The Impact of Debt on Economic Growth: A Case Study of Indonesia

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Abstract

The paper is the first attempt to analyse the impact of debt on economic growth in the context of Indonesia by combining the application of wavelet and non-linear techniques. Our results tend to indicate that there are complex lead-lag dynamic interactions between external debt-to-GDP ratio and GDP growth. Debt is shown to be inversely related with economic growth in a shorter scale, while it is not in the longer scale. Nonetheless, positive contribution of debt on economic growth is very restricted as it only occurs as the country stops borrowing more debt. Perhaps, this result confirms that Indonesia is one of the examples of "debt intolerance" countries. Therefore, our recommendation to the policy makers would be for a shift to risk-sharing system which shields the economy from any adversity resulting from interest-bearing system and hence spurs the economic growth.

Key words: Debt Intolerance, Economic Growth, Indonesia, Wavelet Coherence, Maximal Overlap Discrete Wavelet Transform, Non-Linear Hansen Threshold.

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1.0. Introduction

Plethora of studies scrutiny the trade-off between debt and economic growth. Studies by Easterly (2001), Reinhart, Rogoff, and Savastano (2003), Clements, Bhattacharya, and Nguyen (2003), Baker (2004), Cordella, Ricci, and Ruiz-Arranz (2005), Kumar and Woo (2010), Reinhart and Rogoff (2010), Checherita and Rother (2010), Checchetti, Mohanty, and Zampolli (2011), and Patillo, Poirson, and Ricci (2002, 2004, 2011), are only several empirical papers which document the negative correlation between public debt and economy growth at different studies specification. Most of studies, for example: Cochrane (2001); Chowdhury (2001); Schclarek (2004); Cordella, Ricci, and Ruiz-Arranz (2005); Checherita and Rother (2010), are found empirical evidence on relatively inverse long-term impact of debt to economy growth. Meanwhile, Baum, Checherita-Westphal, and Rother (2012) scrutinized the debt-growth relationships for 12 E.U. countries (1990-2010) from the short- and long-term perspective. Their study suggests that short-run impact of debt on GDP growth is positive and highly statistically significant, whereas high debt-to-GDP ratios (>95%) has negative impact on economic activity in the short-run. In addition to that, it is also suggested that long-term interest rate tends to increase pressure when the public debt-to-GDP ratio is above 70%.

The underlying grounds for the negative correlation between debt and growth is due to heightened risks related to public debt. The logic is as follows: high public debt raises global interest rates, crowding out capital and lowering output in the long run. The increasing global interest rates, thus cost of debt service, would also lead to tax increases or cutbacks in infrastructure spending which consequently would lower supply. In addition to that, sovereign rating would depreciate and increase sovereign risk premiums (World Bank, 2012). This theory leads for a general perception of long-run impact of debt on growth without considering the relationships across the time horizon. Therefore, often time, the efficacy of fiscal policy for economy growth is found to be forsaken for the benefit of the incumbent political power. Moreover, it is presumed that debt contributes to short-term growth, of which has been empirically showed by the recent study by Baum, Checherita-Westphal, and Rother (2012).

Nonetheless, it might not be always the case. Iyoha (1999) shows that additional debt to a mount external debt depresses investment through both a "disincentive" effect and a "crowding out" effect for Sub-Saharan countries. Due to responsibility for debt service lies on the public sector, it is possible that raising another debt over the mount of current debt would force government to increase taxes, limit public expenditure, and raise market interest rates hence creating disincentive and crowding out prior to debt overhang. Since this implies serious implication for creditor country as well as debtor, it is recognized the need to incorporate different time scales in the analysis. This analysis could be achieved via a relatively new approach known as wavelet analysis.

Furthermore, there are growing number of literatures on non-linear relationships between debt and growth. Studies, which have been done, amongst others: Pattillo, Poirson, and Ricci (2002); Reinhart and Rogoff (2010); Checherita and Rother (2010); Minea and Parent (2012); and, Pattillo, Poirson, and Ricci (2011), have empirically evidenced the non-linear impact of debt on growth. Pattillo, Poirson, and Ricci (2002) studied 93 developing countries, from 1969-1998, and found that for a country with average indebtedness, doubling the debt ratio would reduce annual per capita growth by between half and a full percentage point. Furthermore, the differential in per capita growth between countries with external indebtedness below 100% of exports and above 300% of exports seems to be in excess of 2% per annum. Nevertheless, the average impact of debt becomes negative at about 160-170% of exports or 35%-40% of GDP. Checherita and Rother (2010) found that over a period of about 40 years, the average impact of government debt on per-capita GDP of 12 E.U. countries at about 90-100% has a deleterious effect on long-term growth while negative growth effect starts from levels of 70-80% of GDP. Reinhart and Rogoff (2010) studied on 44 countries in 200 years and discovered the threshold of 90% of GDP for developed markets and 60% of GDP for emerging markets before the median growth rates fall by 1%. Nevertheless, Minea and Parent (2012) using a similar dataset used by Reinhart and Rogoff (201), proved a little loose threshold, that is 115% debt-to-GDP ratio, suggesting that an increasing public debt path is not necessarily generating bottomless pit growth losses.

This study is a humble attempt to show evidence the impact of external debt on GDP growth of Indonesia. Indonesia is chosen as the country-case as it is among the few countries with a strong positive economic growth amidst the global sluggish growth (World Bank, 2012; IMF, 2012; Ministry of Finance of Indonesia, 2012). The desire outlook of Indonesian economy has advanced the country investment rating for sovereign debt from BB+ to BBB- at Fitch ratings, the first time after 14 years (BBC News, 2011). This automatically lowers the cost of capital, endorses the expansion of Indonesian credit market, and more importantly repackages Indonesia as an attractive alternative destination for investors during the downturn. This investment climate is a result of the fundamental domestic economy growth, accompanied by a fundamental reform of the macroeconomic policy framework (IMF Staff Report, 2012). However, this situation could turn to be unfavourable at any times, considering the fragility of the economy as the debt level soars. Additionally, political disruption is also considered as one of problems which potentially hinders ongoing policy reform process. Fitch noted this political risk remains high for Indonesia (BBC News, 2011).

This study evidences the impact of external debt on GDP growth has time-varying nature embedded in it. Using quarterly data of Indonesia external debt and GDP, from Q1 2003-Q4 2012. Wavelet Coherence (WTC) is applied as to provide an overall multi-scale analysis on the relationship of the variables, and further analyzed using Maximal Overlap Discrete Wavelet Transform (MODWT) to decompose the impact of debt on economy growth. These wavelet techniques served as the "lens" to analyse the time-varying relationships between external debt and GDP which enhance the efficiency and reduce bias. Nevertheless, the discussion is further expanded as to discover whether the relationships of debt on GDP is linear or non-linear which hence suggests an useful and insightful

information, to the government, investors, creditor countries, as well as to all related policy makers for their decision making.

The rest of the paper is organized as follows: in Section 2, literatures which capture intellectual discourse surrounding the topic of debt, such as debt overhang and debt intolerance, are under reviewed. Section 3 discussed the methods applied in this research, that are WTC and MODWT wavelet techniques as well as Hansen for Multivariate Non-Linear Regression Thresholds, are explained. Section 4 demonstrates the empirical results, together along with the discussion from Islamic finance perspective. Section 5 concludes and suggests recommendation.

2.0. Literature Review

For more than a century, the world has witnessed hundreds of financial waves and tides. Industrial depressions of the 1870s and 1930s, to Latin American debt crisis, African debt crisis, Collapse of ex-Communist countries, East Asian 1997 financial crisis, and recently 2008 subprime crisis as well as the sovereign debt crisis of EU, just to name a few, are all recorded in the economic history. Although the causes and nature of these crises have differed, it is observed that debt is the common thread for these crises. Contemporary studies by Keynes (1936), Kaufman (1986), Easterly, Islam, and Stigiltz (2000), Minsky (1992, 2008) appointed debt as the source for most crises. The channel for debt-system could be sourced from the imbalanced and uncontrolled fiscal and monetary policies (Easterly, 2001), or private debt which is reverted to public debt once bails out are endowed to rescue conglomerates. Debt, thus, is seen as the source for economic volatility and is of importance due to adverse effects to the economic growth (Keynes, 1936; Minsky, 1992; Easterly, Islam and Stiglitz, 2000).

The problems associated with debt are well scrutinized. Historically, the Modigliani-Miller (MM) theorem of debt irrelevance strengthened the view which believe the sunny-side of debt, that is the act of creating debt contributes to economic exhilaration. Miller (1991) explained the theorem through illustration of the price of whole milk would be the price of the cream plus the skim milk, provided no costs of separation. Hence, given a fixed amount of total capital, the allocation of capital between debt and equity is irrelevant. Mainly focus its discussion on firms capital structure, the MM theory indeed has brought a major implication at country level too that borrowing is justified to undertake projects which have high return to the people. Bohn (1988) adds the merits of having foreign currency debt as a hedging device as it is perceived to reduce uncertainty in net wealth and consumption. Furthermore, internal debt is seen to cause a large decline in people's utility level, external debt is thus preferred (Diamond, 1965). For studies on merits of debt, see for example Diamond (1965), Bohn (1988), Greiner (forthcoming).

Nevertheless, it is realized that the obligations inherent in debt may impose hardships on lenders and borrowers and, indeed, on the economy and the financial markets as a whole (Kaufman, 1986). The hardship is sourced to the prospective income stream or economy growth which cannot be known with certainty whilst interest rate is a certain and fixed in

nature. This feature of conventional economy system, by default, is endogenous to the system and is the source for financial fragility. Keynes (1936) and Minsky (1992) asserted that capital development is the characteristic of a capitalist economy which inserts instability within the system. Capital development of a capitalist economy is accompanied by exchanges of present money for future money, that is commitments to pay money at dates specified or as conditions arise. This structure is evidenced by Keynes (1972) as it is quoted in Minsky (1992), which reads:

> "*There is a multitude of real assets in the world which constitutes our capital wealth -buildings, stocks of commodities, goods in the course of manufacture and of transport, and so forth. The nominal owners of these assets, however, have not infrequently borrowed money in order to become possessed of them. To a corresponding extent the actual owners of wealth have claims, not on real assets, but on money. A considerable part of this financing takes place through the banking system, which interposes its guarantee between its depositors who lend it money, and its borrowing customers to whom it loans money wherewith to finance the purchase of real assets. The interposition of this veil of money (money is connected with financing through time) between the real asset and the wealth owner is an especially marked characteristic of the modern world."*

This is heavily correlated with Ponzi financing scenario, for instance, whereby the near-term receipt, which is exposed to business risks and uncertainty, is no longer sufficient to cover interest payment which is fixed. This failure elevates the amount of debt of a country, hence placing the country into a series of default episodes. Therefore, a nation is called *Ponzi nation* episode when the debt burden is extremely large exceeding country's capacity to repay, and thus suffer from *debt overhang* period.

Debt overhang episode is country's default to meets its obligation to creditors, resulted in a greater proportion of government revenues to service existing debt instead of to fuel public expenditures and stimulate economy growth. To service debt, it depends fundamentally on the continuing growth of output (Solomon, 1977). Therefore, the vicious cycle is government borrowings invoke interest rate which adds stress to government's balance of payment. In a distress situation (where rate of return of real economy $\{r\}$ < interest rate $\{i\}$), government would borrow more money to service their dues and avoids penalties. More recent studies raised this particular issue, for example, Kumar and Wo (2010), Reinhart and Reinhart (2010), and Reinhart, Reinhart, and Rogoff (2012), which suggest that there is an inverse relationship between debt and growth which subsequently explaining debt overhang episode. Considering this, debt repudiation and debt relief are also heavily scrutinized. See, for example, the discussion by Eaton and Gersovitz (1981), Calvo (1988); and Easterly (2002).

In addition, a study by Reinhart, Rogoff, and Savastano (2003) has found out that emerging markets is a "debt intolerance" countries. The reason for such conclusion is due to empirical and historical evidences which suggest that unlike developed markets, several

emerging countries under studied still could not manage their debt despite the relatively low level of debt hence went into debt overhang period. Using the analogy of a lactose-intolerance individual, these debt intolerance countries could not manage the risk exposed by borrowing at any level of debt. Due to this nature, debt becomes futile to the growth of economy. In fact, this country would face a high interest-rate considering the country's level of riskiness perceived by the lender. Notwithstanding that, Reinhart, Rogoff and Savastano advanced their study by estimating the "safe level" of debt tolerance for the emerging economies. Thus, it is found that the threshold for these countries to be as low as 15% of external debt-to-GNP. Catão and Kapur (2006) further advance Reinhart, Rogoff, and Savasatano study through extending the explanation for debt intolerance phenomenon. It is contended that the underlying high volatility of macroeconomic aggregates is a key driver of sovereign risk in developing countries. All in all, these theories on debt have served as the basis for contemporary analysis on the trade-off between debt and economy growth.

3.0. Research Methods

This research explores the relationships between debt and economy growth using a country specific study, that is Indonesia. Due to limited data of Indonesian external debt, The investigation is performed using GDP data (in current form) from quarter 1 2003 to quarter 4 2012, hence total 40 observations are adopted for each variable considered. External debt is a total of public and private debt and is converted to IDR (Indonesian Rupiah) from its original in USD accordingly. GDP, as mentioned, is in IDR current form. This data set are taken from Datastream Thomson Reuters version 5.0. From the original set, external debt (IDR) is thus divided by the current GDP (IDR) to arrive into debt-to-GDP ratio. Additionally, GDP growth is calculated by taking difference between GDP_t and GDP_{t-1} thus divided by GDP_{t-1}. From here, the study is embarked.

This research employs empirical investigation using wavelet analysis; that are Wavelet Coherence (WTC), Maximal Overlap Discrete Wavelet Transform (MODWT), and Multivariate Non-linear regression technique of Hansen Threshold (2000). Wavelet techniques of analysis are employed since this study is interested to discover the impact of external debt on GDP growth at different frequencies. The findings from this analysis are deemed to be essential since: it reflects the volatility of debt at higher frequencies via MODWT, CWT, and the dynamic cross-correlations between external debt and GDP growth via Wavelet Coherence.

3.1. Wavelet Coherence

First analysis in the application of wavelet coherence (in this study) is the continuous wavelet transform (CWT). CWT is used as to apply the wavelet as a band-pass filter to the time series, that the wavelet is stretched in time by varying its scale (s). The CWT has edge artefacts because the wavelet is not completely localized in time, hence the Cone (or Cone of Influence, COI) are introduced. The COI is the area in which the wavelet power caused by a discontinuity at the edge has dropped to e^{-2} of the value at the edge.

The CWT is defined:

$$W_X(u,s) = \int_{-\infty}^{\infty} x(t) \frac{1}{\sqrt{s}} \psi\left(\frac{t-u}{s}\right) dt \quad , (1)$$

where ψ(.) is a specific wavelet onto the examined time series, *u* is the location parameter that determines the exact position of the wavelet and *s* is the scale parameter that defines how the wavelet is stretched or dilated (smoothing factor) (Loh, 2013). Worth noting that the ψ(.) deployed in this study is Mother wavelet (known as "Morlet"), which is defined as:

$$\psi^M(t) = \frac{1}{\pi^{1/4}} e^{i\omega_0 t} e^{-t^2/2} \quad , (2)$$

In addition to that, the cross wavelet transform (XWT) is introduced. XWT of two time series x_n and y_n is defined as $W^{XY}=W^X W^{Y*}$, where * denotes complex conjugation (Grinsted, Moore, and Jevrejeva, 2004). XWT can be interpreted as the local relative phase between x_n and y_n in time frequency space. Torrence and Compo (1998) in Grinsted, Moore, and Jevrejeva (2004) explained the theoretical distribution of the cross wavelet ower of two time series with background power spectra P_k^X and P_k^Y is given as:

$$D\left(\frac{|W_n^X(s) W_n^{Y*}(s)|}{\sigma_X \sigma_Y} < p\right) = \frac{Z_\nu(p)}{\nu} \sqrt{P_k^X P_k^Y} \quad , (3)$$

where $Z_\nu(p)$ is the confidence level associated with the probability *p* for a pdf defined by the square root of the product of two χ^2 distributions. The function of cross wavelet transform is to reveal areas with high common power. Another useful measure is how coherent the cross wavelet transform is in time frequency space (Grinsted, Moore, and Jevrejeva, 2004). This, thus, brought us to wavelet coherence techniques.

Technically, definition of wavelet coherence (WTC) of two time series is as follows:

$$R_n^2(s) = \frac{\left|S\left(s^{-1} W_n^{XY}(s)\right)\right|^2}{S\left(s^{-1}\left|W_n^X(s)\right|^2\right) \cdot S\left(s^{-1}\left|W_n^Y(s)\right|^2\right)} \quad , (4)$$

where *S* is a smoothing operator (Torrence and Webster, 1998 as quoted in Grinsted, Moore, and Jevrejeva, 2004). Therefore, wavelet coherence is a technique which measures local correlation of two time series in time frequency domain. The cross-wavelet coherence also gives an indication of the correlation between rotary components that are rotating in the same direction as a function of time and periodicity, hence the ratio resulted from this product of each series can be thought of as the local correlation between two CWTs (Madaleno, 2012).

Furthermore, the statistical significance level of the wavelet coherence is estimated using Monte Carlo simulation methods. Here, large ensemble of surrogate data set pairs with the same AR1 coefficients as the input datasets are generated. From here, the wavelet coherence for each pair is calculated and the significance level for each scale is using only values outside the cone. The Monte Carlo estimation of the significance level requires of the order of 1000 surrogate data set pairs.

3.2. Maximal Overlap Discrete Wavelet Transform (MODWT)

MODWT is a linear filtering operation that transforms a series into coefficients related to variations over a set of scales (Cornish, Bretherton, and Percival, 2005). Like DWT, MODWT also produces a set of time-dependent wavelet and scaling coefficients and is suitable for analysis of variance (ANOVA) and multi-resolution analysis (MRA). According to Percival and Walden (2000) in Cornish, Bretherton, and Percival (2005), while DWT is a orthogonal transform, MODWT is a highly redundant non-orthogonal transform, therefore it retains downsampled values at each level of the decomposition. This merits of MODWT has enable researcher to work with more flexible length of data, whereas for DWT - a complete decomposition requires N to be a multiple of 2^J. Another merits of MODWT, as quoted from Cornish, Bretherton, and Percival (2005), are as follows:

> *(1) The redundancy of the MODWT facilitates alignment of the decomposed wavelet and scaling coefficients at each level with the original time series, thus enabling a ready comparison between the series and its decomposition;*
>
> *(2) ANOVAs derived using the MODWT are not influenced by circular shifting of the input time series, whereas values derived using the DWT depend upon the starting point of the series (Percival and Walden, 2000);*
>
> *(3) The redundancy of the MODWT wavelet coefficients modestly increases the effective degrees of freedom on each scale and thus decreases the variance of certain wavelet-based statistical estimates.*
>
> *(4) MODWT coefficients for different scales are approximately uncorrelated and are hence useful statistical measures for partitioning variability by scale.*

The filtering operation of MODWT at the jth level consists of applying a wavelet (high-pass) filter $\{\tilde{h}_{j,l}\}$ to yield a set of wavelet coefficients:

$$\overline{W}_{j,t} = \sum_{l=0}^{L_j-1} \tilde{h}_{j,l} X_{t-l} \quad , (5)$$

and a scaling filter $\{\tilde{g}_{j,l}\}$ to yield:

$$\overline{V}_{j,t} = \sum_{l=0}^{L_j-1} \tilde{g}_{j,l} X_{t-l} \quad , (6)$$

To complete the filtering operation at each level of a finite time series, the MODWT coefficients are thus:

$$\widetilde{W}_{j,t} = \sum_{l=0}^{L_j-1} \tilde{h}_{j,l} X_{t-l \bmod N} \quad , (7) \text{ and}$$

$$\tilde{V}_{j,t} = \sum_{l=0}^{L_j-1} \tilde{g}_{j,l} X_{t-l \bmod N}$$, (8) for t = 0, …, N-1.

In addition to that, MODWT requires specification of a wavelet filter, such as Daubechies, Least Asymetric, Best Localized, and Coiflet, and of the index J_0 for the maximum scale of interest.

Notwithstanding that, one should make a careful selection of wavelet filter. There are three factors which one needs to be considered upon selection, they are; (1) length of the data, (2) complexity of the spectral density function, and (3) the underlying shape of features in the data (Gençay *et.al,* 2009). Taking these three factors into consideration, it is viewed that Daubechies extremal phase wavelet filter of length 4 [d(4)] is considered to be a better selection. As the length of time series used in this study is short, i.e. only 40 observations, it is viewed that shorter wavelet filter, that is Daubechies extremal phase wavelet filter of length 4 [d(4)], is more suitable for the time series used in the study. The rule of thumb is that the longer the original data, the more dynamic of the spectral density function, the longer filters if necessary (after taking into account the issue of what the underlying features of the data look like). d(4) filter is available at width $L_j = (2^j - 1)(L-1)+1$.

3.3. Hansen Multivariate Non-Linear Regression Threshold

Unlike previous threshold models, Hansen Multivariate Non-Linear Regression model is a useful model which construct asymptotic confidence intervals by inverting the likelihood ratio statistic. The asymptotic distribution of the least-squares estimate $\hat{\gamma}$ of the threshold parameter γ, is pertinent in order to avoid mis-splitting sample due to nuisance parameters and a scale effect. This is true in the case of Threshold Autoregressive (TAR) where the sample is split into two groups, depending on whether the initial endowment is above a specific threshold.

Hansen advanced the approach. He (2000) proposed the solution, that is to let the threshold effect, δ_n, to be as near as to zero. Generally, model of threshold regression takes the form as following:

$$\begin{aligned} y_i &= \theta_1' x_i + e_i, \qquad q_i \le \gamma, \\ y_i &= \theta_2' x_i + e_i, \qquad q_i > \gamma, \end{aligned}$$, (9)

where q_i may be called the threshold variable and is used to split the sample into two groups called "classes" or "regimes", and random variable e_i is a regression error. y_i and q_i are real-valued and x_i is an m-vector. Hence, the threshold variable q_i could be an element of x_i and is assumed to have a continuous distribution.

Hansen approach is thus to let $\delta_n = \theta_2 - \theta_1 \to 0$ as $n \to \infty$ (Hansen, 2000). In order to attain the objective, θ_2 is hold to be fixed as to allow the threshold effect to be zero. In addition to that, Hansen threshold model finds that the likelihood ratio test is asymptotically pivotal when δ_n decreases with sample size, and that this asymptotic distribution is an upper

bound on the asymptotic distribution when δ_n does not decrease with sample size (Hansen, 2000).

This study seeks to explain debt-to-GDP ratio. The specification is as follows:

$(D/Y)_t - (Y_1\text{-}Y_0/Y_0)_t$

$= \zeta + \beta(D/Y)_t + \pi_1(Y_1\text{-}Y_0/Y_0)_t + e_i$, (10)

where:

$(D/Y)_t$ = External Debt to GDP of quarter *t;*

$(Y_1\text{-}Y_0/Y_0)_t$ = GDP growth of quarter *t;*

Afterwards, heteroskedasticity-consistent Lagrange multiplier (LM) test is applied and *p*-values are computed by a bootstrap analog, fixing the regressors from the right-hand side and generating the bootstrap dependent variable from the distribution $N(0,\hat{e}_i^2)$ where $\hat{e}$ is the OLS residual from the estimated threshold model. In addition to this specification, it is viewed that only one threshold for this study which is expected. Thus threshold model for single threshold effect of this research is as follows:

$y_i = \zeta + \beta'_1(D/Y)_t + \pi'_1(Y_1\text{-}Y_0/Y_0)_t + e_i$ *if* $q_i <= \gamma$,

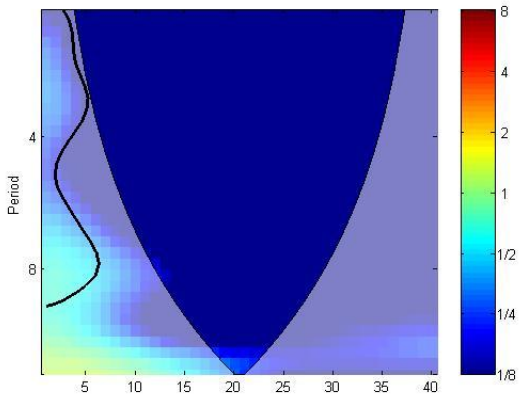
$y_i = \zeta + \beta'_2(D/Y)_t + \pi'_2(Y_1\text{-}Y_0/Y_0)_t + e_i$ *if* $q_i > \gamma$, (11)

4.0. Empirical Results and Discussion

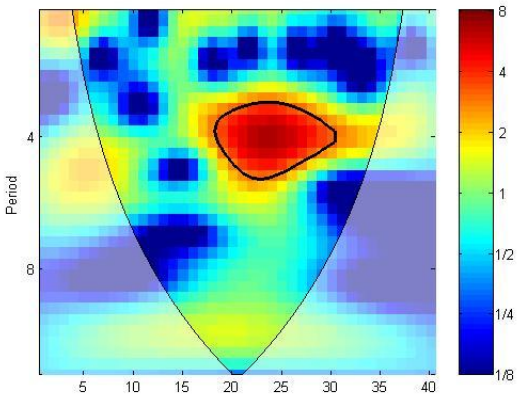
The first analysis is the Continuous Wavelet Transform (CWT). Fig.1 and Fig.2 show the CWT of the Debt-to-GDP ratio and GDP growth respectively. There are clearly no common features in the wavelet power of the two time series. Both does not imply a similar band-pass filter, instead the CWT power of Fig.1 does not statistically significant within the Cone. Nevertheless, Fig.2 reflects that the wavelet power of the GDP growth in ~ 3-6 quarters between Q4 2007 and Q2 2010 is statistically significant. Therefore, the differences between the portrayed patterns is insignificant and therefore is inconclusive. The cross wavelet transform helps in this regard.

Figure 1. The CWT of Debt-to-GDP Ratio

Figure 2. The CWT of GDP Growth



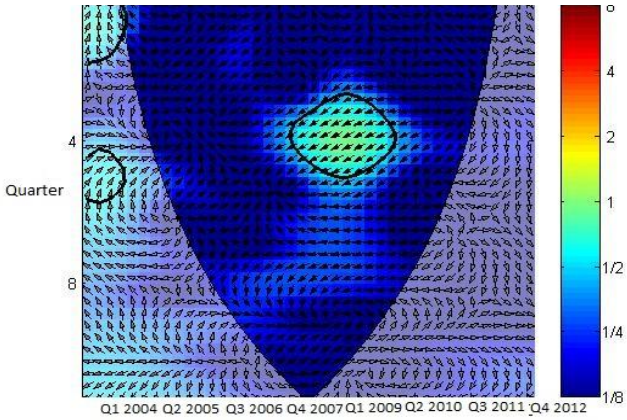
Source: Data Processed



Source: Data Processed

The XWT of Debt-to-GDP ratio and GDP growth is shown in Fig. 3. Here, for area within the cone, it is noticed that there is relatively weak common power in the ~3 to 5 quarter band from Q4 2007 - Q2 2010. For there to be a simple cause and effect relationship between the phenomena recorded in the time series, the phase is under scrutinized. It can be implied that GDP growth are not a simply mirrors the Debt-to-GDP ratio, as it is found that phase and anti-phase direction are varying at all scales. Therefore, it could be inferred that there is a weak link between Debt-to-GDP ratio and GDP growth.

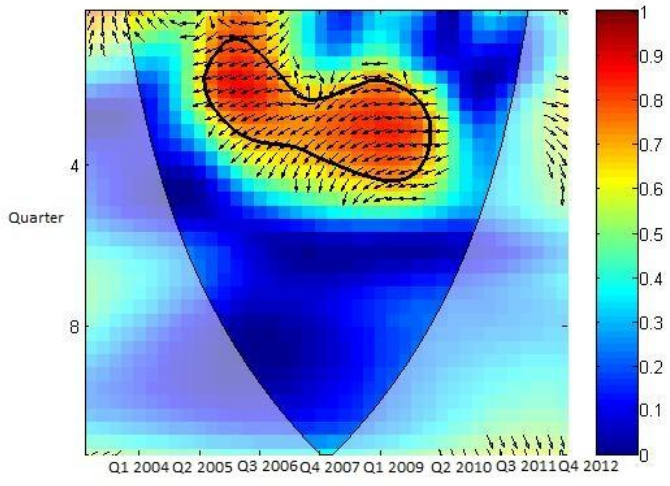
Figure 3. Cross Wavelet Transform (XWT)



Source: Data Processed

The wavelet coherence of Debt-to-GDP ratio and GDP growth is shown in Fig. 4. Compared with XWT, a larger section stands out to be significant and all these areas inside the Cone, in particular, show an anti-phase relationship between Debt-to-GDP ratio and GDP growth. Short period (~1-4 quarters) around Q2 2005 - Q1 2010 shows that external debt-to-GDP ratio leads the debt to GDP growth. Worth noting that the 5% significance level against red noise is shown as a thick contour.

Figure 4. Debt to GDP Ratio v. GDP Growth



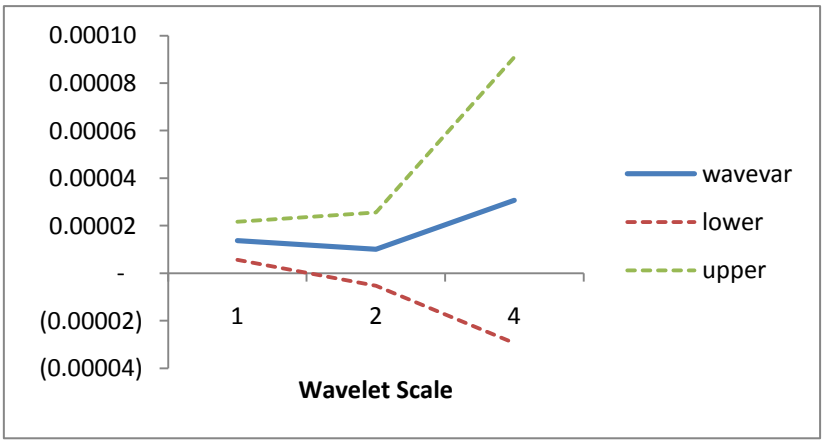
Source: Data Processed

This result confirms mostly recent studies, amongst others, by Pattillo, Poirson, and Ricci (2002, 2004), Clement, Bhattacharya and Nguyen (2003), Cordella, Ricci, and Ruiz-Arranz (2005), Checherita and Rother (2010), which found the causality relationship between debt-to-GDP ratio and GDP growth, that GDP growth is determined by debt-to-GDP ratio. Nevertheless, this causal relationship has yet provide a complete information for policy makers, in particular the regulators, politicians, as well as investors, hence the relationship is further examined using MODWT Wavelet analysis.

To begin, Daubechies extremal phase wavelet filter of length 4 is chosen while the series is decomposed up to scale 4. Fig. 5 and Fig. 6 illustrate the MODWT-based variance of debt-to-GDP ratio and GDP growth in different time scale. The straight lines indicate the variance and the dotted lines indicate the 95% confidence interval.

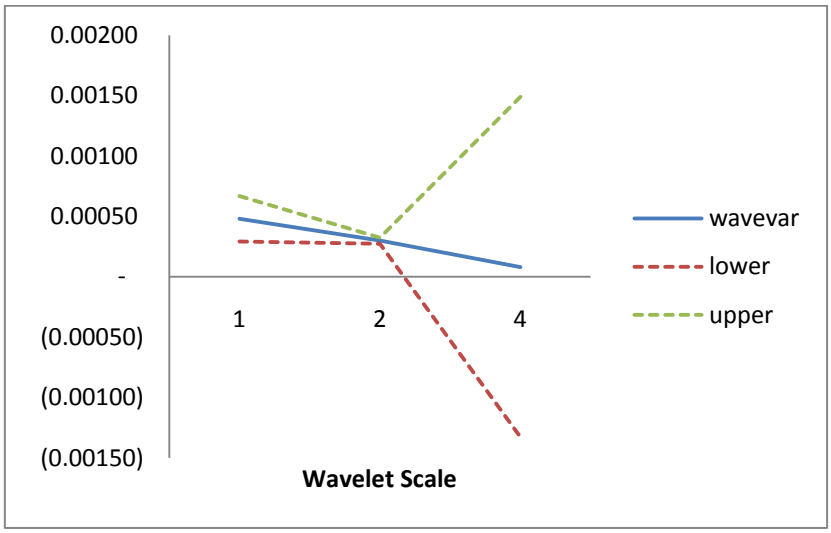
There is less evidence for linear relationship between the wavelet variance and the wavelet scale of 4, but is more an approximate to linear relationship in scale of 2. This indicates that variance of both debt-to-GDP ratio and GDP growth decreases together in the shorter scale, but move inversely as the wavelet scale increases. This result implies that debt-to-GDP ratio is more volatile while GDP decreases relatively in the longer scale.

Figure 5. Estimated Wavelet Variance of Debt-to-GDP ratio



Source: Data Processed

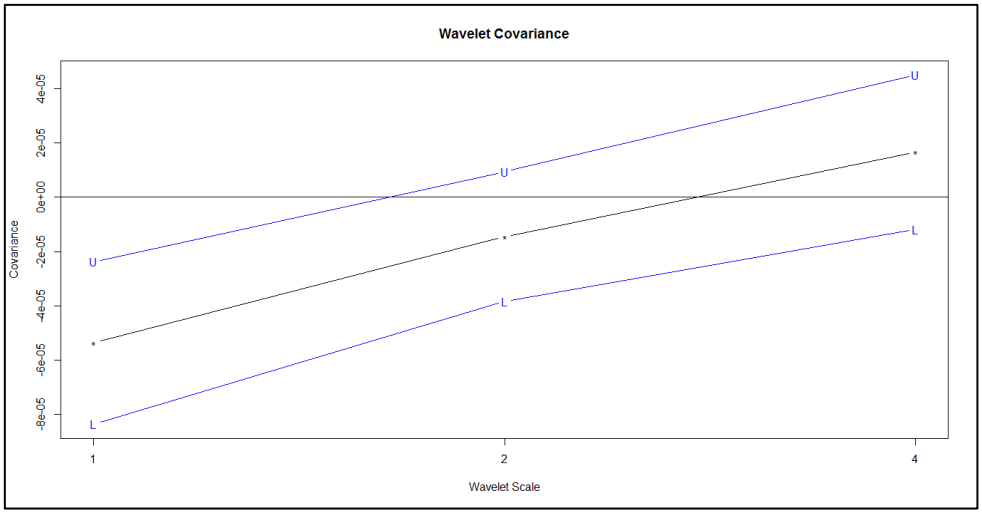
Figure 6. Estimated Wavelet Variance of GDP Growth



Source: Data Processed

In addition to that, the covariance and correlation of the debt-to-GDP ratio and GDP growth is demonstrated in Fig. 7 and Fig. 8. Fig. 7 indicates the co-movement between the two series to some extent, that is debt-to-GDP ratio and GDP growth are moving together across the time scale. However, the wavelet covariance are negative at scale 1-2 and positive at scale 2-3. This indicates negative co-movement of debt-to-GDP ratio and GDP growth, i.e. inverse relationship between the two series in the lower scale (higher frequency data), while positive co-movement in the higher scale (lower frequency data). Nonetheless, wavelet correlation analysis is pertinent in order to enrich the findings.

Figure 7. Wavelet Covariance



Source: Data Processed

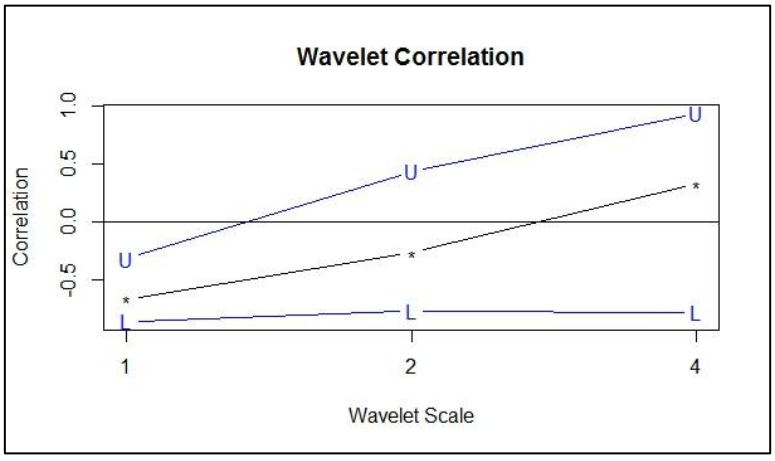
Table 1. Wavelet Correlation

	wavecor	lower	upper
d1	(0.66422)	(0.85533)	(0.31400)
d2	(0.26346)	(0.76602)	0.43899
d4	0.33329	(0.77764)	0.93934
s3	0.99072	NaN	NaN

Source: Data Processed

The wavelet correlation is constructed to examine how the two series are related over various time scales. The upper and lower lines represent the 95% confidence interval. From Figure 8, correlation is shown to increase rapidly at scale d2-d4 in comparison at scale d1-d2. Furthermore, negative correlation is shown at scale d1-d2, while at scale d2-d4 the variables are significantly positive correlated. Despite such, table 1 presented that the wavelet correlation at scale 1 (Quarter 2) is -0.664 and at scale 2 (Quarter 4) is -0.263 (negative correlation) which confirms similar interpretation with the wavelet covariance of inverse relationships between the variables. The relationship is different in the longer-run. At scale 4 (Quarter 16), the wavelet correlation increases to 0.333, which shows a magnitude leap from negatively correlated to a positive correlation. This implies that whenever debt-to-GDP ratio, GDP growth decreases in the shorter term. Also, as time scale increases, the relationships of debt-to-GDP ratio and GDP growth becomes more positively correlated. Therefore, increasing debt-to-GDP ratio would be at government's disadvantage in the shorter-run due to inverse relationship of the two variables, while policy which diminish debt-to-GDP ratio would be a more favourable policy for the government and politicians which often time are perceived to be short-term viewed entities.

Figure 8. Wavelet Correlation: Debt-to-GDP ratio and GDP Growth



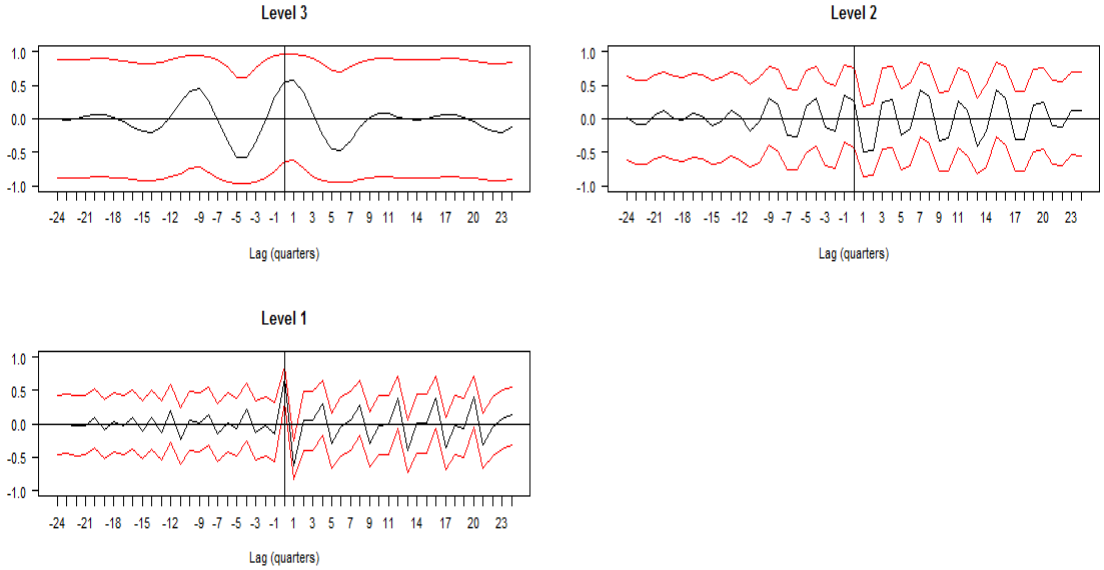
Source: Data Processed

In addition to that, this study also deployed wavelet cross-correlation analysis. The cross correlation is a more powerful tool for examining the relationship between two time series as it considers not only the two series but also with a time shift (In and Kim, 2013). Causal relationships (in the sense of Granger causality) is the output from this analysis.

Figure 9 depicts the cross-correlation analysis. At level 1 (shortest period), significant positive and negative cross-correlations are observed with debt-to-GDP ratio mainly leads GDP growth. Similar interpretation also applies at level 2, as significant positive and negative cross-correlations are also observed, and still debt-to-GDP ratio mainly leads GDP growth. Inferences established at level 1 and 2 are similar with our earlier findings using Wavelet coherence which suggest that it is more likely for debt-to-GDP ratio to determine GDP growth than it is not. However, at level 3, significant positive and negative cross-correlations are also observed yet the causality seems to be shifted. GDP growth seems to be the main leader while debt-to-GDP ratio lags. This inferences statistically positive and negative values were found providing evidence of a complex lead and lag dynamic interactions between debt-to-GDP ratio and GDP growth, which most studies are failed to capture.

After finding a complex lead and lag dynamic interaction between the series, it is natural to question whether there is a non-linear relationship in the model. With nonlinearity, the effect of debt-to-GDP ratio on GDP growth depends on the value of debt-to-GDP ratio; in effect, debt-to-GDP ratio somehow interacts with itself. Therefore, a threshold of which it shows the level where the regime shifts is obtained. Considering that asymptotic method is the best approach to diminish the effect of nuisance parameters and scale in sample splitting and threshold estimation, Hansen threshold is regression model is thus deployed. Table 2 and Figure 10 show the output from threshold estimation as well as the confidence interval construction for threshold.

Figure 9. Wavelet Cross-Correlation between Debt-to-GDP ratio and GDP Growth



Source: Data Processed

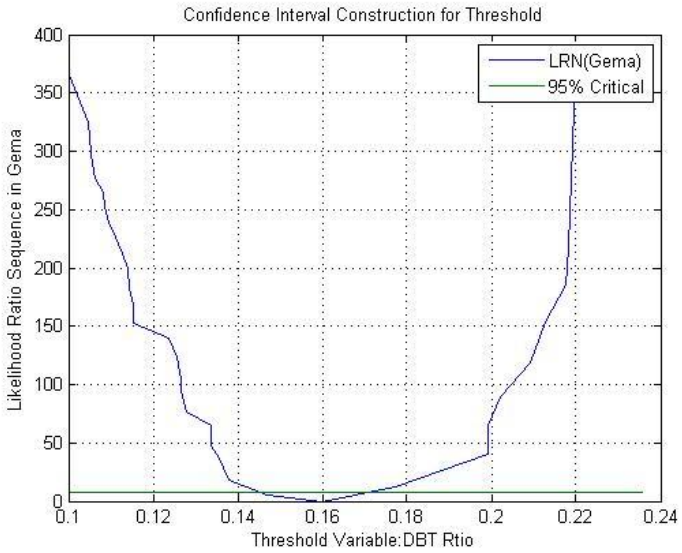
Table 2. Hansen Threshold Estimation

OLS	Dependent	Constant	0.0276

Estimation, Without Threshold	Variable: GDP Growth		(0.0125)
		Debt-to-GDP	0.1123 (0.100)
		R-squared	0.0242
		Heteroskedasticity Test (P-Value)	0.026
Threshold Estimation	Threshold Variable: Debt-to-GDP	Threshold Estimate	0.1556
		Heteroskedasticity Test (p-value)	0.026
Regime1	Debt-to-GDP<=0.1556	Constant	0.0277(0.0158)
		Debt-to-GDP	0.1425(0.1634)
		R-squared	0.0261
Regime2	Debt-to-GDP>0.1556	Constant	-0.2255 (0.07376)
		Debt-to-GDP	1.423 (0.393)
		R-squared	0.3997

Source: Data Processed

Figure 10. Confidence Interval Construction for Threshold: Debt-to-GDP Ratio as The Threshold Variable



Using 1000 bootstrap replications, the *p*-value for the threshold model using initial per capital output was significant at 0.026. As it can be inferred from Table 2 and Fig. 10, the Least-Squared estimate of γ is the value that minimize the graph occurs at $\hat{\gamma}$ = 15.56%, with a

95% asymptotic confidence interval [12.69% , 18.71%]. Hence, the estimated model from out empirical result can be represented as follows:

$$y_i = \zeta + \beta'_1(D/Y)_t + \pi'_1(Y_1\text{-}Y_0/Y_0)_t + e_i \qquad \text{if } q_i <= 15.56\%,$$

$$y_i = \zeta + \beta'_2(D/Y)_t + \pi'_2(Y_1\text{-}Y_0/Y_0)_t + e_i \qquad \text{if } q_i > 15.56\%,$$

This result confirmed that there is a non-linear relationship between the observed variables. The threshold is found to be little less than 16% before shifting to another regime. The constant coefficient in the first regime is shown to be positive and significant indicating negative contribution of debt to the GDP growth. In another words, under regime where debt-to-GDP raito is less than 15.56%, GDP growth is more likely to be positive than not. The goodness-of-fit, however, is seen to be low that indicates there might be other channels, which could be useful to stimulate Indonesian economy to grow, should be also adopted in order to improve the model. Studies which scrutinized relationships amongst debt, other channels, and economy growth are done by Easterly, Islam, and Stiglitz (2000) which found that besides debt reduction, wage rigidities and policy regime of a country shall be diminished in order to boost the economy growth; Clement, Bhattacharya, Nguyen (2003) which analysed debt relief for Highly Indebted Poor Countries (HIPCs) are statistically improving country's economic performance; and Aizenman and Kletzer (2007) which found that public investment and fiscal policy to contribute significantly to economy growth.

In the second regime, where debt-to-GDP ratio is more than 15.56%, the constant coefficient is shown to be negative and significant. This confirms our earlier findings using MODWT analysis which imply shows the inverse relationship between debt and economy growth. From MODWT output, we understand that the inverse relationship between the two series happened in the shorter scale (higher frequency) while it becomes positive in longer scale (lower frequency). Putting the puzzle into a complete picture together, the result confirms that debt indeed contributes to a negative economy growth. Positive contribution of debt on economy growth is very restricted as it only occurs as the country stops borrowing more debt. Perhaps, Indonesia is one of the example of "debt intolerance" country as it is meant by Reinhart, Rogoff, and Savastano (2003).

As for the case of Indonesia, the country is perceived to have successfully reduced its dependence on external resources as well as increased the efficacy of macroeconomics policy framework which perceives to be in favour of domestic sources of growth. Fiscal expansion, debt reduction, and domestic market strengthening, amongst others have been the methods to unleash the potentials of Indonesia, at least these recent years under the cabinet of President Yudhoyono. However, perhaps, the most crucial factor which has unleashed the potentials is the debt reduction, as evidenced in this study. The recent IMF Staff Report on Indonesia (2012) has reported that Indonesia public debt has fallen from around 76% of GDP in 2001 to under 25% currently and external debt as a proportion of GDP is low. It is believed that it could enhance Indonesia fiscal flexibility as to maintain growth stability amidst a volatile global environment. From this regard, borrowing is perceived to be futile as it creates

pressures to the economy and closes room for fiscal manoeuvre. Had budget deficits seen to give pressures for borrowing, Islamic financial system provides the solution for the problem.

Islamic financial system is based on risk-sharing system to achieve a stage where the economy expands. Understanding the consequences of interest, for instance, could be used to understand the prohibition of borrowing with additional payment on top of its principal. Findings of studies by prominent economists, such as Keynes (1936), Minsky (1992), amongst others which argue that financial instability starts from the characterization of the economy as a capitalist economy with capital development. This views are in alignment with Islamic finance principles which stands against *riba* transaction. *Riba* transaction is broadly defined as a transaction which shifts the risks exposure of entering the transaction from the capital owner to the borrower. This, of course, includes debt with interest payments, and derivatives as asset classes which are unconnected with the real assets. Bails out by the government to the big corporations, which convert private to public debt, also an example of risk-shifting government policy which cause public (individual current and future tax payers) to suffer. Hence, macroeconomic policy of an Islamic financial system could not consist *riba* and shall be based on risk-sharing.

Risk-sharing monetary instrument proposed here is attributed to Mirakhor (2012). The objective here is to provide an alternative to external or internal borrowing to finance government budget which adds exposures to "sudden stop" risk, and mal-distribution issue as well as to replace interest-rate bearing government bond. Government could issue a medium-to-long-term instruments of risk sharing which would allow portfolio adjustments of private sectors; firms and households. Another proposal is that risk-sharing instrument as a perpetual security whose rate of return would be a function of the growth of the national income or tied to the rate of return in the real sector of the economy. Hence, money growth is tied to the growth of real sector and not to the time.

As the findings suggest that Indonesia is a "debt intolerance" country, and also a serious participant in Islamic finance, it is more likely than not that this risk-sharing monetary instruments could the only way of undertaking its monetary policy. As for fiscal policy, it is also proposed a risk-sharing based mechanism which is simpler and inherently justice, such as taxes on wealth and taxes on income, should be opted than the current complex tax system which stimulate moral hazards of the tax payers. Accompanied by transparency and good governance, adoption to this proposal of fiscal policy is foreseen to be able to enhance fiscal discipline and flexibility as it stops moral hazards of the tax payers. All in all, this is viewed that risk-sharing macroeconomic policies would spur the economic growth and shield the economy from any adversity resulted from interest-bearing system.

5.0. Conclusion

This study has made an initial attempt to analyze the impact of debt on Indonesian economy growth and its dynamic relationships between the sample period Q1 2003 and Q4 2012. To achieve the objective, wavelet analysis, that are wavelet coherence and MODWT, and non-linear techniques of Hansen threshold model are applied. Wavelet analysis provides

a multi-scale information regarding the co-movement and causality of external debt-to-GDP ratio and GDP growth. Meanwhile, non-linear technique of Hansen threshold model is applied in order to understand debt-economy growth non-linear relationship.

The results demonstrate that there is a complex lead and lag dynamic interactions between external debt-to-GDP ratio and GDP growth. Debt is shown to be inversely related with economy growth in a shorter scale while the negative relationship is shown to be ameliorate in the longer scale. This complex lead and lag dynamic interactions as per expected considering the volatility nature of debt which increases as the horizon is longer. This study, perhaps, the first study which employs wavelet analysis to fill in the gap of multi-scale relationship between debt and economy growth as well as the first study which scrutinizes Indonesia. Our result also indicates the non-linear relationship between debt and economy growth of which Indonesian debt-threshold is found to as low as 15.56%. Nevertheless, this debt-threshold does not indicate the "safe indebtedness level" as further analysis of the non-linear result suggests that Indonesia is a "debt intolerance" country. This result confirms the result from recent studies by Reinhart, Rogoff, and Savastano (2003) which concludes that emerging markets are "debt intolerance".

Notwithstanding that, recommendations for Indonesian government are also suggested. This findings has put imperative to Indonesian government to adopt risk-sharing macroeconomic policies. It is such because interest-rate is inherently built in the conventional monetary and fiscal policies which could not be tolerated at any level by debt intolerance countries, in this case Indonesia. It is also envisaged that risk-sharing macroeconomic policies would be more likely to unleash Indonesian economy potentials, as it is likely to increase the efficacy of monetary and fiscal policies to spur real sector activities.

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