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Trilemma to Quadrilemma: An empirical study from Indonesia

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Abstract: The objective of this study is to test the trilemma and the quadrilemma monetary policy using Indonesia data with covering years 1983 – 2017. The research suggest that the monetary independence and capital account openness might have been more passionately pursued by Bank Indonesia for testing the trilemma; while testing of the quadrilemma, the concentration seems to have shifted to take a middle position within each policy objectives. In this study, the full sample period is split in three subsamples: 1983-2017, 1983 – 1999 and 2000 – 2017. The methodology used in this research is ordinary least square. Our findings show that the policy might have shifted from exchange rate stability, capital account openness and foreign reserves in the first subsample to other four policy objectives in the second subsample. It indicates that foreign reserve plays as fourth objective leading the central bank to achieve at the same time the three "impossible" goals. Therefore, taking into account foreign reserve as a monetary policy objective is deserved. Adequacy of reserves could higher our capacity to prevent or mitigate external shocks.

Keywords: trilemma, quadrilemma, Indonesia, foreign reserve, monetary policy

JEL Classification: E42, E50, E52, E59

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1. INTRODUCTION

In past, various international financial system has attempted achieve a combination of two of the three monetary policy objectives e.i the Gold Standard system (ensuring capital mobility and exchange rate stability) and the Bretton Woods system (providing monetary autonomous and exchange rate stability). Facing the complexity of management policies, policy makers deal with simple old theoretical boundaries, called trinity or Illustration of trilemma, can be seen in Figure 1.

Although it has received wide recognition, empirical research on the hypothesis of "the impossible trinity" has not been done much. That is because measuring the level of systematic achievement of the three policy objectives of the trilemma is quite difficult. If it does not know to what extent each policy choice was been reached, it is difficult to estimate what other types of policy choices are still available and the extent of the policies that have been made.

Aizenman et al. (2013) have created a trilemma index that measures the level of achievement in each of the three policy choices for a wide range of countries and years. Using indices, they empirically prove that the hypothesis is valid by showing that the three trilemma measures are linearly related to each other. Recent research from Rajbinder et al., (2019) found that in India, the

election of quadrilemma is better than trilemma because the interaction of the trinity index variable and foreign exchange reserves has changed the effect of policy efficiently and made this policy choice more stable, especially a combination of monetary independence and capital account openness. In short, it can be concluded that the Indian economy can continue with capital account openness coupled with monetary independence. However, the tradeoffs to exchange rate stability were unavoidable, so a higher foreign exchange reserve was needed.

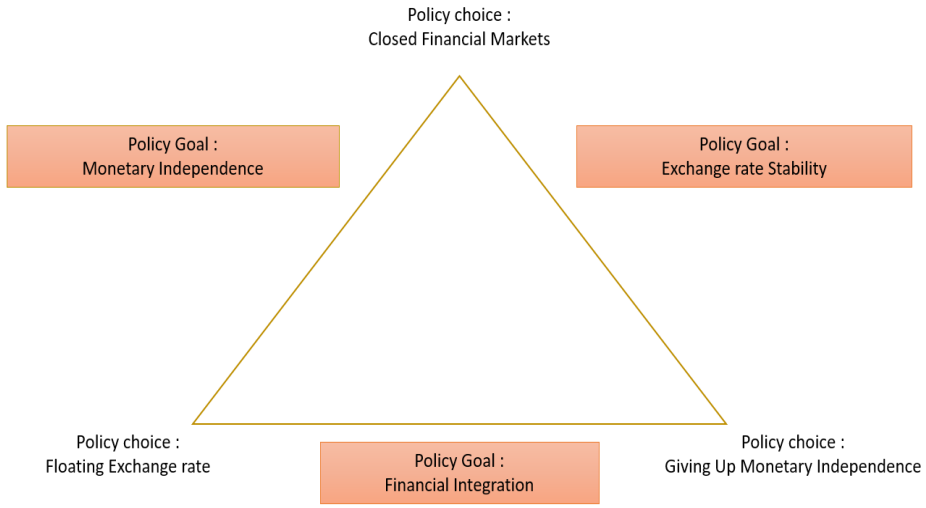

Figure 1. The Trilemma (Impossible Trinity)
Sources: Aizenman (2008)

The rapid development of financial globalization can be a risky policy for developing countries. The increasing international reserves in large numbers can reduce the risks arising from financial transparency. Open macroeconomic management must be prepared to face financial turbulence associated with the sudden cessation of capital inflows, capital flight, and deleveraging crisis. As many researchers have pointed out, developing countries, especially developing market economies, have significantly increased the number of foreign exchange reserves in recent years. In fact, the 1997-1998'crisis in East Asia caused a large change in demand for international reserves, increasing with the time of stockpiling by affected countries (Aizenman & Lee, 2007). It shows that the insurance motive is one of the motivations for developing countries to have massive international reserves (Aizenman & Marion, 2004).

Before financial integration, reserve demand provides insurance against uncertain currents. However, the financial integration of developing countries also adds to the need to insure against uncertain financial flows. Based on the nature of financial markets, exposure to rapidly increasing demand for foreign currencies is triggered by financial volatility, exceeding wide margins triggered by trade volatility. Recent studies validate the importance of "financial factors" as a key determinant, alongside traditional trade factors, in accounting for an increase in international reserves / GDP ratio. Indeed, recent research has revealed that the role of financial factors has increased along with the growth of financial integration. Countries that are more financially open, deeper financially, with greater exchange rate stability tend to have more reserves. The relationship between backing up reserves and financial integration adds a fourth dimension to the trilemma, financial stability, can add it and turn it into a quadrilateral where international reserves can act as a buffer (Aizenman et al., 2013). He suggested that developing countries might need to manage their open macro policies based on "quadrilemma" rather than "trilemma" Understanding this mixed regime is still a challenge.

This research was conducted to fill the gap where there is no research that addresses the specific problem of trilemma or quadrilemma policy using Indonesian data. The aim of this study is to test the trilemma and quadrilemma policy challenges in the case of Indonesia. An understanding

of how Indonesian banks manage and pursue their various monetary policy goals amidst the constant challenges that many face will indeed be of interest to policy makers. So that, this study has had two objectives. First is to test the monetary policy trilemma in Indonesia. The second is to test monetary quadrilemma: two of the four monetary policies that Bank Indonesia has attempted during the sample period.

2. LITERATURE REVIEW

The theoretical model was built by Ito & Kawai (2014) two assumptions were made to predict the optimal combination of the three policies under the trilemma limit. First, apart from the double-edged sword, policymakers tend to focus only on the positive aspects of open triad macroeconomic policies (exchange rate stability, financial market openness and independence of monetary policy) and pursue higher levels of achievement in all three policies. That is, they believe a higher level of achievement in this policy will help them stabilize their economy better. Second, policy makers are limited by the linear relationship of the three policies. In other words, if the achievement of the three policy objectives can be measured by a number of normalized indexes, the sum of the three indexes must be constant. More specifically, if each index is assumed to range from 0 to 1, the sum of the three indices must be 2. With this assumption, we formulate the problem of optimizing policymakers in the following way:

$$\min_{MI,ERS,CA} K_1 (1 - MI)^2 + K_2(1 - ERS)^2 + K_3(1 - CA)^2 \quad (1)$$

Subject to 0 ≤ MI, ERS, CA ≤ 1 and MI + ERS + CA = 2

Where MI, ERS, and CA are variables that measure the degree of independence of monetary policy, exchange rate stability, and financial market openness. Whereas the parameter Kj (= 1, 2, dan 3) refers to the weight of the place of policy makers of each of the three policy objectives. A country's policymakers will choose the optimal combination of the three policies, but such a combination will depend on its choice, which reflects the economic and structural conditions of the country with whom its policy management is charged. For example, policy makers in a small open economy can place a higher weight on exchange rate stability and financial market openness than the independence of monetary policy. A policymaker in a financially developed economy can place a higher weight on financial market openness than on other policy objectives. The higher interest rate ratio between two countries the higher the domestic capital inflow, which results in higher Capital inflow (Marlina, Andaiyani, & Hartawan, 2019). Basically, the parameters help determine the optimal level of MI, ERS, and CA.

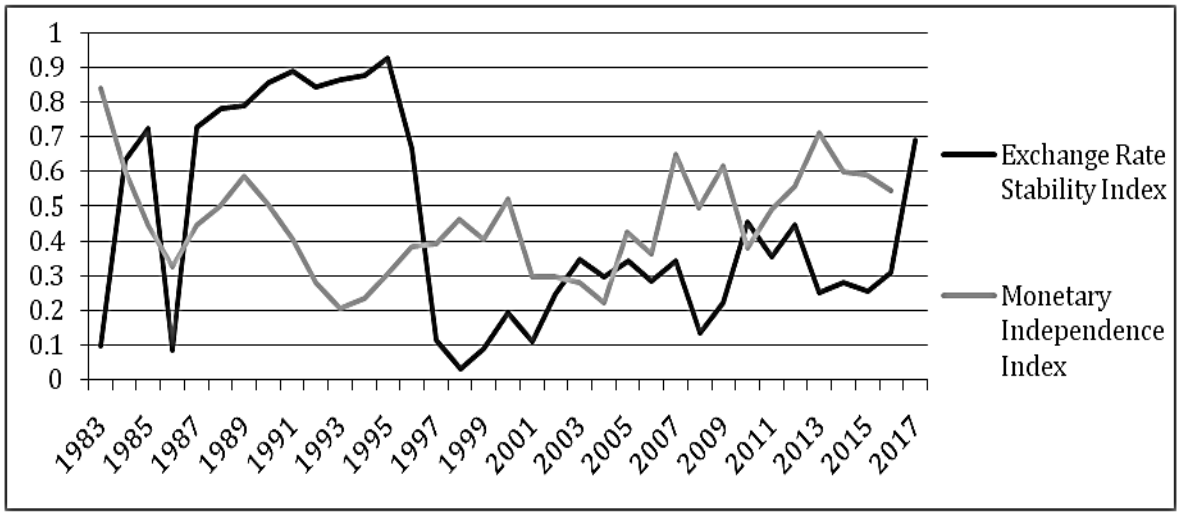

Figure 2. Exchanges Rate Stability Index and Indonesian Monetary Independence
Source: http://web.pdx.edu/~ito/trilemma_indexes.htm (2020)

The optimization problem can be interpreted as the result of a well-known stabilization problem for achieving stable non-inflation economic growth in the open macroeconomic model. Three policy options (exchange rate stability, financial market openness, and monetary policy independence) are expected to influence economic growth and inflation rates given the country's economic and structural conditions. The usual optimization problem for policy makers (to minimize output distortion from potential output and actual inflation from the inflation target) can be expressed as an optimization problem (Eq. 1).

Any policy combination under the trilemma plain to the origin (or in the rest of the cube shaved by the trilemma plain) is also feasible because the sum of the three indices for the policy combination will be less than 2 (i.e., MI + ERS + CA <2). However, such a combination of policies will not be efficient. Conversely, policy combinations above the trilemma plain far from their origin (or outside the cube shaved by the trilemma plain) are not feasible because the sum of the three indices for such a policy combination will be greater than 2 (i.e. MI + ERS + CA> 2). Figure 3 illustrates optimization in two dimensions.

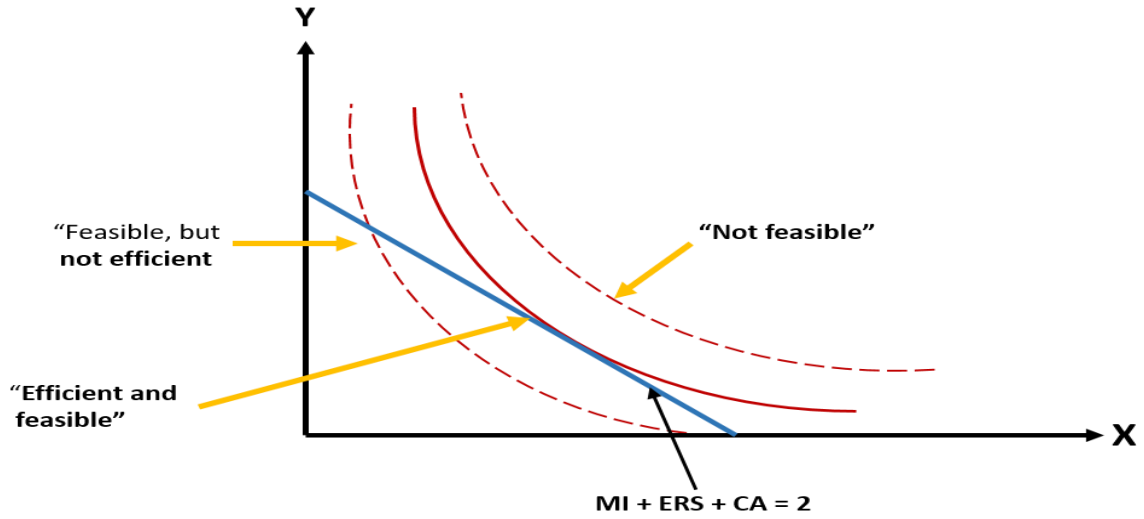

Figure 3. Optimal Two Dimensions
Source: Ito & Kawai (2014)

Several studies have been conducted to test the trilemma or quadrilemma hypothesis. Su et al., (2015) find that during the 1975-2014 period in Fiji, the re: trilemma, monetary independence and exchange rate stability might be more seriously pursued by the central bank; re: quadrilateral, the focus seems to have shifted to foreign exchange reserves and capital account openness. Mansour (2014) concludes that the hoarding of independent IRs for monetary decisions on Mundell's three triangular policies, in other words, IR is not included or does not play any economic role in monetary policy.

Hutchison, Sengupta, & Singh, (2012) assert that increased financial integration, especially after the mid-2000s, has changed trade-off policies that face emerging market economies such as India. Increased capital account openness has come at the cost of reducing the independence of monetary policy or limiting ER. Aizenman, Chinn, & Ito (2016) suggests that exchange rate market pressures in peripheral economies are sensitive to movements in the exchange rate of the central economy during and after the global financial crisis. Open macro policy settings, especially exchange rate regimes, also have an indirect effect on the strength of financial relations, interacting with other macroeconomic conditions. As such, trilemma policy arrangements, including exchange rate flexibility, continue to influence developing countries' sensitivity to policy changes and shocks in the central economy.

3. MATERIALS AND METHODS

The data used in this study were obtained from various sources. The calculation of monetary independence index (IM), exchange rate stability (ERS) and capital openness (CA) follows the calculations carried out by Aizenman et al. (2013). Data types are time series and cover the period 1983–2017 because of the availability and consistency of data for this period. To vary the analysis, the time series will be divided into three periods: 1983-2017, 1983-1999, and 2000–2017. It was necessary to capture the difference between before and after crisis' 1998. Besides, it was expected to get the best result and to achieve high goodness of fit. This study focuses on using Indonesian data to be more comprehensive in policy discussions and recommendations. There are three indices used in trilemma regression - namely, monetary independence (MI), exchange rate stability (ERS) and capital account openness (CA). In quadrilateral regression, we use three indices (MI, ERS, and CA) together with foreign exchange reserves (FR). This study extracts MI, ERS, and CA data from "The Trilemma Index" `1983 to 2017 except for MI where data is only available until 2016. Therefore, we update the IM Index up to 2017 using data from Bank Indonesia with the same methodology. The fourth CA index, from 1983 to 2017, was calculated using data from the International Financial Statistics (IFS). The construction of each index is defined by Aizenman et al., (2013) as discussed below:

3.1. Monetary Independence (MI)

The monetary independence is calculated as the inverse of the annual correlation between the monthly interest rates of the country of origin and the base country. Money market rates are used for calculations. The index for monetary independence is defined as:

$$MI = 1 - \frac{corr(i_i - i_j) - (-1)}{1 - (-1)} \quad (2)$$

where i refers to the country of origin (Indonesia) and j to the base country (US). With construction, the maximum value is 1 and the minimum value is 0. A higher index value means more monetary policy independence.

3.2. Exchange Rate Stability (ERS)

To calculate exchange rate stability, the annual standard deviation of the monthly exchange rate between the country of origin and the base country is calculated and included in the following formula to normalize the index between 0 and 1. Higher values indicate higher ERS

$$ERS = \frac{0.01}{0.01 + stdev(\Delta \log (ex_{rate})} \quad (3)$$

3.3. Open Account Capital (CA)

Openness of the Capital Account was obtained from Aizenman et al (2013) who adopted research from Chin and Ito (2006) based on Exchange Arrangements and Restrictions (AREAER) data provided by the IMF. Given that CA is based on reported restrictions, it is a de jure index of capital account openness. The CA index is normalized between 0 and 1. Higher values than this index indicate that a country is more open to cross-border capital transactions.

3.4. Foreign Reserves (FR)

Foreign reserves are defined as the ratio of total international reserves (net of gold), IR, and GDP. This shows that the greater the FR ratio the higher the position of holding foreign exchange reserves. Testing the validity of the trilemma hypothesis was examined by linear regression. This research model uses a configuration suggested by Aizenman et al., (2013). Because there is no specific functional form of exchange or interrelation of these three policy objectives, they estimate the simplest linear specification for the three trilemma indices and check whether the sum of the

weights of the three trilemma policy variables equals constants. This reduces to checking the merits of this linear regression.

The reason behind this exercise is that economic policy makers must choose a weighted average of the three policies to achieve the best combination of the two. Therefore, if we can find the goodness of fit for the regression model above high, it would suggest a linear specification rich enough to explain the trade-offs among the three policy dimensions. In other words, the lower the virtue, the weaker support for the existence of exchange, show that the trilemma theory is wrong, or that the relationship is not linear. However, in contrast to Aizenman et al., (2013), we set the dependent variable to be two whereas the previous authors used a constant number one.
Trilemma hypothesis testing model:

$$c = \beta_1 MI_t + \beta_2 ERS_t + \beta_3 CA_t + \varepsilon_t \quad (4)$$

Quadrillemma hypothesis testing model:

$$c = \beta_1 MI_t + \beta_2 ERS_t + \beta_3 CA_t + \beta_4 FR_t + \varepsilon_t \quad (5)$$

Following the literature, this study establishes a value of c = 2. The regression model used is ordinary least square (OLS) and to account for autocorrelation in error (εt), the Newey-West strong standard error is used. When the goodness of fit for the above regression is high, it would be suggested that the linear specification is suitable for an explained trade-off policy. On the other hand, a low match value implies that the trilemma boundary is not binding or the relationship is not linear. Also, if the trilemma is indeed linear, the regression prediction values should point around the value of c, and the prediction error indicates how many of the three policy choices are "Not fully used" (the predicted value below c and the residue is therefore negative) or the extent to which the trilemma "Unbound" (prediction value above c and the residue is therefore positive). Finally, the relative contribution of the three policies can be further examined using the predicted value of $\beta_1 MI_t,\ \beta_2 ERS_t\ dan\ \beta_3\ CA_t$ where βi is the estimated OLS value of βi from the regression above.

4. RESULTS AND DISCUSSION

Statistical summary of the variables in Table 1 illustrate that in the year 1983 to 2017 Indonesia has a higher focus on capital account openness and monetary independent. Magnitude will be different when the observation time is divided into two periods. In 1983 – 1999, exchange rate stability is more dominant than the monetary independent while the current 2000 – 2017 shows interesting things where focus on capital account openness and exchange rate decrease, on the other hand, an increase in foreign reserve. The implication of this clearly shows that the grouping of the sub-period of time into similar characteristic is crucial. Comparison of the evidence trilemma hypothesis can be done for Indonesia with different period of time. Table 1. Descriptive statistic summary of sub period of time per variable.

Table 1. Statistic Descriptive

Periods	Statistic	MI	ERS	CA	FR
1983 - 2017	Mean	0.45	0.442	0.798	10.678
	Std. Dev.	0.14	0.290	0.204	4.400
	CV	0.021	0.084	0.041	19.367
1983 - 1999	Mean	0.431	0.586	0.955	8.200
	Std. Dev.	0.154	0.344	0.101	5.127
	CV	0.024	0.118	0.010	26.282
2000 - 2017	Mean	0.476	0.307	0.588	12.844
	Std. Dev.	0.141	0.131	0.142	2.091
	CV	0.020	0.017	0.020	4.372

Source: Data processed, 2020

The value of Indonesia reserve foreign increased over time. The ratio of foreign reserves to GDP is relatively constant with the exception during the 1997-1999'crisis. Since 2009, the ratio of foreign

reserves to GDP is constant at the level of 12%. According to the IMF balance of payment manual, the adequacy of reserves is assessed by their capacity to prevent or mitigate external shocks.

Trilemma index development can be seen in Figure 4. Monetary independent index reached its maximum level in 1983 and then decrease with time and since 2010 experienced a rising trend. Exchange rate stability index illustrates the sharp fluctuations which was relatively stable in 1986 – 1996 and started to fluctuate since 2000. Meanwhile, the capital account openness shows three average rate and decreased during the period which was the maximum level in the year 1983 to 1994, relatively stable in 2000 – 2010 and stable with a lower index value since 2011 until 2017.

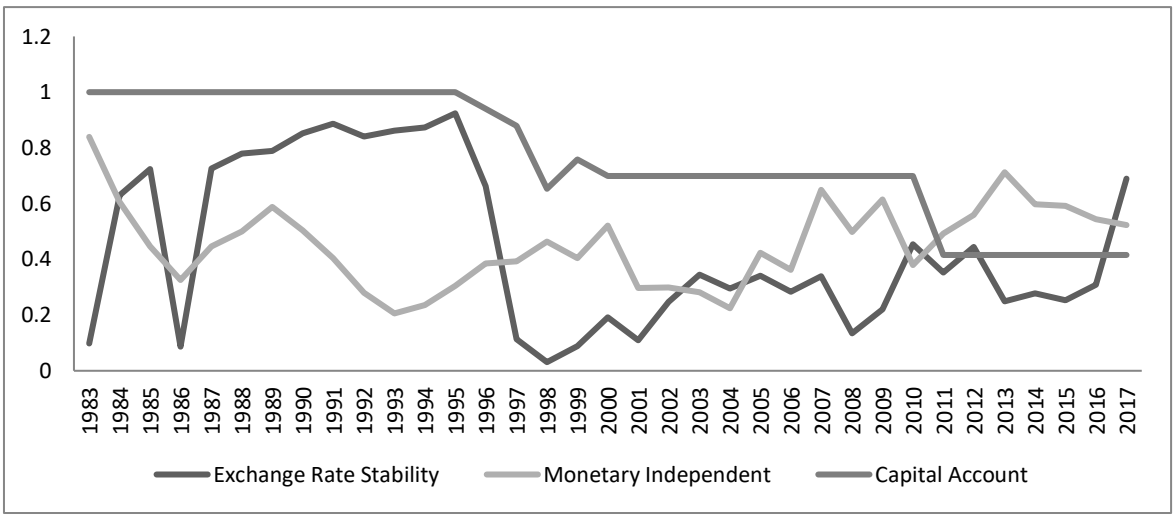

Figure 4. MI, ERS, CA index on 1983 – 2017
Source: The Trilemma Indexes, 2020

Trilemma and quadrilemma regression result for full sample (1983 – 2017) were reported in Table 2. Clearly, both regressions achieve high goodness of fit (R-squared and adjusted R-squared), suggesting the validity of linear specification in explaining the policy trade-off in Indonesia. Trilemma estimations show that Indonesia chose monetary independence and capital account openness as monetary policy goals. It can be trace by looking at the variable which significant in explains the model. MI and CA were significant at 1% level of error.

Table 2. Trilemma and Quadrilemma Estimation

Variable	1983 – 2017	
	Trilemma	**Quadrilemma**
MI	1.959***	1.132***
	(6.799)	(6.216)
ERS	(0.0427)	0.358*
	(0.1679)	(2.514)
CA	1.3433***	0.932***
	(5.5776)	(6.729)
FR	-	0.055***
		(8.830)
Obs.	35	35
R-squared	0.9693	0.9912
Adjusted R-squared	0.9362	0.958

Note: *, **, ***, significant at 10%, 5%, 1% level

When the sample was split into two period of time, we find that the contributions of each variable are of great interest in terms of the trilemma policy configuration and how it changes over time. Results in Table 3 show that FR receives high policy weight throughout the entire period. In the second sub-period, as capital openness or financial integration decrease, MI is significantly become important. This result in line with the lesson of the 1990s that emerging markets converged

to the middle ground of Mundell's trilemma: controlled exchange rage flexibility and limited financial integration, retaining monetary independence (Aizenman, 2015).

Since 1999, Indonesia has changed its exchange rate regime from fixed to floating system. This changing has advantage that the FR will let monetary authority to be able to intervene implicitly in the financial market, by manipulating the FR from time to time in order to control the financial market (Mansour, 2014). That's why it is called managed floating exchange rate regime (not totally pegged, not totally free capital mobility, not totally monetary independence). It is supported by (Yunita, Achsani, & Anggraeni, 2017) that conclude Bank Indonesia faces a tradeoff in determining the combination of its policy objectives. The tradeoff is heavier during the free-floating regime period because of the fear of floating problem, while the tradeoff is lighter when the inflation targeting is applied.

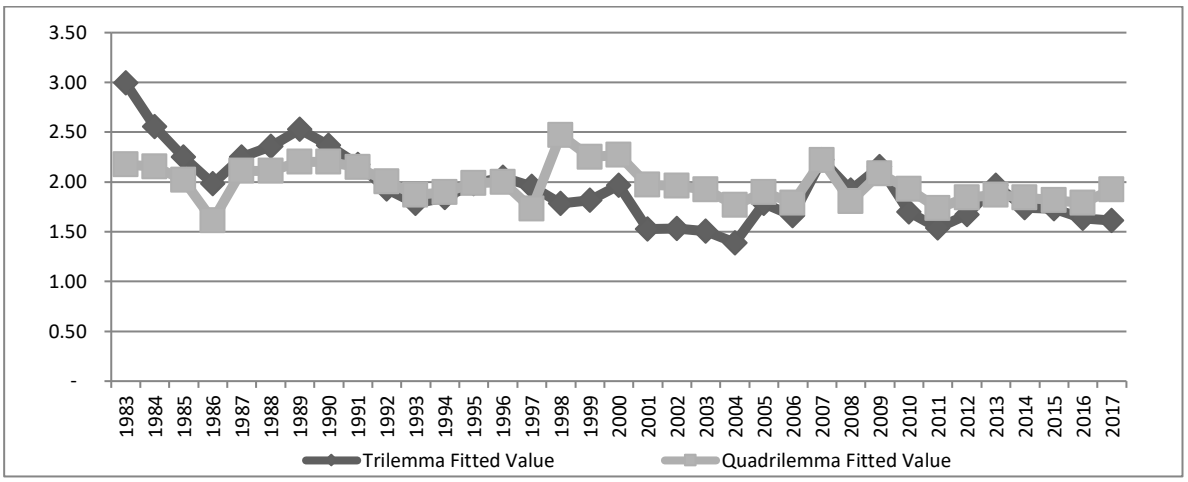

Figure 5. Regression Fitted Values: Trilemma vs. Quadrilemma
(Trilemma and Quadrilemma Fitted Values are Obtained Based on The Results from Table 2)
Sources: data processed, 2020

Figures 5 show that the predicted values based on the model hover around the value of two closely for only for sub sample 1983-1999, while for sub sample 2000 – 2017 the predicted values were dynamic. This result indicating that the trilemma and quadrilemma are "binding" only for 1983-1999. Aizenman et al. (2013) gave the meaning of this condition that a change in one of the Trilemma (Quadrilemma) variables would induce a change with the opposite sign in the weighted average of the other two (three).

Table 3.Trilemma and Quadrilemma Estimation, Split Samples

Variable	1983 – 1999		2000 – 2017	
	Trilemma	**Quadrilemma**	**Trilemma**	**Quadrilemma**
MI	0.009	0.034	1.409***	1.135***
	(0.027)	(0.471)	(5.173)	(4.350)
ERS	0.366*	0.121**	0.961**	0.669**
	(-2.053)	(-3.029)	(2.713)	(5.113)
CA	2.300***	1.881***	1.722***	0.885***
	(9.769)	(34.329)	(8.5931)	(3.090)
FR	-	0.032***	-	0.0561**
		(17.512)		(3.449)
Obs.	17	17	18	18
R-squared	0.9926	0.9997	0.990	0.994
Adjusted R-squared	0.9201	0.9227	0.922	0.922

Note: *, **, ***, significant at 10%, 5%, 1% level
Sources: data processed, 2020

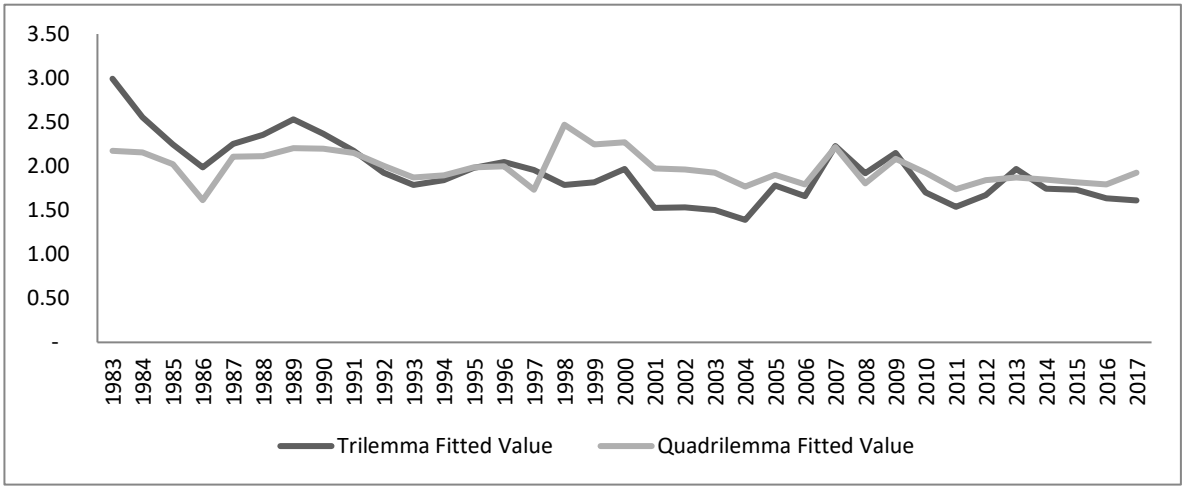

Figure 6. Regression Fitted Values: Trilemma vs. Quadrilemma
(Trilemma and Quadrilemma fitted values are obtained based on the results from Table 3, split into two subsamples, 1983 – 1999 and 2000 – 2017).

As results from above and experiences showed that "no 3 without 4", so FR was deserved to be added as a fourth objective. So, the impossible can be possible and the triangle of three policies can be a diamond chart with four policies which are monetary independence, exchange rate stability, IR/GDP ratio, and financial inclusion. The origin has been normalized so as to represent zero monetary independence, pure float, zero international reserves, and financial autarky. The "diamond charts" in Figure 8 are useful to trace the changing patterns of the quadrilemma configurations in Indonesia.

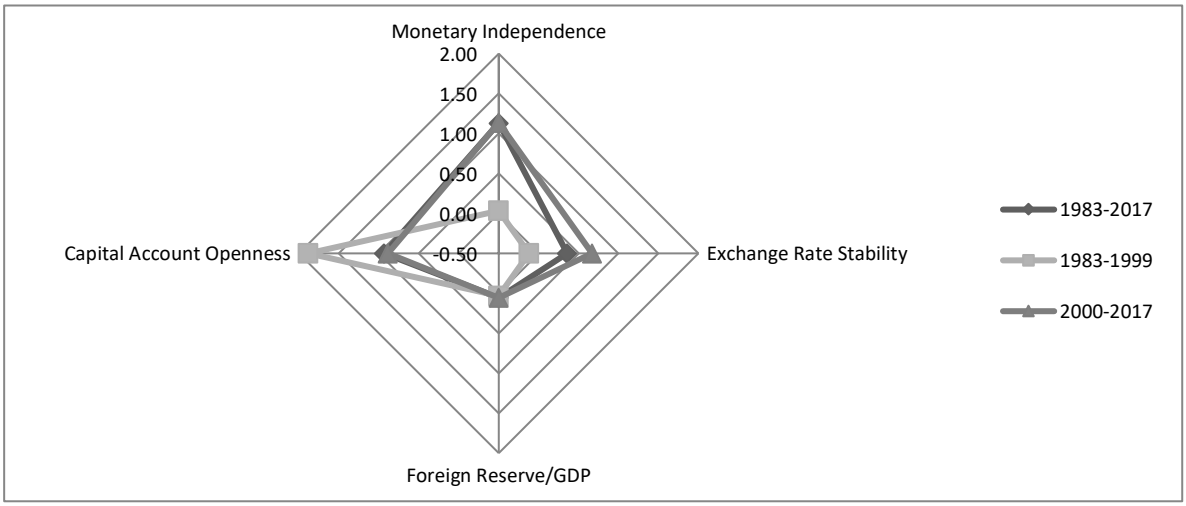

Figure 7. The "Diamond Charts": Variation of Quadrilemma
Sources: data processed, 2020

5. CONCLUSIONS

This paper examines the linearity of the trilemma, and show that the weighted sum of the three trilemma variables adds up to a constant. So, a rise in one trilemma variable should be traded-off with a drop of the weighted sum of the other two. Fact that holding a higher level of international reserves may help countries to get prepared for a future choice of policies that are more distinctively different from each other, make the Foreign Reserve as a 4th objective leading the monetary authority to achieve at the same time the 3 "impossible" goals. The regression result show that FR is significant and gives better explanation of the model which can be seen as greater adjusted R-square achieved. Therefore, policy recommendation which can be offered is that Government must

taking into account FR as a monetary policy objective. Adequacy of reserves could higher our capacity to prevent or mitigate external shocks.

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