieving fiscal sustainability. It manages to reduce the debt-to-gross domestic product (GDP) ratio from 25% to 65% in 2000.

Various attempts have been made to evaluate, measure, and provide warning systems which can define, warn, and suggests solutions regarding fiscal sustainability. Some papers suggest the importance of currency mismatch to evaluate the currency composition of explicit government liabilities. Papers investigate such approach are Calvo et al. (2003) and Hausmann and Panizza (2003), among others. Bussiere et al. (2004), investigating 28 emerging markets, show that if a significant share of the debt is denominated in foreign currency-creating a currency mismatch- and borrowing is constrained by solvency, then currency mismatch can create and exacerbate a maturity mismatch. Currency miss-match is also applied in banking sector to control unhedged borrowing from the volatility of exchange rates (Ranciere et al., 2010). The main problem of the aforementioned measure is that the liabilities included in the model usually consists only explicit government liabilities. This will underestimate the total amount of liabilities.

Baldacci and Petrova (2011) develop indicators for fiscal sustainability and fiscal stress following a framework of rollover risk developed by Cottarelli (2011). The indices show that developed countries have higher fiscal vulnerability that the emerging countries. Jedrzejowicz and Kozinski (2012) propose a framework to assess country's fiscal position, consisting of five elements, namely the level of public debt, the medium-term dynamics of public debt, long-term sustainability of public debt; public debt management and the liquidity position of the government, and fiscal rules and institutions. They present an assessment of Poland's fiscal vulnerability using the framework above, and find that Poland's vulnerability to fiscal risks is quite limited.

Another approach to fiscal sustainability of the debt-to-GDP (Adrogue, 2005). This measure shares the same problem with the currency mismatch approach to fiscal sustainability, in which the ratio excludes various types of government liabilities and assets. A better measure for fiscal solvency would be the balanced-sheet approach which accommodates various liabilities and assets of government. Therefore, the ratio used to measure the fiscal solvency would be liabilities-to-asset ratio (LAR). The government balanced-sheet in this case is government financial and real assets and the present value of tax revenue. These various types of non-debt liabilities and assets might be influenced by changes in real exchange rates and domestic and international interest rates. Fiscal liabilities, namely pension and wages, are denominated in domestic currency, but tax on tradable goods are, partly, denominated in foreign currencies, such tax on exported goods. Therefore, currency depreciation could increase government income, and currency appreciation could decrease government income.

Measuring debt sustainability using debt-to-asset ratio is considered as more appropriate than the traditional debt-to-GDP ratio since shocks also influence the government assets. This paper models fiscal sustainability or fiscal vulnerability using conditional value-at-risk (VaR) of ratio liabilities-to-asset. This model describes the condition of all components in the balanced-sheet.

2. METHOD

This paper analyzes data on Indonesia balance sheet using a simple analysis, namely modeling LAR. This ratio is an alternative measure for the famous debt-to-GDP ratio (Adrogue, 2005). This paper uses a simple autoregressive equation to model the first moment of LAR. This kind of model is famous for its power to forecast, even though it does not give a mean to control the LAR, since no other exogenous variables included in the model. The alternative models that can be used include the moving average (MA), autoregressive MA (ARMA), or autoregressive integrated MA models. This type of models provides a possibility to include exogenous variables, and called as ARMAX, which X symbolizes the possible exogenous variables. For the second moment regression, this paper uses a simple univariate generalized autoregressive heteroscedasticity (GARCH) model of Bollerslev (1986), which is a generalized model of univariate ARCH model of Engle (1982).

The result of the second moment regression, which is the conditional variance, is used as the ingredient to calculate the conditional standard deviation (sometimes called conditional volatility). The conditional volatility is then used to estimate the VaR for LAR. Since the VaR uses conditional volatility, it is also famous as conditional VaR.

The VaR of the LAR is expected to represent the country's balance sheet, since the ratio is calculated using all types of liabilities (explicit liabilities, contingent liabilities, net present value [NPV] of social security, NPV of health insurance, NPV of other insurance, and net worth), and all types of assets (liquid asset, physical asset, NPV of tax revenue, and net worth of state-owned-enterprise). This VaR provides a warning of risky situation when the actual value of LAR is lower than the corresponding conditional VaR.

Limited amount of researches on VaR for both debt-to-GDP ratio and LAR have been conducted. Forecast of VaR for balance sheet has been done by Barnhill and Kopits (2003), using unconditional VaR. Forecast of unconditional VaR for debt-to-GDP ratio has been conducted by Adrogue (2005). This paper estimates conditional VaR on LAR, which is an extension of those researches.

3. RESULTS

The data used in this paper is quarterly data on LAR. Both data on liabilities and asset are taken from Asian Development Bank (2014), ranges from Quarter 1, 2009 to Quarter 3, 2014, with the total of 19 observations.

The model to estimate is as follows:

$$LAR_t=\beta_0+\beta_1 LAR_{t-1}+\varepsilon_t \tag{1}$$

$$\varepsilon_t = \eta_t \sqrt{h_t} \tag{2}$$

$$h_t = \omega+\alpha\varepsilon_{t-1}^2 + \beta h_{t-1} \tag{3}$$

Where, LAR is liabilities-to-asset ratio. Equation (1) represents the first moment regression. Equation (2) represents the components of residuals (ε_t), which are the standardized residuals (η_t) and the volatility ($\sqrt{h_t}$). Equation (3) models the conditional variance as the function of log of squared residual (ARCH term) and lag of conditional variance (GARCH term).

VaR for LAR_t can be calculated as:

$$VaR_t=E(y_t|F_{t-1})-z\sqrt{h_t}\ , \tag{4}$$

with h_t resulted from Equation (3).

The estimation results are presented in Table 1.

Table 1: Estimation results

Conditional mean equation. The dependent variable is LAR			
Variable	**Coefficient**	**t-statistic**	**P**
C	0.282990	7.610423	0.0000
AR (1)	0.767314	4.664900	0.0000
Conditional variance equation. The dependent variable is h_t			
C	0.000105	1.789012	0.0736
Residual(−1) ^{2}	−0.270268	−175.7737	0.0000
GARCH(−1)	1.190287	37.65443	0.0000

GARCH: Generalized autoregressive heteroscedasticity, LAR: Liabilities-to-asset ratio

From the result of first moment regression, it can be seen that AR(1) terms significantly influence the LAR (the P is 0.0000 and the t-statistic is 4.67, which is far more than 2). From the result of second moment regression, it can be inferred that both ARCH and GARCH terms significantly influence the conditional variance. It can be confirmed from the probability of both terms which are 0.000, and the t-statistics which are −175.77 and 37.65 for ARCH and GARCH terms, respectively.

The serial GARCH resulted from the estimation are then used to calculate the VaR. The serial GARCH and its square root, namely the volatility (standard deviation) are in column 3 and 5 of Table 1, respectively. The VaR based on z and t distributions, using 5% significance level, are in column 6 and 8, respectively. The violation, namely the difference between actual LAR and the VaR for z and t distributions are in column 7 and 9, respectively.

It can be seen that there are no negative values in both column 7 and 9, showing that during the period of evaluation, the fiscal sustainability is not in risky situations (Table 2). These situations are depicted in Figures 1 and 2 for normal and t distributions, respectively.

VaR assuming normal distribution with confidence level of 90% (or significance level of 10%) can be seen in column 6 of Table 3. The violations of this distribution are provided in column 7. We can see three violations in this case, namely in first quarter 2010, second quarter 2011, and second quarter 2012, which indicate that during such periods, the fiscal positions are in a risky state. These situations are depicted in Figure 3.

VaR assuming t distribution with confidence level of 90% (or significance level of 10%) can be seen in column 7 of Table 3. The violations of this distribution are provided in column 9. We can see two violations in this case, namely in first quarter 2010 and second quarter 2012, which indicate that during such periods, and the fiscal positions are in a risky state. This finding indicates that the fiscal capacity is not in its optimum size (Sriyana, 2016). These situations are depicted in Figure 4.

4. CONCLUSION

This paper models fiscal risk in Indonesia. It uses balanced-sheet approach using LAR measure. This approach is considered better

Figure 1: Actual liabilities-to-asset ratio and the corresponding value-at-risk, normal distribution, 5% significance level

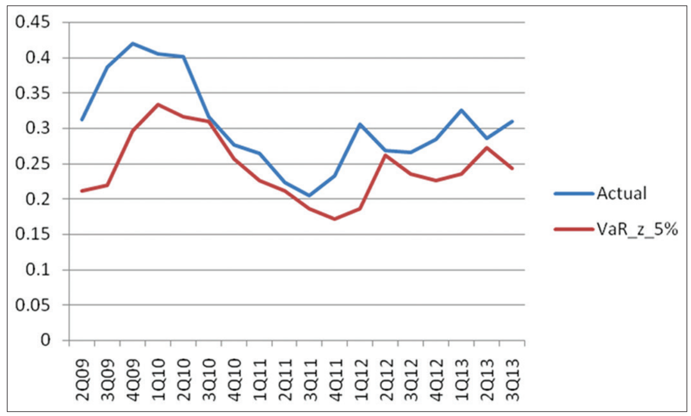


Table 2: Conditional VaR calculation using 5% significance level, 2010-2014

Quarter	Actual	GARCH	Vol	Fitted	VaR_z	Violation_z	VaR_t	Violation_t
1	2	3	4	5	6	7	8	9
2Q10	0.311446	0.00228	0.047746	0.289938	0.211158	−0.1003	0.206861	−0.1046
3Q10	0.385664	0.002694	0.051902	0.304825	0.219187	−0.1665	0.214515	−0.1711
4Q10	0.419212	0.001546	0.039314	0.361774	0.296905	−0.1223	0.293367	−0.1258
1Q11	0.404582	0.001053	0.032457	0.387515	0.33396	−0.0706	0.331039	−0.0735
2Q11	0.401054	0.001281	0.035786	0.376289	0.317242	−0.0838	0.314021	−0.0870
3Q11	0.315753	0.001464	0.038262	0.373583	0.31045	−0.0053	0.307007	−0.0087
4Q11	0.275259	0.000944	0.030727	0.308129	0.25743	−0.0178	0.254665	−0.0206
1Q12	0.263491	0.000937	0.030613	0.277058	0.226546	−0.0369	0.223791	−0.0397
2Q12	0.223327	0.001171	0.034223	0.268028	0.211561	−0.0118	0.208481	−0.0148
3Q12	0.20421	0.000959	0.030974	0.23721	0.186102	−0.0181	0.183315	−0.0209
4Q12	0.232588	0.000953	0.030872	0.222541	0.171603	−0.0610	0.168824	−0.0638
1Q13	0.305234	0.001213	0.034822	0.244316	0.18686	−0.1184	0.183727	−0.1215
2Q13	0.267869	0.000546	0.023361	0.300058	0.261512	−0.0064	0.259409	−0.0085
3Q13	0.264698	0.000475	0.021794	0.271387	0.235427	−0.0293	0.233466	−0.0312
4Q13	0.283541	0.000659	0.025665	0.268954	0.226607	−0.0569	0.224297	−0.0592
1Q14	0.32464	0.000832	0.028843	0.283413	0.235821	−0.0888	0.233225	−0.0914
2Q14	0.284986	0.000636	0.025225	0.314949	0.273328	−0.0117	0.271058	−0.0139
3Q14	0.308983	0.00062	0.024903	0.284522	0.243432	−0.0656	0.241191	−0.0678

VaR: Value-at-risk, GARCH: Generalized autoregressive heteroscedasticity

Table 3: Conditional VaR calculation using 10% significance level

Quarter	Actual	GARCH	Vol	Fitted	VaR_z	Violation_z	VaR_t	Violation_t
1	2	3	4	5	6	7	8	9
2Q09	0.311446	0.00228	0.047746	0.289938	0.228346	−0.0831	0.226293	−0.0852
3Q09	0.385664	0.002694	0.051902	0.304825	0.237871	−0.1478	0.23564	−0.1500
4Q09	0.419212	0.001546	0.039314	0.361774	0.311058	−0.1082	0.309368	−0.1098
1Q10	0.404582	0.001053	0.032457	0.387515	0.345645	−0.0589	0.344249	−0.0603
2Q10	0.401054	0.001281	0.035786	0.376289	0.330125	−0.0709	0.328586	−0.0725
3Q10	0.315753	0.001464	0.038262	0.373583	0.324225	0.0085	0.322579	0.0068
4Q10	0.275259	0.000944	0.030727	0.308129	0.268492	−0.0068	0.267171	−0.0081
1Q11	0.263491	0.000937	0.030613	0.277058	0.237567	−0.0259	0.23625	−0.0272
2Q11	0.223327	0.001171	0.034223	0.268028	0.223881	0.0006	0.22241	−0.0009
3Q11	0.20421	0.000959	0.030974	0.23721	0.197253	−0.0070	0.195921	−0.0083
4Q11	0.232588	0.000953	0.030872	0.222541	0.182716	−0.0499	0.181389	−0.0512
1Q12	0.305234	0.001213	0.034822	0.244316	0.199396	−0.1058	0.197899	−0.1073
2Q12	0.267869	0.000546	0.023361	0.300058	0.269922	0.0021	0.268917	0.0010
3Q12	0.264698	0.000475	0.021794	0.271387	0.243273	−0.0214	0.242336	−0.0224
4Q12	0.283541	0.000659	0.025665	0.268954	0.235846	−0.0477	0.234743	−0.0488
1Q13	0.32464	0.000832	0.028843	0.283413	0.246205	−0.0784	0.244965	−0.0797
2Q13	0.284986	0.000636	0.025225	0.314949	0.282409	−0.0026	0.281324	−0.0037
3Q13	0.308983	0.00062	0.024903	0.284522	0.252397	−0.0566	0.251326	−0.0577

VaR: Value-at-risk, GARCH: Generalized autoregressive heteroscedasticity

Figure 2: Actual liabilities-to-asset ratio and the corresponding value-at-risk, t distribution, 5% significance level

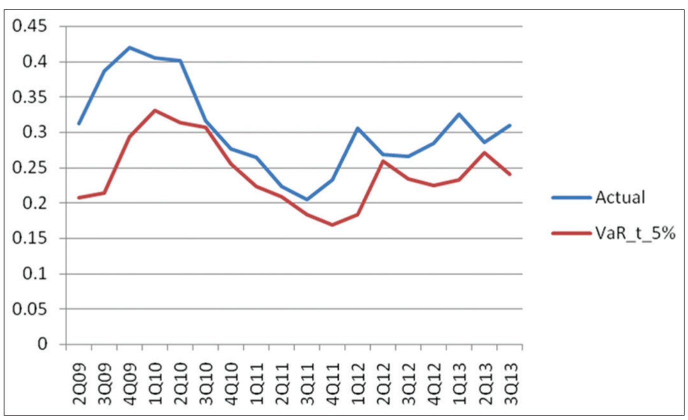
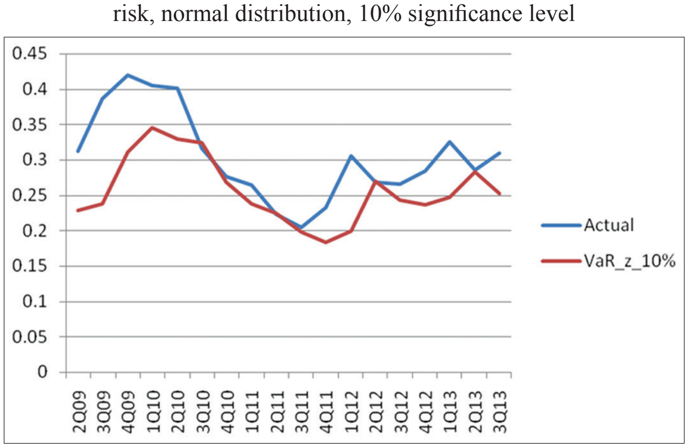


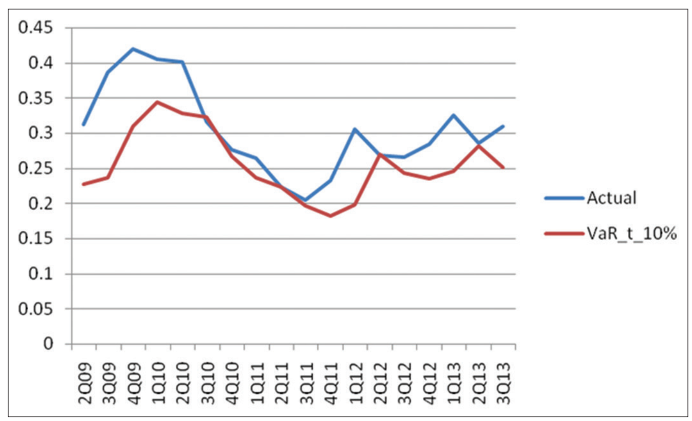
Figure 3: Actual liabilities-to-asset ratio and corresponding value-at-risk, normal distribution, 10% significance level



than the famous debt-to-GDP measure, since it accommodate various types of liabilities and assets of the government.

In finding the risky ratio, it assumes that the ratios follow certain types of distributions, such as normal t-student distributions. It then

Figure 4: Actual liabilities-to-asset ratio and the corresponding value-at-risk, t distribution, 10% significance level



assumes that the risky ratios are resulted from unexpected shocks, which might occur in non ordinary situation. With the assumption that the non ordinary situation occur in 5% of all situations, we can calculate such risky values, which are nothing but the VaR. To model the volatility in the ratio, this paper apply GARCH family model. Therefore, the VaR resulted from such calculation can be called as conditional VaR.

The analysis finds that autoregressive term in the conditional mean regression significantly influence the dependent variable (LAR). It also finds that both ARCH and GARCH terms significantly influence the conditional variance, proving that LAR is truly volatile.

Comparing the actual LAR and its corresponding conditional VaR values, both assuming normal and t distributions, using a 95% confidence level, this paper finds no violation, suggesting that in the evaluation period, Indonesia fiscal sustainability are not in risky situations. The violations are found when the paper uses 90% confidence level. Using the later confidence level, it finds three violations and two violations for normal and t distributions, respectively.

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