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Analysis of twin deficits hypothesis in Indonesia and its impact on financial crisis

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ABSTRACT

This study aims to analyze the relationship between the current account and budget deficit (twin deficits hypothesis), measuring the account performance and other macroeconomic indicators in predicting the debt crisis in Indonesia. Furthermore, the data used for hypothesis was obtained from 2004q1-2017q4, followed by the application of the ARDL method, while values based on debt crisis were taken from the year 1981–2017, and indicators performance measurement required the use of Early Warning System (EWS) method, which was conducted through Quadratic Probability Score (QPS), and Global Squared Bias (GSB). The results indicate a long-term positive relationship between the current account and budget deficit (twin deficits), while the short-term studies reveal a negative association termed twin divergence, which occur on instances where a country has high savings rate. Furthermore, it was established that the current account deficit towards predicting the debt crisis in Indonesia was of a low performance, and the leading macroeconomic indicators include short-term debt-foreign exchange reserves, the temporary debt-total external type, M2-foreign exchange reserves, inflation, IMF, and domestic credit-GDP. Therefore, the EWS model possesses 60% predictive abilities and an NTSR of 0.25, where the QPS value obtained was 0.373, and that of GSB was 0.005.

1. Introduction

Indonesia current transactions from the year 2013–2017 are observed to always been in deficit, with the highest occurrence being 3.19% in GDP of 2013, sustained up to 2017 with a value of -1.7% of GDP. This was due to a deficit in world economic growth and the fall in commodity prices worldwide, which resulted in a major decline in Indonesian exports, based on natural resources. Therefore, the current account deficit was also influenced by domestic production capacity that had not been able to meet the needs of raw materials, thus promoting imports (Bank Indonesia, 2013, 2014a, b).

Conversely, this condition occurs simultaneously with budget deficit, which was experienced within 2013–2017, with a value of -2.33% to -2.41% of GDP. This phenomenon was observed to occur on instances where government expenditure exceeds the revenue from taxes received (Samuelson and Nordhaus, 2010: 631) (see Figure 1).

There are several theories explaining the relationship between the current account with budget deficit, including (1) Mundell-Fleming's concept, which explains the propensity of an increase in budget deficit to promote interest rates. This initiates capital inflows, exchange rate appreciation, and the establishment of a current account deficit. (2) The absorption theory of Keynes, which explains the probability of an increase in budget deficit to cause an upsurge in aggregate demand, further encouraging imports, and current account deficit. Therefore, both approaches explain a relationship termed twin deficits hypothesis (Marinheiro, 2008).

This contradicts with the Ricardian equivalence hypothesis, which assumes a non-correlation, as it stated that an increase in taxes leads to a reduction in budget deficit and subsequently not affect current accounts. This is because a decline in government savings does not affect consumption due to the fact that people tend to prefer hoarding, thus, private savings increase (Barro, 1989).

The debate about twin deficits hypothesis is not only in terms of the theory, as several studies have also proven discrepancies, e.g that conducted by Papadogonas and Stournaras (2006), proving the existence of a positive relationship between both deficits in Greece. Meanwhile, similar evidence was established in Turkey, as reported by Altintas and Taban (2011). Some studies at showing the truth behind the twin deficits hypothesis, reported mixed outcomes, e.g., Kim and Roubini (2008) stated the existence of a negative relationship between both account deficits,

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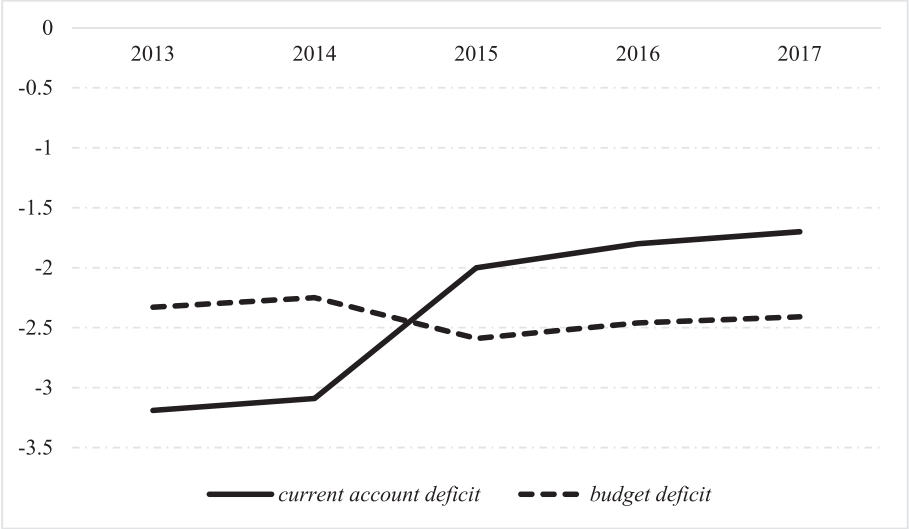

Figure 1. Conditions of Budget Deficit and Current Account Deficit in Indonesia for 2013–2017 (in the GDP percentage).
Source: Bank Indonesia (2018) & Ministry of Finance (2018)

called twin divergence in the United States. While Marinheiro (2008) actually demonstrated an inverse relationship termed reverse causation in the Egypt. Furthermore, it is possible for the correlation to also occur in two directions or bidirectionally as shown by Feldstein and Horioka (1980).

Our study focus on financial crisis, motivated by a research from Neaime (2015), where its' imbalance was observed to be positively related with current account deficit (Christopoulos and León-Ledesma, 2010; Baharumshah et al., 2003; Gruber and Kamin, 2012; Obsfeld, 2012; Kalou and Paleologou, 2012). This is often associated with various phenomena, including changes in the amount of credit and asset prices, failure of financial intermediation, and balance sheet problems. Furthermore, financial crisis is a multidimensional issue, hence, the difficulty in measuring it with one particular indicator (Claessens and Kose, 2013), thus, it is divided into three types, which entails currency, banking, and debt crisis (Lestano et al., 2004). In other hand, the study also focuses on debt crisis, and Carbaugh (2009: 349) stated that a country experiencing current account deficit, tends to commit debt, with amount within certain limits to others, possibly disrupting the balance, and can cause a debt crisis. Corsetti et al. (1999) stated the probability of financial crisis occurrence on instances where the quantity of a country's debt is greater than its capital reserves, thus making their economy dependent on the willingness of others that provide loans. Otherwise, Lestano et al. (2004) also stated the experience to occur in countries that reschedule debt because of the inability to pay.

The method used to measure performance of current account deficit and other macroeconomic indicators was the Early Warning System (EWS), divided into two types, including the parametric and nonparametric (Comelli, 2013), and the latter was adopted in this investigation, which entails signal extraction. This approach is possibly used to evaluate the performance of the EWS models produced from leading indicators, measured by the level of accuracy and calibration, using the Quadratic Probability Score (QPS) and Global Squared Bias (GSB) (Berg and Pattillo, 1999).

This research considers the rare utility of ARDL method in assessing twin deficits hypothesis, long and short-term relationships between budget and current account deficit. Therefore, the amount of supporting literature on the EWS method alongside the measurement for model performance of debt crisis is also relatively less in contrast with that of currency and banking. The use of QPS and GSB was comparatively new because of its high use in cases of currency crisis, and QPS was specifically applied with the nonparametric EWS in instances of debt, as seen in the research of Knedlik and Von Schweinitz (2012). Moreover, the differences observed was in the use of monthly data, which was not the case for GSB method, as emphasis was also laid on the debt crisis in European countries. This was, anticipated in Indonesia, which instigate the use of EWS model performance measurement methods to strengthen policy recommendations. This method was in accordance with the conditions of Indonesia because the determination of budget deficit is contained in the State Budget Revenue and Expenditure (APBN), which had previously been prepared by the government together with the House of Representatives (DPR) (Ministry of Finance, 2014). Therefore, this research is expected to provide detailed analyze of the current account deficit condition in Indonesia and its impact on financial crisis.

2. Theoretical background

2.1. Twin deficits hypothesis

Dornbusch et al. (2011: 26) explained the possibility of describing national income through the expenditure approach by the following equation:

$$Y = C + I + G + NX \tag{2.1}$$

The equation depicts national income as the sum of consumption (C), investment (I), government expenditure (G), and net export value (NX), which illustrates the positive relationship between budget and current account deficit (twin deficits). Krugman et al. (2012: 304–305) explained the incidence of government increasing budget deficit (G - T), private saving and investment to not initiate significant changes, as there is often a current account deficit (CAD), based on the elevation in that of budget. The condition of twin deficits is illustrated by Eq. (2.5).

$$S = I + CA \tag{2.2}$$

$$S = Y - C - G = (Y - T - C) + (T - G) = S^p + S^g \tag{2.3}$$

$$S^p = I + CA - S^g = I + CA - (T - G) = I + CA + (G - T) \tag{2.4}$$

$$CA = S^p - I - (G - T). \tag{2.5}$$

The pattern of this relationship is also explained through several philosophies, and the results of empirical studies, where the Mundell-Fleming's theory explains that an increase in the budget deficit reduces interest rates, which drives up domestic savings, consequently hampering the growth of domestic investments. This further attract investors, hence, capital inflows occurs, leading to an appreciation in

domestic currency. It is therefore concluded that budget deficit financed by foreign savings initiates a shortfall in current account. Mundell-Fleming's theory is illustrated in Figure 2.

Keynes's absorption theory explains the flow of twin deficits with a different approach from Mundell-Fleming, stating the increase in that of budget causes an elevation in domestic absorption, and the subsequent expansion of imports. This, therefore, leads to current account deterioration (Kouassi et al., 2004).

The existence of twin theory contradicts Ricardian equivalence, which explains the effect increasing taxes on the reduction of budget deficit, but not on the current account balance. Therefore, tax deductions causes higher taxes in the future, with values equivalent to the amount reduced, instigating people to intensify savings, and consequently not alter consumption, which leads the current transactions to remain unchanged (Barro, 1989).

The differences in pattern of twin deficits does not only take place in theory, because there are also research results that show patterns of different relationships regarding the budget and current account deficit empirically. In addition, some reports showed the occurrence of an inverse relationship (reverse causation), negative relations (twin divergence), and bidirectional causality.

Marinheiro (2008) explains the existence of several reasons underlying the reverse connection, which includes the result of capital inflow that leads to appreciation, subsequently enhancing less competitiveness of export goods. Therefore, domestic consumers switch to the use of imported items due to the fact that they are cheaper, and the deterioration of the current account impact on budget deficit following a decline in tax revenues. Reverse causation occurs due to the economic slowdown effect of current account deficit, thus, increasing government expenditure, and also due to the relation with economic conditions of a country. This is because a decline in main commodity exports leads to a reduction in the states' revenue, thus, triggering a budget deficit.

Twin divergence is evidenced by the report of Kim and Roubini (2008), indicating a negative relationship, where an increase in budget deficit leads to a decline in that of current account. This event occurs in instances where the economy is in a state of recession, characterized by output decline, and budget deficit, leading to a decrease in investment that is more significant than the drop in national savings.

Bidirectional causality is shown by a report of Feldstein and Horioka (1980), was supported by Xie and Chen (2014), which proved the existence of a two-way relationship between the variables of current account and budget deficit for eleven OECD countries. This was said to occur on instances where savings and investment are highly correlated, thus demonstrating a high level of capital mobility.

2.2. Financial crisis

Salvatore (2004: 9) stated financial crisis to be one of the most serious international economic problems faced by numerous countries worldwide, especially the developing ones. Pugel (2004: 533–538) explained

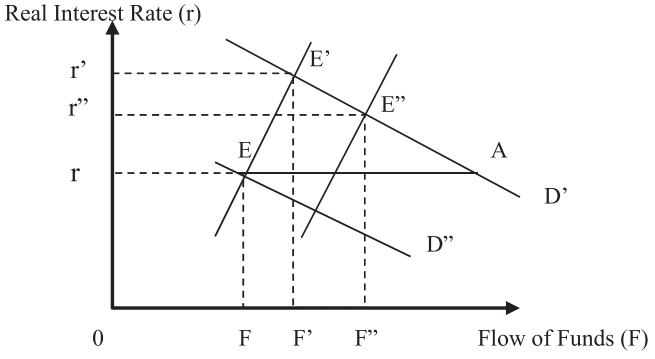

Figure 2. Relationship between budget deficit and current account deficit. Source: Salvatore (2006).

the driving factors to be inclusive of overlending and overborrowing, international shocks, exchange rate risk, short-term loans, and global contagion.

Lestano et al. (2004) divided financial crisis into three types, encompassing (1) currency, which occurs on instances where a currency experiences sharp depreciation due to an attack (Claessens and Kose, 2013). (2) Banking crisis that is in contrast, due to a bank run, which is an event that ensues when customers withdraw large amounts of money as a result of reduced trust in banking liquidity. (3) Debt crisis happen in cases where a country is unable to pay off foreign loans.

Krugman et al. (2012: 300) stated that countries borrow from others to finance the purchase of goods or services imported when the amount of imports exceed exports. Baharumshah et al. (2003) stated the current account deficit as a reflection of economic imbalance and also a trigger for financial crisis, while Dornbusch (1984) reported its propensity to initiate an increase in external debt, although there is also a probability of financing through the sales of state assets or foreign debt (Rode, 2012: 104).

Certain amounts of debt initiate the occurrence of debt crisis, which Corsetti et al. (1999) stated to perhaps occur when the amount of a country's debt is greater than its capital reserves, thus their economy becomes dependent on the willingness of others to provide loans. Lestano et al. (2004) also stated this phenomenon to occur if there is reschedule as a result of an inability to pay debt.

2.3. Early Warning System

The EWS method is generally divided into two broad types, including the parametric and nonparametric methods, specifically pioneered by Kaminsky et al. (1998), using a signal approach to determine the performance of each macroeconomic indicator in predicting currency crisis. Therefore, the leading markers include exports, real exchange rates, M2-foreign exchange reserves, output, and price similarity.

Berg and Pattillo (1999) also conducted a similar research with the aim of predicting the probability of currency crisis, using the signal approach method, based on previous study conducted by Kaminsky et al. (1998). In addition, probit, which is a parametric technique was also applied as an alternative, and the result showed an increase in the performance of current account indicators and M2-foreign exchange reserves. Berg and Pattillo (1999) used Quadratic (QPS) and Log (LPS) Probability Score methods to measure the accuracy of EWS model, while Global Square Bias (GSB) was adopted in measuring its level of calibration.

Probit and logit methods are often applied in EWS research with a parametric approach. A study by Bussiere and Fratzscher (2006) uses a multinomial logit to determine the leading indicators of currency crises in emerging countries, with the aim of overcoming post crisis bias problems that have previously been conducted. This approach divides the currency predicament into three regimes, including tranquil, pre-, and post-crisis. In addition, the leading macroeconomic indicators encompasses the degree of overvaluation of the exchange rate, current transactions (GDP percentage), short-term debt-foreign exchange reserves, credit growth, real GDP growth, and the contagion financial sector. Therefore, the study model was able to predict the occurrence of a currency crisis of about 65.5%, with an error rate of 42.3%.

The multinomial logit parametric method was subsequently modified by Ciarlone and Trebeschi (2005) prior to application in debt crisis, and the outcome showed the leading macroeconomic indicators to include interest payments on external debt-foreign exchange reserves, the level of openness of international trade, and export growth, total external debt, short-term debt-GDP, and total foreign exchange reserve based on external debt. This model is also able to forecast the occurrence by about 76%, with error rate of 36%.

Other research focusing on debt crisis using parametric methods include Fuertes and Kalotychou (2006), which used the logit panel method in examination within 96 developing countries, as well as the

application of QPS and LPS in the measurement of accuracy levels as used in currency crises. Meanwhile, a study conducted by Candelon et al. (2012) developed a method with the possibility of being used in the assessment of parametric EWS models performance, in cases of currency, banking and debt crises. This also involved the use of QPS as well as The Area Under The ROC Curve (AUC), then Clark-West test was employed in the identification of the most optimal between both.

The use of nonparametric EWS methods in European countries were reported by Knedlik and Von Schweinitz (2012), employing a signal extraction technique, using monthly data, and QPS was subsequently applied in the measurement of its performance. Meanwhile, within Indonesia, similar study was performed by Handoyo (2012) in analyzing other forms of financial crises, including that for currency and banking. This subsequently involved the use of signal approach and logit methods, where the leading macroeconomic indicators in the study differed according to its nature. In addition, the indicators include exports, term of trade, current transactions-GDP, foreign exchange, debt-GDP, inflation, GDP per capita, and savings.

Research based on debt crisis were also developed by Dawood et al. (2017) with the aim of determining its leading indicators in several developed and developing countries. This involved the use of several methods, which include binary, and multinomial logit, as well as dynamic signal extraction, and the leading macroeconomic indicators in the study were total debt, IMF credit, world interest rates, foreign currency reserves, trade openness, current account, FDI, real GDP growth, inflation, M2-foreign exchange reserves, REER, government spending, national savings, domestic credit, bank assets, and government bank loans.

2.4. Analysis model

This required the use of long- and short-term ARDL models with the intention of answering the hypothesis, suggesting the probability of a positive relationship between budget and current account deficits. This model refers to the type applied in the report by Altintas and Taban (2011), indicated as follows:

Long-term model:

$$CA_t = \alpha_0 + \sum_{i=1}^{m} \alpha_{1i} CA_{t-i} + \sum_{i=0}^{m} \alpha_{2i} BD_{t-i} + \sum_{i=0}^{m} \alpha_{3i} I_{t-i} + U_t \quad (2.6)$$

Short-term model:

$$\Delta CA_t = \alpha_0 + \alpha_1 ECM_{t-1} + \sum_{i=1}^{m} \alpha_{2i} \Delta CA_{t-i} + \sum_{i=0}^{m} \alpha_{3i} \Delta BD_{t-i} + \sum_{i=0}^{m} \alpha_{4i} \Delta I_{t-i} U_t \quad (2.7)$$

Meanwhile, the equation for Litsios and Pilbeam (2017) was as follows:

$$\Delta CA_t = -\sum_{h=1}^{p-1} \gamma \Delta CA_{t-h} + \sum_{j=1}^{k} \sum_{i=0}^{qj-1} \Delta X_{j,t-h} \beta_{j,h} - \widehat{\theta} EC_{t-1} + \epsilon_t \quad (2.8)$$

Both approaches incorporated investment variables (I) to their models, where that of Altintas and Taban (2011) consists of two models, which were the long- and short-term, while Litsios and Pilbeam (2017) only applied the short-term ARDL in this study, which include:

$$\Delta CAD_t = \alpha_0 + \sum_{i=1}^{p-1} \alpha_{1i} \Delta CAD_{t-i} + \sum_{i=0}^{p-1} \alpha_{2i} \Delta BD_{t-i} - \widehat{\theta} EC_{t-1} + U_t \quad (2.9)$$

Meanwhile, the long-term ARDL model applied was as follows:

$$CAD_t = \alpha_0 + \sum_{i=1}^{p-1} \alpha_{1i} CAD_{t-i} + \sum_{i=0}^{p-1} \alpha_{2i} BD_{t-i} + U_t \quad (2.10)$$

where:

CAD_t = CAD in year t.
CAD_{t-i} = CAD on certain lags.
BD_{t-i} = BD on certain lags.
EC_{t-1} = Error correction term.
U_t = Error.

3. Research methodology

3.1. Data

The type of data used were secondary and time series based, obtained from Bank Indonesia, Ministry of Finance, IMF, World Bank, Asian Development Bank, and Paris Club. Furthermore, information for twin deficits were quarterly records from 2004Q1 to 2017Q4, while data on related budget deficits were interpolated using linear methods, with the help of Eviews 9. EWS was obtained as annual data from the period 1981 to 2017, and the details regarding each variable along with the sources used in the study were explained in Table 1. This research has a lack of avaibility of data related with twin deficit in particular before 2004. At that time Indonesia implemented new regime namely Indonesia's Reformation Era, after "President of Soeharto regime". Furthemore, the reformative regime (based on new act of states budgeting) has implemented financing public debt theough secondary market, so government was able to issue the government bond to finance its deficit.

Table 1. Variables for *Twin Deficits Hypothesis* and *Early Warning System*.

Variables for Twin Deficit Hypothesis				
No	Variable	Unit	Period	Source
1	CAD	Percent	Quarterly	Bank Indonesia
2	Budget Deficit	Percent	Quarterly	Ministry of Finance and interpolated
Variabels for EWS				
No	Indicator	Unit	Period	Source
1	CAD	Percent	Annually	IMF
2	Export Growth	Percent	Annually	IMF
3	Real GDP Growth	Percent	Annually	IMF
4	Short Term Debt-Foreign Exchange Reserve	Percent	Annually	World Bank
5	Short Term Debt-Total External Debt	Percent	Annually	World Bank
6	Inflation	Percent	Annually	IMF
7	IMF Credit-GDP	Percent	Annually	World Bank
8	M2-Foreign Exchange Reserve	Percent	Annually	World Bank
9	Domestic Credit-GDP	Percent	Annually	World Bank

3.2. Methodology

This investigation uses the Autoregressive Distributed Lag (ARDL) method to analyze the relationship between budget and long-term, as well as short-run current account deficits. A one-way relation is aimed at adjusting conditions in Indonesia where budget deficit is contained in the State Budget Revenue and Expenditure (APBN). This ARDL method was developed by Pesaran et al. (2001), which possesses advantages in contrast with several other cointegration test methods, in the aspect that it does not require all variables to be stationary at the specified level, and that its propensity of being combined with several at the level and first difference. This technique is appropriate for relatively smaller data quantity, and it also allows for varying optimal lags on each variable (Litsios and Pilbeam, 2017).

The signal extraction Early Warning System (EWS) method was chosen to measure the performance of macroeconomic indicators in predicting the debt crisis of Indonesia, and also to evaluate the predictive ability of the overall model, with reference to a previous study conducted by Dawood et al. (2017). In addition, the level of accreditation (accuracy) and calibration was also evaluated, using the Quadratic Probability Score (QPS), and Global Square Bias (GSB) methods, respectively (Berg and Pattillo, 1999).

3.3. Autoregressive Distributed Lag (ARDL) method

The ARDL method was initiated with a stationary test, aimed at determining the level or first different status of current account and stationary budget deficit variables. In addition, stationarity tests are often referred to as unit root tests, where Augmented Dickey-Fuller (ADF) was applied in this investigation, to ensure all variables are not stationary at the second difference level.

Therefore, the next step involves choosing the most optimal lag possibly involving the use of Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC), or Hannah-Quinn Criterion (HQC) (Nkoro and Uko, 2016). The value of AIC and SBC tend to be the best, although this study uses SBC, due to the reference to the research conducted by Litsios and Pilbeam (2017), which also applied similar criteria.

The next stage requires the implementation of bound testing, which is a cointegration test that aims at determining the propensity of a variable to have long-term relationships. The outcome, however, depends on the value of F statistics, thus, on instances where it exceeds critical value, a cointegration is observed between the budget and current account deficits.

The short- and long-term ARDL models ought to be tested for suitability in policy making, hence, instigating the necessity of a diagnostic process, in order to identify any problems. This includes test for normality, autocorrelation and heteroscedasticity, and the decision rule for all is to accept the null hypothesis (H0) if the probability is greater than 0.05.

3.4. Early Warning System (EWS) method

The EWS method occurs in several important stages, which include (1) determining the period of the debt crisis (2) resolving macroeconomic indicators, (3) measuring their performance (4) evaluating EWS model performance. The definition of the debt crisis is required in the period determination, with reference to Dawood et al. (2017), and Ciarlone and Trebeschi (2006). Hence, a country is said to experience debt crisis on instances of involvement in at least one of the following events:

1. Rescheduling or debt restructuring.

This occurs when the country is unable to initiate debt payments and data for debt rescheduling and restructuring periods were obtained through the Paris Club.

2. Accumulated principal and interest arrears that exceed 5% of total external debt.

Accumulated arrears are calculated by summing the stock of principal and interest arrears, subsequently dividing with total external debt. In addition, the data was obtained from the World Bank.

3. Receiving credit from the IMF that exceeds 100% of the quota set for that country.

The data is calculated the ratio of credit amount received and the estimated quota, in accordance with the applicable periodI, as obtained from the IMF.

Macroeconomic indicators are said to signal a crisis on instances where they cross the threshold (above or below) the previous set (Dawood et al., 2017), and a negative sign is said to designate that the indicator were below threshold, subsequently signaling a crisis. Meanwhile, a reverse is the case for positive sign, also denoting a crisis. The macroeconomic indicators used in the study conducted by Ciarlone and Trebeschi (2005), Handoyo (2012), and Dawood et al. (2017) were adopted in this study, explained in Table 2.

Measurement of macroeconomic indicator performance is conducted through signal extraction, initiated by determining the threshold, which is the mean value and one standard deviation. In addition, each value is

Table 2. Indicators determining crises and their relationships with crises.

Indicators	Interpretation and Relationship with the Crisis	Source
CAD (-)	The worse demonstration of the current account causes a crisis.	Ciarlone and Trebeschi (2005), Handoyo (2012), and Dawood et al. (2017)
Export Growth (-)	The declining export value indicates a lack of competitiveness and triggered a crisis.	Ciarlone and Trebeschi (2005), Handoyo (2012), and Dawood et al. (2017)
Real GDP Growth (-)	Declining real GDP growth increases the probability of a crisis.	Ciarlone and Trebeschi (2005), Dawood et al. (2017)
Short-Term Debt-Foreign Exchange Reserve (+)	An enhanced value of short-term debt leads to a higher probability of crisis.	Ciarlone and Trebeschi (2005)
Short-Term Debt-Total External Debt (+)	The higher value of short-term debt causes an elevated probability of crisis.	Ciarlone and Trebeschi (2005)
Inflation (+)	The increased rate of inflation triggers economic instability.	Ciarlone and Trebeschi (2005), Handoyo (2012), and Dawood et al. (2017)
Domestic Credit-GDP (+)	High credit growth threatens liquidity and trigger a crisis.	Handoyo (2012), and Dawood et al. (2017)
Credit Domestic-GDP (+)	The amount of IMF credit exceeding 100% of the quota triggers a crisis.	Dawood et al. (2017)
M2-Foreign Exchange Reserve (+)	M2- Foreign exchange reserves shows the ability of central bank to meet customer demand for third party banking funds.	Handoyo (2012), and Dawood et al. (2017)

Table 3. Indicator signal matrix.

	Crisis (in 2 years)	There is no crisis (in 2 years)
There is a signal	A	B
There is no signal	C	D

A = The number of years in which the indicator shows a good signal, past the threshold
B = The number of years in which the indicator shows false signals or interference
C = The number of years in which the indicator failed to show a good signal
D = The number of years in which the indicator is stuck to show a false signal
Source: Dawood et al. (2017) and Handoyo (2012).

observed to assess its position about the estimated threshold (above or below), hence, if it crosses, a crisis is signaled (Dawood et al., 2017). These are, therefore, used to determine the performance of indicators, through signaling windows process, with reference to Table 3.

Table 3 describes the performance measurement indicators, using signaling windows, and Dawood et al. (2017) stated the propensity of macroeconomic indicators to provide good signal was limited to the possibility of being followed by a crisis within a window of catastrophe. This study refers to a two-year time period as determined by Dawood et al. (2017), and the signaling windows process is conducted in order to calculate the number of good or false signals (noise).

Goldstein et al. (2000) explained that possibility of unconditional crises was denoted by P (crisis) = (A + C)/(A + B + C + D), while that for crisis with conditions was P (Crisis| S) = A/(A + B). This signaling window process requires the selection of optimal threshold, in order to avoid "type I errors" which was explain to occur on instances where indicators fail to demonstrate a crisis, and "type II errors" which ensue when false signals are shown.

Optimal threshold selection is performed in order to minimize the occurrence of type I and II errors, using noise to signal ratio (NTSR), which was defined by Kaminsky (1999) and Dawood et al. (2017), tousing the following hypothesis:

H0 = crisis (A + C)
H1 = no crisis (B + D)

Type 1 error refers to the probability of rejecting H0 when a crisis is proven (A + C), while type 2 is based on the possibility of accepting H0 on instances where it is proven that no crisis (B + D) exists.

$$NTSR = \frac{Type\ II\ Error}{1 - Type\ II\ Error} = \frac{P(B|B+D)}{1 - P(C|A+C)} = \frac{P(B|B+D)}{P(A|A+C)} \quad (3.1)$$

After going through the signal extraction process using signaling windows, the performance extent of macroeconomic indicators is then known. This includes the probability of a crisis, and the value of NTSR, thus, those above 50% or <0.5 respectively are termed good indicators, although not all are leading. These were, therefore, measured by calculating the composite index value (It), and an indicator with NTSR <0.5 was used in this study in accordance with the research conducted by Dawood et al. (2017). In addition, the output was computed by weighting the signal (S_t^j)from each leading indicator, with the inverse of the NTSR at a certain time ω^j).The result was accumulated into one, hence, the composite index value is generated every period of the year.

$$I_t = \sum_{j=1}^{n} \frac{S_t^j}{\omega^j} \quad (3.2)$$

EWS model performance measurement was conducted by observing the conditional probability value, which is obtained from the calculated composite index value, located at an interval $(I_L < I_t < I_U)$, through a ratio against the number of years. This is followed by a crisis occurring in a crisis window (Dawood et al., 2017). Goldstein et al. (2000: 65) and Suh et al. (2011) reported the adjustment of interval towards the results of the composite index value.

$$P(C_{t,t+h}|I_L < I_t < I_U) = \frac{\sum t\ with\ I_L < I_t < I_U\ followed\ by\ crisis\ on\ a\ crisis\ window}{\sum t\ with\ I_L < I_t < I_U} \quad (3.3)$$

This conditional probability value is used to measure the performance of EWS model, conducted with the signaling windows concept as previously performed for the indicators. In addition, the value higher than the threshold is observed to signal a crisis, and 50% was adopted in this study or 0.5, selected based on the research by Berg and Pattillo (1999). Therefore, the signal produced is compared with actual crisis, and the performance is identified through the signaling windows process.

This assessment does not stop at measuring the extent to which EWS model predict crisis, but also the propensity of evaluating performance by discerning its level of accuracy and calibration using QPS, and GSB, respectively (Berg and Pattillo, 1999).

$$QPS = 1/T \sum_{t=1}^{T} 2(P_t - R_t)^2 \quad (3.4)$$

$$GSB = 2(\overline{P} - \overline{R})^2,\ \text{where}\ \overline{P} = 1/T \sum_{t=1}^{T} P_t,\ \overline{R} = 1/T \sum_{t=1}^{T} R_t \quad (3.5)$$

The QPS values range from 0 to 2, and the closeness to 0 indicates the likely accuracy of the model, and the same goes for GSB values. In addition, the number of research samples is symbolized by T, where the value of P_t refers to the conditional probability value in period t, while R_t is a value, which is worth 1 on instances where there is a crisis in the crisis window.

4. Results

4.1. Twin deficits hypothesis in Indonesia

Table 4 explains the absence of stationary variables at the second difference level, indicating the propensity of the ARDL method to accurately test the relationship between budget and current account deficits. Meanwhile, the optimal lag in this study was (1,1).

Table 5 describes the results of bound testing, showing the F statistic value of 5.443 to be greater than the critical value by 10%, which was 4.78. These indicated a long-term relationship between budget and current account deficits, hence, the next step was to estimate the long- and short-term equations.

Table 6 shows a significant relationship was observed on the long run, as a 1% elevation in the budget deficit initiates a 2.22% increase in that of current account. Based on short term, a negative relationship was observed, as a 1% increase in budget deficit lead to a decrease in current account deficit by 1.91%. The results also illustrate the resultant reaction magnitude to equilibrium deviations for each period by 33%, and it was also established that the estimation outcomes of the adopted model was free from the problems of autocorrelation and heteroscedasticity.

Figure 3 shows the results of Cusum Squared test, which indicates the model as relatively stable and good, in terms of its propensity of being

Table 4. Stationery test of ARDL model.

No	Variable	ADF Stat	Level (Prob)	ADF Stat	First Difference (Prob)
1	CAD	-2.569*	0.0065	-9.329*	0.0000
2	BD	-0.421**	0.3376	-3.537*	0.0071

* Significant on α = 10%.
** Significant on α = 5%.

Table 5. Cointegration test (bound testing).

F Statistic	5.443	k=1
Critical Value	I (0)	I (1)
10%	4.04	4.78
5%	4.94	5.73
2.5%	5.77	6.68
1%	6.84	7.84

Table 6. Result of ARDL model estimation.

	Coefficient	Standard Error	t-statistic	Prob
ECT	-0.336*	0.102	-3.28	0.002
BD	2.221*	0.622	3.57	0.001
Δ*BD*	-1.915*	0.916	-2.09	0.042

* Significant on α = 5%.

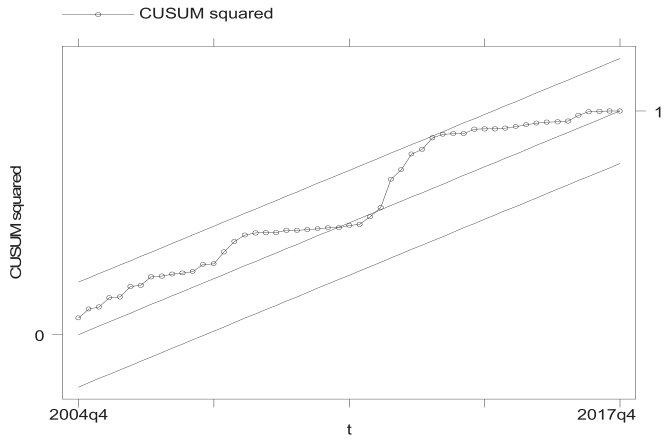

Figure 3. Cusum squared test.

used as a basis for policy making. Cusum test for the case instability is appropriate for testing for parameter instability in the intercept term. It is best described as a test for instability of the variance of post-regression residuals. This is in accordance with the research conducted by Altintas and Taban (2011), as well as Litsios and Pilbeam (2017), both of which are related with the conditions in Indonesia, which has experienced current account deficit right from the fourth quarter of 2011. This occurred due to a decline in world demand and commodity prices, thus, non-oil exports were observed to exhibit a slowdown. Furthermore, the deficit was reported to also occur as result of an increase in oil shortage, and the reduction of gas surplus (Bank Indonesia, 2013).

Nizar (2015) stated this occurrence was due to several factors, including the decline in trade balance of goods surplus, a service account deficit and a reduction in net income, illustrating that income flowing abroad is greater than that entering the country. Therefore, the Interest in foreign loans as a form of state revenue flows out, and is, subsequently recorded in the State Budget Revenue and Expenditure (APBN), causing the twin deficit in 2012.

In contrast to the results of the long-term research, the short-term study outcomes demonstrate a negative relationship between the budget and the current account deficit (twin divergence). The report of Kim and Roubini (2008) showed this occurrence in the United States, while data from the Bank of Indonesia declared the current transactions in the first and third quarter of 2011 to show a surplus trend, despite a deficit in several other periods, which coincides with a budget deficit. This shows a negative relationship between both variables, as an increase in budget deficit tends create surplus current transactions (twin divergence).

Bon (2014) also conducted a study on the twin deficits hypothesis in Asian regions, including Indonesia, which showed the experience of twin divergence in 1985–2012. Meanwhile, the main factors included that a majority tend to practice high savings rates, thus, data from Key Indicators for Asia and Pacific, published by the Asian Development Bank (2013)also reported the rising indices of domestic savings for Indonesia from 2005 to 2012, amounting from 27.5%, to 36.6% of the GDP value, respectively.

4.2. Measurement of performance of macroeconomic indicators using the EWS method

The debt crisis period in Indonesia based on data obtained from the Paris Club, World Bank, and IMF explained in Table 7.

The results of the study shows the indicators with a NTSR value of <0.5, are also short-term foreign exchange reserves, short-term debt-total external debt, inflation, IMF-GDP credit, M2-foreign exchange reserves, and domestic-GDP credit. However, not all values <0.5 had a crisis probability of >50%, which include short-term debt-total external debt, inflation, and IMF-GDP credit. Therefore, the results of overall performance measurements are explained in Table 8.

Table 9 explains the measurement of the EWS model performance using predetermined leading indicators that predicted a crisis of 60%. In addition, there were signals that appeared and were subsequently followed by a crisis of 3, others that were not followed, indicated a crisis value of 2, while the category that failed, showed 7. Meanwhile, the normal period demonstrated no signal, and a crisis of 25, thus, this model is seen as good. This is because of the occurrence of a fairly small NTSR value (0.25), indicating the number of good signals is better than the false.

The measurement using the QPS and GSB methods indicated that the model had the right level of accuracy and perfect calibration, as shown by the value of 0.373 and 0.005, respectively which were close to 0.

The current account deficit is not a leading indicator of the debt crisis in Indonesia, as the actual data shows a sharp increase of its peak, which occurred in 1983, with a deficit of -6.49% of GDP. This actually promoted and showed a surplus during the period of debt crisis, between 1997 and 2005, where the indicator behavior tends to fluctuate, and was incapacitated to appropriately show a signal of the occurring crisis. In addition, similar outcomes were observed for macroeconomic indicators, including exports and real GDP growth, which is not appropriate for demonstrating debt crisis.

Furthermore, inflation, IMF-GDP credit, M2-foreign exchange reserves, domestic-GDP credit, short-term foreign exchange reserves and short-term external debt were observed to have NTSR values < 0.5. This indicates the capacity of being used as a leading indicator for debt crisis in Indonesia, which are also able to appropriately signal the occurrence

Table 7. Period of debt crisis in Indonesia and cause of crisis.

No	Year	Cause of Crisis		
		IMF Lending	Rescheduling	Interest and Principal Arrears
1	1997	Yes	No	No
2	1998	Yes	Yes	No
3	2000	Yes	Yes	Yes
4	2001	No	No	Yes
5	2002	No	Yes	Yes
6	2003	No	No	Yes
7	2004	No	No	Yes
8	2005	No	Yes	No

Source: Paris Club (2018), World Bank (2018), IMF (2018a, b), processed

Table 8. Macroeconomic indicator performance measurement results using *Signaling Windows*.

No	Indicator	A	B	C	D	A/A + C	B/B + D	NTSR (B/B + D)/(A/A + C)	Probability of Crisis A/A + B
1	CAD	4	26	6	1	0.4	0.962963	2.407407407	13%
2	Export Growth	10	25	1	1	0.909091	0.961538	1.057692308	29%
3	Real GDP Growth	10	26	0	1	1	0.962963	0.962962963	28%
4	Short-Term Debt-Foreign Exchange Reserve	3	4	7	23	0.3	0.148148	0.49382716	43%
5	Short-Term Debt-Total External Debt	3	2	8	24	0.272727	0.076923	0.282051282	60%
6	Inflation	1	0	9	28	0.1	0	0	100%
7	IMF Credit-GDP	6	0	4	27	0.6	0	0	100%
8	M2-Foreign Exchange Reserve	3	4	7	23	0.3	0.148148	0.49382716	43%
9	Domestic Credit-GDP	4	5	6	22	0.4	0.185185	0.462962963	44%

Table 9. EWS model performance measurement results using *Signaling Windows*.

A	B	C	D	A/A + C	B/B + D	NTSR (B/B + D)/(A/A + C)	Probability of Crisis A/A + B
3	2	7	25	0.3	0.074	0.25	60%

of a crisis. Therefore, the results of performance measurement were observed to also be in accordance with that of a study conducted by Dawood et al. (2017) and Handoyo (2012), and the differences occurred in M2-foreign exchange reserve.

The EWS model produced had a good performance, with an NTSR value of 0.25, and a probability of crisis of 60%. This was higher, in contrast with Dawood et al. (2017), applied in the Southeast Asian crisis which was 40.9%. Furthermore, the study model also had a fairly good level of accuracy and calibration, indicated by the calculated values of QPS and GSB that approached 0, which were 0.373, and 0.005, respectively. These were also in accordance with the research of Berg and Pattillo (1999), as seen in the case of a currency crisis, where the recorded outcomes were 0.267, and 0.00002, respectively.

5. Conclusions

The results on the twin deficits hypothesis, using the ARDL method indicates the occurrence of a positive relationship between budget deficit and the long-term current account deficit, while a negative correlation was observed in the short term assessment. In addition, the study outcomes were also supported by several previous reports, where the use of EWS signal extraction method indicated that current account deficit was not a leading indicator for the debt crisis faced by Indonesia within the period of 1981–2017. This is reinforced by the behavior of inaccurate current account deficit indicators, towards issuing related signals.

The leading macroeconomic indicators included short-term foreign exchange reserves, and debt-total external debt, inflation, IMF-GDP credit, M2-foreign exchange reserves, and domestic-GDP credit. Therefore, the results of assessing the model performance showed the propensity of the EWS to predict a crisis by 60%, with an NTSR value of 0.25, which is quite good. The following measurement of accuracy and calibration showed the EWS model to be of a fairly good level, due to the QPS and GSB of 0.373, and 0.005, respectively, which were close to 0.

The current account deficit was observed to not be a leading indicator of debt crisis, and short-term debt happens to be one that needs to be addressed due to the fact that it is directly related. This ought to be considered based on the purpose of debt utility, especially on instances where it is used in the consumption sector, e.g., oil imports, subsequently increasing the current account deficit. This was consistent with the report by Pitchford (1989), Yol (2009), and Makin et al. (2014).

The research results of twin deficits and negatives (twin divergence) proved the effect of government controlling budget deficit, therefore, viewing the incidence from the aspect of expenditure, the infrastructure sector is seen to be the development priority. Hence, the expected regulation ought to be conducted through this implementation, with the intention to enhance the efficiency of growth. This control ought to be performed with consideration that the occurrence was due to oil deficit, and the effect of falling commodity prices, triggered by factors in rising imports. This factor must, therefore, always be monitored, in order to limit the probability of an increase to occur in terms of excessive importation. Meanwhile, the decline in commodity prices is identified to greatly affect Indonesia, due to the fact that exports rely on sectors that are natural resource base, thus, the government ought to initiate the development of non-natural resource based commodity, given the volatility of the natural resource bases.

In addition, there is need for regulating the movements of each leading indicator, in order to not trigger a debt crisis, therefore M2 growth and inflation control is required, thus, preventing the occurrence of imbalances. Furthermore, the growth of domestic credit also needs to be organized, in an attempt for banks to not experience liquidity problems, also, IMF credit must be sought not to exceed the prescribed quota, thus, eliminating the incidence of crisis. Meanwhile, the purpose of using short-term debt ought to be an important concern because of its relationship with the current account deficit. Hence, the need for limiting its application towards financing productive sectors, including infrastructural and of Human Resources (HR) development, in order to produce optimal returns.

Future studies are expected to analyze the twin deficits hypothesis, by adding control variables, in order to obtain an in-depth explanation of conditions related to the current account deficit in Indonesia. In addition, further research is also expected to enhance the proficiency of assessing its performance in association with other forms of crises, including that of currency. Therefore, additional investigation is required, given the different periods determined from each type of crisis, with the aim of producing varying degree of performance.

Declarations

Author contribution statement

Rossanto Dwi Handoyo: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data.

Angga Erlando Nita Tri Astutik: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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