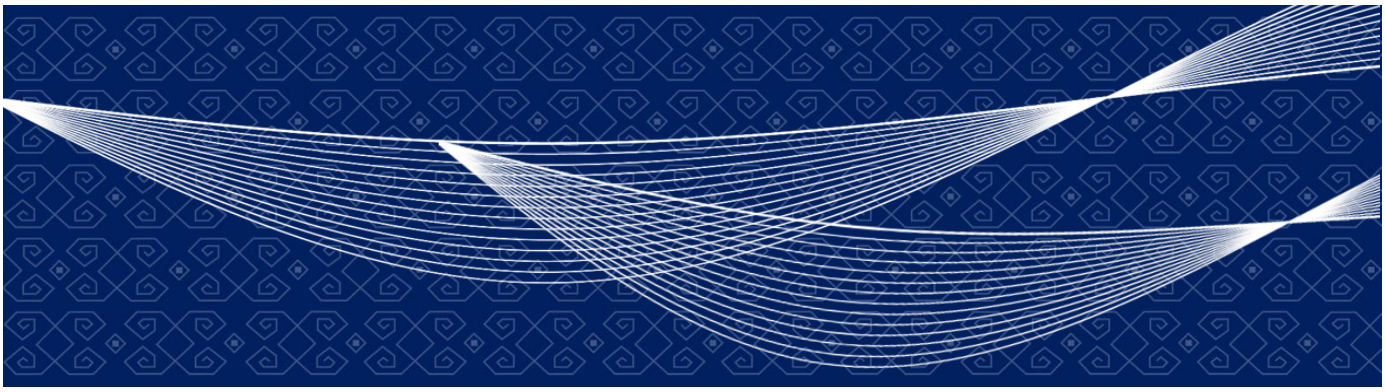
BANK INDONESIA
BANK SENTRAL REPUBLIK INDONESIA



WP/03/2021

WORKING PAPER

FX INTERVENTION STRATEGY AND EXCHANGE RATE STABILITY IN INDONESIA

Solikin M. Juhro
Prayudhi Azwar

2021

FX INTERVENTION STRATEGY AND EXCHANGE RATE STABILITY IN INDONESIA

Solikin M. Juhro and Prayudhi Azwar

Abstract

This study aims to measure the effectiveness of foreign exchange (FX) intervention strategy in Indonesia in affecting the rupiah exchange rate stability. Using the instrumental variable (IV) approach to analyze FX intervention strategies from January 2010 to December 2020, we find that there are differences in the effectiveness of intervention in the spot market and the derivative market. Partially, FX intervention is more effective in the spot market than in the derivative market. We find also that intervention strategies carried out simultaneously by Bank Indonesia in the spot and derivative markets effectively improves the effectiveness of policy strategy in affecting rupiah exchange rate stability. Amid increasingly complex challenges facing by central banks in managing exchange rate stability, this study brings fundamental policy implications regarding to the importance of an integrated intervention strategy; not only in spot and derivative markets, but also in bond markets.

Keywords: *Effectiveness, FX Intervention, Spot Market, and Derivative Market.*

JEL Codes: F31, E58, C22, and O24.

Acknowledgment: The conclusion, interpretation, and opinion expressed in this paper are those of the authors and not necessarily represent the views of Bank Indonesia. The authors would like to acknowledge insightful comments and support from Arlyana Abubakar and Budi Trisnanto of Bank Indonesia Institute. The author also gratefully acknowledges excellent research assistance from Bank Indonesia Institute Research Group.

1. Introduction

The exchange rate is an important indicator in influencing economic performance. As the global economy becomes increasingly integrated, the transfer of foreign currencies in international transactions moves very quickly and increasingly leads to non-physical movements whose composition continues to dominate international transactions. In many small-open economies the dynamics of the exchange rate pose vulnerabilities to foreign capital flows and speculative activities. It is what happened during the era of the exchange rate crisis that occurred in Latin American countries in the early 1990s and Southeast Asian countries in 1997/1998. The exchange rate is also an important indicator of crisis detection, dominant in developing and developed countries. For example, the financial crisis experienced by several Asian countries in 1997/1998 was also triggered by exchange rate fluctuations that started in Thailand in mid-July 1997 and then spread to other Asian countries. Market panic also occurred in Indonesia, which caused massive outflows of foreign capital amplified by rampant speculative activities in the forex market, further exacerbating the depreciation of the rupiah (Abubakar et al., 2020; Baek & Jun, 2011; Baharumshah & Wooi, 2007; Goeltom & Zulverdi, 2003; Tai, 2004; Warjiyo & Juhro, 2016).

In the case of Indonesia, the exchange rate policy is essential in supporting economic development. During the last five decades, Indonesia has implemented three exchange rate regimes. Beginning with implementing a fixed exchange rate regime in 1970-1978, a managed floating exchange rate regime in 1978-July 1997, and a floating exchange rate regime in August 14, 1997, until now. Under current regime, the exchange rate policy aims to support the achievement the rupiah stability, comprises stable inflation and exchange rate. Adopting a floating exchange rate regime will provide independence in monetary policy in absorbing external instability due to the free capital flow. However, implementing a floating exchange rate regime and free capital flow as adopted by Indonesia also causes a higher exchange rate volatility (Dell'Ariccia et al., 2012). Thus, the Bank Indonesia must continue to develop foreign exchange (FX) intervention strategy to overcome the misalignment potential of the exchange rate from its fundamental level, stabilize market expectations, and reduce market volatility.

The experience of dealing with the 1997/1998 Asian financial crisis and the 2008/2009 global financial crisis (the GFC) has taught Indonesia a valuable lesson, that the implementation of multiple policy instruments is a must in dealing with complex policy challenges amid the dynamics of foreign capital flows and domestic inflationary pressures. Therefore, after the GFC, Bank Indonesia implemented a more flexible inflation targeting framework (flexible ITF) as a monetary policy framework[1]. This flexible ITF is implemented as an integrated part of the central bank policy mix strategy with keeping the inflation target as the overriding objective. Bank Indonesia does not only looks at the inflation target in its policy formulation but also considers various other factors, including financial sector stability, the dynamics of foreign capital flows, and exchange rate movements. In line with this policy perspective, the movement of exchange rates and the management of foreign capital flows are two elements that by consensus need to be incorporated in managing an optimal monetary policy trilemma.(Juhro & Goeltom, 2015; Warjiyo & Juhro, 2019).

Many countries, including Indonesia, continue to develop various FX intervention strategies as a part of exchange rate policy. Bank Indonesia initially used a conventional FX intervention

[1] Bank Indonesia formally adopted the Inflation Targeting Framework (ITF) in July 1, 2005

strategy, e.g. buying or selling foreign exchange in the spot market. It was later developed into a dual intervention strategy and a triple intervention strategy recently implemented. The dual intervention strategy is an intervention strategy carried out in two markets, namely the spot market and the secondary market for government bonds. Meanwhile, the triple intervention strategy is an exchange rate intervention policy carried out in three markets at once: the spot market, secondary government bond market, and domestic foreign exchange futures market (Domestic Non-Deliverable Forward/DNDF). This intervention strategy is considered feasible in the midst of complex challenges confronted by Bank Indonesia in safeguarding stability, not only in the money markets, but also in the financial market as a whole.

Central banks around the world carry out various FX intervention strategies. In fact, not only has the frequency of intervention policies increased, but the amount of foreign exchange reserve used has also increased in recent years (Domanski et al., 2016; Viziniuc, 2021). In addition, the level of transparency in disclosing information related to FX intervention practices is also getting higher. However, various empirical studies from various countries still show mixed results in terms of effectiveness. The majority of research results found that the intervention was effective in controlling exchange rates (Adler, Lama, et al., 2019; Adler, Lisack, et al., 2019; Akdogan, 2020; Arango-Lozano et al., n.d.; Banerjee et al., 2018; Daude et al., 2016; Gamboa-Estrada, 2019; Keefe & Shadmani, 2018; Kitamura, 2020; Kuersteiner et al., 2018; Lee & Kim, 2020; Pontines, 2018; Santos, 2021; Vargas-Herrera & Villamizar-Villegas, 2020). However, some studies find that the effectiveness of intervention policies is still ambiguous (Viola et al., 2019) and even ineffective in controlling exchange rates (Besuyen et al., 2021).

Therefore, it is essential to analysis exchange rate policies in Indonesia and review the effectiveness of FX intervention strategies in supporting monetary stability. This research has a strand contribution. First, In contrast to other studies that mostly use coarser FX intervention proxies, we use the newly constructed refined FX intervention proxies available. By using this approach the estimation of model parameters becomes more robust and contributes significantly to the analysis and implementation of monetary policy. Second, the case of Indonesia is representative considering that it is a small-open economy with a substantial economic role in the region and Emerging Market Economies (EMEs)[2], and has a lot of experience or lessons learned in monetary management in times of Asian financial crisis 1997/1998 and the GFC 2008/2009. Thus, a study on the implementation of Indonesia's exchange rate policies and intervention strategies can be a reference for developing exchange rate policy strategies for other EME countries. Third, in the case of Indonesia, studies on the effectiveness of FX intervention strategies are still very limited. Rahman (2019), for example, examines the effect of the number of individual domestic FX transactions on the rupiah exchange rate, both in the short and long term. However, the intervention policy measured in this study was only limited to limiting the purchase of foreign exchange by domestic individuals. Meanwhile, many policy innovations have been carried out (in line with the implementation of central bank policy mix strategy), where the exchange rate intervention strategy has been transforming from conventional strategies to the dual and triple intervention strategies.

This study aims to measure the effectiveness of FX intervention strategy in affecting exchange rate stability in Indonesia. We find that FX intervention strategies carried out simultaneously by Bank Indonesia in the spot and derivative markets effectively improves the

[2] Indonesia is a member of the G20 forum representing a country with a large economic potential in the world. The G20 Forums collectively represent 85% of the world's economy, 75% of international trade, 80% of global investment and 60% of the world's population.

effectiveness of policy strategy in affecting rupiah exchange rate stability. Following this section, the rest of the paper is organized as follows. Section 2 discusses the theoretical and empirical foundation. Section 3 focuses on our methods, explaining the identification strategy and data. Section 4 analyzes the empirical results. Section 5 concludes.

2. Theoretical and Empirical Perspectives

2.1 Theoretical Perspectives

The central bank commonly carries out the FX intervention strategy through agent banks. Agent banks will buy or sell foreign currencies (majority in USD) depending on market conditions, whether there is excess supply or excess demand in the market. Most of the transactions are in the form of spot transactions and partly in the form of swap and forward transactions according to each bank's needs and conditions of foreign exchange liquidity. This exchange rate intervention in the spot market is referred to as conventional intervention or single intervention because it only focuses on one market.

Exchange rate intervention in the form of buying and selling foreign currencies can affect domestic liquidity. Therefore, exchange rate intervention must be integrated with domestic currency monetary operations in order to be consistent with interest rate policy. When there is a strong appreciation pressure against domestic currency, the expansion of domestic liquidity due to the purchase of foreign currency to stabilize domestic currency exchange rate can be absorbed through domestic monetary operations in the form of providing more domestic currency time deposits, reverse repo operations using government bonds, and deposit facilities. Vice versa, when there is a large depreciation pressure on domestic currency, the domestic liquidity shortage due to the sale of foreign currency to stabilize domestic currency exchange rate is tackled using domestic monetary operations. This kind of intervention is a sterilized intervention because the sale or purchase of foreign exchange does not affect the money supply. The central bank will offset the decrease or increase in the money supply due to selling or buying foreign exchange by conducting domestic market operations.[3]

Villamizar-Villegas dan Perez-Reyna (2015) surveyed the leading theories shaped the sterilized FX intervention literature. There are three main theories in the literature, (1) the theory which states that FX intervention is useless; (2) the theory which states that FX intervention will be effective even if there is some market friction such as limited arbitrage; and (3) the theory that advocates the use of FX intervention as long as the intervention conveys a clear signal about the future stance of monetary policy. In general, the types of FX interventions can be categorized into two, namely sterilized intervention and non-sterilized intervention. The difference between the terms sterilized and non-sterilized is based on the ability of the intervention to affect money market interest rates. If the intervention has no impact on money market interest rates, it is called sterilized,

[3] Therefore, understanding the behaviour of foreign investors is an important aspect in conducting exchange rate interventions, considering the effect of their behaviour on capital flows has a major impact on exchange rate movements. In general, foreign investors can be divided into two categories, namely hedge fund investors and long-term investors. Hedge-fund investors seek to profit from foreign exchange differences (carry trades). Their behaviour often causes capital flows and exchange rates to become volatile. Meanwhile, long-term investors seek higher profits in the form of interest rate gains and capital gains whose value is influenced by the economic fundamentals of the country where they invest. This type of investor has stable behaviour, and it is not easy to react to short-term events.

but if the intervention has an impact on money market interest rates, it is called non-sterilized (Abildgren, 2005).

Sterilized intervention can affect the exchange rate through two channels, namely signaling channel and portfolio balance channel (insert references). The signaling channel effect stems from changes in market players' expectations of future monetary policy and exchange rates as a result of the central bank's intervention in buying or selling foreign exchange. Meanwhile, the portfolio balance channel stems from the reaction of the private sector trying to rebalance its foreign and domestic asset portfolio holdings due to the intervention of buying or selling foreign currency or domestic assets by the central bank. When the central bank intervenes in the foreign exchange market by buying foreign currency and selling domestic assets, it means that the central bank places its assets in foreign bonds by selling domestic bonds. If the private sector previously had a balanced portfolio prior to the intervention, then they will react by rebalancing their portfolio by selling domestic bonds and then converting the proceeds of the sale into foreign currency or foreign bonds. If the yield of foreign and domestic bonds is assumed to be unaffected, the domestic currency will tend to be weaken.

Non-sterilized intervention can affect the exchange rate through four channels, namely monetary channel, signaling channel, inventory adjustment channel, and noise trader channel (insert references). Monetary channel is the effect that comes from changes in liquidity due to central bank intervention which will depress interest rates and then affect the exchange rate. For example, if the central bank buys foreign currency, the liquidity of the domestic currency will increase, therefore, interest rates will be depressed and weaken the value of the domestic currency. Similar to sterilized intervention, the signaling channel for non-sterilized intervention is the effect that comes from changing expectations of market players on future monetary policy and exchange rates due to the intervention of buying or selling foreign exchange by the central bank. Interventions that are open (announced) or closed (secret) will still give signals to market players. Secret intervention, for example, will be able to affect market players because foreign exchange prices are influenced by the size of the order flow. If the central bank buys or sells foreign exchange, then the order will contribute to the exchange rate fluctuation because market players see the central bank order as new information that reflects future monetary policy and exchange rates.

Meanwhile, inventory adjustment channel is an effect that comes from the behavior of market players who tend to want to keep their asset inventory at a moderate level (not too big and not too small). If there is a foreign exchange purchase order from the central bank that is too large, for example, the price will tend to increase. Vice versa, if there is a sale of foreign exchange from the central bank that is too large, the price will tend to decrease. Lastly, noise trader channel is an effect arising from the behavior of market players who trade based on technical analysis. If central bank intervention causes exchange rates to move in a certain direction, they will tend to follow that direction (bandwagon effect). This will further amplify the effect of central bank intervention on the exchange rate.

2.2 Salient Empirical Studies

This study builds on the growing literature discussing the effectiveness of FX intervention policies. In general, the literature can be divided into two groups. The first group concentrates on cross-country evidence (Adler, Lisack, et al., 2019; Akdogan, 2020; Arango-Lozano et al., n.d.; Daude et al., 2016; Gamboa-Estrada, 2019; Keefe & Shadmani, 2018) , while the second one

focuses on single-country evidence (Banerjee et al., 2018; Besuyen et al., 2021; Kitamura, 2020; Kuersteiner et al., 2018; Lee & Kim, 2020; Pontines, 2018; Santos, 2021; Vargas-Herrera & Villamizar-Villegas, 2020; Viola et al., 2019).

The study using cross-country evidence was conducted by Daude et al. (2016) who analyzed the effectiveness of FX interventions in 18 developing countries during 2003-2011. The results show that on average, the intervention carried out by the central bank is effective in controlling the real exchange rate with desired direction. Keefe dan Shadmani (2018) examined FX intervention strategies in 24 developing countries during January 2000 – December 2016. There is strong evidence that central banks in developing countries prefer to dampen the appreciation of the domestic currency rather than reduce the depreciation of the domestic currency in order to promote growth and stimulate economic activity. Meanwhile, using a sample of 52 countries consisting of 13 developed countries and 39 developing countries in 1996-2013, Adler et al. (2019) found that central bank FX intervention was effective in influencing exchange rate movements in a persistent and symmetrical manner. The purchase of foreign exchange at 1% of GDP causes a depreciation of the nominal exchange rate of the domestic currency by 1.7 to 2%, and the real exchange rate of the domestic currency by 1.4 to 1.7%. Then, Akdogan (2020), using a sample with a relatively similar composition of the number of countries (52 countries consisting of 21 developed countries and 31 developing countries) but with a more recent research period (January 2008-December 2017) found that FX intervention conducted by central bank is effective and it provides evidence of the causality of exchange rate behavior in developing countries.

Gamboa-Estrada (2019) examines the effectiveness of FX interventions by focusing on a sample of developing countries in Latin America during January 2000 – December 2013. The results show that FX interventions through the coordination channel (which takes into account persistent exchange rate misalignments caused by non-fundamental factor) proved to be effective. Then, Arango-Lozano et al. (2020) with a meta-analysis covering a sample of 19 countries and a research period of 50 years concluded that for every USD currency purchase of USD1 billion causes a 1% depreciation of the domestic currency and a decrease in FX market volatility of 0.6 percent. In addition, the study also finds that the influence of various economic factors becomes larger for conditions consistent with the monetary trilemma (the effect is larger if financial openness and monetary independence are low). Then the effect of the influence of various economic factors will also be greater in developing countries compared to developed countries when it is safe from the banking crisis, the size of the exchange rate intervention is large, and the intervention is announced to the public.

The aforementioned cross-country studies are complemented by studies that only focuses on a single-country evidences. Pontines (2018) and Kitamura (2020) evaluate the effectiveness of the Japanese central bank's FX intervention policy during January 1 1999 – December 31 2011 and September 15 2010 – October 31 2011, respectively (which is divided into four intervention periods). Pontines (2018) finds that large-scale, irregular (rare), and sporadic interventions are effective interventions while Kitamura (2020) finds that out of a total of four interventions, only two interventions are effective in controlling persistent depreciation and reducing exchange rate volatility, even one of the interventions actually caused the opposite effect even though it was temporary.

Kuersteiner et al. (2018) and Vargas-Herrera and Villamizar-Villegas (2020) tested the effectiveness of FX interventions in Colombia using same period (December 24 2001 - February 3 2012). The results show that the FX intervention is effective in influencing the exchange rate

although the effect of the intervention according to the findings of Kuersteiner et al. (2018) is relatively short, which is only 2 weeks. Then, foreign exchange purchases have an incremental effect in limiting exchange rate volatility, which is close to 5% based on the findings of Vargas-Herrera and Villamizar-Villegas (2020).

For the case of Slovakia, Banerjee et al. (2018) with data from January 1999 to April 2007 found that the FX intervention policy was only effective in a few hours, because in the longer term, its effect gradually weakened. There is also evidence that the impact of FX intervention is asymmetric (the effect is stronger when selling foreign currency than buying foreign currency).

For the case of Brazil, Santos (2021) used two separate sample periods (October 10 2011 - July 17 2013 and August 16 2013-December 18 2013), while Viola et al. (2019) using data for the period January 2, 2003 - December 31, 2014. Santos (2021) found that discretionary FX interventions were more effective than pre-announced FX intervention programs. Then for Viola et al. (2019) found contradictory results when using daily FX intervention data and net accumulated position data. Because when using net accumulated position FX intervention data, FX market volatility decreases when the monetary authority sells USD, but when using daily intervention data, the results are opposite.

For the case of Korea, Lee and Kim (2020) using data October 1999 - November 2016 found that the purchase of the domestic currency led to a significant strengthening of the domestic currency. This study also finds that FX intervention policy in Korea focuses on stabilizing the FX market rather than weakening the Korean won. This pattern became more visible after the 2008 global financial crisis.

Besuyen et al. (2021) found evidences that contradicted the majority of previous studies. After examining the exchange rate in New Zealand from June 2007 - September 2015, they found that the actual FX intervention and the release of the Monetary Policy Statement (MPS) proved ineffective in influencing the movement of the NZD currency exchange rate. Even the policy release speech actually weakened NZD 1.12% (even though the effect was small and short). Furthermore, they conclude that exchange rate interventions, both explicit and implicit, are weak policy instruments in influencing the NZD exchange rate.

For the case of Indonesia, Rahman (2019) shows that the number of individual domestic FX transactions has an effect on the rupiah exchange rate, both in the short and long term. This means that Bank Indonesia's policy of restricting the purchase of foreign currency by domestic individuals is an effective policy in controlling the exchange rate. Fianto et al. (2020) predict Indonesia's exchange rate return. They find that external factors dominate the evolution of Indonesia’s exchange rate. In term of equilibrium price of Indonesian rupiah, Rasbin et al. (2021) find that the real exchange rate experienced an undervaluation in 1987-1992, an overvaluation in 1993-1997 except near the economic crisis of 1997/1998, an undervaluation when approaching the economic crisis of 1997/1998, and an undervaluation in 1998-2018.

The studies based on the unit of analysis of cross-countries and single-country above provide views of the relationship between FX intervention policies and various exchange rate movements. The majority of studies stated that the FX intervention policy was effective, but there were also those who stated that the relationship was still ambiguous, and some even found the opposite facts. The various exchange rate systems and FX intervention strategies applied by each country that are used as units of analysis are also different, considering that the selection of exchange rate systems and intervention strategies is closely related to the unique characteristics of each country. Thus, in

the case of Indonesia, it is important to investigate specifically regarding the implementation of the exchange rate system and the FX intervention strategy as well as the effectiveness of the FX intervention.

2.3 Regulatory Environment and FX Intervention Strategy of Bank Indonesia

To maintain the exchange rate stability in line with its fundamental values, Bank Indonesia's monetary operations are conducted through the implementation of FX interventions and/or other FX transactions on the FX market. Monetary operations consist of Open Market Operations (OMO) and Standing Facilities (SF)[4]. To strengthen FX intervention strategy, since September 2011, apart from trading in the FX market (spot market), Bank Indonesia has also been involved in the secondary market for government bonds. This intervention is referred to as a dual intervention. As suggested by Fanelli dan Straub (2020), central bank intervention in the bond market can affect the exchange rate and yield spread between foreign and domestic bonds.

According to Warjiyo (2013), the objectives of Bank Indonesia to participate in the secondary market for government bonds are as follows:

a) In the case of rupiah depreciation, the purchase of government bonds can support FX intervention in stabilizing the exchange rate. It can directly address the root cause of depreciation pressure, namely the reversal of foreign portfolio investment (capital reversal) in government bonds.

b) In the case of rupiah depreciation, the purchase of government bonds plays a role in returning government bonds into the financial system. Domestic currency liquidity is absorbed by FX intervention. It is consistent with the overall objective of domestic monetary operations.

c) The central bank's participation in the secondary market of government bonds is also consistent with its objective to use government bonds as its own preference monetary instruments. Dual intervention is an intervention in the spot FX market and a bond market that helps strengthen the stability of the financial system because it contributes to maintaining the stability of two markets out of three existing financial markets.

Experience in the 2008 global crisis, massive intervention to defend the rupiah's value from the global crisis's impact has caused domestic liquidity shortages and put pressure on banks, especially small banks. In the dual intervention strategy, the problem of liquidity drought will be able to be tackled through the purchase of government bonds in the secondary market. This measure will address the root causes of exchange rate pressures and, at the same time, help stabilize financial markets.

Since the launch of the DNDF (Domestic Non-Deliverable Forward) instrument in November 2018, the FX intervention strategy implemented by Bank Indonesia was updated to a triple intervention strategy (Bank Indonesia, 2020). It is called a triple intervention because Bank

[4] Open Market Operations (OMO) are transaction in the money market and/or FX market conducted by Bank Indonesia with banks and/or other parties for monetary operation in a conventional manner and based on *sharia* principles. OMO in domestic currency is divided into two, namely OMO absorption and OMO injection, considering liquidity conditions in the banking system both conventional and *sharia*. Standing Facilities (SF) are activities to provide rupiah funds from Bank Indonesia to banks and placement of rupiah funds by banks at Bank Indonesia for Monetary Operations, which can be conducted conventionally and based on *sharia* principles.

Indonesia intervenes in the spot FX market, the secondary market for government securities (SBN), and the DNDF market.

A DNDF transaction is a transaction similar to a forward transaction. Both are instruments used for hedging. The difference is that in a forward transaction, both parties must submit their respective money at the agreed exchange rate. In contrast, in a DNDF transaction, both parties only submit the exchange rate difference resulting from the exchange rate forecast, which must then be converted into rupiah using the JISDOR benchmark (Jakarta Interbank Spot Dollar Rate).

Not everyone can take advantage of the DNDF instrument. Only those with the underlying are allowed to use the DNDF instrument, such as exporters, importers, and investors with high obligations or exposure to foreign exchange. Bank Indonesia issued this instrument to support the stability of the rupiah exchange rate through the deepening of the FX market.

Along the way, the regulation regarding DNDF has experienced several changes to adapt to market conditions. In 2019, the first changes were made, namely: (1) relaxing the supply side of DNDF by excluding the obligation to provide underlying for DNDF selling transactions of up to US$5 million; (2) allowing DNDF transaction termination (unwind); (3) and allowing the use of forecast documents as underlying DNDF selling transactions. Meanwhile, in 2020, a second change was made to expand the underlying DNDF transaction by adding foreign-owned rupiah (vostro) account ownership as a condition.

To encourage the effectiveness of the implementation of DNDF transactions as part of Bank Indonesia's triple intervention policy, another change to the DNDF arrangement was made in 2021. In this third change, contracts in DNDF transactions can use standard contracts. Underlying transactions are expanded by adding underlying in the form of deposit holdings in foreign currencies that have been placed for a minimum of 1 month, especially for selling DNDF transactions in foreign currencies against the rupiah. Transaction extensions (rollovers) for DNDF transactions are also allowed. However, rollovers between banks and customers and/or foreign parties may not exceed the nominal and term of the underlying transaction. The third amendment to the DNDF regulation aims to increase liquidity in the DNDF market, especially from the supply side and facilitate market participants in transacting while still paying attention to the principle of prudence through the development of the types of underlying transactions and the DNDF transaction mechanism. In addition, Bank Indonesia also strives to improve market players' risk management and credibility by encouraging the use of standard contracts as a legal complement in conducting DNDF transactions.

From the explanation above, the format for implementing the triple intervention strategy carried out by Bank Indonesia is as follows (Bank Indonesia, 2021):

1) Spot FX intervention to stabilize the rupiah exchange rate by Bank Indonesia is conducted by selling foreign currency in cash to increase supply and stabilize the exchange rate in the market (see **Error! Reference source not found.Error! Reference source not found.**).

Figure 1 Bank Indonesia Spot Transactions

2) Intervention in the DNDF market is carried out through forward FX transactions without any movement of funds (notionally) with an agreed premium on the FX market. In addition to hedging, DNDF intervention stabilizes expectations of the rupiah exchange rate going forward (see **Error! Reference source not found.**)

Figure 2 Bank Indonesia DNDF Transactions

3) Intervention in the FX market is by selling FX and in the SBN market is to buy SBN from the secondary market. It can happen during periods of capital outflows. For example, due to the global financial market panic, foreign investors sell SBN and buy foreign currency in the market through their bank agents (see **Error! Reference source not found.**).

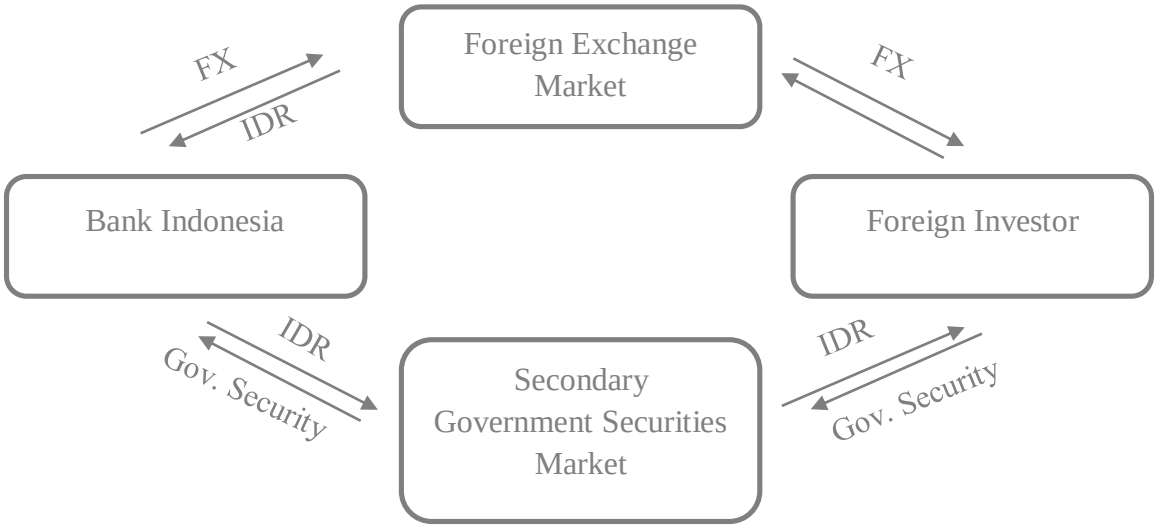


Figure 3 Bank Indonesia Government Bond Secondary Market Transactions

It worth to note that in addition to the above strategy, as an integrated part of supporting strategy in controlling inflation amid blighted global uncertainty, Bank Indonesia also keeps continuing the sale/purchase of SBN in the secondary market (*operation twist*) to strengthen the

stabilization of the Rupiah exchange rate by increasing the attractiveness of SBN yields for entry of foreign portfolio investment through an increase in the yield on short-term SBN in line with the development in the policy rate (e.g. BI7DRR interest rate) and an increase in the yield structure for long-term SBN lower. This strategy is carried out by taking into account that ongoing inflationary pressures are more in the short term and will decline back to their target in the medium to long term.

3. Data and Methodology

The purpose of this paper is to examine whether the FX intervention conducted by Bank Indonesia is effective in maintaining the rupiah exchange rate. This study uses monthly data from January 2010 to December 2020. We employ instrumental variables (IV) approach to cope with the endogeneity issue, especially between the intervention strategy and the exchange rate movements. As widely known in FX intervention literatures, the main problem in measuring the impact of the FX intervention strategy is the endogeneity of FX intervention on exchange rate movements (Adler, Lisack, et al., 2019). In this case, while intervention in the FX market is intended to influence exchange rate movements, decision to intervene is also influenced by exchange rate movements (two-way causality). This will lead to insignificant estimation between FX intervention strategies and exchange rate movements and sometimes result in the opposite sign of the coefficients (Daude et al., 2016). We, therefore, adopted basic equation proposed by Adler, Lisack, et al. (2019) which is applied to time-series data as follows:

$$EXR_t = \alpha + \beta\, EXR_{t-1} + \gamma' \widehat{\boldsymbol{FXI}_t} + \delta'\boldsymbol{X}_t + \varepsilon_t \quad (1)$$

$$'\boldsymbol{FXI}_t = a + b\, EXR_{t-1} + c'\boldsymbol{Z}_t + d'\boldsymbol{X}_t + u_t \quad (2)$$

EXR is the percentage change in the rupiah exchange rate against USD. An increase (decrease) in *EXR* indicates depreciation (appreciation). Vector *FXI* is a proxy for the FX intervention strategy consisting of a combined intervention in the spot and derivatives market (*FXI_BROAD*), a partial intervention in the spot market (*FXI_SPOT*), and a partial intervention in the derivatives market (*FXI_DERIV*) available in billions of US dollars and percent of GDP, respectively. An increase (decrease) in *FXI* represents a buying (selling) FX transaction by Bank Indonesia.

So, in this case, we predict that coefficient of *FXI* would be positive ($\gamma > 0$) as buying foreign exchange would cause the rupiah exchange rate to depreciate. Vector *X* contains control variables such as volatility index to measure global risk aversion (*VIX*), interest rate differential in the form of first difference (Δ*INTERESTDIF*), price differential in the form of first difference (Δ*PRICEDIF*), and economic openness (*OPENNES*). Vector *Z* contains instrument variables such as changes in the ratio of M2 to GDP ($\Delta\frac{M2}{GDP}$), import coverage ($\frac{RESERVE}{IMPORT}$), and a dummy of low import coverage (*LOWIMPORTCOV*).

Equation (1) is a second-stage equation capturing that exchange rate movements are influenced by exchange rates in the previous period, FX intervention policies (fitted value from Equation (2)), and vector of control variables. Meanwhile, Equation (2) is a first-stage equation showing that the FX intervention policy is influenced by the exchange rate in the previous period, the vector of the instrument variable, and the vector of the control variable.

Time-series regression of non-stationary variables can lead to spurious results. Therefore, before estimation, all variables in Equation (1) and Equation (2) are tested for stationarity to ensure that the variables used in the model are stationary.

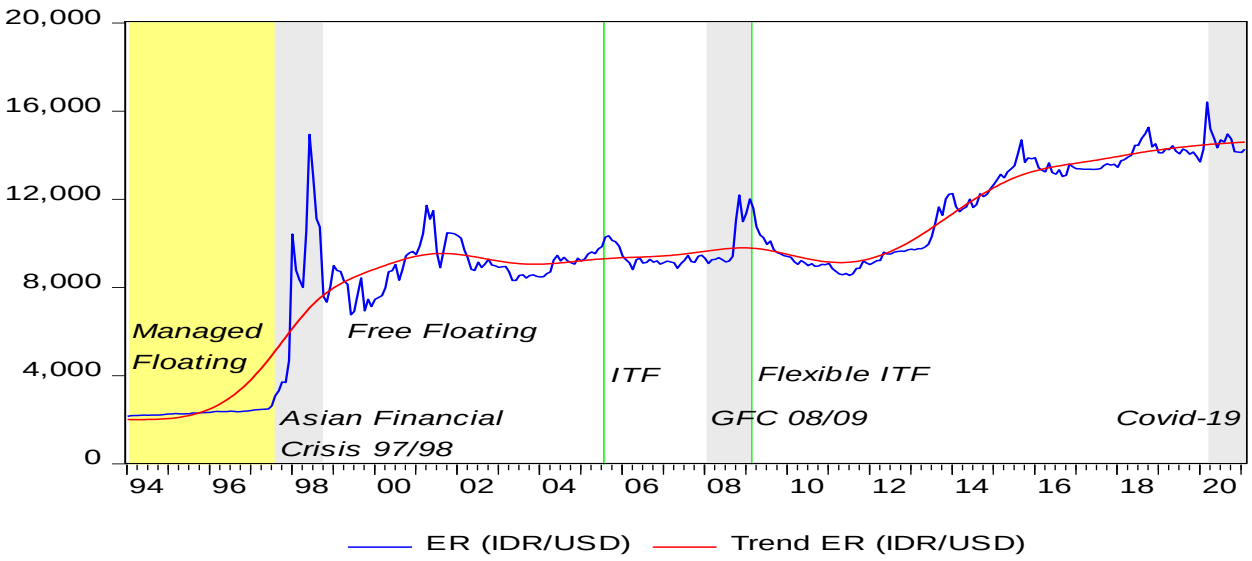
In contrast to other studies that mostly use coarse foreign exchange intervention proxies (variables derived from net foreign assets and dummy interventions), we use the intervention proxies estimated by Adler et al. (2021). All transactions that change the central bank's foreign currency position, according to Adler et al. (2021), can only be said to be a FX intervention if it has four elements as follows: (i) Transaction is considered an intervention if the transaction is active. Passive changes in the central bank's foreign currency balance, such as transactions originating from interest income and changes in the price of reserve assets, are not considered as interventions; (ii) A transaction is considered an intervention if the transaction relates to a central bank entity. Currency operations performed by public sector entities (e.g. governments) do not count as interventions; (iii) A transaction is considered an intervention if the transaction focuses on the foreign currency balance of the central bank, which includes all exchanges of foreign currency assets against domestic currency assets; and (iv) All transactions that meet the above criteria are included in the FX intervention, regardless of whether the central bank's intention is only to accumulate foreign exchange reserves without affecting the exchange rate (e.g. precautionary motive) because the intention cannot be verified and the operation remains can still affect the exchange rate.

4. Empirical Analysis

4.1. Salient Observations

The behavior of the nominal exchange rate of the rupiah against the USD from time to time is shown in **Error! Reference source not found.**. Differences in exchange rate regimes significantly affect the behavior of nominal exchange rates. The nominal exchange rate movement looks more stable in the managed floating regime compared to the floating regime. It can also be seen that fluctuations in the nominal exchange rate movement are significantly lower in the managed floating regime compared to the floating regime.[5] The 1997/1998 Asian financial crisis had a major impact on nominal exchange rates. The nominal exchange rate of the rupiah, which was initially at the level of Rp2,599/USD in July 1997, depreciated deeply to reach Rp14,900/USD in June 1998. To maintain external balance and macroeconomic stability as whole, in August 1998, Indonesia implemented a floating exchange rate system (or free-floating regime). In the managed floating regime, Bank Indonesia will necessarily intervene the FX market to influence the rupiah nominal exchange rate movement between a predetermined range. Meanwhile, in a free-floating regime, Bank Indonesia encourages the movement of the rupiah in accordance with market mechanisms, and will carry out measurable FX interventions so that the rupiah is always in line with (around) its fundamental value. The rupiah nominal exchange rate movement appears to behave up and down around its long-term trend value, which is estimated using the Hodrick-Prescott filter (Hodrick & Prescott, 1997). This indicates that stabilization policy strategies have been carried out by Bank Indonesia to maintain the development of the exchange rate in line with its fundamental level.

[5] Although the managed floating regime makes the exchange rate more stable, it requires large FX reserves to maintain its stability and with open capital mobility, making managed floating in the long term has an expensive cost (Hall, 2008).

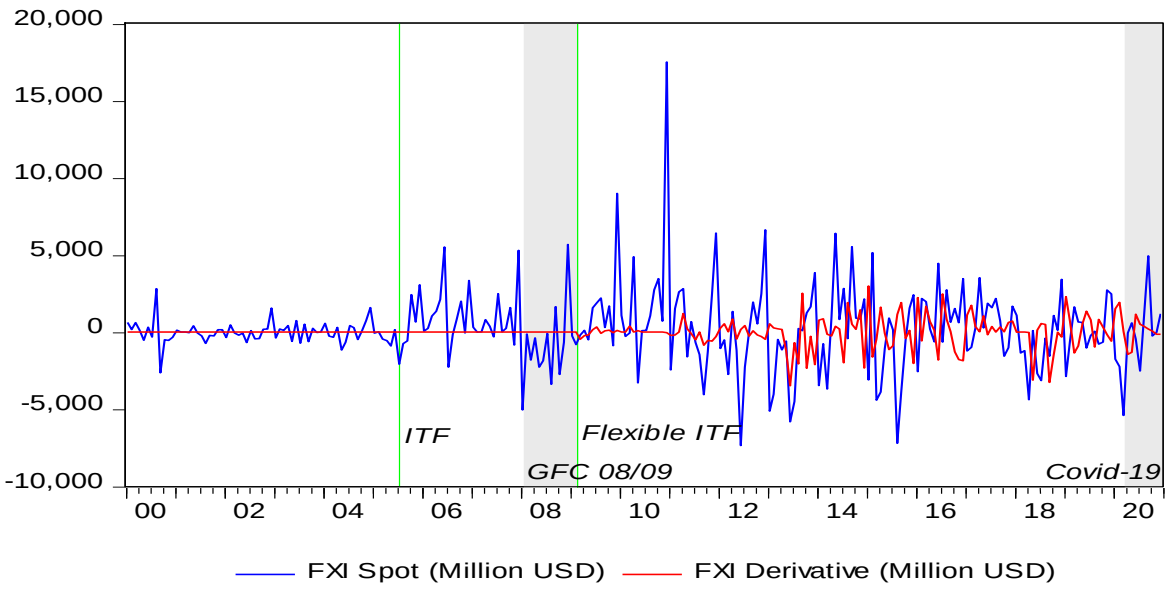


Source: Bank Indonesia (processed data).

Figure 4 Movement of IDR/USD Nominal Exchange Rate 1994M01-2021M02

As a common understanding, the main motive for central bank to intervene the FX market is to influence exchange rate movement. Although there are other motives, such as precautionary motive to maintain the adequacy of the reserves, it is not the objective of the intervention. This policy perspective is also in line with the FX intervention strategy implemented by Bank Indonesia.[6] It can be seen at the beginning of the COVID-19 pandemic shocks (March 2020), when the nominal rupiah exchange rate was depreciated by 15%, from Rp14,234/USD to Rp16,367/USD. Bank Indonesia intervened in the form of selling foreign exchange amounting to 5,377 billion USD to dampen further depreciation pressures. Interventions in the form of FX sales continued to be carried out in April, and May 2020, amounting to USD1.513 billion and USD733 million and succeeded in stabilizing the rupiah to Rp14,733/USD. In practice, in the case of Indonesia, the intervention to control the exchange rate is carried out not only in the spot market and bond market, but also in the derivatives market - so called as the triple intervention strategy.

[6] As stipulated in Article 12 of the Board of Governors Regulation No. 2/21/PDG/2000 concerning the Management of Foreign Exchange Reserves.



Source: Estimated Results of Adler et al. (2021) (processed data).

Figure 5 Bank Indonesia Foreign Exchange Intervention 2000M01-2020M12

Error! Reference source not found.5 shows the dynamics of intervention in the FX spot and derivatives markets. As of February 2009, Bank Indonesia's FX intervention was 100 per cent carried out in the spot market, with total FX sales amounting to USD811.57 million. Starting in March 2009, Bank Indonesia began to intervene in the derivatives market by 70 per cent (total foreign currency sales of USD470 million) and the remaining 30 per cent in the spot market (total net foreign currency sales of USD202.45 million). While the central bank's intervention in the FX derivatives market is increasing yearly, the FX intervention in the spot market is still more dominant than in the derivative market.

4.2. *Estimation* Results

The effectiveness of the FX intervention strategy in Indonesia is measured by estimating the effect of the FX intervention on the exchange rate movement, which is proxied by the nominal percentage change in rupiah exchange rate against USD (see Equation (1)) using an instrumental variable (IV) approach. APPENDIX Table 1 displays descriptive statistics and definitions of each variable used in this study. In the next stage, we employed Augmented Dickey-Fuller and Phillips-Perron stationarity tests by considering constants as well as constants and trends. The stationarity tests are used to check the level of stationarity of the variables in the system to avoid spurious regression caused by non-stationarity variables. Table 3 presents the results of the unit root test for each variable. Based on the result, the null hypothesis, which states that the variables used in the study have unit roots, can be conclusively rejected, or in other words, the variables are stationary.

Table 2. Stationarity Tests

Variables	Augmented Dickey-Fuller		Phillips-Perron	
	Constant	Constant and Trend	Constant	Constant and Trend
EXR_t	-12.187*** (0.0000)	-12.146*** (0.0000)	-12.252*** (0.0000)	-12.211*** (0.0000)
$FXI\_SPOT\_NOM_t$	-10.900*** (0.0000)	-10.914*** (0.0000)	-10.918*** (0.0000)	-10.931*** (0.0000)
$FXI\_DERIV\_NOM_t$	-12.346*** (0.0000)	-12.330*** (0.0000)	-12.576*** (0.0000)	-12.575*** (0.0000)
$FXI\_BROAD\_NOM_t$	-9.977*** (0.0000)	-9.956*** (0.0000)	-10.065*** (0.0000)	-10.048*** (0.0000)
$FXI\_SPOT\_GDP_t$	-11.613*** (0.0000)	-11.677*** (0.0000)	-11.583*** (0.0000)	-11.648*** (0.0000)
$FXI\_DERIV\_GDP_t$	-12.437*** (0.0000)	-12.417*** (0.0000)	-12.630*** (0.0000)	-12.622*** (0.0000)
$FXI\_BROAD\_GDP_t$	-10.957*** (0.0000)	-10.973*** (0.0000)	-10.981*** (0.0000)	-11.002*** (0.0000)
VIX_t	-4.657*** (0.0001)	-4.633*** (0.0009)	-4.579*** (0.0001)	-4.556*** (0.0012)
$\Delta\, INTERESTDIF_t$	-9.701*** (0.0000)	-9.680*** (0.0000)	-9.865*** (0.0000)	-9.845*** (0.0000)
$\Delta\, PRICEDIF_t$	-7.004*** (0.0000)	-7.013*** (0.0000)	-6.500*** (0.0000)	-6.489*** (0.0000)
$OPENNES_t$	-4.089*** (0.0010)	-6.667*** (0.0000)	-3.716*** (0.0039)	-6.984*** (0.0000)
$\Delta \frac{M2_t}{GDP_t}$	-10.898*** (0.0000)	-10.933*** (0.0000)	-10.942*** (0.0000)	-10.970*** (0.0000)
$\frac{RESERVE_t}{M2_t}$	-1.846 (0.3581)	-3.383* (0.0537)	-2.011 0.2817)	-3.506** (0.0388)
$\frac{RESERVE_t}{IMPORT_t}$	-4.654*** (0.0001)	-6.222*** (0.0000)	-4.430*** (0.0003)	-6.432*** (0.0000)
$LOWIMPORTCOV_t$	-6.791*** (0.0000)	-7.428*** (0.0000)	-7.101*** (0.0000)	-7.844*** (0.0000)

Note: The values in parentheses are the p-values of the t-statistics; Statistical significance at 10%, 5%, and 1% level shown by *, **, and *** signs, respectively.

Table 3. Instrumental Variable: Estimation Result

Variables	EXR_t	EXR_t	EXR_t	EXR_t	EXR_t	EXR_t
	1	2	3	4	5	6
EXR_{t-1}	-0.16008*	-0.09072	-0.13325	-0.15888*	-0.08866	-0.13717
	(0.08732)	(0.10918)	(0.08935)	(0.08755)	(0.10854)	(0.08922)
$FXI\_SPOT\_NOM_t$ (*Instrumented*)	0.27318**					
	(0.13069)					
$FXI\_DERIV\_NOM_t$ (*Instrumented*)		0.87279				
		(0.80657)				
			0.31203**			

$FXI\_BROAD\_NOM_t$ (*Instrumented*)			(0.13596)			
$FXI\_SPOT\_GDP_t$ (*Instrumented*)				2.10011** (0.99393)		
$FXI\_DERIV\_GDP_t$ (*Instrumented*)					8.32642 (7.27253)	
$FXI\_BROAD\_GDP_t$ (*Instrumented*)						2.33139** (1.02214)
VIX_t	0.07532** (0.03282)	0.05457* (0.03168)	0.07568** (0.03307)	0.07281** (0.03263)	0.05684* (0.03167)	0.07343** (0.03293)
$\Delta\ INTERESTDIF_t$	5.21079*** (1.12602)	4.85681*** (1.09778)	5.42207*** (1.15776)	5.06686*** (1.11020)	4.83621*** (1.09724)	5.20987*** (1.13200)
$\Delta\ PRICEDIF_t$	-0.05336 (0.31794)	0.17816 (0.35132)	0.00264 (0.32064)	-0.04041 (0.31827)	0.20266 (0.35946)	0.01180 (0.32107)
$OPENNES_t$	-0.00987 (0.12402)	0.08785 (0.12800)	0.00116 (0.12437)	-0.01818 (0.12505)	0.08832 (0.12815)	-0.01027 (0.12527)
Constant	-0.78659 (1.63327)	-1.61500 (1.67649)	-0.94786 (1.64805)	-0.66383 (1.64275)	-1.66776 (1.69425)	-0.79173 (1.65343)
F-Statistics	4.98802	4.66337	5.03009	4.98173	4.61410	5.00975
Uncentered R-Squared	0.07010	0.10750	0.04800	0.06550	0.09310	0.04570
Centered R-Squared	0.05392	0.09197	0.03146	0.04920	0.07727	0.02912
Observations	132	132	132	132	132	132

Note: EXR_t is a percentage change in rupiah exchange rate against US dollar; $FXI\_SPOT\_NOM_t$ is foreign exchange intervention in the spot market in the form of buying/selling foreign exchange in billions of US dollar; $FXI\_DERIV\_NOM_t$ is a foreign exchange intervention in derivative market in the form of buying/selling foreign exchange in billions of US dollar; $FXI\_BROAD\_NOM_t$ is a foreign exchange intervention in the spot and derivative market in the form of buying/selling foreign exchange in billions of US dollar; $FXI\_SPOT\_GDP_t$ is a foreign exchange intervention in the spot market in the form of buying/selling foreign exchange in percent of GDP; $FXI\_DERIV\_GDP_t$ is a foreign exchange intervention in derivative market in the form of buying/selling foreign exchange in percent of GDP; $FXI\_BROAD\_GDP_t$ is a foreign exchange intervention in the spot and derivative market in the form of buying/selling foreign exchange in percent of GDP; VIX_t is a volatility index to measure global risk aversion; $\Delta\ INTERESTDIF_t$ is the difference in interest rate between Indonesia and America in the form of first difference; $\Delta\ PRICEDIF_t$ is the difference in consumer price index between Indonesia and America in the form of first difference; $OPENNES_t$ is a trade openness proxied by the ratio of total exports and imports to GDP in percent; The instrument variables used are: $\Delta \frac{M2_t}{GDP_t}$ is the ratio of money supply (*M2*) to GDP in percent, $\frac{RESERVE_t}{M2_t}$ is the ratio of foreign exchange reserves to *M2* in percent in the form of lag 0 and lag 1, $\frac{RESERVE_t}{IMPORT_t}$ is import coverage proxied by the ratio of foreign exchange reserves to imports in percent in the form of lag 0 and lag 1, and $LOWIMPORTCOV_t$ is the dummy whose number will be 1 if the import coverage less than the first quartile; The values in parentheses are the p-values of the t-statistics; Statistical significance at 10%, 5%, and 1% level shown by *, **, and *** signs, respectively.

The estimation results using the IV approach are presented in **Error! Reference source not found.**. The coefficient of the foreign exchange intervention is found to be significantly positive and consistent with the theory. The combined FX intervention strategy conducted simultaneously

by Bank Indonesia in the spot and derivative markets, shows a positive and significant impact on exchange rate movements. This means that the purchase (sale) of foreign currency by the central bank in these two markets causes the depreciation (appreciation) of the rupiah against the USD. The rupiah exchange rate against the USD will appreciate by 1 percent for every foreign exchange sale of 3 billion USD. If the FX intervention is expressed as a percentage of GDP, the rupiah exchange rate against the USD will appreciate by 2.3 percent for every foreign exchange sale of 1 percent of GDP.

Table 4. Bound Tests

F-*statistic*	K	Significance Level	*Critical Bounds*	
			Lower Bound I(0)	*Upper Bound I*(1)
Model 1: ARDL (1, 0, 2, 0, 1, 0)				
31.1573	5.000	10%	2.0800	3.0000
		5%	2.3900	3.3800
		1%	3.0600	4.1500
Model 2: ARDL (1, 2, 2, 0, 2, 1)				
28.6169	5.000	10%	2.0800	3.0000
		5%	2.3900	3.3800
		1%	3.0600	4.1500
Model 3: ARDL (1, 0, 2, 0, 1, 0)				
30.5087	5.000	10%	2.0800	3.0000
		5%	2.3900	3.3800
		1%	3.0600	4.1500
Model 4: ARDL (1, 0, 2, 0, 1, 0)				
31.1939	5.0000	10%	2.0800	3.0000
		5%	2.3900	3.3800
		1%	3.0600	4.1500
Model 5: ARDL (1, 2, 2, 0, 2, 1)				
28.5358	5.0000	10%	2.0800	3.0000
		5%	2.3900	3.3800
		1%	3.0600	4.1500
Model 6: ARDL (1, 0, 2, 0, 1, 0)				
31.3147	5.0000	10%	2.0800	3.0000
		5%	2.3900	3.3800
		1%	3.0600	4.1500

Note: K indicates the number of independent variables. H_0 is for no cointegration.

This study also finds that there are differences in the effectiveness of FX interventions in the spot market and the derivatives market. In the derivatives market, the intervention coefficient is found to be larger than in the spot market, but not statistically significant. As is known, most transactions in the derivatives market are in the form of transaction agreements whose realization will occur in the future. However, the magnitude of derivative transactions carried out by the central

bank can provide a signal to market players regarding the central bank's stance towards the current exchange rate movement, but because the realization of the transactions will occur in the future, this makes the effect less effective or less significant.

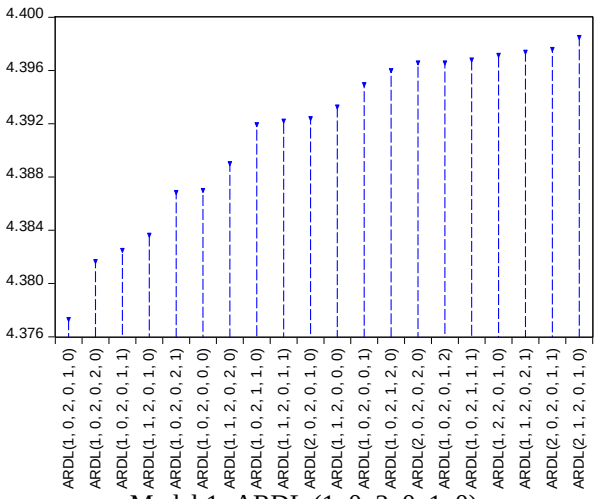
This study shows significant result on the effectiveness of the combined FX intervention in the spot and derivative markets, whereby it can be seen that the degree of significance (t-statistic) of the effect of combined FX intervention in the spot and derivative markets (-2,3) is higher than the effect of intervention only in the spot market (-2.1). This finding leads to fundamental implication of that interventions will be more effective if they are carried out simultaneously in the spot and derivatives markets. Other important findings are also shown by the influence of the control variables, namely the perception of global financial risk and interest rates differential, at the level of 10% and 5%, respectively.

Robustness Tests

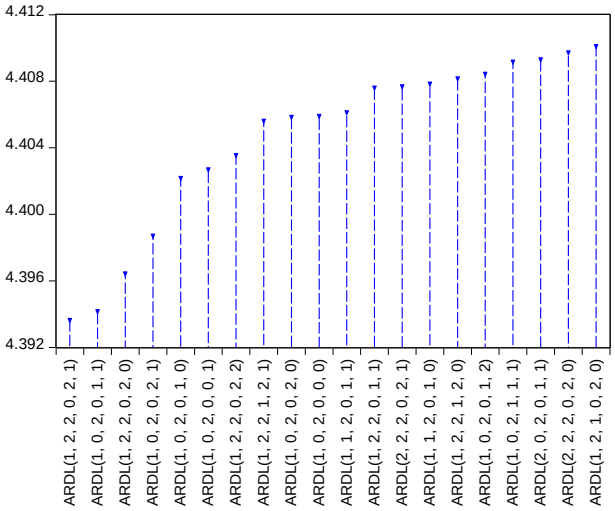
Robustness tests is also carried out through model's performance assessment using different approach, that is the Autoregressive Distributed Lag (ARDL) (Pesaran & Shin, 1999; Pesaran et al.,2001). This approach is useful for testing whether there is a short-term correction mechanism to equalize the relationship between variables in the long term.[7]

To estimate the ARDL model, we conduct lag selection tests using the Akaike information criterion to get the optimal lag to avoid autocorrelation problems (see **Error! Reference source not found.**). The model with the smallest Akaike information criterion value will be selected, and it will be tested using the Bounds test to see the cointegration relationship in each variable. If the F-statistics value of the Bounds test is greater than the critical lower bound *I*(0) and upper bound *I*(1), there is exist a cointegration relationship between variables and it is possible to do long-term analysis. From the results of the Bound test (see **Error! Reference source not found.**4), there are six selected models namely ARDL (1,0,2,0,1,0), ARDL (1,2,2,0,2,1), ARDL (1,0,2,0,1,0), ARDL (1,0,2,0,1,0), ARDL (1,2,2,0,2,1), and ARDL (1,0,2,0,1,0). The F-statistic for Model 1 to Model 6 is greater than the lower bound and upper bound critical values with a significance level of 10%, 5%, and even 1%. So, it can be concluded that there is a long-term relationship between the dependent and independent variables that allows us to do long-term analysis.

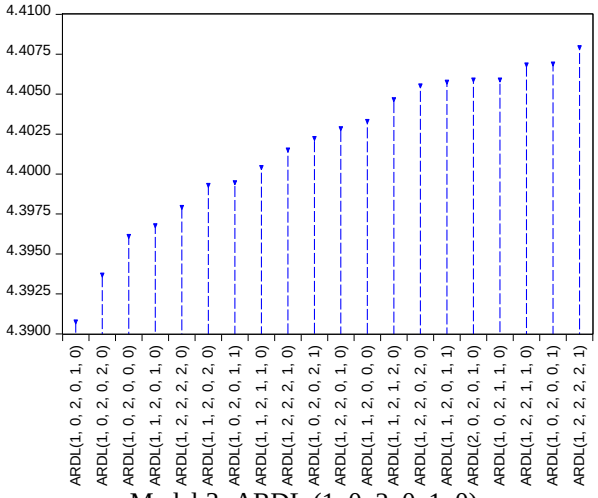
[7] The ARDL approach consists of two steps. The first step is conducting a cointegration test to examine the long-term relationship between variables. If there is a cointegration relationship between variables, the next step is to estimate the long-term and short-term coefficients using the error correction model (ECM). However, if there is no cointegration relationship, only the short-term coefficient can be estimated.



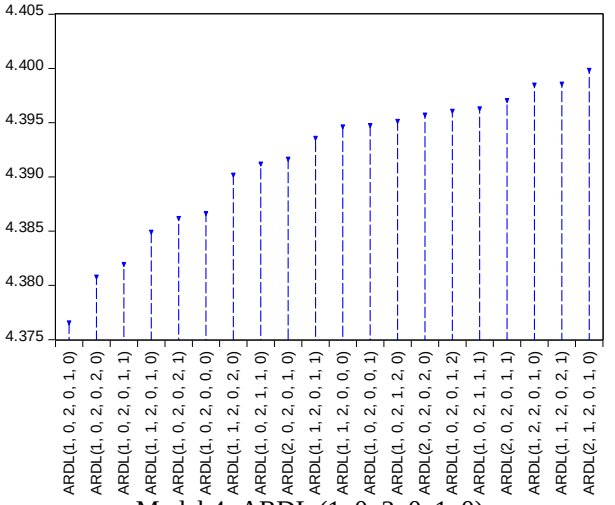
Model 1: ARDL (1, 0, 2, 0, 1, 0)



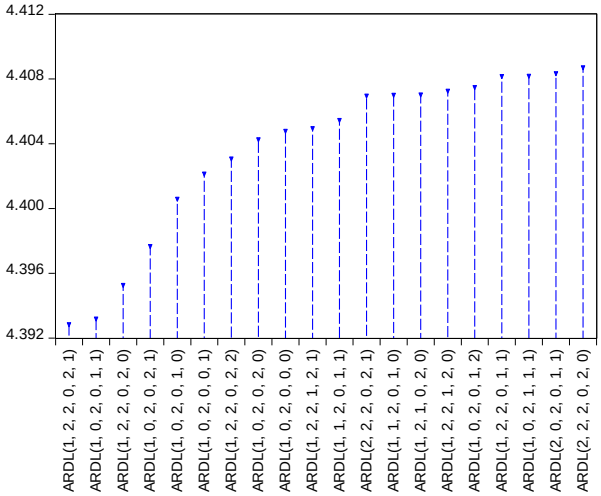
Model 2: ARDL (1, 2, 2, 0, 2, 1)



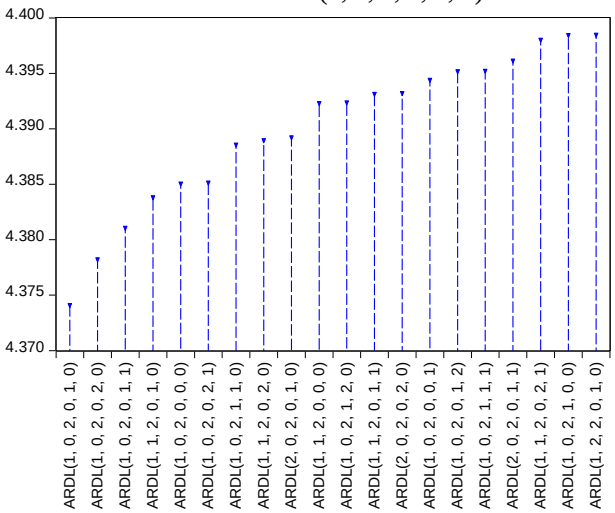
Model 3: ARDL (1, 0, 2, 0, 1, 0)



Model 4: ARDL (1, 0, 2, 0, 1, 0)



Model 5: ARDL (1, 2, 2, 0, 2, 1)



Model 6: ARDL (1,0, 2, 0, 1, 0)

Figure 6. Akaike Information Criterion

Table 5. ARDL: Long-Run Estimation Results

Variabel	EXR_t	EXR_t	EXR_t	EXR_t	EXR_t	EXR_t
	1	2	3	4	5	6
	(1,0,2,0,1,0)	(1,2,2,0,2,1)	(1,0,2,0,1,0)	(1,0,2,0,1,0)	(1,2,2,0,2,1)	(1,0,2,0,1,0)
$FXI\_SPOT\_NOM_t$ (*Instrumented*)	0.3824*** (2.9789)					
$FXI\_DERIV\_NOM_t$ (*Instrumented*)		-0.7036 (-0.9148)				
$FXI\_BROAD\_NOM_t$ (*Instrumented*)			0.0591*** (2.8648)			
$FXI\_SPOT\_GDP_t$ (*Instrumented*)				2.9445*** (2.9896)		
$FXI\_DERIV\_GDP_t$ (*Instrumented*)					-6.7220 (-0.9347)	
$FXI\_BROAD\_GDP_t$ (*Instrumented*)						3.5284*** (2.9419)
VIX_t	0.0004 (0.0156)	-0.0121 (-0.5493)	-0.0089 (-0.3535)	-0.0031 (-0.1174)	-0.0141 (-0.6494)	-0.0016 (-0.0591)
$\Delta\ INTERESTDIF_t$	4.6190*** (5.3070)	2.7052*** (3.5239)	5.6397*** (5.4537)	4.4251*** (5.2201)	2.7377*** (3.6134)	4.8239*** (5.2092)
$\Delta\ PRICEDIF_t$	0.0845 (0.3164)	0.4381 (1.1294)	0.0020 (0.0080)	0.1047 (0.3918)	0.4148 (1.0406)	0.1887 (0.6833)
$OPENNES_t$	-0.0274 (-0.2997)	-0.0543 (-0.6190)	0.0972 (1.1261)	-0.0390 (-0.4213)	-0.0545 (-0.6257)	-0.0318 (-0.3356)
Constant	0.6696 (0.5498)	1.1426 (0.9945)	-0.8034 (-0.6741)	0.8417 (0.6853)	1.1868 (1.0235)	0.7015 (0.5571)
ECM_{t-1}	-1.1443*** (-15.1270)	-1.3882*** (-14.5087)	-1.2181*** (-14.9688)	-1.1425*** (-15.1359)	-1.3908*** (-14.4882)	-1.1059*** (-15.1652)
Observations	132	132	132	132	132	132
Diagnostic Test:						
Prob. $\chi^2 LM\ test$	0.9727	0.9105	0.7823	0.9795	0.9163	0.9798
Prob. $\chi^2 ARCH$	0.9349	0.7168	0.9121	0.9327	0.7153	0.9340
Stability CUSUM	Stable	Stable	Stable	Stable	Stable	Stable

Note: EXR_t is a percentage change in rupiah exchange rate against US dollar; $FXI\_SPOT\_NOM_t$ is foreign exchange intervention in the spot market in the form of buying/selling foreign exchange in billions of US dollar; $FXI\_DERIV\_NOM_t$ is a foreign exchange intervention in derivative market in the form of buying/selling foreign exchange in billions of US dollar; $FXI\_BROAD\_NOM_t$ is a foreign exchange intervention in the spot and derivative market in the form of buying/selling foreign exchange in billions of US dollar; $FXI\_SPOT\_GDP_t$ is a foreign exchange intervention in the spot market in the form of buying/selling foreign exchange in percent of GDP; $FXI\_DERIV\_GDP_t$ is a foreign exchange intervention in derivative market in the form of buying/selling foreign exchange in percent of GDP; $FXI\_BROAD\_GDP_t$ is a foreign exchange intervention in the spot and derivative market in the form of buying/selling foreign exchange in percent of GDP; VIX_t is a volatility index to measure global risk aversion;

$\Delta\, INTERESTDIF_t$ is the difference in interest rate between Indonesia and America in the form of first difference; $\Delta\, PRICEDIF_t$ is the difference in consumer price index between Indonesia and America in the form of first difference; $OPENNES_t$ is a trade openness proxied by the ratio of total exports and imports to GDP in percent; The instrument variables used are: $\Delta \frac{M2_t}{GDP_t}$ is the ratio of money supply (*M2*) to GDP in percent, $\frac{RESERVE_t}{M2_t}$ is the ratio of foreign exchange reserves to *M2* in percent in the form of lag 1, $\frac{RESERVE_t}{IMPORT_t}$ is import coverage proxied by the ratio of foreign exchange reserves to imports in percent in the form of lag 1, and $LOWIMPORTCOV_t$ is the dummy whose number will be 1 if the import coverage less than the first quartile in the form of lag 1; The values in parentheses are the p-values of the t-statistics; Statistical significance at 10%, 5%, and 1% level shown by *, **, and *** signs, respectively

Error! Reference source not found.5 shows the results of the long-term estimation of the ARDL model with instrumented FX intervention variables. The error correction term is statistically significant at the 1% level with a negative coefficient. The error correction term of the six ARDL models is -1.23 on average, which means that the error correction process fluctuates around the long-term value in a dampening manner rather than monotonically leading to an equilibrium path.[8] However, after the process is complete, the convergence to the equilibrium path takes place rapidly. The result estimation of the ARDL model are generally relatively the same as the results of IV estimates, where the combined FX intervention in the spot and derivatives market, as well as partial intervention in the spot market, shows a positive and significant effect.

5. Conclusion and Implication

We measure the effectiveness of FX intervention in Indonesia by employing an instrumental variable approach that tackles with endogeneity issues in policy measurement. In contrast to other studies that mostly use coarser foreign exchange intervention proxies, we use the newly constructed refined FX intervention proxies estimated by Adler et al. (2021). Using Indonesia as a representative of a small open economy with a substantial economic role in the region and EMEs, we find that FX intervention carried out simultaneously by Bank Indonesia in the spot and derivative markets effectively influences the exchange rate stability. If we look at the partial effect between the spot market and the derivatives market, exchange rate intervention is more effective in the spot market than in the derivatives market. It can happen because in the derivatives market, foreign exchange transactions can affect the balance sheet of the central bank indirectly, so there is the potential for delays that can change market expectations of the central bank's policy response. Its asymmetric effect of foreign exchange intervention in spot and derivative market suggesting central bank to make spot market as primary target in taming exchange rate fluctuation. Lower effect of derivative market indicate that derivative market in Indonesia is still shallow. Domestic Non Deliverable Forward (DNDF) instrument launched by Bank Indonesia as an effort to accelerate the deepening of the domestic foreign exchange market needs to be increased in magnitude or loosened the transaction rules.

These findings have fundamental implications regarding the importance of an integrated FX intervention strategy, not only in the spot market, but also in the derivatives market. This FX intervention strategy is also very relevant to be carried out by EMEs which are currently experiencing severe challenges in mitigating spillover impacts as a result of global capital flow dynamics or liquidity cycles and heightened uncertainties in global financial markets. Referring to Indonesian experience in managing exchange rate stability, given increasingly complex challenges ahead, the FX intervention strategy needs to be further strengthened, among others by conducting

[8] If the coefficient value is between -1 and -2, then it shows a dampened fluctuation in the dependent variable on the equilibrium path (Narayan & Smyth, 2006).

an integrated intervention strategy; not only in spot and derivative markets, but also in bond markets (i.e. through triple intervention and operation twist). This will be an important research topic to do in the future.

References

Abildgren, K. (2005). *Sterilised and non-sterilised intervention in the foreign-exchange market*. 61–71.

Abubakar, A., Diah Utari, G. A., & Azwar, P. (2020). Early warning indicators and optimal policies for mitigating economic crises: Evidence from meta-analysis. *Bulleting of Monetary Economics and Banking*, *23*(2), 269–293. https://doi.org/10.21098/bemp.v23i1.1421

Adler, G., Chang, K. S., Mano, R. C., & Shao, Y. (2021). Foreign exchange intervention: A dataset of public data and proxies. In *IMF Working Paper: Vol. WP/21/47*.

Adler, G., Lama, R., & Medina, J. P. (2019). Foreign exchange intervention and inflation targeting: The role of credibility. *Journal of Economic Dynamics and Control*, *106*, 1–20. https://doi.org/10.1016/j.jedc.2019.07.002

Adler, G., Lisack, N., & Mano, R. C. (2019). Unveiling the effects of foreign exchange intervention: A panel approach. *Emerging Markets Review*, *40*, 1–29. https://doi.org/10.1016/j.ememar.2019.100620

Adler, G., & Mano, R. C. (2021). The cost of foreign exchange intervention: Concepts and measurement. *Journal of Macroeconomics*, *67*, 1–26. https://doi.org/10.1016/j.jmacro.2018.07.001

Akdogan, I. U. (2020). Understanding the dynamics of foreign reserve management: The central bank intervention policy and the exchange rate fundamentals. *International Economics*, *161*, 41–55. https://doi.org/10.1016/j.inteco.2019.11.002

Arango-Lozano, L., Menkhoff, L., Rodríguez-Novoa, D., & Villamizar-Villegas, M. (n.d.). The effectiveness of FX interventions: A meta-analysis. *Journal of Financial Stability*, 1–24. https://doi.org/10.1016/j.jfs.2020.100794

Baek, I. M., & Jun, J. (2011). Testing contagion of the 1997-98 crisis in Asian stock markets with structural breaks and incubation periods. *Journal of Asian Economics*, *22*(5), 356–368. https://doi.org/10.1016/j.asieco.2011.05.005

Baharumshah, A. Z., & Wooi, H. C. (2007). Exchange rate volatility and the Asian financial crisis: Evidence from South Korea and ASEAN-5. *Review of Pacific Basin Financial Markets and Policies*, *10*(2), 237–264. https://doi.org/10.1142/S0219091507001057

Banerjee, B., Zeman, J., Ódor, Ľ., & Riiska, W. O. (2018). On the Effectiveness of Central Bank

Intervention in the Foreign Exchange Market: The Case of Slovakia, 1999–2007. *Comparative Economic Studies*, *60*(3), 442–474.

Besuyen, A., Coupé, T., & Das, K. K. (2021). Effectiveness of foreign exchange interventions: evidence from New Zealand. *New Zealand Economic Papers*. https://doi.org/10.1080/00779954.2020.1871063

Daude, C., Levy Yeyati, E., & Nagengast, A. J. (2016). On the effectiveness of exchange rate interventions in emerging markets. *Journal of International Money and Finance*, *64*, 239–261. https://doi.org/10.1016/j.jimonfin.2016.01.004

Dell'Ariccia, G., Igan, D., Laeven, L., Tong, H., Bakker, B., & Vandenbussche, J. (2012). *Policies for macrofinancial stability: How to deal with credit booms* (12/06; IMF Staff Discussion Note). https://www.imf.org/external/pubs/ft/sdn/2012/sdn1206.pdf

Departemen Komunikasi Bank Indonesia. (2020). *Langkah penguatan Bank Indonesia menjaga stabilitas moneter dan keuangan*. https://www.bi.go.id/id/publikasi/ruang-media/news-release/Pages/sp_221520.aspx

Domanski, D., Kohlscheen, E., & Moreno, R. (2016). Foreign exchange market intervention in EMEs: What has changed? In *BIS Quarterly Review*. https://ssrn.com/abstract=2842332

Fanelli, S., & Straub, L. (2020). A theory of foreign exchange interventions. In *NBER Working Paper Series*. https://doi.org/10.2139/ssrn.2846984

Fianto, B. A., Laila, N., Sukmana, R., & Madyan, M. (2020). Predictors of exchange rate returns: Evidence from Indonesia. *Bulletin of Monetary Economics and Banking*, *23*(2), 239–252.

Gamboa-Estrada, F. (2019). The effectiveness of foreign exchange intervention in Latin America: A nonlinear approach to the coordination channel. *Global Finance Journal*, *40*, 13–27. https://doi.org/10.1016/j.gfj.2018.11.004

Goeltom, M. S., & Zulverdi, D. (2003). Manajemen nilai tukar di Indonesia dan permasalahannya. *Buletin Ekonomi Moneter Dan Perbankan*, *1*(2), 69–91. https://doi.org/10.21098/bemp.v1i2.169

Hodrick, R. J., & Prescott, E. C. (1997). Postwar U.S. business cycles: An empirical investigation. *Journal of Money, Credit and Banking*, *29*(1), 1–16. https://doi.org/10.2307/2953682

Juhro, S. M., & Goeltom, M. S. (2015). Monetary policy regime in Indonesia. In A. Kohsaka (Ed.), *Macro-Financial Linkages in the Pacific Region* (Issue January 2015). Routledge. https://ssrn.com/abstract=2875631

Keefe, H. G., & Shadmani, H. (2018). Foreign exchange market intervention and asymmetric

preferences. *Emerging Markets Review*, *37*(June), 148–163. https://doi.org/10.1016/j.ememar.2018.08.001

Kitamura, Y. (2020). A lesson from the four recent large public Japanese FX interventions. *Journal of the Japanese and International Economies*, *57*, 1–15. https://doi.org/10.1016/j.jjie.2020.101087

Kuersteiner, G. M., Phillips, D. C., & Villamizar-Villegas, M. (2018). Effective sterilized foreign exchange intervention? Evidence from a rule-based policy. *Journal of International Economics*, *113*, 118–138. https://doi.org/10.1016/j.jinteco.2018.04.003

Lee, S., & Kim, Y. M. (2020). Effect of foreign exchange intervention: The case of Korea. *Pacific Economic Review*, *25*(25), 641–659. https://doi.org/10.1111/1468-0106.12317

Narayan, P. K., & Smyth, R. (2006). What determines migration flows from low-income to high-income countries? An empirical investigation of Fiji-U.S. migration 1972-2001. *Contemporary Economic Policy*, *24*(2), 332–342. https://doi.org/10.1093/cep/byj019

Pesaran, M. H., & Shin, Y. (1999). An autoregressive distributed-lag modelling approach to cointegration analysis. In S. Strøm (Ed.), *Econometrics and Economic Theory in the 20th Century* (pp. 371–413). Cambridge University Press. https://doi.org/10.1017/ccol521633230.011

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*, 289–326. https://doi.org/10.1002/jae.616

Pontines, V. (2018). Self-selection and treatment effects: Revisiting the effectiveness of foreign exchange intervention. *Journal of Macroeconomics*, *57*(June), 299–316. https://doi.org/10.1016/j.jmacro.2018.06.007

Rahman, R. E. (2019). Understanding Indonesia's exchange rate behavior. *Studies in Economics and Finance*. https://doi.org/10.1108/SEF-09-2018-0296

Rasbin, Ikhsan, M., Gitaharie, B. Y., & Affandi, Y. (2021). Real exchange rate misalignments: The case of the Indonesian rupiah. *Bulletin of Monetary Economics and Banking*, *24*(3), 441–464. https://doi.org/10.21098/bemp.v24i3.1268

Santos, F. L. (2021). Comparing the impact of discretionary and pre-announced central bank interventions. *Journal of International Money and Finance*, *110*, 1–16. https://doi.org/10.1016/j.jimonfin.2020.102307

Tai, C.-S. (2004). Can bank be a source of contagion during the 1997 Asian crisis? *Journal of*

Banking & Finance 28 (2004), *28*, 399–421. https://doi.org/10.1016/j.jbankfin.2003.02.001

Vargas-Herrera, H., & Villamizar-Villegas, M. (2020). Effectiveness of FX intervention and the flimsiness of exchange rate expectations. *Journal of Financial Stability*, *xxxx*, 100813. https://doi.org/10.1016/j.jfs.2020.100813

Villamizar-Villegas, M., & Perez-Reyna, D. (2015). A theoretical approach to sterilized foreign exchange intervention. *Journal of Economic Surveys*, *00*(0), 1–23. https://doi.org/10.1111/joes.12136

Viola, A. P., Klotzle, M. C., Pinto, A. C. F., & Barbedo, C. H. da S. (2019). Foreign exchange interventions in Brazil and their impact on volatility: A quantile regression approach. *Research in International Business and Finance*, *47*, 251–263. https://doi.org/10.1016/j.ribaf.2018.08.002

Viziniuc, M. (2021). Winners and losers of central bank foreign exchange interventions. *Economic Modelling*, *94*, 748–767. https://doi.org/10.1016/j.econmod.2020.02.016

Warjiyo, P., & Juhro, S. M. (2016). *Kebijakan Bank Sentral: Teori dan Praktik*. PT Raja Grafindo Persada.

Warjiyo, Perry. (2013). *Indonesia: Stabilizing the exchange rate along its fundamental* (No. 73; BIS Papers). https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2473999

APPENDIX

Table 1. Descriptive Statistics

Variables	Description	Mean	Std. Dev.	Minimum	Maximum
EXR_t	Percentage change in rupiah exchange rate against US dollar.	0.3405	2.5896	-7.3929	14.9853
$FXI\_SPOT\_NOM_t$	Foreign exchange intervention in the spot market in the form of buying/selling foreign exchange in billions of US dollar.	0.1730	3.0333	-7.3677	17.5069
$FXI\_DERIV\_NOM_t$	Foreign exchange intervention in derivative market in the form of buying/selling foreign exchange in billions of US dollar.	-0.0152	1.1212	-3.4830	2.9800
$FXI\_BROAD\_NOM_t$	Foreign exchange intervention in the spot and derivative market in the form of buying/selling foreign exchange in billions of US dollar.	0.1578	3.0180	-9.3014	17.4669
$FXI\_SPOT\_GDP_t$	Foreign exchange intervention in the spot market in the form of buying/selling foreign exchange in percent of GDP.	0.0299	0.3941	-0.9225	2.7768
$FXI\_DERIV\_GDP_t$	Foreign exchange intervention in derivative market in the form of buying/selling foreign exchange in percent of GDP.	-0.0019	0.1223	-0.3947	0.3285
$FXI\_BROAD\_GDP_t$	Foreign exchange intervention in the spot and derivative market in the form of buying/selling foreign exchange in percent of GDP.	0.0280	0.3939	-1.0540	2.7705
VIX_t	Volatility index to measure global risk aversion.	18.2848	7.0461	9.5100	53.5400
$INTERESTDIF_t$	The difference in interest rate between Indonesia and America.	5.4201	1.5800	2.5600	7.6900
$PRICEDIF_t$	The difference in consumer price index between Indonesia and America.	19.4398	12.8880	-2.1273	36.4413
$OPENNES_t$	Trade openness proxied by the ratio of total exports and imports to GDP in percent	11.9837	1.8281	7.4772	15.3002
$\frac{M2_t}{GDP_t}$	Money supply (*M2*) to GDP ratio in percent.	147.7640	10.6320	126.2661	176.5616
$\frac{RESERVE_t}{M2_t}$	The ratio of foreign exchange reserves to M2 in percent.	32.4470	2.6458	27.1625	40.7860
$\frac{RESERVE_t}{IMPORT_t}$	Import coverage proxied by the ratio of foreign exchange reserves to imports in percent.	8.3807	1.7043	5.3207	15.4699
$LOWIMPORTCOV_t$	Dummy, 1 if the import coverage less than the first quartile.	0.2727	0.4471	0.0000	1.0000