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CO-MOVEMENT BETWEEN BANK LOAN GROWTH AND ECONOMIC GROWTH IN INDONESIA USING WAVELET COHERENCE ANALYSIS

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ABSTRACT

This study investigates the co-movement between bank loan growth and economic growth in Indonesia from 2010 to 2020 using the Wavelet Coherence Analysis. The co-movements are divided into three different categories, i.e., bank ownership type, credit types, and bank size classification based on the Indonesian Financial Services Authority (OJK), referred to as the BUKU. This study shows that economic growth precedes bank loan growth in Indonesia between 2010-2020. Meanwhile, state-owned banks show the highest correlation between economic growth and loan growth among different types of bank ownership. In contrast, foreign-owned banks' loan growth shows a low correlation to economic growth. We also find that working capital loan growth has the highest correlation to economic growth than other loan types. Finally, this study reveals that medium-size banks (classified in BUKU 3) loan growth has the highest correlation to Indonesia's economic growth. Additionally, banks' loan growth in small banks (classified in BUKU 1 & 2) and large banks (classified in BUKU 4) shows fewer correlations. By discovering different co-movements between economic growth and loan growth of different bank ownership types, bank size groups, and loan types, regulators are expected to make valid policies to improve Indonesia's economic growth.

***JEL classification**: G2, O4, C6.*
***Keywords**: Bank loan growth, economic growth, wavelet analysis, bank size, credit, decomposition.*

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1. INTRODUCTION

The study of the co-movement between credit and economic growth has been a long source of research (FitzGerald, 2006). However, no conclusive answers of the relationship across countries can be found from the previous studies. Some researches show that loan growth accelerates economic growth. While some other researches show, economic growth accelerates loan growth. Other researches also show the feedback relationship between loan growth and economic growth. Many variables have been used to measure the financial sector growth, i.e.

stock market capitalization, private-sector credit, and bank loan growth. Bank, as an intermediary institution, plays a major role in economic growth. Study by Kirikkaleli and Athari (2020) conclude that the relationship between bank loan growth and economic growth is also influenced by the bank ownership variable. Other previous studies indicate that type of credit also influences the relationship (Samatas et al., 2019; Bezemer et al., 2020). Bank size is also listed as a factor influencing the relationship (Montagnoli et al., 2021).

A large number of studies have been performed for many developed countries' data. There are just a few studies in developing countries, in particular Indonesia. However, this phenomenon can also be observed in Indonesia banking data. The co-movement between bank loan growth and economic growth in Indonesia can be seen in Figure 1. The figure for the co-movement is taken from Q1 2010 to Q2 2020.

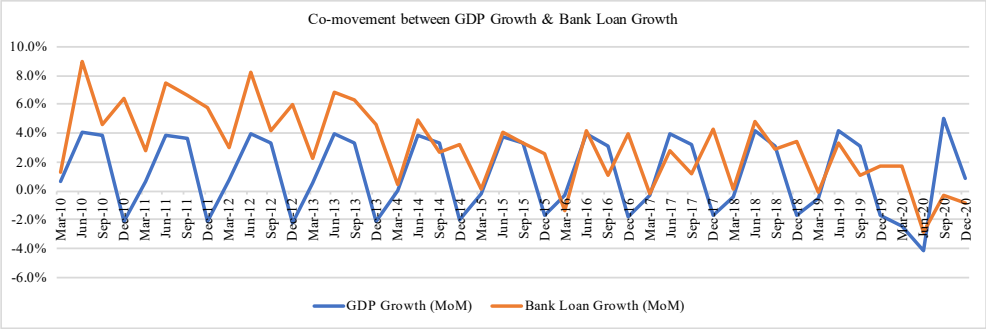

Figure 1: Co-movement between GDP growth and bank loan growth.

The method used in this study is *Wavelet Coherence Analysis*. *Wavelet Coherence Analysis* is a method used to analyze the signal process. The method is widely used in science and engineering studies. *Wavelet* analysis can decompose time series into time-frequency components to show hidden patterns in the data. The Research method that was used previously before *wavelet* analysis is a time-series filter (Çepni et al., 2020). The foundation of *wavelet* analysis is Fourier Transformation representing every periodic function into a summation of sine and cosine function. The weakness of this methodology is the frequency cannot change over time. To overcome that weakness, this study uses *wavelet* analysis. Another advantage of using this method is that it can detect transitory effects that are hard to detect when using other econometrics methods (Aguiar-Conraria et al. 2008).

Bank size is one of many factors that influence the co-movement between bank loan growth and economic growth. This is backed by a previous study (Lorenc & Zhang, 2020) which stated that bank size significantly impact on the economic condition. Further study by Mkhaiber and Werner (2021) is conducted to explore the relationship between bank size and economic growth, especially during periods of financial distress. Similarly, Montagnoli et al. (2021) concludes different relationships of big banks and small banks on business cycles. However, that study used Hodrick and Hamilton (2018), which have some drawbacks, one of which is that cyclicality can only be detected in the time dimension. Big banks and small banks in Indonesia can be grouped based on Indonesia Financial Service Authority (In Indonesian: Otoritas Jasa Keuangan / OJK) No. 6 / 2016. The classification is called BUKU or commercial banks based on business activity groups.

There are four types of BUKU groups, i.e. BUKU 1, BUKU 2, BUKU 3, and BUKU 4. The BUKU classification is based on the business activities that are allowed to be carried out and the minimum amount of core capital that must be owned by the banks. The banks in BUKU

1 have a core capital of less than IDR 1 trillion. The banks in BUKU 2 have a core capital greater than or equal to IDR 1 trillion to less than IDR 5 trillion. The banks in BUKU 3 have a core capital greater than or equal to IDR 5 trillion to less than IDR 30 trillion. The banks in BUKU 4 have a core capital of more than or equal to IDR 30 trillion. Other than differences based on core capital, BUKU 1 can only conduct most of their business activities in IDR. Meanwhile, BUKU 2 can carry out most of their business activities in foreign currencies. BUKU 3 can do what BUKU 2 do and open branches only in Asian countries. BUKU 4 can do what BUKU 3 do and open branches both inside Asian and outside Asian countries.

The previous study in this field failed to consider the bank's size on the co-movement between bank loan growth and economic growth in Indonesia using the *Wavelet Coherence Analysis.* Bank size in Indonesia is enclosed in the BUKU grouping based on the Indonesian Financial Authority (in Indonesia: OJK). In addition to the bank's capital size and the types of business activities that the banks can carry out in each BUKU group, there are also other criteria, i.e. the minimum amount of loan that should be disbursed. Therefore, this study attempts to fill that gap, i.e. analyzing the relationship between bank loan growth and economic growth based on various types of bank ownership, various types of credit, and bank size using the *wavelet* coherence technique for banking data in Indonesia.

Based on the research gap that has been explained earlier, this study aims to address several questions that emerge due to several variations in the explanation of the co-movement between loan growth and economic growth. The first question is whether there is a co-movement between loan growth and economic growth in Indonesia. In addition, factors, such as bank ownership type, type of credit have been studied in previous studies in other countries. It is important to study whether those factors distinguish the co-movement between loan growth and economic growth in Indonesia. The first important factor is bank ownership type. So, the second question to be answered in this study is whether bank ownership becomes a differentiating factor in the co-movement of those two variables.

On the other hand, loan types factors were also studied that have different effects on the co-movement. Therefore, the third question to be answered in this study is the loan types that are disbursed become differentiating factors in the co-movement. The third factor to be addressed but not previously studied in the co-movement of those two variables is bank size, which in Indonesia can be enclosed in BUKU groups. So, this factor will be the new factor that has not been included yet. The fourth question to be answered is whether bank size becomes a differentiating factor in the co-movement between credit and economy in Indonesia.

2. LITERATURE REVIEW

Many previous studies analyze the co-movement between finance and economic growth (Orhan et al., 2019). There are two prominent hypotheses in the literature about this finance-growth nexus. The first hypothesis states that finance development precedes economic growth, commonly known as the *supply-leading hypothesis*. The second hypothesis states that economic growth precedes finance growth, popularly known as the *demand-following hypothesi*s (Adeyeye et al., 2015). The supply-leading hypothesis supporters said that the idea that financial development that distributes the capital and technology will be followed by economic growth. Entrepreneurs will borrow money from the bank to expand their business operations and produce productive investments. Financial institutions will help allocate optimal resources, reduce cost, and facilitate trade that eventually will increase economic growth (Acaravci et al., 2009).

Meanwhile, the second hypothesis states that economic growth precedes financial

growth. The argumentations of the supporters of this hypothesis said that when the economy grows, then the need for financial instruments will increase and then be followed by financial products. Financial institutions are needed to fulfil the need (Acaravci et al., 2009; Orhan et al., 2019). An argument strengthens this hypothesis, which says that "where venture drives, finance follows" (Chow et al., 2019). Apart from these two prominent hypotheses, there is another hypothesis that combines the two hypotheses, namely the "*stage of development*" hypothesis (Adeyeye et al., 2015). The supply-leading hypothesis was present when the economy was at an early stage of development and slowly disappeared, replaced by the demand-following hypothesis when the economy was at a later stage.

3. METHODS

This study aims to analyze the co-movement between bank loan growth and economic growth in Indonesia. The bank loan growth data are taken from Indonesia Banking Statistics from Indonesia Financial Services Authority (Otoritas Jasa Keuangan / OJK) from 2010 until 2020. The economic growth data are taken from Indonesia Central Bureau of Statistics (Biro Pusat Statistik) quarterly from 2010 to 2020.

The empirical procedure that precedes *wavelet* analysis is *Fourier Transformation*. The base of Fourier Transformation is that every function can be expressed in the summation of infinite terms of sine and cosine function in different frequencies. Fourier analysis has been used to analyze the impact of the cycle in every frequency of the signals (Çepni et al., 2020). The weakness of this Fourier Transformation method is that the frequency component cannot change over time. Information about the time domain is lost by using this methodology (Pal & Mitra, 2017). The second weakness is that Fourier Transformation uses a constant window, resulting in overestimating or underestimating real frequency components.

To overcome the weakness that arises when using Fourier Transformation, we use the *wavelet* transformation. Using *Wavelet* Transformation, one time series can be decomposed into two dimensions, i.e. time and frequency (Mensi et al., 2020). *Wavelet* Transformation that decomposes a time series into time and frequency domain can be defined as follows:

$$W_x(k,f) = \int_{-\infty}^{+\infty} x(t)\psi^*{}_{k,f}(t)dt \qquad (1)$$

With * represents complex conjugate and ψ is a *wavelet*, which is a basis with finite length, oscillates, real-valued function. The study uses the *Wavelet Power Spectrum* (WPS). For one variable analysis (univariate analysis), the WPS has the formula as follows:

$$WPS_x(k,f) = |W_x(k,f)|^2 \qquad (2)$$

With location/time parameter (k) and frequency parameter (f) of the *wavelet* (ψ). It can be said that this metric can be viewed as a contribution to the variance of time series in a certain time and a certain frequency scale.

To measure the correlation of two time-series, i.e. bank loan growth and economic growth, we use the *Cross Wavelet Transform (CWT)* formula. This is a bivariate analysis of two variables which is equivalent to the covariance between the variables in the time-frequency domain. CWT can be written mathematically as follows:

$$W_{xy}(k,f) = W_x(k,f)\, W_y(\underline{k},f) \qquad (3)$$

LBIFf 20(1), pp.1-11.

With $W_x(k,f)$ and $W_y(k,f)$ are continuous *wavelet* transformations of two time series, i.e. $x(t)$ and $y(t)$ (Torrence & Compo, 1998).

In the context of the problem that will be examined in this study, *wavelet* squared coherence can be written in the formula below

$$R^2(k,f) = \frac{|C(f^{-1}W_{xy}(k,f))|^2}{C(f^{-1}|W_x(k,f)|^2)C(f^{-1}|W_y(k,f)|^2)} \qquad (4)$$

With $C(.)$ is a smoothing operator in the time-frequency domain. The range of R^2 value is from 0 to 1. To get the value of *wavelet coherence* $R_{xy}(k,f)$, it is calculated by taking the square root of $R^2(k,f)$. This value is analogs with the correlation coefficient which is calculated by normalizing the covariance of the two variables with the standard deviation of each variable (Meng & Huang, 2019). If the value of R^2 approaches zero, it means there is no correlation between both two time-series variables which is represented by blue color. If the value of R^2 approaches 1, it means those two time-series variables have a high correlation which is represented by red color. However, the R^2 value is not sufficient to identify the sign of the correlation between the two-time series variables. Therefore, another metric is used, i.e. the phase difference between the time series variables (Torrence & Compo, 1998).

The equation below shows the *wavelet* coherence phase difference:

$$\phi_{xy}(k,f) = tan^{-1}\left(\frac{L\{C(f^{-1}W_{xy}(k,f))\}}{O\{C(f^{-1}W_{xy}(k,f))\}}\right) \qquad (5)$$

With *L* is the imaginary operator, and O is the actual operator. In the plot, the phase difference is represented by an arrow. If the arrow points to the right, both time-series variables are in the same phase (moving together). If the arrow points to the left, the two time series move in a different phase (direction). If the arrow points to the top right or down left, the second variable (y) precedes the first variable (x). If the arrow points to the down right or top left, the first variable (x) precedes the second variable (y).

4. FINDINGS & DISCUSSIONS

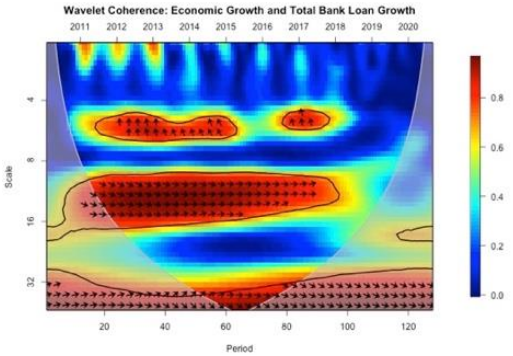

Figure 2: Total bank loan.

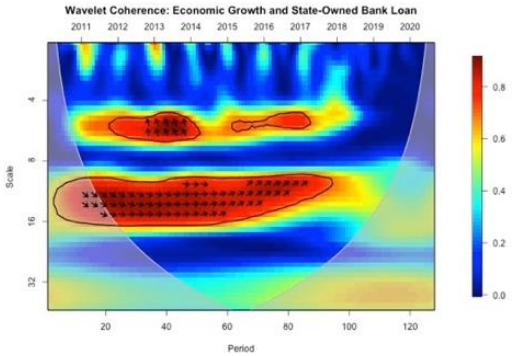

Figure 3: State-owned bank

Figure 2 shows that all period have a strong correlation (red coloured) between economic growth and total bank loan growth from 2011-2020 with the cycle of 8-16 months (long period). The arrows point to the bottom right shows that economic growth and total loan growth

are in the same phase (move in the same direction), with economic growth precedes total bank loan growth. The economic growth that precedes Indonesia's total bank loan growth aligns with the previous result (Çepni et al., 2020). The possible explanation of this phenomenon is that the increase of economic growth in Indonesia will be followed by bank loan growth *(demand-following hypothesis)*.

From Figure 3, a high correlation between state-owned bank loan growth and economic growth in the year 2011-2018 with the cycle of 8-16 months. The arrows point to the right up show that state-owned bank loan growth precedes economic growth in the same direction. The strongest correlation is shown between state-owned loan growth and economic growth. This result is different from the previous evidence (Kirikkaleli & Athari, 2020), concluding that the correlation between state-owned bank loan growth and economic growth is weaker than private-owned bank loan growth. The different results possibly due to the decisive role of government banks in Indonesia compared to Turkey.

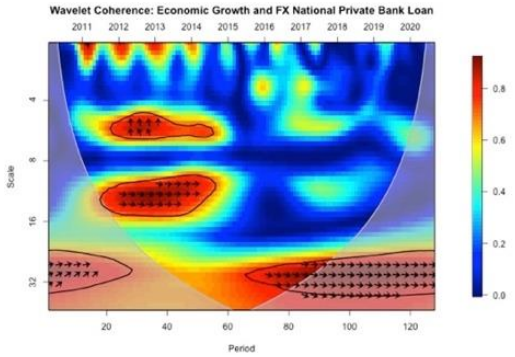

Figure 4: FX national private bank.

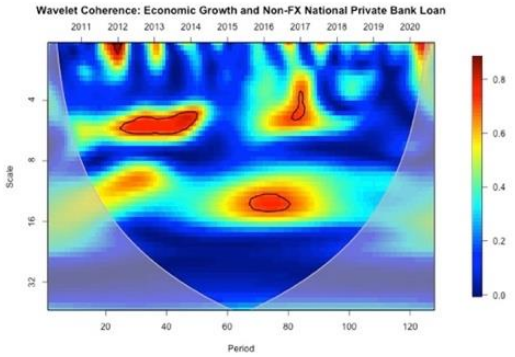

Figure 5: Non-FX national private bank.

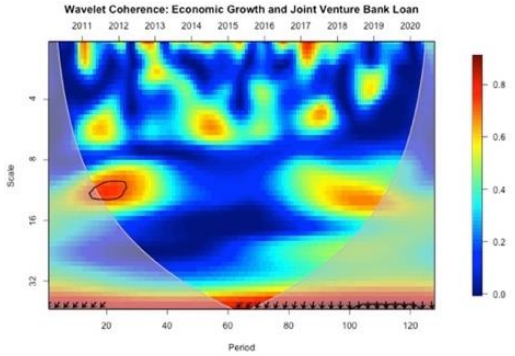

Figure 6: Joint venture bank.

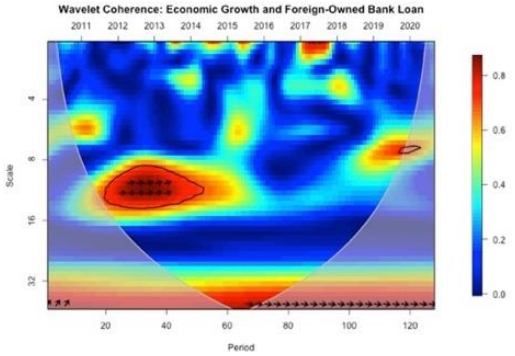

Figure 7: Foreign-owned bank.

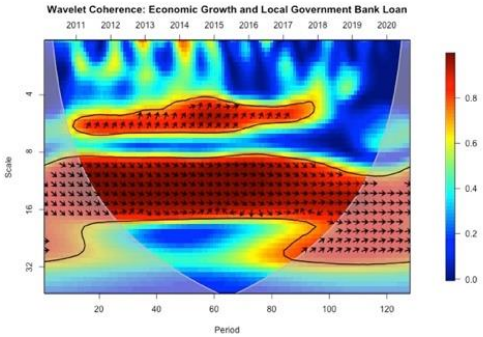

Figure 8: Local government bank.

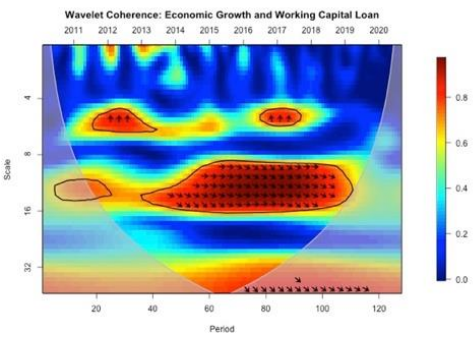

Figure 9: Working capital loan.

From Figure 4, a high correlation between economic growth and FX national private bank loan growth is found only at the beginning of the period, i.e. the year 2011-2015 with a cycle of 4-8 months. The arrows point to the left up means that economic growth precedes FX national private bank loan growth and they move in a different direction. Figure 5, Figure 6, and Figure 7 depict the correlation between economic growth and Non-FX national private bank loan growth, joint venture bank loan growth, and foreign-owned bank loan growth. The dominance of the blue coloured area can be seen in all three figures. This means that the relationships are weak. The loan growth of both joint venture banks and foreign-owned banks have a lower correlation to economic growth than other types of bank ownership. This result is the same as previous results (Çepni et al., 2020; Kirikkaleli & Athari, 2020) that say the main focus of joint venture banks and foreign-owned banks is not only the country in the study. The critical factor that also influences foreign-owned banks' loan growth is the capital in-flow (Mara et al., 2021). Figure 8 shows the co-movement between economic growth and local government bank loan growth. The red colour area dominates the plot. This indicates the strong relationship between local government bank loan growth and economic growth.

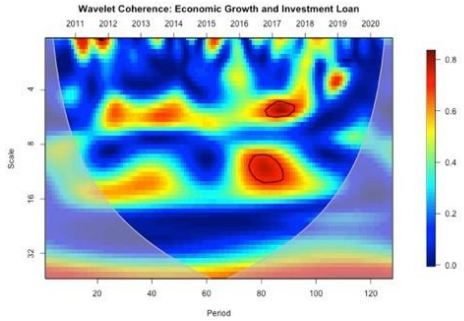

Figure 10: Investment loan.

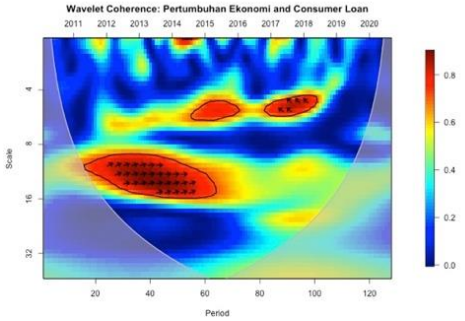

Figure 11: Consumer loan.

Based on the loan types, the correlation between loan growth of each type of loan and economic growth can be observed in Figure 9 – Figure 11. From Figure 9, it can be observed that for the cycle of 8-16 months, from 2014 – 2019, the area is dominated by red colour. The downright arrows represent that economic growth leads the working capital loan growth and move together in the same direction. One possible explanation is that companies tend to get increased demand to increase revenue when the economy is in good condition. Therefore, they need additional working capital to increase their human resources, machines, raw-material for their production. This result aligns with the previous study (Çepni et al., 2020; Soedarmono et al., 2017).

In Figure 10, the blue coloured area dominates the plot, and no arrows appear. This phenomenon indicates that the relationship between investment loan growth and economic growth is weak. Investment loan shows weak correlation to economic growth compared to the relationship of other types of loan. This result aligns with the previous result (Çepni et al., 2020). The possible explanation is that most investment loans are influenced by foreign capital inflow to the country determined by global macroeconomic conditions (Çepni et al., 2020).

In Figure 11, for the cycle of 8-16 months year 2011-2015, the correlation between economic growth and consumption loan growth is strong. The arrows point to upright means that consumption loan growth leads the economic growth with a positive correlation. However, compared to Figure 9, the correlation seems weaker. The relationship between consumption loan growth and economic growth is stronger than investment loan but weaker than the working capital loan. The possible explanation is that consumption loan only moves the consumption

to a later period. The expectation of economic condition in the future determines the behavior of consumption of society (Çepni et al., 2020).

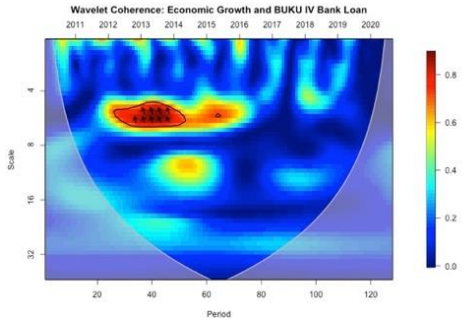

Figure 12: BUKU 4 bank.

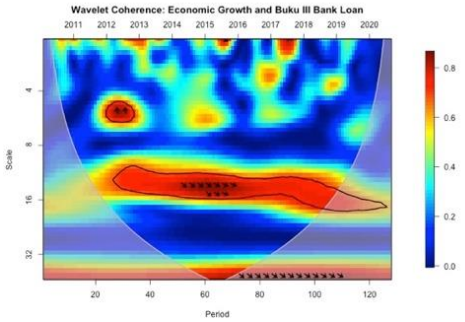

Figure 13: BUKU 3 bank.

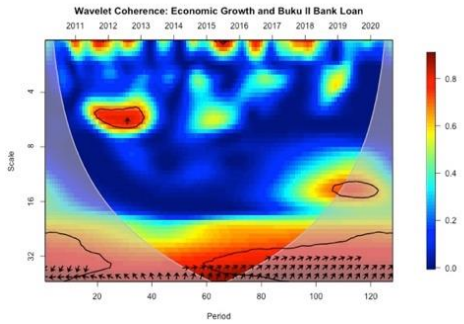

Figure 14: BUKU 2 bank.

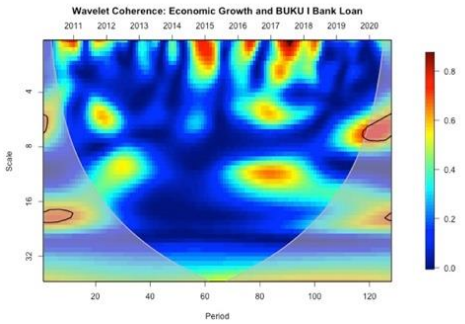

Figure 15: BUKU 1 bank.

The classification of BUKU groups in Indonesia is based on the size of the banks (the minimum capital) and business activities that the banks can conduct. Based on the size of the banks in Indonesia, the correlation between loan growth of each type of bank size to economic growth can be found in Figure 12 – Figure 15. In Figure 12, only in the cycle of 4-8 months in 2012-2015, the correlation of banks loan growth in BUKU 4 (big sized banks) is strong, while in other periods, the weak correlation is observed. BUKU 4 bank loan growth shows a weak correlation to economic growth because the "too big to fail" hypothesis indicates that the government will bail out big banks if they fail (Montagnoli et al., 2021). This result aligns with the study by Bouheni and Hasnaoui (2017), that says that big banks tend to have *counter-cyclical.* In Figure 13, a strong correlation is observed in the cycle of 8 – 16 months. This finding indicates that the loan growth of banks in BUKU 3 (medium-sized banks) is stronger than BUKU 4. The arrows that point to downright mean that economic growth leads BUKU 3 loan growth and moves in the same direction. BUKU 3 (medium-sized banks) banks loan growth has a stronger correlation to economic growth than other BUKU because these banks tend to use their resources to mitigate the risk of non-performing loans. This result aligns with the previous studies (Bouheni & Hasnaoui, 2017; Montagnoli et al., 2021). They try to increase the capital buffer when the economy is down (Montagnoli et al., 2021).

Figure 14 and Figure 15 show the correlation between banks' economic growth and loan growth in BUKU 2 and BUKU 1 (small-sized banks). Both BUKU 1 and BUKU 2 loan growth have a weak correlation to economic growth than banks in other BUKU groups. These are observed from the dominance of the blue-coloured region in both of the figures. BUKU 1 and BUKU 2 banks (small-sized banks) tend to have a low correlation to economic growth. The

possible explanations are the weak ability in absorbing the credit risk (Montagnoli et al., 2021) and the limited business activity that the banks can conduct in BUKU 1 and BUKU 2.

5. CONCLUSIONS

This study uses *Wavelet Coherence Analysis* to explain the co-movement between two-time series, including the two dimensions analysis, i.e. time and frequency. Based on the author's knowledge, this is the first study in Indonesia that uses *Wavelet Coherence Analysis* for financial data and the classification of banks based on BUKU. The data sample used in this study is from January 2010 to September 2020. The first result of the study is that economic growth leads the total bank loan growth in Indonesia. This result aligns with the previous result (Çepni et al., 2020; Kirikkaleli & Athari, 2020). It can be said that Indonesia is in the mature stage of economy because the banks follows the economy, not the economy that follows the banks' loan growth. So, banks in Indonesia are expected to fulfil the needs of the economy. More advanced banking products and services should be arranged according to the more complicated business needs nowadays. Banks cannot just rely on standard products to survive in the rapid growth of economy in Indonesia. Second, there are different co-movements of economic growth and bank loan growth based on bank ownership. The state-owned bank loan growth shows the strongest correlation to economic growth compared to the loan growth of other bank ownership types. The correlation of local-government bank loan growth also shows a strong correlation compared to the loan growth of other bank ownership types. This means that the role of government banks, both state-owned national and local-government is crucial in shaping the economy in Indonesia. The Indonesian government should have more attention to strengthen the national state-owned bank and local government bank, especially when the focus of the government is developing the economy of the country by distributing more loan to more productive sectors. The correlation of bank loan growth of Non-FX national private bank, joint venture bank, and the foreign bank show weak correlation compared to the loan growth of other bank ownership types.

Third, by analyzing the different types of loan, this study reveals a difference in the co-movement between loan growth and economic growth in Indonesia. Working capital loan growth has the strongest correlation to economic growth compared to the growth of other loan types. Consumption loan credit growth shows a weaker correlation to economic growth than working capital loan growth. Lastly, investment loan growth shows the weakest correlation among other loan types. So, the focus on developing the economy in Indonesia means focusing the policy in the growth of working capital loan among other types of bank loan. Fourth, by including the analysis of those co-movement based on Indonesia Financial Service Authorities, refer to BUKU. This study can explain different co-movement of bank loan growth from different BUKU groups to economic growth in Indonesia. Interestingly, the loan growth of banks in BUKU 3 (medium-sized banks) shows the strongest correlation to economic growth compared to loan growth of other BUKU groups. Meanwhile, the loan growth of banks in BUKU 4 (large-sized banks) shows a high correlation to economic growth only in some period. Finally, the loan growth of banks in BUKU 1 dan 2 (small-sized banks) shows the weakest correlation compared to banks' loan growth in other BUKU groups. This finding means that to have a stronger economy, Indonesia should have more medium-sized and large-sized banks that are more stable compared to small-sized banks and can absorb more risks. This can be done by doing mergers and acquisitions of several small-sized banks into one medium-sized/large-sized banks.

LBIFf 20(1), pp.1-11.

6. IMPLICATIONS

By discovering the co-movements of different categories of bank loan growth and economic growth in Indonesia, the Indonesian government is expected to understand more comprehensively different co-movements of those variables in each bank category based on ownership, bank size (BUKU), and loan types. The dimensions of time and frequency of those co-movement can also be understood better after this study. Therefore, the government can make policies with specific priorities, e.g. short-term and long-term goals, private banks or state-owned banks, working capital loans or consumption loans, big-sized banks, or small-sized banks. Those priorities are expected to have a significant and accurate impact on economic growth in Indonesia for the future.

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