We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

5,100
Open access books available

126,000
International authors and editors

145M
Downloads

Our authors are among the

154
Countries delivered to

TOP 1%
most cited scientists

12.2%
Contributors from top 500 universities

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com

Chapter 7

Impacts of Exchange Rate Volatility on Macroeconomic and Financial Variables: Empirical Evidence from PVAR Modeling

Oguzhan Ozcelebi

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.74406

Abstract

In this study, Panel Vector Autoregression (PVAR) models are used to determine the impacts of exchange rate volatility on industrial production growth rate, consumer price inflation, short-term interest rates and stock returns for 10 OECD countries. The variance decompositions (VDCs) found that exchange rate volatility can be a secondary factor for the variations in immediate interest rates, implying that Uncovered Interest Rate Parity (UIP) condition should be analyzed by the inclusion of other macroeconomic variables. Impulse response functions (IRFs) expose that volatility in exchange rates can have a positive impact on the liquidity conditions in money market and an increase in real economic activity because investors have to move their money away from currency markets to money markets. The relatively lower impact of exchange rate volatility may arise from the zero bound problem, thus it is emphasized that the examination of impacts on exchange rate volatility on macroeconomics variables should be made both considering conventional and unconventional monetary policy. Although impulse response functions (IRFs) did not detect the significant impact of exchange rate volatility on inflation, VDCs obtained supporting results to exchange rate pass-through (ERPT). I suggest that the monetary policy to be developed should clarify alternative channels that exchange rate may affect inflation.

Keywords: panel vector autoregression, exchange rate volatility, uncovered interest rate parity, exchange rate pass-through, OECD countries

1. Introduction

Introducing financial variables other than exchange rates particularly into the Taylor rule to explore the linkages among economic activity and the financial sector has become familiar

IntechOpen

© 2018 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/3.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. CC BY

practice in the monetary policy setting [1–3]. Herein, dynamics in stock markets have also been described as an important indicator of the functioning of the economy since a large amount has been invested in stock markets in the prevalent financial integration process. However, currency markets are a promising investment area leading to a great expansion in other financial markets by offering potential high returns on investments and opportunities for expanded diverse portfolios. Additionally, currency markets can be the center of economic analyses since variations in major currencies can be the source of fluctuations in financial markets and have consequences in economic activity that monetary policy authorities should consider. The relationship between interest rates and exchange rates is generally explained by the Uncovered Interest Rate Parity (UIP) rule, stating that the difference in interest rates between two countries is equal to the expected change in exchange rates among the countries' domestic currencies. In this respect, it can be inferred that interest rates may also influence the real exchange rates and, thus, the foreign competitiveness of a country. When the scientific literature is examined, it has been recognized that there have been various studies examining the consistency UIP and focusing on the determination of factors which may lead to deviations from the rule. The validity of UIP rule was also tested by recent studies made after the 2008–2009 Global Financial Crisis in terms of the possible impacts of monetary policy changes on the rule. For instance, [4] obtained results with a Markov-switching vector autoregression (VAR) supporting the consistency of UIP framework, especially in the case of Spain-UK, after the entrance of Spain into the EU. Conversely, [5] found empirical evidence against the UIP in response to an unexpected monetary policy tightening for the UK. After the recent financial crisis, it has become necessary to develop the UIP rule by adding new variables in line with [6]. In the relevant study, they extended the traditional parity condition model by including non-parity factors, namely, trade, productivity and foreign reserves. The results of [6] found support for both Purchasing Power Parity (PPP) and International Fisher Effect (IFE) theorems.

Exchange rate volatility may have negative impacts on economies; however, volatility computations with different methods may lead to considerably different relationships between exchange rate volatility and macroeconomic and financial variables. In this respect, the study by [7] has been recognized as a pioneering approach analyzing the relationship between different exchange rate volatility measures and macroeconomic variables. Grossmann et al. [7] found that there was not strong evidence of significant differences in the responses of macroeconomic and financial variables to the overall volatility vis-à-vis volatility attributed to the high-frequency components. Following to [7], the exchange rate volatility series was transformed into its frequency components. Thus, I generated filtered series with Inverse Discrete Fourier Transform (IDFT) and included them in my Panel VAR (PVAR) model. For the selection of countries to be included in the PVAR model, it is assumed that fixed exchange rates are not supposed to show changes, and thus, exchange rates have no volatility, whereas exchange rates are expected to have a degree of volatility in floating exchange rate regime. Moreover, I limited the extent of my study for the case that exchange rate policy cannot be used to mitigate currency fluctuations. Countries included in the panel data set have both floating currency regimes, while countries having capital control regimes that are not classified as "Wall" according to the IMF are also included in the empirical exercise. Thus, I assumed that capital control policies cannot be implemented by the economic policy makers of those

countries to mitigate exchange rate volatility. In line with the Taylor rule framework, this study examines the interactions between the industrial production growth rate, consumer price inflation, short-term interest rates, stock returns and exchange rate volatility by employing PVAR methodology for 10 OECD countries outside the Euro area (Canada, Czech Republic, Iceland, Israel, Korea, Mexico, Norway, Poland, Sweden and the United Kingdom). More specifically, the possible impacts of exchange rate volatility on the industrial production growth rate, consumer price inflation, short-term interest rates and stock returns are studied. In this respect, the aims of this study are: (i) to compute the proportion of changes in industrial production growth rate, consumer price inflation, short-term interest rates, stock returns that are due to their own shocks, versus shocks from exchange rate volatility and the other variables by estimating the variance decompositions (VDCs) of PVAR model and (ii) to show the responsiveness of the industrial production growth rate, consumer price inflation, short-term interest rates, stock returns in the PVAR to shocks for exchange rate volatility by computing impulse response functions (IRFs). The main hypothesis of this paper is whether volatility in exchange rates has an impact on GDP, consumer price inflation, short-term interest rates and share prices in the following periods. Therefore, the research question of this study is formulated as follows: whether changes in exchange rate volatility causes changes in the monetary policy stance of countries under investigation. It is also intended that the policy implications and suggestions derived from this study shed light on the optimal approach for monetary policy conduction in those countries.

2. Literature review

Due to economic and financial liberalization, international trade and capital flows have increased among countries, leading to significant fluctuations in foreign exchange rates. This phenomenon has caused the development of empirical literature explaining the exchange rate volatility with the related models in both developed and developing countries. Additionally, the number of studies analyzing the effects of foreign exchange volatility is increasing rapidly in the scientific literature. Herein, variations in international mutual fund flows have become critically important since they can influence the relationship among bond, equity and foreign exchange rate markets. In this respect, [8] used VAR modeling by decomposing international equity and bond market returns into changes in expectations of future real cash payments, interest rates, exchange rates, and discount rates. By providing evidence from the US and global markets, they found that inflation news was the main driver of international bond returns. Based on the results of [8], it can be asserted that news related to the macroeconomic developments can also influence the relationship between exchange rates and interest rates and other macroeconomic variables. More specifically, it can also be assumed that deviations from the UIP rule can be analyzed by economic and non-economic factors. In this respect, [9] stressed the role of volatile risk premium to resolve the UIP puzzle. Thus, it is implied that political and social factors in a country can also increase the risk that economic variables are opposed to. According to [10], the deviation from UIP rule could be explained by high uncertainty environments. Ismailov and Rossi [10] derived new exchange rate uncertainty

index using five industrialized countries vis-a'-vis the US dollar, whereupon they measured how unpredictable exchange rates were relative to their historical past. In order to analyze the risk factors that the relationship with exchange rates and interest rates is opposed to, some indicators can be incorporated into the empirical analysis. In this respect, [11] adopted Credit Default Swaps Spreads (CDS) for bonds as a measure of risk premium into wavelet coherency analysis in order to investigate the relationship between the exchange rate changes and interest rates in emerging economies. It was revealed that exchange rates were related to interest rate differentials, risk premium, the FED's monetary policy implementation and its policy uncertainty.

With the 2008–2009 Global Financial Crisis, monetary policy emerged as the most important risk factor for deviations from the rule [12–14]. In this respect, [12] investigated which type of Taylor rule may resolve the UIP puzzle by representing monetary policy as foreign and domestic Taylor rules. On the basis of their model, [12] found that the foreign Taylor rule responded to exchange rate variation but the domestic Taylor rule did not and the model performed better. More specifically, calibrations of [12] showed that the model consisting of foreign and domestic Taylor rules was in line with Fama's negative correlation between interest rate differentials and currency depreciation rates. The significance of Taylor rules in explaining the deviations from the UIP was also confirmed by [14] who exposed that there was a tendency of high interest rate currency to appreciate which in turn caused the deviation from UIP. Tambakis and Tarashev [14] employed a small open-economy model that is subject to domestic and foreign shocks. Along with Taylor rules, [14] enhanced their analysis by the inclusion of IS and New-Keynesian Philips curve equations and it was found that forward-looking rule based on CPI inflation could cause strong UIP violations. In a similar approach, [13] incorporated an open macroeconomic model and it was indicated that UIP puzzle became more pronounced when the monetary policy rule was stricter against inflation. The validity of [13]'s model was tested with regression of future exchange rate returns on interest rate differentials before and after the recent global financial crisis. Park and Park [13] found that economies reducing the reaction of the policy interest rate to inflation in response to the crisis had positive slope coefficients in the UIP regressions after the crisis. On the other hand, interactions between exchange rates and interest rates can be examined without being limited by the UIP theory because the central banks in emerging countries tend to employ the interest rate and exchange rate policies in order to maintain price stability. The transmission channels between exchange rates and interest rates can vary according to the level of development and structural characteristics of countries. The empirical literature on the relationship between exchange rates and interest rates focused on developed countries applying floating exchange rates. Because developing or emerging countries have generally applied fixed of managed type of exchange rate regimes, the empirical exercises on the relationship between exchange rates and interest rates are fewer. Most recently, [15] examined the interactions between interest rates and exchange rates using wavelet-based methodologies for the case of Romania. It was revealed that the short-term relationship was negative in line with the sticky-price models, whereas the relationship was positive and confirmed the Purchasing Power Parity theory in the short term. Andrieș et al. [15] exposed that the relationship between exchange rates and interest rate was fundamentally different in countries implementing a direct inflation targeting because their

central banks had to pay simultaneous attention to both variables in order to achieve their monetary policy targets.

The impacts of exchange rates and macroeconomic variables can also be analyzed within the inflation targeting framework. More specifically, Taylor rules can also be modified by the inclusion of exchange rates and thus variations in exchange rates can have significant consequences on monetary policy conduction. This kind of approach is not limited to a specific framework, but rather contributes to the analysis of more macroeconomic factors. As an asset, exchange rates can be included in the monetary policy formulations of central banks particularity using the Taylor principle as a framework. Mackiewicz-Łyziak [16] investigated the Czech Republic, Hungary, and Poland and found the analyzed central banks might respond to exchange rate changes by increasing interest rates in the case of depreciation of the currency, or vice versa. In addition, central banks can focus on the role of the effects of exchange rates on real economic activity when determining their interest rate policy. Accordingly, [17] employed a theoretical model, namely a type of DSGE model to analyze the consequences of real exchange rate volatility on business cycles. Output volatility increased by up to 22% as the share of foreign denominated debt increased from 0 to 100%. Gumus and Taşpınar [17] also found that real exchange rate fluctuations could be an important source of volatility in emerging markets through their effect on borrowing costs when countries borrowed in foreign currency. On the other hand, both monetary policy and exchange rates can influence macroeconomic variables simultaneously and thus these impacts can be detected with VAR-type of models. In this respect, [18] employed the Bayesian time-varying VAR approach with stochastic volatility model of [19] to explore whether the reaction of output and prices to interest rate and exchange rate shocks changed over time (1996–2012) in the Polish economy. Estimations by [18] showed that interest rate and exchange rate shocks had a time-varying impact on output. Consumer prices might respond to interest rate shocks during high inflation periods, while the effects of exchange rate shocks on price level might decrease over time. By developing a simple open-economy model with imperfect capital mobility, [20] examined whether the policy interest rate and sterilized foreign exchange market intervention could stabilize inflation and output in emerging market countries while attenuating disequilibrium currency movements. According to the calibrations of their model allowing for the role of aggregate demand and foreign real interest rate shocks, foreign exchange intervention led to an improvement in welfare under discretionary monetary policy and inflation targeting. Further, (two-way) sterilized intervention-cum-inflation targeting could provide more positive outcomes in the presence of imperfect capital mobility/asset substitutability.

In order to analyze the impacts of exchange rate variations on economic activity, the concept of exchange rate pass-through to the consumer prices (ERPT) should be clarified. It has generally been acknowledged that the exchange rate pass-through to domestic consumer prices operates in three stages. Firstly, impost prices are influenced; secondly, the changes in exchange rates have impact on producer prices. Consequently, there also exist a channel form producer prices to consumer prices. Additionally, the completion of ERPT is determined by the assumptions of perfectly competitive markets, fully flexible prices and the consistency of law of one price. Thus, it can be inferred that deviations from those situations can cause incomplete ERPT [21]. The vast body of empirical literature on ERPT indicates that pass-through is highest for import

prices and lowest for consumer prices, while cross-country variation in the pass-through can be accepted as a major factor. In terms of the analysis of the role of cross-country variation, [22] used VAR type of models and it was revealed that ERPT was high and relatively rapid in most Commonwealth of Independent States (CIS) countries as well as a large heterogeneity among countries. CIS countries are also studied with VAR-type of models by [23]. More specifically, they performed short- and long-term analysis for ERPT using heterogeneous panel frameworks and control for cross-sectional dependence. Beckmann and Fidrmuc [23] showed that average pass-through after 1 year was 30–50% for the dollar and around 20% for the euro. According to the estimates of [23], there existed heterogeneous short-run ERPT across countries and countries with high-energy imports from Russia generally had higher exchange rate pass-through. Beckmann and Fidrmuc [23] also exposed that the long-run pass-through was around 60% for both currencies. Most recently, [21] studied the ERPT for the case of CIS countries using heterogeneous panel frameworks and control for cross-sectional dependence. It was found that the ERPT was relatively high and rapid for CIS countries in the case of the nominal effective exchange rate, but not significant for the bilateral rate with the US dollar.

Inflation dynamics can also be closely related to the degree of ERPT particularly in countries having current account deficits. Accordingly, this phenomenon can also become a determinative factor in the formulation of monetary policy. According to some studies in the literature [24–26], there was a lower inflation rate to be associated with lower ERPT and thus it was implied that a credible inflation targeting policy could reduce ERPT. For instance, [25] used both a theoretical and empirical OSL model to analyze the ERPT using a large database that includes 1979–2000 data for 71 countries. It was found that there was a strong evidence of a positive and significant association between the pass-through and the average inflation rate across countries and periods. Barhoumi and Jouini [24] used quarterly data for 8 developing countries over the period 1980–2003 for their empirical model and it was found that a decline in the pass-through to consumer prices could influence the conduct of monetary policy because changes in exchange rate pass-through had important implications for the international transmission of shocks. Barhoumi and Jouini [24] also showed that "expenditure-switching" effects might occur when import prices were less responsive to movements in the exchange rate. Along with inflation targeting policy, some studies in the literature suggested that more flexible exchange rate regime led to decrease in ERPT, particularly for emerging markets [27, 28].

Due to the possible negative impacts of exchange rate volatility, economic agents and particularly the firms can highly be opposed to exchange rate risk. Additionally, [29] stated that a trader's response to exchange rate risk was related to the risk attitude. More specifically, the risk-averse trader would avoid trade in response to an increase in exchange rate fluctuations. On the other hand, the risk-tolerant trader would raise trade today to decrease any loss of income in the future. Accordingly, it can be asserted that the overall dominance of risk-averse or risk-tolerant traders may determine the ultimate impact of exchange rate uncertainty on trade flows. Influences of exchange rate volatility on trade follows can be studied both between one country and the rest of the world and aggregate trade flows between two countries. Nevertheless, [30] obtained empirical results supporting the rate volatility could have positive and negative effects on the trade flows and those effects could be country specific. The outcomes of [30] were also supported by recent studies conducted by [31–34]. Following to [30, 35] assumed that the effects of exchange rate volatility on trade flows could

be asymmetric and they are sourced from the change in expectations of traders when a currency depreciates as compared to a case when that currency appreciates. More specifically, [35] investigated the asymmetric effects by using monthly data from 54 Malaysian industries that export to the US and from 63 Malaysian industries that import from the US. It was found that there existed both short-run and long-run asymmetric impacts in almost one-third of the industries. Moreover, [35] identified industries that were affected when volatility increased versus those that were affected when volatility decreased. The results of [35] were partially supported by [36] who explored the effects of exchange rate volatility on the exporting behavior of firms using a very rich Turkish firm-level data for the period of 1989–2013. It was found that although exchange rate volatility had a negative impact on foreign sale share of firms, the magnitude and the sign of the effect differed substantially across firm classifications. It has also been generally recognized that one of main international transmission channels of exchange rates operates through stock markets due to the rising volume of international trade among firms quoted in stock markets. In this respect, [37] investigated the relationship between exchange rates and stock markets by the inclusion of oil prices and global economic activity into their empirical model. More specifically, they employed a Structural VAR (SVAR) and a trivariate DIAGONAL BEKK GARCH model to analyze the interactions among exchange rate changes, and stock market returns in China and the US from February 1991 to December 2015. Bai and Koong [37] found that there was a significant parallel inverse relation between the US stock market and the dollar and between the China stock market and the exchange rate. Furthermore, the possible impacts of exchange rates on international trade can be studied within logistics perspective. Kim [38] studied the effects of exchange rates on South Kore's loaded port cargo throughput along with global economic activity and the volatility of Baltic Dry Index as dependent variables using cointegration techniques. Kim [38] concluded that appreciation of exchange rate and increase in global economic activity had positive impacts on loaded port cargo throughput.

3. Research methodology

In this study, PVAR modeling was employed to estimate the relationship between exchange rate volatility and macroeconomic and financial variables over the period 1999:M1 to 2017:M6,[1] taking into account the availability of data for all countries. More specifically, we intended to detect the possible effects of the exchange rate volatility on industrial production growth rate, consumer price inflation, the difference between short-term interest rates and stock returns, and discuss the possible impacts of exchange rate volatility on economic and financial conditions for the following periods by estimating IRFs and VDCs. As for the empirical exercise, daily exchange rate data (exchange rate of a currency against the US dollar) were used to obtain quarterly standard deviations, which measured the overall volatility ($volex_t$). I generated the filtered series ($filvolex_t$) with Inverse Discrete IDFT, using a subset of the frequency spectrum of the original exchange rate volatility series.[2] Industrial production

[1]Panel models are generally estimated with annual data, however the scientific literature contains studies using panel-type models with monthly and quarterly data [39, 40].

growth rate ($indg_t$) was computed as percentage of changes in the related index (base year 2010 = 100) over the previous period. Similarly, consumer price inflation ($cpri_t$) denotes the change in CPIs (base year 2010 = 100) over the previous period of the current year. The difference between short-term interest rates ($dirt_t$) was generated by subtracting immediate central bank interest rates in the US (irt_t^{usa}) from the immediate central bank interest rates of each country (irt_t^c). I obtained the stock returns (sto_t) as the percentage of change in the stock market index (base year 2010 = 100) from the previous month. This paper contributes to the existing literature by including the differences between interest rate policies of monetary authorities reflected in the short-term interest rates. The PVAR model incorporates the role of consequences of the 2008–2009 Global Financial Crisis by using dummy variables taking the value of 1 for the period from 2008:M1 to 2017:M6. In order to derive the variables of the model, the database from the OECD and databases from the relevant central banks are applied.

I firstly performed panel unit root analysis to determine the appropriate type of my empirical model. Panel root tests with different assumptions indicated that the variables were stationary at levels, even at the 1% significance level.[3] Thus, I employed PVAR modeling due to the theoretically assumed interactions among the variables. The ordering of the variables in the vector is expressed as ($filvolex_t, indg_t, cpri_t, dirt_t, sto_t$), implying that the critical importance is given to the exchange rate volatility in my study. More precisely, I accepted that exchange rate volatility may be harmful to the economy by raising the risk factor for domestic firms trading internationally and increased prices to hedge against the additional risk premium. I also considered the fact that volatility in exchange rates may have negative impacts on real economic activity via changes in international competitiveness. Within Cholesky decomposition, it was assumed that changes in exchange rates have impact on industrial production and inflation, particularly through the trade channel. Another assumption determining the ordering of the variables in my PVAR model is that changes in economic activity influence the monetary policy stance, which in turn affects the share market. Although different theoretical assumptions can cause changes in the identification of VAR-type of models, alternative ordering of PVAR models' variables showed no significant differences, supporting the robustness of estimation results of my PVAR model.

4. Results and discussion

PVAR models have been recognized as an effective tool to analyze the impacts of macroeconomic policy conduction because imposing a prior constant on the relationship between the variables is not needed. However, it is necessary to impose the same underlying structure for each cross-sectional unit (country), while a constraint may be violated in practice. In line with [40], I used the Helmert procedure to remove the fixed effects because fixed effects may be

[2] I chose the number of steps as 20 for the magnitude and the phase for the IDFT analysis. The robustness of the results was verified because alternative frequency component indexes showed little difference from my IDFT analysis.

[3] I can provide panel unit root test results upon request.

correlated with the regressors. Accordingly, I used the lagged regressors as the instruments of the model instruments to estimate the coefficients with the GMM procedure. The optimal lag length of the PVAR model was suggested by the Moment and Model Selection Criteria (MMSC), whereupon PVAR model was estimated and VDCs and IRFs were computed based on a PVAR (1) model.

4.1. Variance decomposition analysis results

The degree of transmission of exchange rate volatility on the volatility of other financial and economic variables is a crucial issue addressed by monetary policy makers. As shown in **Tables 1**–**4**, VDCs of PVAR revealed that the proportion of exchange rate volatility to variation in GDP growth rate, inflation, differences in short-term interest rates between the US and OECD countries, and returns on stock price index were not found as the primary decisive factor. These findings revealed that exchange rate volatility may not become a primary factor leading to volatility in industrial production growth rate, inflation, short-term interest rates and stock prices partially in line with [17, 18]. According to the VDCs of PVAR, it was indicated that exchange rate volatility accounted for nearly 10% of the variation in industrial production growth up to the following 36th month. In this respect, it can be inferred that exchange rate volatility can influence the supply and demand dynamics significantly by leading to changes in international competitiveness level of the OECD countries under investigation. Due to the foreign currency denominated debt level in those OECD countries, economic agents can be significantly opposed to exchange rate risk arising from exchange rate volatility. The role of exchange rate volatility in affecting the variations in inflation rate was found as in a significant level. VDCs showed that variations in inflation level were approximately explained for 10% by exchange rate volatility up to the following 36th month, revealing the importance of ERPT for the OECD countries under investigation. According to VDCs of PVAR, industrial production growth rate and inflation were primarily explained by their own past values, indicating the importance of supply and demand dynamics and inflation expectations. Financial markets and monetary policy decisions played a secondary role in explaining the variations in industrial production growth rate and inflation, revealing that these financial markets cannot be the main source of the deterioration in the economic activity of these countries despite the fact that financial markets have been developing over the last decades. Thus, I suggest the investigation of supply and demand shocks on industrial production growth and inflation considering the role of the decisions of different economic agents in a

	VDCs				
Forecast horizon	$filvolex_t$	$indg_t$	$cpri_t$	$dirt_t$	sto_t
1	0	1	0	0	0
12	0.058926	0.880153	0.035353	0.000249	0.025318
24	0.109118	0.82907	0.035718	0.000795	0.025299
36	0.119114	0.818611	0.035747	0.001238	0.02529

Table 1. VDCs of industrial production growth rate from PVAR.

Forecast horizon	VDCs				
	$filvolex_t$	$indg_t$	$cpri_t$	$dirt_t$	sto_t
1	0	0.002346	0.997654	0	0
12	0.043537	0.013542	0.924498	0.016763	0.00166
24	0.10393	0.016113	0.857737	0.020293	0.001927
36	0.124067	0.017302	0.834486	0.022104	0.002041

Table 2. VDCs of consumer price inflation from PVAR.

Forecast horizon	VDCs				
	$filvolex_t$	$indg_t$	$cpri_t$	$dirt_t$	sto_t
1	0	0.034652	0.094121	0.871227	0
12	0.047749	0.264064	0.048448	0.624629	0.01511
24	0.05082	0.280703	0.040757	0.609567	0.018153
36	0.052191	0.287624	0.037563	0.603167	0.019455

Table 3. VDCs of short-term interest rate difference from PVAR.

Forecast horizon	VDCs				
	$filvolex_t$	$indg_t$	$cpri_t$	$dirt_t$	sto_t
1	0	0.0151747	0.003866	0.0038903	0.9770691
12	0.0470597	0.0217683	0.066185	0.004263	0.860724
24	0.0473945	0.0218706	0.0671909	0.0060914	0.8574527
36	0.0472988	0.022397	0.0671949	0.0075241	0.8555852

Table 4. VDCs of stock returns from PVAR.

plausible DSGE framework. Nevertheless, PVAR model's VDCs highlight that the value of exchange rates and their volatility can have considerable consequences on economic conditions and thus cause financial and economic instability.

Similarly, the variations in the immediate rates were mainly driven by their own shocks up to the following 36th month in these countries, emphasizing that the way in which immediate interest rates are influenced by their past values should be parameterized. Hence, the monetary policy authorities, intending to control economy-wide interest rates and achieve the objectives of monetary policy, should determine money market dynamics and interactions among interest rates at different maturities. On the other hand, determination of the role of exchange rate volatility on short-term interest rates within VDCs can expose what level of deviation from the UIP rule may be in the following periods. VDCs of PVAR showed that exchange rate volatility accounted for nearly 5% of the variation in difference between immediate interest rates. Up to the following 36th month, industrial production growth explained

for nearly 30% of the variation in difference between immediate interest rates, whereas inflation dynamics has a minor role on the same variable. VDCs implied that interest rate decisions taken by the central banks of relevant OECD countries and the FED are due to the change in real economic activity. More specifically, developments in goods and services markets are crucial for the variations in short-term interest rates for the countries under investigation. VDCs of PVAR model stressed the minor importance of capital market for explaining the variations in difference between short-term interest rates. Stock returns account for nearly 2% of the variation in immediate interest rate in those countries. Accordingly, VDCs of PVAR indicated that deviations in the difference between immediate interest rates can be significantly explained by the other variables of the model. In line with [12–14], it can also be interpreted that UIP rule cannot be recognized as sufficient enough to explain the variations in short-term interest rates. VDCs suggested enhancement of the UIP rule by the inclusion of macroeconomic and financial variables parallel to [6]. Furthermore, I found that a considerable portion of the variations in stock prices was accounted for by their past values in PVAR. Firms quoted on the stock exchanges of these countries can be exposed to interest rate and/or exchange rate risk. Moreover, exchange rate volatility and past values of stock prices may play a major role in analyzing the future trends of stock prices; therefore, investors and policy makers along with the incorporation of economic and political factors can employ technical analysis methods.

4.2. Impulse response analysis results

The IRFs revealed that the value of a home currency is a crucial factor for interest rates. More precisely, changes in exchange rate markets led to significant changes in the dynamics of money markets, and this phenomenon also influenced monetary policy implementation and vice versa. IRFs depending on PVAR revealed that immediate interest rates of the countries studied were negatively affected due to positive shocks in exchange rate volatility. This finding is consistent with the IFE and in line with [6, 8], implying that despite a domestic flow of funds causing instability in currency markets, it may promote real economic activity through the credit channel. Volatility in exchange rates may prompt investors to move their money away from currency markets to money markets in these countries. Impulse response exercise revealed that pricing in bond markets can be positively affected by exchange rate volatility due to capital inflows to these countries along with the possible increase in firm values (**Figure 1**).

Despite being generally assumed that exchange rate volatility may negatively influence the financial and economic stability, IRFs of PVAR revealed that economic growth in these countries was triggered due to the increasing availability of domestic funds for households and firms. Since the decisions of economic agents are influenced by the value of exchange rates, exchange rate volatility is also crucial in terms of affecting the supply and demand dynamics and thus the price level. Despite the impulse responses implying that real economic activity can be triggered due to the increase in variations in exchange rates, no statistically significant responses of inflation to exchange rate volatility were found. Thus, exchange rate volatility may not have a significant impact on the direction or the supply and demand that can change the price level permanently. More precisely, capital flows in these countries may affect the economic conditions without having an impact on the price level in terms of increasing and

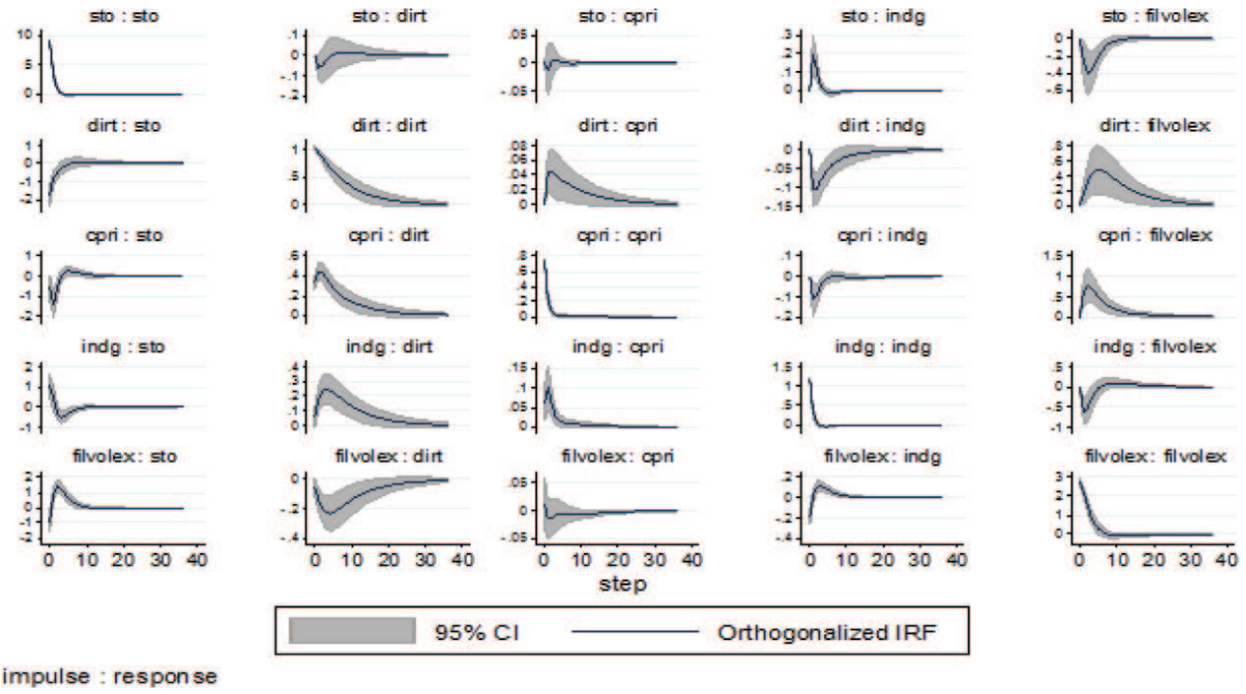

Figure 1. IRFs for the PVAR with filtered exchange rate volatility.

decreasing inflation. Accordingly, exchange rate volatility may not cause a considerable amount of volatility in the price level in these countries in contrast to ERPT.

5. Conclusions

In this study, the PVAR model is estimated considering the interactions between industrial production growth rate, consumer price inflation, short-term interest rates, stock returns and exchange rate volatility for 10 OECD countries outside the Euro area. In this respect, VDCs analysis is performed to determine the role of exchange rate volatility in explaining the variations in the other variables of the model for the following periods. According to the VDCs of my PVAR model, it is implied that there can be variations from the UIP rule. More specifically, VDCs indicated that exchange rate volatility may have a secondary role in explaining the variations in immediate interest rate difference between the US and selected OECD countries. According to the VDCs of my PVAR model, the importance of the enhancement of the analysis of the UIP rule by the inclusion of other variables is revealed. VDCs showed that variations in immediate interest rate difference are mainly explained by the past its past value, thus I can interpret that the FED's and ECB's interest rate policy decisions can be crucial as a conventional monetary policy tool. Because VDCs showed that industrial production growth is also important to the variation in the immediate interest rate difference, I can assert that it might be useful to study the effects of supply and demand shocks in the open-economy framework by the DSGE. Along with the UIP rule, VDCs did also not have strong evidence for the consistency of IFE because VDCs found that only a small part of the variations in short-term interest rate difference is explained by

the consumer price inflation. The relatively lower impact of inflation and exchange rate volatility on immediate interest rates differences can be sourced from the possible zero bound interest rate problem in the US. However, it can be assumed that inflation and exchange rate volatility may have considerable effects on different interest rates in the money market and also inflation and exchange rate volatility may have impact on indicators related to unconventional monetary policy. Thus, I suggest that the impacts of exchange rate volatility and inflation should also be explored in an unconventional monetary framework. Empirical finding of the study also stresses the derivation of optimal monetary policy framework examining the effects of exchange rate volatility on economic activity through alternative channels because VDCs indicated that exchange rate has a significant impact on inflation in line with ERPT.

On the other hand, impulse response analysis from PVAR showed that volatility in exchange rates of these countries may lead to a fall in their interest rates, which, in turn, may stimulate real economic activity via the credit channel. I can infer that even though exchange rate volatility in these countries may arise from capital inflows, these flows may increase the liquidity in money markets and thus decrease the interest rate difference relative to the US interest. Volatility in exchange rates can affect the risk-taking behavior of investors in exchange rate markets negatively and can canalize the investors' portfolios into money markets. These implications have also been supported by the findings of impulse response analysis showing that exchange rate volatility may have a positive impact on economic growth. Thus, investors can move away from currency markets to money markets due to the increasing exchange rate volatility, while economic growth may be promoted within the credit channel framework. However, there has been a consensus on economic grounds that exchange rate volatility may be the major source of macroeconomic instability due to the contagion effects among financial markets and economies. Despite exchange rates highly influencing inflation trends through the changes in import prices, impulse response analysis did not detect a statistically significant effect of exchange rate measures on inflation. According to the IRFs from PVAR, exchange rate volatility did not have a significant impact on aggregate demand and aggregate supply to lead to considerable changes in inflation. Thus, exchange rate volatility cannot influence the dynamics of business cycles and thus cannot become a major factor leading to an inflation problem. However, exchange rate volatility can determine the amount of exchange rate risk that firms can be opposed to; therefore, exchange rate volatility is a crucial issue that should be monitored by central banks in order to prevent contagion of negative microeconomic developments to macroeconomic activity and stability.

Author details

Oguzhan Ozcelebi

Address all correspondence to: ogozc@istanbul.edu.tr

Department of Economics, Istanbul University, Istanbul, Turkey

References

[1] Airaudo M. Monetary policy and stock prices with limited asset market participation. Journal of Macroeconomics. 2013;**36**:1-22. DOI: 10.1016/j.jmacro.2013.01.003

[2] Cassola N, Morana C. Monetary policy and the stock market in the euro area. Journal of Policy Modeling. 2004;**26**:387-399. DOI: 10.1016/j.jpolmod.2004.03.012

[3] Cecchetti SG, Genberg H, Lipsky J, Wadhwani S. Asset prices and central bank policy. The Geneva Report on the World Economy. 2000;**2**:1-160

[4] Beyaert A, García-Solanes J, Pérez-Castejón JJ. Uncovered interest parity with switching regimes. Economic Modelling. 2007;**24**:189-202. DOI: 10.1016/j.econmod.2006.06.010

[5] Cover JP, Mallick SK. Identifying sources of macroeconomic and exchange rate fluctuations in the UK. Journal of International Money and Finance. 2012;**31**:1627-1648. DOI: 10.1016/j.jimonfin.2012.03.004

[6] Ariff M, Zarei A. Exchange rate behavior of Canada, Japan, the United Kingdom and the United States. Open Economies Review. 2016;**27**:341-357. DOI: 10.1007/s11079-015-9372-x

[7] Grossmann A, Love I, Orlov AG. The dynamics of exchange rate volatility: A panel VAR approach. Journal of International Financial Markets, Institutions and Money. 2014;**33**:1-27. DOI: 10.1016/j.intfin.2014.07.008

[8] Cenedese G, Mallucci E. What moves international stock and bond markets? Journal of International Money and Finance. 2016;**60**:94-113. DOI: 10.1016/j.jimonfin.2015.05.001

[9] Fama EF. Forward and spot exchange rates. Journal of Monetary Economics. 1984;**14**:319-338. DOI: 10.1016/0304-3932(84)90046-1

[10] Ismailov A, Rossi B. Uncertainty and deviations from uncovered interest rate parity. Journal of International Money and Finance. Article in Press. DOI: 10.1016/j.jimonfin.2017.07.012

[11] Özmen MU, Yılmaz E. Co-movement of exchange rates with interest rate differential, risk premium and FED policy in "fragile economies". Emerging Markets Review. 2017;**33**:173-188. DOI: 10.1016/j.ememar.2017.10.007

[12] Backus D, Gavazzoni F, Telmer C, Zin S. Monetary policy and the uncovered interest parity puzzle. NBER Working Paper. 2010;**16218**:1-54. DOI: 10.3386/w16218

[13] Park C, Park S. Can monetary policy cause the uncovered interest parity puzzle? Japan and the World Economy. 2017;**41**:34-44. DOI: 10.1016/j.japwor.2016.12.001

[14] Tambakis D, Tarashev N. Systematic monetary policy and the forward premium puzzle. BIS Working Paper. 2012;**396**:1-39

[15] Andrieș AM, Căprarua B, Ihnatova I, Tiwari K. The relationship between exchange rates and interest rates in a small open emerging economy: The case of Romania. Economic Modelling. 2017;**67**:261-274. DOI: 10.1016/j.econmod.2016.12.025

[16] Mackiewicz-Łyziak J. Active and passive monetary policy in CEE countries with inflation targeting: The case of the Czech Republic, Hungary, and Poland. Eastern European Economics. 2016; **54**:133-152. DOI: 10.1080/00128775.2015.1126789

[17] Gumus I, Taşpınar ZT. Real exchange rate volatility and business cycles in emerging market economies. Economics Letters. 2015;**134**:127-129. DOI: 10.1016/j.econlet.2015.07.011

[18] Arratibel O, Michaelis H. The impact of monetary policy and exchange rate shocks in Poland: Evidence from a time-varying VAR. ECB Working Paper. 1636;**2014**:1-37

[19] Primiceri GE. Time varying structural vector autoregressions and monetary policy. Review of Economic Studies. 2005;**72**:821-852. DOI: 10.1111/j.1467-937X.2005.00353.x

[20] Ghosh AR, Ostry JD, Chamon M. Two targets, two instruments: Monetary and exchange rate policies in emerging market economies. Journal of International Money and Finance. 2016;**60**:172-196. DOI: 10.1016/j.jimonfin.2015.03.005

[21] Comunalea M, Simola H. The pass-through to consumer prices in CIS economies: The role of exchange rates, commodities and other common factors. Research in International Business and Finance. Article in Press. DOI: 10.1016/j.ribaf.2017.07.076

[22] Korhonen I, Wachtel P. A note on exchange rate pass-through in CIS countries. Research in International Business and Finance. 2006;**20**:215-226. DOI: 10.1016/j.ribaf.2005.09.006

[23] Beckmann E, Fidrmuc J. Exchange rate pass-through in CIS countries. Comparative Economic Studies. 2013;**55**:705-720. DOI: 10.1057/ces.2013.8

[24] Barhoumi K, Jouini J. Revisiting the decline in the exchange rate pass-through: Further evidence from developing countries. Banque de France Working Paper. 2008;**213**:1-11

[25] ChoudhriE HDS. Exchange rate pass-through to domestic prices: Does the inflationary environment matter? Journal of International Money and Finance. 2006;**25**:614-639. DOI: 10.1016/j.jimonfin.2005.11.009

[26] Gagnon JE, Ihrig J. Monetary policy and exchange rate pass-through. International Journal of Finance & Economics. 2004;**9**:315-338. DOI: 10.1002/ijfe.253

[27] Beirne J, Bijsterboch M. Exchange rate pass-through in Central and Eastern European member states. Journal of Policy Modeling. 2011;**33**:241-254. DOI: 10.1016/j.jpolmod.2010.11.001

[28] Coulibali D, Kempf H. Does inflation targeting decrease exchange rate pass-through in emerging economies? Bank of France Working Paper. 2010;**303**:1-20

[29] De Grauwe P. Exchange rate variability and the slowdown in growth of international trade. IMF Staff Papers. 1998;**35**:63-84

[30] Bahmani-Oskooee M, Hegerty SW. Exchange rate volatility and trade flows: A review article. Journal of Economic Studies. 2007;**34**:211-255. DOI: 10.1108/01443580710772777

[31] Asteriou D, Masatci K, Pılbeam K. Exchange rate volatility and international trade: International evidence from the MINT countries. Economic Modelling. 2016;**58**:133-140. DOI: 10.1016/j.econmod.2016.05.006

[32] Baek J. Does the exchange rate matter to bilateral trade between Korea and Japan? Evidence from commodity trade data. Economic Modelling. 2013;**30**:856-862. DOI: 10.1016/j.econmod.2012.11.020

[33] Hall S, Hondroyiannis G, Swamy PAVB, Tavlas G, Ulan M. Exchange-rate volatility and export performance: Do emerging market economies resemble industrial countries or other developing countries? Economic Modelling. 2010;**27**:1514-1521. DOI: 10.1016/j.econmod.2010.01.014

[34] Hooy CW, Siong-Hook L, Tze-Haw C. The impact of the Renminbi real exchange rate on ASEAN disaggregated exports to China. Economic Modelling. 2015;**47**:253-259. DOI: 10.1016/j.econmod.2015.02.025

[35] Bahmani-Oskooeea M, Aftab M. On the asymmetric effects of exchange rate volatility on trade flows: New evidence from US-Malaysia trade at the industry level. Economic Modelling. 2017;**63**:86-103. DOI: 10.1016/j.econmod.2017.02.004

[36] Tunc C, Solakoglu MN. Not all firms react the same to exchange rate volatility? A firm level study. International Review of Economics and Finance. 2017;**51**:417-430. DOI: 10.1016/j.iref.2017.07.002

[37] Bai S, Koong KS. Oil prices, stock returns, and exchange rates: Empirical evidence from China and the United States. North American Journal of Economics and Finance. DOI: 10.1016/j.najef.2017.10.013

[38] Kim CB. Impact of exchange rate movements, global economic activity, and the BDI volatility on loaded port cargo throughput in South Korea. The Asian Journal of Shipping and Logistics. 2016;**32**:243-248. DOI: 10.1016/j.ajsl.2016.12.008

[39] Adiguzel U, Sahbaz A, Ozcan CC, Nazlioglu S. The behavior of Turkish exchange rates: A panel data perspective. Economic Modelling. 2014;**42**:177-185. DOI: 10.1016/j.econmod.2014.06.014

[40] Calomiris CW, Longhofer SD, Miles WR. The foreclosure–house price nexus: A panel VAR model for U.S. states, 1981–2009. Real Estate Economics. 2013;**41**:709-746. DOI: 10.1111/reec.12011