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DEBT-TO-GDP RATIO FOR FISCAL SUSTAINABILITY IN INDONESIA: A CONDITIONAL VALUE-AT-RISK APPROACH

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Abstract: *This paper models fiscal sustainability in Indonesia. The fiscal sustainability is measured by debt to GDP ratio. The model is constructed based on the relationship this variable and the primary balance. To evaluate the sustainability, this paper estimates a Value-at-Risk (VaR) on the ratio. The novelty of this paper lies on the application of conditional volatility to calculate the VaR. The volatility is modelled using an Autoregressive Conditional Heteroscedasticity (ARCH). This model captures the unsustainable situation following the global financial crisis. External financial crisis has an important role to the increasing domestic fiscal risk.*

Keywords: *Fiscal sustainability, debt to GDP ratio, Value-at-Risk, ARCH*

JEL Classification: *C22, C53, E62, E63*

INTRODUCTION

Macroeconomic indicators are influenced by economic policies, both fiscal and monetary policies. As a developing country, fiscal policies in Indonesia are of expansionary ones, using budget deficit instruments. The question is how the government finances the budget deficit. Theoretically, there are two options available, namely financing the deficit with debt and financing the deficit with printing money. Indonesia has been employing both options. Some examples are selling government bonds both inside and outside the country, and privatizing some government enterprises. One important thing to note is that increasing the debt brings risks to the government's asset value on the balance sheet. Moreover, due to the low quality of fiscal management, Indonesia has experienced long rung run fiscal disequilibrium (Sriyana, 2015).

Fiscal conditions of a country are generally reflected in the government budget. The government attempts to make the budget is strong and sustainable which support the performance of the national economy (Alvarado *et al.*, 2004). In the situation government revenue is lower than government spending, the government should conduct deficit fiscal policy to optimize the performance of government budget. This

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policy also aims to maintain economic stability and economic growth. The deficit fiscal policy may increase government spending (Hondroyiannis and Papapetrou, 2001). Deficit fiscal policy will have an impact on macroeconomic variables, which could potentially bring about economic inefficiency, including the inefficiency of state financial management. If this condition persists in the long term, it will endanger their fiscal sustainability.

Fiscal sustainability in Indonesia is an important issue in fiscal management, due to the financing needs that could suddenly rise as the result of the global economic turbulence. Such situation might affect the macroeconomic indicators, particularly on the fiscal variables volatility. Furthermore it will threat the economy as a whole. Therefore, we need a framework for understanding the source of such turbulence and their impacts on Indonesian fiscal sustainability. We also need some measurement to assess fiscal sustainability.

This paper analyzes fiscal sustainability in Indonesia using debt-to-GDP ratio. A model on the ratio is built based on the ratio's relationship to the primary balance. To evaluate whether the ratio is in an unsustainable level, this paper builds a Value-at-Risk (VaR) on the ratio. The novelty of this paper lies on the use of conditional volatility to calculate the VaR. The volatility is modelled using Autoregressive Conditional Heteroscedasticity (ARCH) model by Engle (1982).

LITERATURE REVIEW

In the past few decade Indonesia has been facing increasing fiscal risks caused by, among others, economic shocks both from outside and inside the country. This condition can threaten the fiscal sustainability. This demands a measure of comprehensive and realistic assessment to determine the extent of the threat will occur. This paper aims at answering the problem.

Various recent empirical studies on the field focused on the role of the currency mismatch with the focus on the pressure on the currency composition of explicit government liabilities. However, explicit liabilities does not include some liabilities such as wages and pension funds, not to mention the asset side of the government balance sheet, which comprises financial assets, the government real assets, and the present value of tax revenue. In such a way, this method might lead to the bias in measurement of such indicator. In addition, one might need to mention that these non-debt liabilities types and assets are affected by changes in the real exchange rate, domestic interest rate and national income (Bhinge, 2007). This means that we need a more sophisticated measure of fiscal sustainability.

The level of fiscal sustainability is a centre of analysis of this research. Barnhill and Kopits (2003) use the concept of Value-at-Risk to measure fiscal risk which can be assumed as an indicator of fiscal sustainability. A lower fiscal risk indicates existing fiscal sustainability in a country. The Value-at-Risk, which is considered the level to watch out for, could be determined. A paper by Adrogue (2005) also used the approach

of Value-at-Risk to measure of the debt-to-GDP ratio which recognized that VaR approach based on balance sheet conditions will be better in modelling fiscal risk.

This paper develops an empirical fiscal risk through calculating conditional VaR. This paper calculates the variance used to calculate the VaR using conditional family of ARCH models found by Engle (1982). The future research might consider the use of the ARCH family model such as Bollerslev (1986) with Generalized ARCH model (or GARCH), Glosten *et al.* (1993) with GJR model, Nelson (1991) with Exponential GARCH model.

METHODS

The Data

This paper uses the annual data from 1991 to 2010, consists of 20 observations for each variable, collected from various sources. It is obvious that the number of observation is small, especially for calculating conditional volatility. The future research should collect higher data frequency such as quarterly or even monthly data to get more robust estimation results.

Method of Analysis

This paper attempts to provide an empirical analysis fiscal sustainability using the Value-at-Risk or VaR. VaR is widely used to measure the risk in finance researches. Following Engle (1982) this paper models such conditional volatility using autoregressive conditional heteroscedasticity (ARCH). To elaborate how government reacts to its debt burden can be done through the estimation of a fiscal reaction function (Burger et al. 2011). A reaction of the primary balance-to-GDP ratio to changes in the one-period lagged public debt-to-GDP ratio. According to Bohn (1995, 2007), if the public debt-to-GDP ratio increases, government should respond by improving the primary balance, to arrest and even reverse the rise in the public debt-to-GDP ratio. The rationale behind this is rooted in the budget constraint of government (Bohn 1998, Gali and Perotti 2003, De Mello 2005).

Regarding to the impact of output gap, we re-parameterizes the model and end up with $\Delta(D/Y)_t$ and $\Delta(B/Y)_t$ as the independent variables. This paper attempts to model the debt-to-GDP ratio based on the conditional volatility model. In order to capture the volatility in the Debt-to-GDP ratio, this paper considers model as follows:

$$DYR_t = \beta_0 + \beta_1 DYR_{t-1} + \beta_2 BYR_{t-1} + \beta_3 OG_{t-1} + \varepsilon_t \quad (1)$$

$$\varepsilon_t = \eta_t \sqrt{h_t} \quad (2)$$

$$h_t = \alpha + \beta \varepsilon_{t-1}^2 + \xi_t \quad (3)$$

where DYR_t = Debt-to-GDP ratio

BYR_t = Primary balance-to-GDP ratio

OG_t = Output Gap
ε_t = error term in equation
η_t = standardized residual
h_t = conditional variance in equation

The VaR threshold for DYR_t can be calculated as:

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

F_t represents all information available at time t. The VaR is different from the aforementioned VaR because the risky debt-to-GDP ratio is the high one. Then, the analysis is to compare the estimated VaR on the debt-to-GDP ratio with its actual value of debt-to-GDP ratio. If the actual debt-to-GDP ratio is bigger than estimated VaR, a violation occurs which indicate the existing of fiscal risk as an indicator of fiscal unsustainable.

RESULT AND DISCUSSION

This section presents the data and result of estimation using ARCH model. The data collected from various sources are presented as follows:

Table 1
Data to Estimate

Year	*Primary Balance (Rp Trillion)*	*Primary Balance (% of GDP)*	*GDP (Rp Trillion)*	*Total Debt (Rp Trillion)*	*Debt-GDP Ratio (%)*	*Output Gap (%)*
	B	BYR	Y	DE	DYR	OG
1991	1,999	0.20	1,008	129,6	12.8	0.999
1992	3,185	0.30	1,073	144,2	13.4	-2.736
1993	1,720	0.15	1,159	150,2	12.9	-0.156
1994	3,811	0.31	1,246	194,4	15.5	-5.686
1995	5,998	0.44	1,349	227,1	16.8	1.369
1996	4,057	0.28	1,454	230,4	15.8	5.557
1997	3,622	0.24	1,523	451,9	29.6	5.049
1998	16,200	1.22	1,323	553,0	41.7	-0.291
1999	1,999	0.15	1,333	940,0	70.4	-3.607
2000	16,132	1.16	1,389	1,234,2	88.8	-1.500
2001	40,485	2.81	1,440	1,273,1	88.3	-0.411
2002	23,652	1.57	1,505	1,225,1	81.3	-0.370
2003	35,109	2.23	1,577	1,232,5	78.1	0.360
2004	23,810	1.44	1,656	1,299,5	78.4	-0.308
2005	14,408	0.82	1,750	1,313,5	75.0	0.427
2006	29,142	1.58	1,847	1,302,1	70.4	0.028
2007	49,844	2.54	1,964	1,389,4	70.7	0.366
2008	4,122	0.20	2,082	1,636,7	78.5	0.767
2009	88,619	4.07	2,178	1,590,6	73.0	-0.395
2010	46,845	2.02	2,314	1,676,1	72.4	-0.247

Note: (1) GDP is collected from IMF, World Economic Outlook Database, October 2013. (2) Total Debt: 1991-1997 are taken from World Bank, GDF, 1999. The rest are from *Biro Pusat Statistik*, Various Publications.

To estimate the model, this paper provides the estimation technique involves both the first and second moments. The second moment in this case is the autoregressive conditional heteroscedasticity (ARCH) by Engle (1982). The estimate result is as follows:

Table 2
Estimate Results on DYRt

Conditional Mean			
Variables	*Coefficients*	*t-stat*	*Prob*
C	3.087091	2.626842	0.0086
DYR(-1)	0.891476	28.87471	0.0000
BYR(-1)	1.591655	2.194765	0.0282
OG(-1)	0.458589	1.913291	0.0557
Conditional Variance			
C	2.455490	0.462977	0.6434
RESID(-1)^2	2.300309	1.805868	0.0709

From the estimation result of conditional mean equation, it can be concluded that all variables statistically influence DYR_t at 5% significance level, except OG_{t-1} which significantly influences DYR_t on 6% significance level. From the estimation result of conditional variance equation, it can be concluded that the ARCH term significantly influences the conditional variance at 5% significance level, suggesting that debt-to-GDP ratio is volatile, which might be the result of various volatile variables such as exchange rates and interest rate.

The estimation result provides conditional variance, which can used to calculate the conditional standard deviation, which is then used to calculate the VaR. Because the VaR is calculated using the conditional standard deviation, also known as conditional volatility, so the appropriate name should be conditional VaR. This paper uses both normal (z) and t distributions to calculate such VaR, using the significance level of 5%. The result is listed in the following table, along with the actual and fitted debt-to-GDP ratios, as well as the violations resulted from the VaR calculated based on normal (z) and t distributions. Table 1 describes all the data series used in this analysis. To see whether violations occurs, Figure 1 displays the VaR based on normal distribution and the actual Debt-to-GDP ratio, and pictures the VaR based on t distribution and the actual Debt-to-GDP ratio.

The result using normal distribution, with the confidence level of 95%, suggests that there is one violation in 2008 (Table 3). This could be related to the financial crises stems from the capital market in the USA. The result using t distribution, with the confidence level of 95%, suggests that there are two violations, both in 1999 and in 2008. The violation in 1999 might be caused by the economic crises started in 1997 in Asia, while the violation in 2008, as above, might be related to the financial crises stems from the capital market in the USA (Table 4).

Table 3
Result of ARCH Estimation

Year	*Actual*	*Fitted*	*GARCH*
1992	13.43379	15.31868	97.48035
1993	12.95434	14.28042	10.62805
1994	15.59148	14.80013	6.500589
1995	16.83600	14.86504	3.896008
1996	15.84055	19.43128	11.39147
1997	29.67177	20.20105	32.1142
1998	41.78954	32.23268	208.7805
1999	70.47710	42.15635	212.5511
2000	88.81182	64.50008	1847.453
2001	88.39038	83.42035	1362.078
2002	81.39361	86.16993	59.27576
2003	78.14624	77.97858	54.9329
2004	78.44774	76.46088	2.520151
2005	75.02220	75.16759	11.53624
2006	70.49652	71.47343	2.504115
2007	70.73210	68.45716	4.650825
2008	78.59661	70.3498	14.36044
2009	73.00456	73.82117	158.8993
2010	72.42082	74.46107	3.989482

Table 4
Value-at-Risk Calculation

Year	*Vol*	*VaRz*	*VaRt*	*Violation,z Dist*	*Violation,t Dist*
1992	9.873214	34.67018	32.49807	-21.23638882	-19.06428181
1993	3.260069	20.67016	19.95295	-7.715821107	-6.998605865
1994	2.549625	19.7974	19.23648	-4.205919783	-3.645002241
1995	1.973831	18.73375	18.29951	-1.897747315	-1.463504567
1996	3.375125	26.04652	25.304	-10.20597764	-9.46345012
1997	5.666939	31.30825	30.06152	-1.63648464	-0.389757982
1998	14.44924	60.55318	57.37435	-18.76364364	-15.58481117
1999	14.57913	70.73145	67.52404	-0.254348293	2.95306086
2000	42.98201	148.7448	139.2888	-59.9329879	-50.47694671
2001	36.90634	155.7568	147.6374	-67.36640509	-59.24700988
2002	7.699076	101.2601	99.56632	-19.86650486	-18.17270824
2003	7.411674	92.50546	90.87489	-14.35922047	-12.72865229
2004	1.587498	79.57238	79.22313	-1.124634732	-0.77538509
2005	3.396504	81.82473	81.0775	-6.802538765	-6.05530793
2006	1.582440	74.57502	74.22688	-4.078497909	-3.73036118
2007	2.156577	72.68405	72.2096	-1.95194737	-1.477500411
2008	3.789517	77.77725	76.94356	0.819359094	1.653052801
2009	12.60553	98.52800	95.75479	-25.52344932	-22.75023345
2010	1.997369	78.37592	77.93649	-5.955098402	-5.515677273

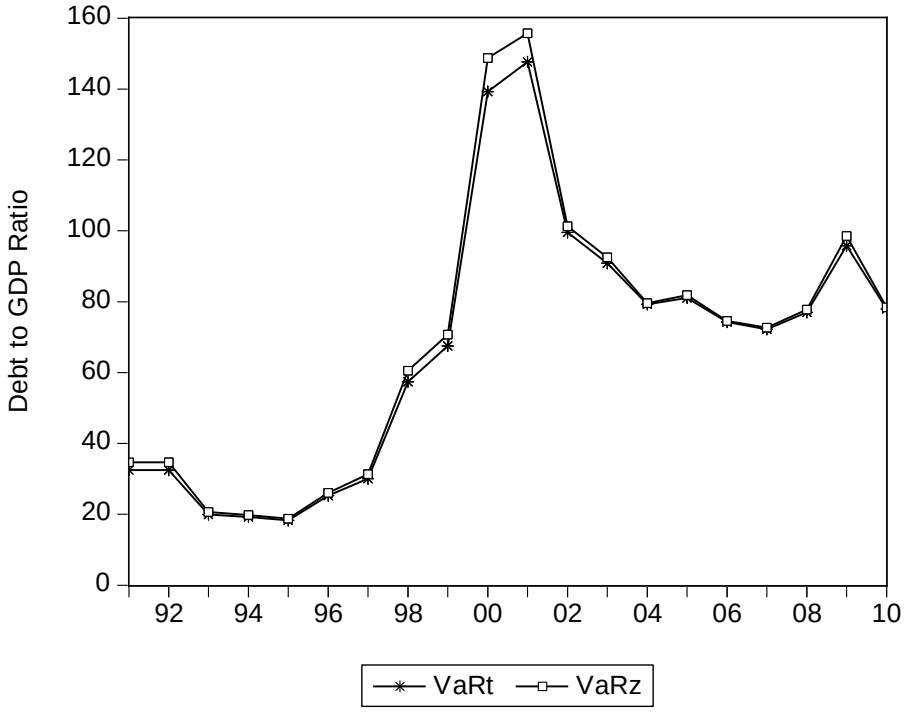

Figure 1: The Volatility of VaRt and VaRz

Overall, it can be inferred that both models, especially the one with *t* distribution, can capture the risky situation of debt-to-GDP ratio, which are mostly caused by severe situations in the global economy. The VaR using *t* distribution provides better result, in the sense that it provides violations for the two unfavourable crises. The advantage of *t* over *z* distribution might come from the fact that the observations used to estimate the model is only 19, which is a small sample. It perhaps also indicates that the distribution of such debt-to-GDP ratio is of fait tail distribution. These findings will complete Adrogue (2005) who noted that not all countries have sufficient data to calculate the VaR. Moreover, this research gives alternative result to explain the role of external financial crisis to the domestic fiscal risk. This result is in line with Barnhill and Kopits (2003) conclusion which explain that government balance sheet has an important role to the fiscal risk.

CONCLUSION

This paper analyzes fiscal sustainability in Indonesia using debt-to-GDP ratio. A model on the ratio is built based on the ratio's relationship to primary balance and output gap. To evaluate whether the ratio is in an unsustainable level, this paper builds a Value-at-Risk (VaR) on the ratio. The novelty of this paper lies on the use of conditional

volatility to calculate the VaR. The volatility is modelled using Autoregressive Conditional Heteroscedasticity (ARCH) model by Engle (1982). This finding provides an empirical analysis of fiscal risk which is possible used as an alternative measurement of fiscal sustainability.

Our empirical models can capture the risky situation of debt-to-GDP ratio which was caused by some global crises. The VaR using *t* distribution provides good result, in the sense that it provides violations for the global crises. Implication of this finding is that external shock which come from other countries lead to increase domestic fiscal risk in Indonesia. Consequently, the fiscal sustainability was threatened for several periods. Moreover, it recommends that debt to GDP ratio might be considered as an appropriate indicator in the fiscal sustainability analysis.

The future research might consider the use of balance-sheet measure in calculating the VaR. This will make the analysis more sophisticated as the balance sheet covers more measure than the debt-to-GDP measure alone. However, this approach needs more data availability. The future research might also consider the use of various multi variates GARCH in estimating the conditional volatility. With this approach is able to accommodate both the interrelationship across variables that influences both the conditional mean and the conditional variance of the model.

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