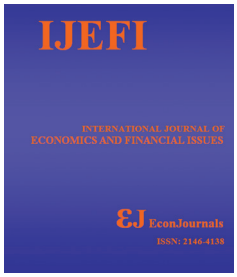

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The Relationship between Exchange Rate Volatility and Foreign Direct Investment in Turkey: Toda and Yamamoto Causality Analysis

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ABSTRACT

Many countries have embraced the floating exchange rate system with the collapse of the Bretton Woods system. As a result of the transition to the floating exchange rate system, the volatilities in exchange rates have become a major problem for countries. The volatility in exchange rates affects the expected benefits of foreign direct investments (FDI) as it increases uncertainty for investors. Therefore, FDI has become one of the important factors affecting the flow of investment. In this study, the relationship between exchange rate volatility and FDI in Turkey for the period 2005Q4-2018Q1 was analyzed using Toda-Yamamoto causality test. Real effective exchange rate volatility is estimated using the generalized autoregressive conditional heteroscedasticity model. As a result, a one-way causality relationship from FDI to exchange rate volatility has been found.

Keywords: Foreign Direct Investment, Exchange Rate Volatility, Toda and Yamamoto Causality
JEL Classifications: F21, F31, C22

1. INTRODUCTION

Many countries have adopted the floating exchange rate system by abandoning the fixed exchange rate system with the collapse of the Bretton Woods system. With the adoption of the floating exchange rate system, the volatilities in exchange rates have become a major problem for countries. Exchange rate volatility refers to all movements and changes that are effective for the depreciation/valuation of a currency (Martins, 2015. p. 14). Exchange rate volatility is an important factor that investors take into account when making investment decisions abroad. Exchange rate volatility affects the prices and quantities of the inputs and outputs of the MNCs and leads to competitiveness in the global market (Kumarasamy, 2010. p. 1). Exchange rate volatility affects the expected returns of foreign direct investments (FDI), which are considered as capital transfers. For this reason, both the level of exchange rate and the level of volatility may have an effect on the investment level (Chowdhury and Wheeler, 2008. p. 2; Asmah and Andoh, 2013. p. 2). Exchange rate volatility can encourage or deterrent direct foreign investments.

The withdrawal of FDI, which has a positive influence on economic growth, has become an important policy target for many countries. FDI has many positive externalities such as providing foreign currency inflows, increasing capital accumulation, creating employment, providing technology and skill transfer, and increasing productivity. According to Husek and Pankova (2008), the depreciation of the currency of the host country will attract FDI inflows for two reasons. First, the depreciation of the currency reduces the production costs (labor and other productive inputs) in the home country, thus makes the home country attractive for FDI seeking production efficiency. Second, the depreciation of the currency of the host country lowers the value of assets in the host country in other currencies, including the currency of the home country. According to this, the cost of FDI in foreign currency is decreasing and the host country is becoming attractive for FDI (Asmah and Andoh, 2013. p. 1-3).

FDI can also affect exchange rate volatility. FDI can increase productivity in the traded good sector and thus reduce real exchange rate volatility by balancing the relative prices of non-traded goods. FDI inflows lead to appreciation of the real exchange rate by increasing the capital stock in the host country. FDI

increases existing capital stock and causes technology to spread. Technology spillovers lead to increased production and lower prices of non-tradable goods. Thus, FDI leads to depreciation of real exchange rate. However, the increase in the production of non-traded goods increases the disposable income and thus the exchange rate appreciates (Biswas and Dasgupta 2012. p. 335).

The purpose of this study, the relationship between FDI and foreign exchange rate volatility by Toda and Yamamoto causality test to analyze for example 2005Q4-2018Q1 period in Turkey. The rest of the paper is organized as follows. The next section provides the theoric framework on the relationship between FDI and exchange rate volatility. In section 3 provides an overview of the applied literature on the relationship between FDI and exchange rate volatility. In section 4, data and econometric methodology adopted to estimate the causality relationships among the selected variables are presented. The results from Toda Yamamoto causality analysis are summarized in section 5, while the final section 6 provides brief conclusions.

2. THE IMPACT OF EXCHANGE RATE VOLATILITY ON FOREIGN DIRECT INVESTMENT

Foreign investors are directing their investments to other countries in order to reduce their production costs and to benefit from cheap raw materials and labor in the host country. FDI depends on factors such as economic and political structure, investment incentives, trade policies (tax exemption or reduction) in the country to be invested. Besides these, real exchange rate volatility also affects direct foreign investment decisions. Real exchange rate volatility creates an ambiguous environment for investment decisions. Such an environment causes either "redistribution of resources between sectors and countries" (production flexibility) or "investors delay investment decisions" (postpone, delay hysteresis) (Azid and Kousar, 2005. p. 749-750).

2.1. Production Flexibility Approach and Export Substitution

According to Aizenman (1992), foreign direct investment is motivated by the initiative of the manufacturer to increase production flexibility. This flexibility offers the manufacturer the option of adjusting the international production model, at the cost of extra production capacity transportation cost (Aizenman, 1992. p. 2). The production flexibility approach suggests that exchange rate volatility leads to redistribution of resources between sectors and countries. The basic assumption of this approach is that producers must have the flexibility to adjust variable factors (i.e., capital costs, labor costs, etc.) following price variability as a consequence of foreign exchange movements, and thus tend to invest more. When exchange rate volatility increases in the host country, firms place greater emphasis on manufacturing flexibility advantage against the uncertainty risk.

In countries experiencing uncertainty about the exchange rate, FDI may be higher because this uncertainty is an obstacle to trade. Multinational companies shift the production of their exported products to foreign markets through direct capital investments. Multinational companies shift the production of their exported products to foreign markets through direct capital investments. This reduces costs and creates a new market for the product. Therefore, to avoid the uncertainty affecting the price of the goods they trade, multinational companies are increasing their FDI to replace the decline in trading volumes at the higher volatility markets (Goldberg and Kolstad, 1995, Khraiche and Gaudette, 2013. p. 3144, Kumarasamy, 2010. p. 11).

The level of exchange rate affects the FDI in many directions depending on the target of the goods produced. If the investor wants to produce for the host country's market, FDI and trade can be considered as substitutes. In this case, the appreciation of the home country currency increases the purchasing power of local consumers, thereby increasing FDI inflows. On the other hand, a depreciation of the real exchange rate of the recipient country increases the FDI by reducing the cost of capital (Chowdhury and Wheeler, 2008. p. 2). As a result, according to this approach, exchange rate volatility of host country is increasing FDI. This effect occurs in the long term.

2.2. Hysteresis (Postpone or Delay) Theory

Firms tend to postpone or delay their investments (e.g.. in the acquisition process) when faced with high exchange rate volatility. In the face of uncertainty, firms often prefer not to wait instead of sticking to a certain production capacity. Waiting is a suitable alternate for investing or not investing (Brzozowski, 2003. p. 8). Since FDI usually involves sunk costs in foreign countries, the best response of multinational companies may be to wait for a more favorable exchange rate before investing abroad. Therefore, the irrevocability of investment expenditures and the expectation of new information leads to investment decisions being sensitive to the real exchange rate uncertainty (Jeanneret, 2007. p. 2). According to Goldberg (2009), the logic underlying the approach to avoidance of risk is that investors want to compensate for the risks that the uncertainty of the exchange rate leads to in the investment returns.

When exchange rates are highly variable, the expected values of investment projects are reduced and thus FDI is reduced (Asmah and Andoh, 2013. p. 2). This effect is considered more effective than the production flexibility approach in explaining the short-term effects of exchange rate volatility (Nyarko et al., 2011. p. 279). As a result, according to this approach FDI decreases as volatility increases in exchange rate.

3. LITERATURE REVIEW

Numerous empirical studies have been conducted to analyze the effect of exchange rate volatility on FDI. Some studies have shown that exchange rate volatility has a positive effect on FDI and some have a negative effect. In Table 1, some of the studies examining the effect of exchange rate volatility on FDI are given.

4. DATA AND ECONOMETRIC METHODOLOGY

4.1. Data

In this study, FDI (US Dollars) and exchange rate volatility variable will be used for the 2005Q4-2018Q1 period in Turkey. Because

Table 1: Relationship between FDI and exchange rate volatility survey

Author	Period/Country	Method	Conclusion
Dal Bianco and To Loan (2017)	1990-2012 10 selected Latin America and the Caribbean region	Panel data analysis	A statistically significant negative effect of exchange rate volatility on FDI is found
Kenneth et al. (2017)	1980-2014 Kenya	Error correction model, multiple regression	Exchange rate volatility coefficient is negative
Martins (2015)	1976-2013 Brazil	ARDL approach	REER volatility has a statistically significant negative impact on Brazilian FDI Inflows in both short and long-terms
Polat and Payaslıoğlu (2015)	2004–2014 Turkey	Markov switching model	There was no evidence supporting the effect of RER level or volatility on monthly FDI inflows
Azhar et al.(2015)	1981-2013 SAARC countries	GMM	The result shows that there is a negative relationship between exchange rate volatility and FDI
Abri and Baghestani (2015)	1980-2011 Eight emerging Asian countries	Time-series and panel data analysis	Results indicate that greater foreign investment in the form of FDI was more effective in reducing real exchange rate volatility for China, India, Malaysia, Singapore, and South Korea. In contrast, greater FDI increased real exchange rate volatility for Indonesia, the Philippines, and Thailand
Wang (2013)	1994-2012 BRIC countries	ARDL approach, cointegration, error correction model	The results indicate a negative long-run relationship between exchange rate volatility and FDI for India and Russia. The existence of a short-run association was found in China, India, and Russia. However, for Brazil no connection between the two variables was observed
Asmah and Andoh (2013)	1975-2011 27 subSaharan African countries	GMM	The exchange rate volatility has a strong negative influence on FDI
Chaudhary et al. (2012)	1980-2010 Asian economies	ARDL approach	There is positive and significant effect of volatility exchange rate on FDI in long run and short run
Ullah et al. (2012)	1980-2010 Pakistan	Cointegration technique	Exchange rate volatility negatively relates with the FDI
Renani and Miraftah (2012)	1980Q2-2006Q3 Iran	Johansen and Juselius's cointegration system approach	The findings of this study reveal that volatility of exchange rate have negative relationship with FDI
Ellahi (2011)	1980-2010 Pakistan	ARDL approach	The result shows that exchange rate volatility has negative impact on FDI inflow in short run and has positive impact in long run
Osinubi and Amaghionyeodiwe (2009)	1970-2004 Nigeria	Error correction model	Exchange rate volatility has positive and significant impact on FDI
Udomkerdmongkol et al. (2009)	1990-2002 16 emerging countries from Latin America, Asia and Africa	Panel data analysis	The results show that exchange rate volatility has a negative effect of on FDI
Del Bo (2009)	1982 and 2005 53 developed and developing countries	Panel data analysis	The results show that exchange rate volatility has a damping effect on FDI flows.
Schmidt and Broll (2009)	1984–2004 outward FDI flows from the US to six selected partner countries.	Panel data analysis	The empirical analysis shows that exchange rate volatility has a statistically significant negative effect on US outward FDI flows for the majority of industries.
Udoh and Egwaikhide (2008)	1970-2005 Nigeria	Regression analysis	The results concluded that inflation uncertainty and exchange rate volatility negatively and significantly affected the FDI in Nigeria

(Contd...)

Table 1: ***(Continued)***

Author	Period/Country	Method	Conclusion
Coleman and Tettey (2008)	1970-2002 Ghana	Cointegration and ECM	The study showed that the volatility of the real exchange rate has a negative influence on FDI inflow
Furceri and Borelli (2008)	1995-2004 35 EMU neighbourhood countries	Panel data analysis	The results show that while there is not a linear relation between exchange rate volatility and FDI, the effect of exchange rate volatility crucially depends on the level of openness
Chowdhury and Wheeler (2008)	192-2005 Canada, Japan, the United Kingdom, and the United States	VAR model	The results show that shocks to exchange rate fluctuations have a positive effect on FDI and that this effect is realized with a lag
Goldberg and Kolstad (1995)	1978 and 1991 Canada, Japan and UK	ADF unit root test and regression analysis	Exchange rate uncertainty increases FDI by foreign firms
Barrell et al. (2003)	1982-1998 Europe and UK	GMM	They found strong negative relation between US FDI and exchange rate volatility in Europe and UK
Brzozowski (2003)	1990 19 emerging market and 13 transition countries	Fixed effects OLS and GMM Arellano-Bond models	Exchange rate uncertainty and volatility may negatively influence the decision to locate investment in transition and accession countries. Nominal exchange rate uncertainty seems to particularly hamper FDI inflows in accession countries
Benassy-Quere et al (2001)	1984-1996 42 developing countries	Panel data analysis	They found a negative impact of exchange rate volatility on flows of FDI.
Cushman (1988)	1963-1986 The United States from the United Kingdom, France, Germany, Canada and Japan	Seemingly unrelated regressions approach	The results show that there is a significant positive correlation between exchange rate volatility and FDI flows

FDI: Foreign direct investments, ARDL: Auto regressive distributed lag

it is an unobservable variable, the real exchange rate volatility series will be measured by the conditional variance values to be obtained from the generalized autoregressive conditional heteroscedasticity (GARCH) model (Bollerslev, 1986). The real effective exchange rate and FDI data are taken from Bruegel and IFS, respectively. The variables were seasoned and their logarithms were taken. In this study, exchange rate volatility and to analyze the relationship between direct foreign investment for Turkey, Toda and Yamamoto (1995) causality test will be used. Before doing Toda and Yamamoto (1995) causality analysis, The Augmented Dickey-Fuller and Phillips-Perron (P-P) unit root tests will be used to determine the stationarity of the series. The Toda-Yamamoto (1995) test can be used to estimate the VAR model in which the level values are included, even if the variables are not stationary.

Therefore, information losses can be prevented. For the Toda-Yamamoto method, the maximum integration level (d_{max}) of the variables and the lag length (k) should be determined using the VAR model. The maximum integration degree (d_{max}) of the variables must be smaller than the lag length (k). Then, the lag length (k) is added to the highest degree of integration (d_{max}). The VAR model for lag [k+(d_{max})] is estimated. MWald hypothesis test is applied. It is determined whether there are causalities by investigating whether the coefficients of k lags in the system VAR (k + d_{max}) are equal to zero as a group with MWald test. More specifically, causality relation is determined if the H_0 hypothesis that the coefficients are equal to zero as a group and the result of the MWald test is rejected. It is assumed that the error terms are subject to a zero mean, a constant variance, and a white noise process in which autocorrelation does not exist.

In this case, the VAR model for exchange rate volatility (VOL) and FDI can be written as:

$$LFDI_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} LFDI_{t-i} + \sum_{j=k+1}^{k+d_{max}} \alpha_{2j} LFDI_{t-j} + \sum_{i=1}^{k} \delta_{1i} LVOL_{t-i} + \sum_{j=k+1}^{k+d_{max}} \delta_{2j} LVOL_{t-j} + \lambda_{1t} \quad (1)$$

$$LVOL_t = \beta_0 + \sum_{i=1}^{k} \beta_{1i} LVOL_{t-i} + \sum_{j=k+1}^{k+d_{max}} \beta_{2j} LVOL_{t-j} + \sum_{i=1}^{k} \varphi_{1i} LFDI_{t-i} + \sum_{j=k+1}^{k+d_{max}} \varphi_{2j} LFDI_{t-j} + \lambda_{2t} \quad (2)$$

According to Equation 1, the H_0 hypothesis implies that the exchange rate volatility is not a Granger cause of FDI. That is, if $\delta_{1i} \neq 0 \forall_i$, it will be one-way causality relation from foreign exchange rate volatility to FDI. In Equation 2, the H_0 hypothesis is that FDI is not the Granger cause of the exchange rate volatility. Similarly, if $\phi_{1i} \neq 0 \forall_i$, FDI is expressed as Granger's cause of exchange rate volatility.

4.2. Econometric Results

4.2.1. Real effective exchange rate volatility modeling

In this study, the GARCH model is used in the real effective exchange rate volatility modeling (Bollerslev, 1986). In the GARCH (p, q) process, the lagged values of the conditional

variance are also included in the model. The GARCH (p, q) model is defined as follows:

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-1}^2 + \sum_{i-1}^{q} \beta_j \sigma_{t-j}^2 \quad (3)$$

In Equation 2, σ^2 denotes the conditional variance of the error term. The first term (ω) represents the average, the second term is the ARCH term, and the third term is the GARCH term.

In this study, the MA (1) model is constructed for the real effective exchange rate and it is tested whether the real effective exchange rate variable has the autoregressive conditionally varying variance (ARCH). The Lagrange multiplier (LM) test developed by Engle (1982) is used when testing whether a variable contains ARCH effects in the literature. The hypothesis set in Equation 2 is tested.

$$H_0 = \alpha_1 = \alpha_2 = = \alpha_p = 0 \quad (4)$$

$$H_0 \neq \alpha_1 \neq \alpha_2 \neq \neq \alpha_p \neq 0$$

In the case of LM> χ_p^2 (p degrees of freedom) table, the null hypothesis can be rejected and the existence of ARCH effect and model specification can be decided. After accepting the ARCH effect, the most commonly used GARCH (1,1) model for volatility estimation was developed.

Table 2: LM test results

Heteroskedasticity test: ARCH			
F-statistic	36.30182	Prob. F (1,47)	0.0000
Obs*R^2	21.35355	Prob. Chi-square (1)	0.0000

ARDL: Auto regressive distributed lag, LM: Lagrange multiplier

Table 3: Estimated coefficients of exchange rate volatility for Turkey

Test	Coefficient	Standard error	Z-value	P-value
GARCH (1,1)	−0.120391	0.045275	−2.659089	0.0078

As shown in Table 2, according to the ARCH LM test for determining volatility in real effective exchange rate, the probability value of χ^2 was found to be significant at 5% level. This result indicates that the null hypothesis, which means equal variance, will be rejected, that is, the ARCH effect exists. So it has serial volatility. Thus, the GARCH variance series obtained from the GARCH (1,1) effect in the real exchange rate shows that it can be used as a measure of the real exchange rate volatility. In Table 3, the estimated coefficients of exchange rate volatility for Turkey is presented.

4.2.2. Unit root test results

Before beginning the analysis of Toda and Yamamoto (1995) causality, ADF (Augmented Dickey Fuller, 1981) and PP (Phillips and Perron, 1988) unit root tests were used to determine the maximum degree of integration of the variables in the model. The unit root test results of the variables in the study are presented in Table 4.

According to the ADF test and the Phillips-Perron test, the level of the foreign variable was not stationary. However, the first difference was found to be stable at the direct investment level of 5% significance. The volatility variable was found to be stationary at the level value. In this case, the maximum degree of integration of the variables is (d_{max} = 1).

4.2.3. Determination of lag length

To be able to perform the Toda-Yamamoto test, the number of lag length to be used in the VAR model needs to be determined. The lag length, which makes the critical values such as LR, Final Prediction Error (FPE), Akaike (AIC) and Hannan Quinn (HQ) smallest, is determined as 2 (Table 5).

According to the results, the appropriate number of lag for the Toda-Yamamoto causality test was determined by adding the maximum degree of integration of the variables (d_{max} = 1) to the optimal number of delays for the VAR model (k = 2). VAR model was estimated at 3rd grade [$(k + d_{max}) = 2+1=3$] and MWald hypothesis test was performed. In the Toda-Yamamoto causality

Table 4: ADF and Phillips-Perron unit root test results

Variable	ADF (%5)		Phillips-Perron (%5)		Order of integration
	Level (intercept)	1st different (intercept)	Level (intercept)	1st different (intercept)	
LFDI	−2.543538 (−2.922449)	−6.744010 (−2.923780)	−2.675275 (−2.922449)	−6.767569 (−2.923780)	I (1)
LVOL	−5.981510 (−2.922449)	−7.648950 (−2.925169)	−5.981510 (−2.922449)	−19.90862 (−2.923780)	I (0)

Table 5: Determination of lag length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−114.0441	NA	0.860855	5.525907	5.608654	5.556237
1	−30.11232	155.8732	0.019147	1.719634	1.967873*	1.810623
2	−24.22901	10.36584*	0.017535*	1.629953*	2.043684	1.781601*
3	−22.93090	2.163519	0.020023	1.758614	2.337837	1.970922
4	−19.31384	5.683948	0.020539	1.776849	2.521565	2.049817
5	−15.07451	6.258061	0.020541	1.765453	2.675661	2.099080
6	−14.59153	0.666961	0.024703	1.932930	3.008630	2.327217
7	−11.77039	3.627180	0.026760	1.989066	3.230259	2.444013
8	−10.95790	0.967250	0.032173	2.140853	3.547537	2.656458

*Indicates lag order selected by the criterion. LR: Sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion

Table 6: Toda-Yamamoto causality test results

Null hypothesis	Chi-square (χ^2)	Probability	Decision
LVOL is not the cause of LFDI	2.309271	0.5107	H0is accepted
LFDI is not the cause of LVOL	8.917796	0.0304	H0 is rejected

test, there is no need for preliminary tests used to determine unit root and cointegration properties.

As can be seen from Table 6, according to the results of the Modifiye Wald (MWALD) statistic, there is a one-way causality relation from FDI to VOL and H0 is rejected. Nevertheless, there was no causality relation from VOL to FDI. The H0 hypothesis has been rejected. In this case, the period of analysis for Turkey, one-way causal relationship between FDI and exchange rate volatility has been found. The direction of causality is from FDI to VOL.

5. CONCLUSION

Foreign investors are investing in countries other than the home country, such as reducing costs, making use of cheap raw materials and labor from the host country. FDI depends on various factors (economic and political structure, investment incentives, trade policies) in the host country. In addition, the real exchange rate volatility, which causes uncertainty for investment decisions, also affects FDI decisions. On the one hand, uncertainty arising from exchange rate volatility in the host country leads to an increase in FDI, which leads to redistribution of resources. On the other hand, it causes investors to postpone investment decisions and thus reduce FDI.

In this study, the relationship between exchange rate volatility of FDI in Turkey, were analyzed using Toda-Yamamoto causality test. One-way causality relation has been found from FDI towards exchange rate volatility. This result shows that exchange rate volatility is influenced by FDI inflows, which is a major source of capital financing. In the literature examining real exchange rate volatility and FDI relationship, most of the studies analyzed the effect of exchange rate volatility on FDI . Few studies have examined the effect of FDI on exchange rate volatility (Abri and Baghestani, 2015). This study differs from other studies in the literature in terms of the results obtained.

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