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HOW DOES THE INTEREST RATE INFLUENCE THE EXCHANGE RATE?

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Abstract

Understanding the effect of increasing the key policy rate on the exchange rate of the national currency remains one of the most critical issues for central banks. The goal of this study is to infer about the signs and the magnitude of this impact using existing studies conducted for 30 countries and aggregating estimates applying the meta-analysis procedure. Results indicate that the short-term impact of interest rate changes on the exchange rate is positive and statistically significant, although the economic significance is weak, while the long-term relationship is found to be insignificant. The analyzed studies do not reveal any evidence of publication bias, which contributes to the validity of empirical findings. The received results conclude that there might be a short-term appreciation of the hryvnia in response to an increase in the key policy rate in Ukraine.

JEL Codes

E43, E52, E58, Y90

Keywords

exchange rate, interest rate, key policy rate, meta-analysis, monetary policy, transmission mechanism.

1. INTRODUCTION

In an era of floating exchange rate regimes and independent central banks concentrating on price stability, exchange rates have lost their priority in economic policy decisions. Meanwhile, the debate on the importance of considering exchange rate movements in an open economy continues to evolve. On the one hand, the impact of monetary policy on the value of the national currency is inexorable as exchange rates remain both a substantial component in the transmission mechanism and the factor that reflects cross-country differences in interest rates through the uncovered interest rate parity (Taylor, 2001). On the other hand, authors such as Obstfeld and Rogoff (1995) warn that substantial deviations from PPP in the short- and the long-run, caused by policies targeted at exchange rate stabilization, are undesirable for the economy. Therefore, understanding the extent of the impact of monetary policy tools, especially the key policy rate, on subsequent exchange rate fluctuations has crucial importance for central banks striving to make prudent and justifiable decisions.

Although the incidence of currency appreciation resulting from the increase in domestic interest rates has a strong theoretical background, making decisions based solely on theoretical grounds is not viable. The main reason for that is a large number of country-specific factors, which might have an impact on the interest rate-exchange rate relationship,

making this relationship both economically and statistically insignificant.

The ability to conduct an empirical research of the relationship in Ukraine is restricted due to an insufficient amount of data: before 2014, the NBU had been keeping the exchange rate stable using foreign exchange interventions under a fixed exchange rate regime. Therefore, an inference about such relationship could be made by analyzing the experience of other countries and conducting a meta-analysis of existing studies, and answering the question, “What are the short- and long-term impacts of increasing interest rates on the domestic exchange rate?”

In this study, an inference about empirical papers examining the interest rate-exchange rate relationship are investigated, and their findings are aggregated using meta-analysis techniques. The research also checks the validity of the effects described in publications and examines whether they are truthful or if there is a publication bias, leaving numerous findings not published due to the mismatch of these findings with theory and due to the statistical insignificance of results. Section 2 describes existing theoretical and empirical evidence on the relationship between interest rates and exchange rates. Sections 3 and 4 describe the particular features of the data and methodology used. Section 5 describes the findings based on the examined literature.

The study reveals the presence of the genuinely positive and statistically significant short-term effect of increases in interest rates on the exchange rate. The findings could be helpful for the National Bank of Ukraine and provide evidence of what to expect from an increase in the key policy rate in terms of the dynamics of the hryvnia exchange rate.

2. LITERATURE REVIEW

Standard theoretical models in international macroeconomics (e.g., Mundell-Fleming model, Dornbusch model) assume the link between interest rates and exchange rate movements through interest rate parity. For the sake of simplicity, it relaxes the presence of possible arbitrage opportunities arguing that ex-ante there are no excess returns from holding deposits or financial assets in one country relative to another (Engel, 2015). For example, whenever interest rates rise in one country, additional gains from investing in its financial assets will soon cease through the appreciation of its currency. Dornbusch (1976) provides a more detailed explanation of this channel as an exchange rate component in the process of adjustment to economic expansion. In the short run, the currency depreciates in response to lower demand and changes in terms of trade. In its turn, it is accompanied by strengthening inflation (even though rising prices might also be accompanied by currency appreciation).

Although the mentioned links seem direct in theory, several decades of empirical studies have revealed that this link frequently does not work (Blinder, 2006). Obtained estimates vary in their signs and the magnitude of their coefficients. Often estimates are statistically insignificant. For example, Gould & Kamin (2000) analyzed this link in Korea, Mexico, Philippines, Indonesia, Malaysia, and Thailand during the Asian financial crisis. They stated that Granger causality tests do not show a statistically significant causal relationship in any of the cases. The authors concluded that although monetary policy could have important impacts on exchange rate movements, a substantial amount of time is required for these effects to be observed in the real data. Eichenbaum and Evans (1995) argue that even though contractionary monetary policy shocks lead to currency appreciation, the persistent changes in the real exchange rate throw into question the short-term nature of adjustment, as predicted by interest rate parity.

Even though it might seem that developed financial markets help make exchange rate adjustment faster, the results are generally mixed even for developed economies. For example, studying the link between interest rates and exchange rates in the U.S., Germany, Japan, and the U.K., Meese and Rogoff (1985) found little evidence of the stable systematic link between these two variables. Similarly, Coe and Golub (1986) have studied the relationship between interest rates and exchange rates for 18 OECD economies and revealed that only in four of them (Austria, Germany, Belgium and France) did an increase in long-term interest rates differential have a statistically significant effect on the appreciation of the domestic currency.

Often the results of many studies on the topic are intensely debated concerning the estimation methods used. Edison and Pauls (1993), as well as Baxter (1994), failed to find a statistically significant causal effect of interest rates on exchange rates using the Engle-Granger cointegration methods. However, MacDonald and Nagayasu (1999), argued that the long-run relationship starts being observed as long

as another estimation technique is used. Using the sample of 14 industrialized countries and methods of Johansen, they showed that interest rates have a statistically significant long-run effect on the exchange rate. Similar findings were reported by Edison & Melick (1999) and MacDonald (1999).

Ultimately, reading a multitude of studies does not endow policymakers with a clear picture of the exchange rate consequences of the interest rate changes. First of all, with the majority of results estimated for developed countries, it is not clear what outcomes to expect in developing economies. Secondly, without considering possible problems with estimation, the dependence of results on the methodology used exacerbates the incomparability of results. Therefore, the proper aggregation of estimates with meta-analysis procedure might help in getting at least the approximate direction of effect (if any) for Ukraine.

3. DATA DESCRIPTION AND METHODOLOGY

During the process of investigation, more than 50 studies have been collected and analyzed on the topic of the impact of such a monetary policy instrument as the key policy rate on a country's exchange rate. However, more than 80% of the papers turn out to be inapplicable for the meta-analysis procedure due to several reasons, including the lack of descriptive statistics, the dependent and independent variables mismatch, etc. Moreover, for the validity and data comparability of the results, only studies with a uniform variables type were chosen. Hence, the final sample of studies includes eight papers that describe the investigated relation in the following form:

$$d(e_{it}) = \beta_0 + \beta_1 \cdot d(r_{it}) + \beta_2 \cdot X_{it} + \varepsilon, \quad (1)$$

whereas
 e – exchange rate,
 r – interest rate,
 $d(\dots)$ – difference operator,
 X – a vector of control variables,
 i and t – country and time indicators, respectively, and
 ε – error term.

Even though the dependent and independent variables in the models forming the final sample for the meta-analysis are the same, the estimation methods vary substantially across the papers. More than 30% of models are estimated using Dynamic Ordinary Least Squares (DOLS), while the half of studies are evenly divided between those applying Fixed Effects (FE) and those using the Vector Error Correction Model (VEC). The rest of the authors aiming at determining the effect of the interest rate on the exchange rate apply the Vector Autoregressive Model (VAR) and Generalized Autoregressive Conditional Heteroscedasticity Model (GARCH).

The coefficients and estimates collected from the studies form a sample of 41 observations of the impact of interest rates on the exchange rate, both in the short run and in the long run. The former is represented as an instantaneous change of the exchange rate in response to interest rate movements, while the latter is determined as the lagged effect of interest rate alterations. Moreover, in the long run, coefficients are found to be insignificant, and are present both positive and negative in equal proportion, while the short term estimates are rather significant and positive. From 31 observations of the short-run effect, 16 coefficients are

positive and statistically significant at the 5% level confidence interval, 9 are positive insignificant, 3 are negative significant and 3 are negative insignificant; the long-run effects consist of 4 positive and 6 negative insignificant coefficients.

The data collected represents the effect size of interest rates on the exchange rate for 30 countries. According to the UN's country classification, 14 of them are developed, 15 are developing, and one is a transition economy. Furthermore, the papers cover different periods from 1999 to 2014, and several studies include estimates for the same countries. Despite the initial methodological heterogeneity of studies, the meta-analysis procedure is geared towards normalizing results and defining the unbiased estimator for the effect of the interest rate on the exchange rate.

The first step is the estimation of the association between the interest rate and exchange rate net of the impact of the set of controlling variables that is the partial correlation coefficient (PCC):

$$PCC_{ij} = \frac{t_{ij}}{\sqrt{t_{ij}^2 + df_{ij}}}, \quad (2)$$

whereas t – t -statistics from i -th regression of j -th study,
 df – number of degrees of freedom.

The second step is the normalization of the PCC obtained using the Fisher z-transformation of the PCCs (Havranek, et al., 2005):

$$Z_{PCC_{ij}} = 0.5 \cdot \ln\left(\frac{1 + PCC_{ij}}{1 - PCC_{ij}}\right), \quad (3)$$

whereas PCC_{ij} – partial correlation coefficient from i -th regression of j -th study.

However, the estimates obtained could be biased through the heterogeneity of studies analyzed, which vary by time period of the effect of the interest rate on the exchange rate; and by country, for which the effect is estimated. Hence, we segregated the data into the following groups: by the period of the effect, and by country. The latter includes subgroups of the income level and the level of monetary freedom.

When talking about income levels, we used the World Bank's classifications to divide countries into two groups. The first one includes countries that the World Bank designates as low and lower middle developed economies. The second group includes economies designated as upper middle and high income. Countries were assigned categories based on their status during the period of study. Should a country change categories during the period of research, status was assigned regarding the income level that dominated in this particular country for the majority of years investigated. For example, Romania analyzed by Sarmidi, Salleh (2011) was marked as a low and lower-middle income economy during the research period of 15 years (1995-2009), nine of which it was classified by the World Bank as a lower-middle economy.

To account for heterogeneity in monetary policies, we made use of a third criterion, which is the level of monetary freedom as modeled by the Index of Monetary Freedom developed by the Heritage Foundation that combines a measure of price stability with an assessment of price controls. Heritage Foundation calculates the Index of Monetary Freedom by subtracting from the base of 100 points the square root of weighted average inflation for the last three years and the penalty (a maximum 20 points) for price control conducted by the government. We have chosen 70 points as a threshold: countries that get less than 70 points are suggested to have a low level of monetary freedom, and countries ranked with more than 70 points are treated as states with high monetary freedom. The 70 points level was determined as a threshold since obtaining at least 70 points allows for combining moderate price control for a penalty of

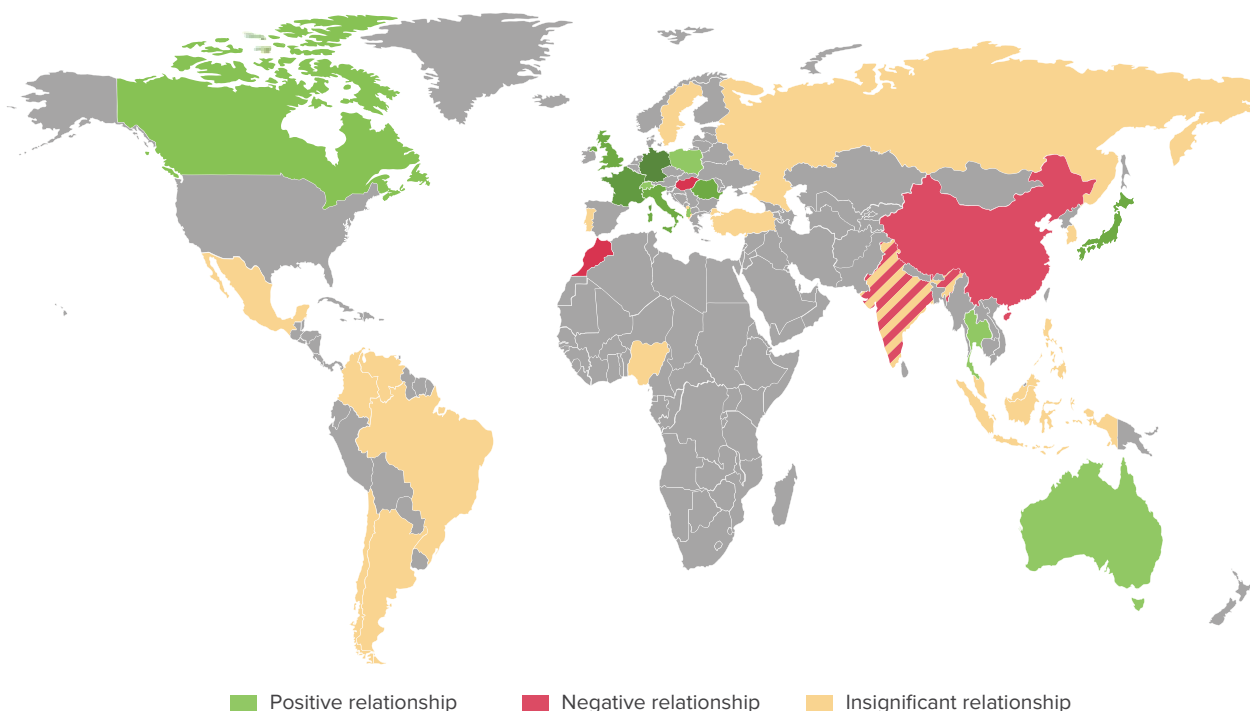


Figure 1. The Association Between the Interest Rate and the Exchange Rate by Country

10 points and weighted average inflation of approximately 9%. The methodology uses a convex functional form (the square root of the weighted average inflation rate for the most recent three years) to better separate countries with low inflation rates and provide much more gradation and accuracy for estimations.

4. AGGREGATION OF PCC

The calculated estimates of PCC vary in the range from -0.388 for Hungary, which is a weak negative correlation, to 0.955 for Germany, which represents a strong positive relationship. The resulting coefficients reflect the following tendency: the more developed country is, the higher positive relationship exists between the examined rates. On the other hand, for most developing economies, the effect of the interest rate on the exchange rate is found to be weak and even negative. In addition, the association between the interest rate and the exchange rate substantially varies for the length of the examined period. The association estimated for the lagged effect is weak in contrast to the instantaneous effect, for which positive moderate or strong correlation is found. The country composition of results is presented in Figure 1: the positive significant effect is marked with green, negative significant – with red and insignificant effect – with yellow.

Taking into account the wide range of PCC obtained, we used several estimation techniques. Since applying only a simple mean to reveal the true effect would be misleading due to the various limitations of this method, we conducted our analysis using three types of estimators: a simple average, a fixed-effect estimator, and a random-effect estimator. Moreover, to overcome a substantial heterogeneity among countries analyzed, we divided coefficients into the following groups: by period of the effect, by country income level, and by level of monetary freedom.

assumption of studied effects' homogeneity, it does not account for between-study heterogeneity. Therefore, we consider this estimator less precise than the random effects estimator. Allowing variation in effects to be normally distributed between studies, this method helps to account

for heterogeneity between them. The random-effects estimate for the size of the effect of the current interest rate on the exchange rate is 18.5%, which is quite close to the simple average of partial correlation coefficients, while the effect of a lagged interest rate on the exchange rate remains economically insignificant and equal to 0.3%.

The obtained values are also aggregated by the income status of the country and by the level of monetary freedom measured by the Heritage Foundation Index of Monetary Freedom. Estimates reveal that for countries with a higher degree of monetary freedom (>70 during the analyzed period), the response of the interest rate change on the exchange rate is higher compared to countries with a lower level of monetary freedom. We also find that for high-income countries, the level of response of the exchange rate on the interest rate change is higher than for the low-income countries. These results are robust to the choice of aggregation method.

To evaluate the heterogeneity of effects in studies, we made use of I-squared. The estimated value of 95.6% reveals that studies of the relationship of interest rate changes on the exchange rate exhibit a substantial heterogeneity, which influences the variation of partial correlation coefficients much more than a simple random error. It is not possible to confidently outline the reasons for such high heterogeneity as I-squared remains at a substantial magnitude even within the studies that we have analyzed.

5. PUBLICATION BIAS

Another objective of this research was to investigate the existence of publication bias, resulting from the tendency of academic journals to mostly publish papers with final results either coinciding with theoretical literature or containing statistically significant estimates. The theory suggests the positive interconnection between the interest rate and exchange rate. So taking into account that 40% of studies in the collected sample report a positive and significant relationship, there might be publication selection concerns related to this literature.

Table 1. Mean Levels of PCC by Category and Overall

Factors	Simple average	Fixed effects average PCC	Random effects average PCC
Total	0.141	0.182(0.163;0.202)	0.142(0.045;0.239)
Estimated PCCs for current and lagged interest rate			
Current	0.187	0.202(0.182;0.222)	0.185(0.069;0.300)
Lagged	-0.001	0.003(-0.059;0.065)	0.003(-0.059;0.065)
Estimated PCCs for countries varying at the level of monetary freedom			
High	0.159	0.217(0.196;0.238)	0.198(0.078;0.318)
Low	0.112	-0.041(-0.093;0.012)	-0.048(-0.161;0.066)
Estimated PCCs for countries varying at the income level			
High and upper-middle-income countries	0.199	0.217(0.196;0.238)	0.198(0.078;0.318)
Low and lower-middle income countries	-0.044	-0.041(-0.093;0.012)	-0.048(-0.161;0.066)

As in Stanley & Doucouliagos (2010), testing the existence of publication bias was implemented using a funnel plot, with partial correlation coefficients on the horizontal axis, and estimates of coefficients' precision – measured as the inverse of their standard errors – on the vertical axis. Typically, if there is no publication bias, the funnel plot tends to be symmetric (thus, its appearance tends to be similar to an inverted funnel) and there is no clear tendency for the effects to follow any direction (Doucouliagos et al., 2005). The estimates for both the short-term and the long-term impact are plotted on figures 1 and 2 respectively.

Figure 1 shows that the funnel plot is skewed to the right with the majority of observations scattered in the middle. These results indicate that the authors in this field tended to publish studies with large samples and mostly positive and significant regression coefficients, which might reach the conclusion of evidence of publication bias. Figure 2 indicates that the lagged effect reported is primarily positive, although it is difficult to conclude a publication bias due to the relatively low number of estimates and the economic insignificance of reported effects. To avoid making sound judgments based solely on the subjective representation of plots, we support our findings with funnel asymmetry tests.

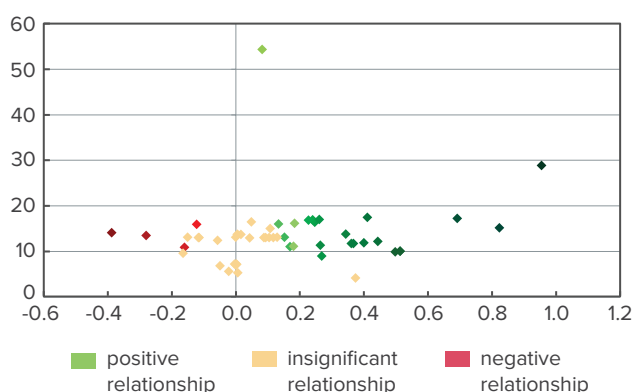


Figure 2. A Funnel Plot of the Instantaneous Effect of Interest Rate on Exchange Rate, 1/S.e.(PCC)

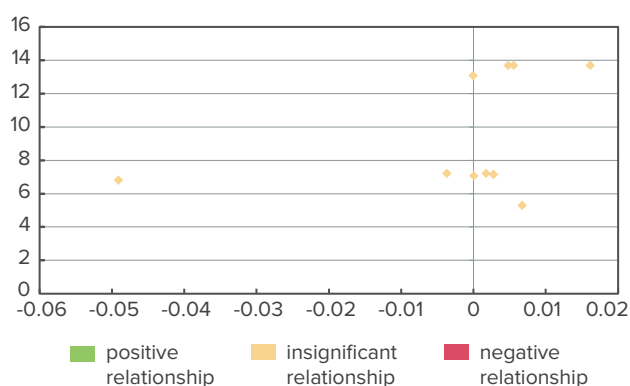


Figure 3. A Funnel Plot of the Lagged Effect of Interest Rate on Exchange Rate, 1/S.e.(PCC)

The formal testing of both the short-term and the long-term impact is provided with the use of a funnel asymmetry regression test. To check for the inherent heteroskedasticity, the weighted least squares regression of the following form is utilized:

$$\frac{PCC_{ij}}{SEpccij} = t_{ij} = \beta_1 + \beta_0 \left(\frac{1}{SEpccij} \right) + v_{ij}, \quad (4)$$

where $SEpccij$ is the standard error of the partial correlation coefficient $PCCij$.

The results of the tests for the publication bias for both the short- and the long-term impact are provided in Table 1. In the absence of publication bias, there is no statistically significant relationship between the magnitude of the effect and its standard error, according to Doucouliagos et al. (2005). Therefore, if there is no publication bias, the intercept of the funnel asymmetry regression – weighted by standard errors – should not be statistically significant. According to Table 1, the intercepts of funnel asymmetry regressions for both the short-term and the long-term impact are not statistically significant. Therefore, the formal tests do not reveal any statistically significant evidence for the presence of publication bias in studies on the relationship between the interest rate and the exchange rate and these results are robust for the timing of effect.

Table 2. Test of the True Effect and Type I Publication Bias

	Short-term	Long-term
1/S.e.(PCC)	0.228* (0.121)	0.020 (0.012)
Constant	-0.519 (2.109)	-0.183 (0.113)
Number of observations	31	10
Number of studies	5	3

In addition to testing the tendency of published results to match theory, the prevalence of significant estimates among studies investigated should be also reviewed. The main threat of Type II publication bias is the selective reporting of studies with significant results. Consequently, studies reporting the absence of the effect could be overlooked, which in turn could mislead both researchers and policymakers on the presence of an effect that does not exist. To test Type II publication bias, the following methodology is used:

$$|t_{ij}| = \beta_1 + \beta_0 \left(\frac{1}{SEpccij} \right) + v_{ij}, \quad (5)$$

where $SEpccij$ is the standard error of the partial correlation coefficient $PCCij$.

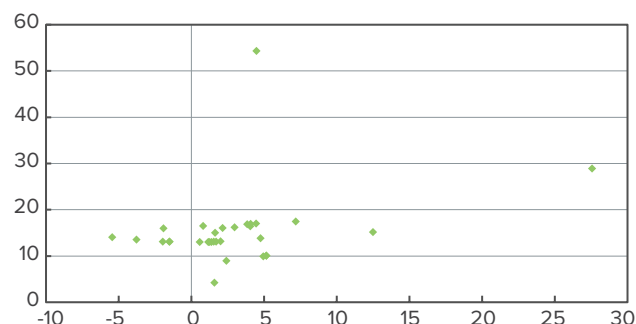


Figure 4. A Funnel Plot of the Effect of Interest Rates on Exchange Rate, t-value, 1/S.e.(PCC)

We didn't reject the null hypothesis that β_0 is equal to 0, which proves the absence of a connection between the significance of estimates and their precision as reflected by $\frac{1}{SEpcc_{ij}}$ both in the short- and in the long-term.

Table 3. Test of the Type II Publication Bias

	Short-term	Long-term
1/SEpcc	0.204 (0.106)	0.003 (0.011)
Constant	0.905 (1.841)	0.050 (0.111)
Number of observations	31	10
Number of studies	5	3

6. MULTIVARIATE META-REGRESSION

Although the methodology of meta-analysis is helpful in netting out the effect of interest rates on the exchange rate from other factors under interest, differences in research designs – as well as country-specific and time-specific factors – can also affect resulting estimates. To verify whether the above-mentioned heterogeneity has any effect on our results, we used a multivariate meta-regression methodology, specified in Havranek & Irsova (2011) by the following equation:

$$t_{ij} = \beta_1 + \beta_0 \left(\frac{1}{SEpcc_{ij}} \right) + \sum_{k=1}^K \frac{\gamma_k Z_{ijk}}{SEpcc_{ij}} + \epsilon_{ij}, k = 1, \dots, K \quad (6)$$

Here, i is the index for a particular study, j is the index of observation within the i study, Z_{ijk} comes as a set of variables that might affect the partial correlation coefficients, and ϵ_{ij} is the study-specific error term. The set of variables is weighted by the inverse of the standard error of the partial correlation coefficient for avoiding the inherent heteroskedasticity.

The obtained results are summarized in the table 4.

According to our forecast, the turnaround is expected to take place slowly. The reason is the above-mentioned inertia in the trend, which implies that even if the gap is negative, the decreasing trend of the previous years may partly or fully offset the mean-reverting forces. Therefore, our estimates predict a slight increase in credit-to-GDP for the following couple of years.

The results of meta-regression show that the heterogeneity in studies has a statistically significant effect on estimated partial correlation coefficients. The main reasons for these differences are the empirical methods and time units used for research. The income status of countries and the usage of a fixed exchange rate regime during the estimation period do not affect the values of partial correlation coefficients as much as the level of monetary freedom. According to the estimates in Table 1, in countries where the values of the Index of Monetary Freedom were higher than 70 during the estimation period, the response of interest rate change on the exchange rate was lower than for countries at the lower levels of the index. It can be observed that the studies that analyzed the period after 1990 reported significantly higher values of partial correlation coefficients. This finding can be explained by the composition of countries: only a few developing countries were present in the pre-1990 sample, while the proportion of developing countries was much higher in the post-1990 sample.

Table 4. Meta-Rregression Results

Variable	Description	Coefficient
$\frac{1}{SEpcc_{ij}}$	Measure of precision for partial correlation coefficient	0.23
Current interest rate	1 – if the explanatory variable is the current level of interest rate	-1.25
After 1990	1 – if the study used observations only starting in 1990	10.36***
Country-specific effects		
High income	1 – if the analyzed country under study was in a high or high-middle income category during the study, 0 – if the country under study was in a low or low-middle income category	-0.04
Monetary free	1 – if the analyzed country had the value of the Heritage Foundation Index of Monetary Freedom over 70 during estimation, 0 – if less	-0.29***
Fixed exchange rate	1 – if the country used the fixed exchange rate regime during at least one year during the estimation period	-0.05
Study fixed effects	Aggarwal(2013)	-0.00
	Gould & Kamin(2000)	0.54
	Hoffmann & MacDonald(2009)	1.10***
	Mehl & Cappiello(2009)	-0.35
	Sarmidi & Salleh(2011)	-1.34

p -values * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

7. CONCLUSION

After conducting a meta-analysis of eight studies covering 30 countries, we conclude that there is a genuinely positive and statistically significant short-term effect of increases in interest rates on the exchange rate. Although being both economically and statistically significant in the short term, the effect is rather ambiguous in the long term, having a mostly insignificant interconnection with interest rates. The aggregation of coefficients – conditional on the country's level of monetary freedom and income status – revealed that in countries with higher levels of income and monetary freedom, the interconnection is stronger than in developing countries. The overall effect is estimated at the level of 14%, while for high-income countries this effect remains higher by 4%. These results are robust to the choice of the aggregation procedure and account for substantial heterogeneity in studies on this topic, resulting in an I-squared of 95.6%.

To check if the results are valid and unbiased, we tested the results on publication selection. We tested for both

Type-1 and Type-2 publication biases, assessing both the extent of selecting only statistically significant estimates for publishing and the extent of selecting the estimates, which are consistent with economic theory. The results of the implemented tests have demonstrated that there is no statistically significant evidence of both types of publication biases in the estimates. The results of meta-regression have shown that the interconnection between interest rates and exchange rates is highly sensitive to a range of macroeconomic factors, especially when we are talking about the level of monetary freedom. Also, the effect was stronger for studies undertaken on post-1990 data.

Although due to data limitations, the inference about the possible effect of interest rate on exchange rate is made based on cross-country evidence rather than on the analysis of Ukrainian data, there is still a high probability that the same kind of relationship might be observed in Ukraine. Although there is no point in discussing the direct estimation of such a monetary policy instrument as the key policy rate on the national currency, the National Bank of Ukraine should take into account such an indirect inference while making its decisions regarding the key policy rate.

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APPENDIX A. TABLES

Table 5. Data Collected for the Meta-Regression

Country	Dependent variable	Independent variable	Coefficient	S.e.	D.f.	PCC	S.e. (PCC)	Z (PCC)	1/S.e. (PCC)
Indonesia	d(ER)	d(r)(t-1)	-0.005	0.015	46	-0.049	0.147	-0.049	6.791
Korea	d(ER)	d(r)(t-1)	0.004	0.316	52	0.002	0.139	0.002	7.211
Malaysia	d(ER)	d(r)(t-1)	-0.011	0.418	52	-0.004	0.139	-0.004	7.211
Mexico	d(ER)	d(r)(t-1)	0.000	0.958	171	0.000	0.076	0.000	13.077
Philippines	d(ER)	d(r)(t-1)	0.000	0.862	50	0.000	0.141	0.000	7.071
Thailand	d(ER)	d(r)(t-1)	0.005	0.252	51	0.003	0.140	0.003	7.141
Brazil	d(ER)	d(r)	0.070	0.061	168	0.088	0.077	0.088	13.012
Chile	d(ER)	d(r)	-0.259	0.170	168	-0.117	0.077	-0.117	13.051
Mexico	d(ER)	d(r)	0.046	0.034	168	0.104	0.077	0.104	13.032
Venezuela	d(ER)	d(r)	0.142	0.093	168	0.117	0.077	0.118	13.051
Indonesia	d(ER)	d(r)	-0.464	0.236	168	-0.150	0.076	-0.151	13.110
Philippines	d(ER)	d(r)	0.109	0.194	168	0.043	0.077	0.043	12.974
Thailand	d(ER)	d(r)	-1.981	1.322	168	-0.115	0.077	-0.115	13.048
Morocco	d(ER)	d(r)	-0.367	0.097	168	-0.280	0.074	-0.288	13.502
Hungary	d(ER)	d(r)	-0.551	0.101	168	-0.388	0.071	-0.409	14.063
Poland	d(ER)	d(r)	0.086	0.043	168	0.152	0.076	0.154	13.115
Portugal	d(ER)	d(r)	0.233	0.138	168	0.129	0.077	0.130	13.071
Romania	d(ER)	d(r)	0.090	0.019	168	0.343	0.072	0.358	13.800
Russia	d(ER)	d(r)	0.046	0.038	168	0.093	0.077	0.093	13.018
China	d(ER)	d(r)	-0.001	0.001	250	-0.122	0.063	-0.122	15.930
Argentina	d(ER)	d(r)(t-1)	-0.710	-9.331	187	0.006	0.073	0.006	13.675
Chile	d(ER)	d(r)(t-1)	0.008	0.128	187	0.005	0.073	0.005	13.675
Colombia	d(ER)	d(r)(t-1)	-0.112	-0.506	187	0.016	0.073	0.016	13.677
Canada	ln(ER)	d(r)	0.860	0.290	252	0.184	0.062	0.186	16.149
Germany	ln(ER)	d(r)	0.860	0.120	252	0.411	0.057	0.437	17.417
Japan	ln(ER)	d(r)	0.300	0.140	252	0.134	0.062	0.135	16.018
Great Britain	ln(ER)	d(r)	0.890	0.220	252	0.247	0.061	0.252	16.382
Australia	ln(ER)	d(r)	0.530	0.130	270	0.241	0.059	0.246	16.930
Sweden	ln(ER)	d(r)	0.290	0.360	270	0.049	0.061	0.049	16.451
Switzerland	ln(ER)	d(r)	0.400	0.090	270	0.261	0.059	0.267	17.022
Malaysia	ln(ER)	d(r)	0.210	0.130	222	0.108	0.067	0.108	14.987
Thailand	ln(ER)	d(r)	0.730	0.190	270	0.228	0.059	0.232	16.875
Taiwan	ln(ER)	d(r)	0.250	0.160	15	0.374	0.239	0.393	4.176
Canada	d(ER)	d(r)	0.320	0.133	74	0.269	0.112	0.275	8.931
France	d(ER)	d(r)	0.400	0.032	74	0.824	0.066	1.168	15.166
Germany	d(ER)	d(r)	0.530	0.019	74	0.955	0.035	1.881	28.871
Italy	d(ER)	d(r)	0.190	0.037	74	0.514	0.100	0.568	10.026
Japan	d(ER)	d(r)	0.330	0.064	74	0.513	0.100	0.567	10.021
UK	d(ER)	d(r)	0.300	0.061	74	0.498	0.101	0.547	9.920
Turkey	d(ER)	d(r)(t-1)	-0.059	-1.638	28	0.007	0.189	0.007	5.292
Great Britain	d(ER)	d(r)	0.340	0.076	2931	0.082	0.018	0.083	54.323

Table 6. The Instantaneous Effect of Interest Rate on Exchange Rate (Fixed Effect estimates vs Random Effect estimates)

Name of the study, Country	ES (95% CI)	% Weight	
		FE	RE
Sarmidi, Salleh (2011), Hungary	-0.39 (-0.53, -0.25)	1.90	2.52
Sarmidi, Salleh (2011), Morocco	-0.28 (-0.43, -0.14)	1.75	2.51
Sarmidi, Salleh (2011), Indonesia	-0.15 (-0.30, -0.00)	1.65	2.50
Sarmidi, Salleh (2011), Chile	-0.12 (-0.27, 0.03)	1.64	2.50
Zhonxia, Jin (2003), China	-0.12 (-0.24, 0.00)	2.44	2.55
Sarmidi, Salleh (2011), Thailand	-0.11 (-0.27, 0.04)	1.64	2.50
Sarmidi, Salleh (2011), Philippines	0.04 (-0.11, 0.19)	1.62	2.50
Mehl, Cappiello (2009), Sweden	0.05 (-0.07, 0.17)	2.60	2.56
Aggarwal (2013), Great Britain	0.08 (0.05, 0.12)	28.39	2.65
Sarmidi, Salleh (2011), Russia	0.09 (-0.06, 0.24)	1.63	2.50
Sarmidi, Salleh (2011), Brazil	0.09 (-0.06, 0.24)	1.63	2.50
Sarmidi, Salleh (2011), Mexico	0.10 (-0.05, 0.25)	1.63	2.50
Mehl, Cappiello (2009), Malaysia	0.11 (-0.02, 0.24)	2.16	2.54
Sarmidi, Salleh (2011), Venezuela	0.12 (-0.03, 0.27)	1.64	2.50
Sarmidi, Salleh (2011), Portugal	0.13 (-0.02, 0.28)	1.64	2.50
Mehl, Cappiello (2009), Japan	0.13 (0.01, 0.26)	2.47	2.55
Sarmidi, Salleh (2011), Poland	0.15 (0.00, 0.30)	1.65	2.50
Mehl, Cappiello (2009), Canada	0.18 (0.06, 0.30)	2.51	2.55
Mehl, Cappiello (2009), Thailand	0.23 (0.11, 0.34)	2.74	2.56
Mehl, Cappiello (2009), Australia	0.24 (0.13, 0.36)	2.76	2.56
Mehl, Cappiello (2009), Great Britain	0.25 (0.13, 0.37)	2.58	2.56
Mehl, Cappiello (2009), Switzerland	0.26 (0.15, 0.38)	2.79	2.56
Hoffmann, MacDonald (2009), Canada	0.27 (0.05, 0.49)	0.77	2.34
Sarmidi, Salleh (2011), Romania	0.34 (0.20, 0.49)	1.83	2.52
Mehl, Cappiello (2009), Taiwan	0.37 (-0.10, 0.84)	0.17	1.64
Mehl, Cappiello (2009), Germany	0.41 (0.30, 0.52)	2.92	2.57
Hoffmann, MacDonald (2009), United Kingdom	0.50 (0.30, 0.70)	0.95	2.40
Hoffmann, MacDonald (2009), Japan	0.51 (0.32, 0.71)	0.97	2.40
Hoffmann, MacDonald (2009), Italy	0.51 (0.32, 0.71)	0.97	2.40
Hoffmann, MacDonald (2009), France	0.82 (0.69, 0.95)	2.21	2.54
Hoffmann, MacDonald (2009), Germany	0.95 (0.89, 1.02)	8.02	2.63
Subtotal (I squared=96.5%, p=0.000)	0.20 (0.18, 0.22)	90.27	77.11
Heterogeneity between groups p=0.000	-0.39 (-0.53, -0.25)		
Overall (I-squared=95.6%, p=0.000)	-0.28 (-0.43, -0.14)	100.00	100.00

Table 7. The Lagged Effect of Interest Rate on Exchange Rate (Fixed Effect estimates vs Random Effect estimates)

Name of the study, Country	ES (95% CI)	% Weight	
		FE	RE
Gould, Kamin (2000), Indonesia	-0.05 (-0.34, 0.24)	0.44	2.15
Gould, Kamin (2000), Philippines	0.00 (-0.28, 0.28)	0.48	2.19
Gould, Kamin (2000), Malaysia	-0.00 (-0.28, 0.27)	0.50	2.20
Gould, Kamin (2000), Thailand	0.00 (-0.27, 0.28)	0.49	2.19
Gould, Kamin (2000), Korea	0.00 (-0.27, 0.27)	0.50	2.20
Gould, Kamin (2000), Mexico	-0.00 (-0.15, 0.15)	1.65	2.50
Luo (2013), Chile	0.00 (-0.14, 0.15)	1.80	2.51
Gusmus (2002), Turkey	0.01 (-0.36, 0.38)	0.27	1.92
Luo (2013), Argentina	0.01 (-0.14, 0.15)	1.80	2.51
Luo (2013), Colombia	0.02 (-0.13, 0.16)	1.80	2.51
Subtotal (I squared=0.0%, p=1.000)	0.00 (-0.06, 0.06)	9.73	22.89