Russia's Invasion of Ukraine and Implications for the Ukrainian Hryvnia and the Russian Ruble

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Abstract

This paper examines the interest rates, expected spot rates, and inflation rates of the Ukrainian Hryvnia (₴) to the Russian Ruble (₽). Our methodology analyzes international parity relationships, including Purchasing Power Parity (PPP) and the International Fisher Effect (IFE). Focusing on the four years from two years before Russia's initial invasion of Ukraine on February 24, 2022, i.e., February 2, 2020 to post-conflict up to December 2023, we hypothesize that the geopolitical tensions induced by the invasion have led to significant fluctuations and high volatility of these currencies. Additionally, we propose that the economic consequences of the invasion, such as disruptions to trade and food and supply shortages, may further affect these variables by increasing domestic and international money financing, therefore triggering higher inflation rates. Our analyses indicate that spot rates predicted using international parity relationships suggest the weakening of the Ukrainian Hryvnia after the Russia-Ukraine conflict. Our findings shed light on the magnitude and direction of currency movements, providing insights into the economic ramifications of the conflict. Specifically, we aim to elucidate how the invasion has impacted the region's exchange rates and economic stability.

Keywords: Ukraine-Russia conflict, Ukrainian Hryvnia, Russian Ruble, purchasing power parity, international fisher effect

1. Introduction

This paper explores the impact of the Russian invasion of Ukraine on various economic indicators. The invasion contributed to an increase in inflation and spot rates, with the primary indicator being the depreciation of the Ukrainian Hryvnia relative to the Russian Ruble. The Russia-Ukraine conflict resulted in a gradual increase in Ukrainian inflation rates for several months post-conflict, followed by a decrease in inflation rates until the end of 2023. The increasing inflation is correlated with the depreciation of the Hryvnia.

Our paper discusses the economic results and the direct impact of the Russian invasion of Ukraine in February 2022. We aim to add to the broader literature on global financial markets and currency exchanges during geopolitical wars. With a focus on the Ukrainian Hryvnia (₴) and the Russian Ruble (₽), this study explores the dynamics and volatility between these two currencies.

By analyzing interest rates, expected spot rates, and inflation rates, the research gathered is used to explain the direct financial implications of the conflict. We hypothesize that the political pressures of the war led to influential fluctuations and volatility of these currencies, weakening the Ukrainian Hryvnia against the Russian Ruble. The research spans two years before the invasion on February 24, 2022 to December 2023. We also consider the economic impacts beyond the conflict, looking at supply shortages and financing by central banks. We examine how spot rates were influenced by the instability during this conflict, by using two international parity relationships: Purchasing Power Parity (PPP) and the International Fisher Effect (IFE).

2. Literature Review and Hypothesis Formulation

2.1 Literature Review

Previous literature has explored the impact of the Russia-Ukraine conflict by analyzing other foreign currencies and exchange rates. This research builds upon previous findings by looking directly at the currencies of the two countries in conflict, Russia and Ukraine, in relation to one another. The methodology explored in this research also differs, focusing on international parity relationships.

Consequences of Russian Invasion on Ukraine: evidence from foreign exchange rates

Aliu, Hašková, and Bajra (2023) explore the invasion's consequences on the following euro exchange rates: Euro/Russian ruble, Euro/US dollar, Euro/Japanese yen, Euro/British pound, and Euro/Chinese yuan. The methodologies used included the impulse response function, variance decomposition, structural vector auto-regression, and the vector error correction model. The exchange rate, EUR/Ruble, had a significant influence on the devaluation of the Euro during this period of conflict. Although the Russian ruble is not considered a strong currency, the Ruble strengthened during this time. The Euro was particularly affected by Russia's role as a gas supplier to the Eurozone. In the short-term, the Euro was sensitive to the Ruble, Dollar, and Yuan following the February 24, 2022 invasion. The results of this study prove that typically weak currencies can have significant consequences on other currencies. These findings show that the geopolitical tensions and economic problems within one country can strongly influence others. This study adds emphasis to the importance of maintaining diverse portfolios in order to mitigate the volatility that results from geopolitical shocks. However, Aliu et al. (2023) do not directly assess the impact of invasion on the Russian Ruble (₽) in terms of Ukrainian Hryvnia (₴).

Exchange rate instabilities during the Russia-Ukraine war: Evidence from V4 countries

Aliu, Kučera, and Horák (2024) investigate the impact of conflict on four foreign currencies- the Russian ruble, the Czech crown, the Polish zloty, and the Hungarian forint- in relation to the euro. This research explores the euro due to the strong economic relations between the Visegrad (V4) countries and the eurozone. Aliu et al. (2024) use several econometric methods to understand the exchange rate instabilities during the Russia-Ukraine war, including the VAR impulse response function, variance decomposition, vector error correction model, and granger causality test. Key findings from this study relate particularly to Russia's role as a significant exporter of oil to the EU. The findings reveal that the exchange rates of the Polish zloty, Czech crown, and Hungarian forint were unaffected by Russia's demand for gas payments in Russian rubles. Gas payments were instead processed using euros, which protected Visegrad (V4) currencies from the instability of Russia's currency. In addition, the study reveals that the V4 currencies are strongly influenced by one another, indicating the interdependence of these countries during geopolitical tensions. Overall, this research underscores how both economic and geopolitical factors influence spot rates. Aliu et al. exclaim that "the national currencies of the V4 countries went into cardiac arrest due to the geographical proximity to Ukraine and heavy reliance on Russian gas" (Aliu et al., 2024, p.11). The vulnerability of these currencies was exacerbated due to these factors. However, Aliu et al. (2024) also do not directly assess the impact of invasion on the Russian Ruble (₽) with respect to Ukrainian Hryvnia (₴).

Russian-Ukrainian War Affects Ruble and Dollar

Jin (2022) aims to understand how threats to the global supply chain system impacted the Russian Ruble and the US Dollar separately. This study does not implement any particular methodologies but analyzes the factors that have influenced the global economy. The Russian ruble's depreciation during this time of conflict was driven by government sanctions, disrupted export revenues within the energy sector, and reduced foreign investments. Many countries stopped importing oil and gas from Russia, which resulted in the price of the Ruble to fall. In order to add value to the Ruble, Russia implemented measures that required Ruble payments for trade. Many countries, however, refused to continue their trade relationship with Russia for this reason. Due to a lack of resources, particularly in the energy sector and agricultural sector, inflationary pressures are high. Thus, costs are increasing, and there are significant delays in distribution and production. On the other hand, the US dollar was considered a safe currency during the uncertainty of conflict. The implications of the conflict as a whole are particularly prevalent to Europe, as their relationship with Russia is dependent on the supply of natural gas. There is an intricate relationship between the Russia-Ukraine conflict on global economies.

While previous studies including Fiorito (2022), Jin (2022), Kim et al. (2022), Skok and Oliver (2022), Arce, et al. (2023), and Aliu et al. (2023, 2024) examine the Russian invasion on various interest rates and inflation rates of European nations and expected spot rates of a few currencies, they do not examine the direct impact of Russian invasion on the Russian Ruble per Ukraine Hryvnia relationship. Thus, in this paper, we sharply focus on the direct impact of Russian invasion on the Russian Ruble per Ukraine Hryvnia relationship.

2.2 Hypothesis Formulation

To focus on the impact of Russian invasion on the Russian Ruble per Ukraine Hryvnia relationship, we postulate that the invasion of Ukraine in 2022 will be followed by the depreciation of the Ukrainian Hryvnia per Russian Ruble to the extent that international parity relationships hold during the extended period of conflict. Disruptions to the economy after the invasion of Ukraine have led to labor, trade, and food and supply shortages, likely leading to heightened

inflation in Ukraine and the depreciation of their currency. While several factors should be considered in the rise of inflation levels, we believe that international parity relationships will illustrate this finding. We predict that as conflict continues and inflation rises, the exchange rate ₴/₽ will increase, indicating the weakening of the Hryvnia relative to the Ruble.

H1: Russia-Ukraine conflict will result in the depreciation of the Ukrainian Hryvnia relative to the Russian Ruble.

During periods of conflict, policies are expected to fluctuate to respond to uncertainty. To create short-term macroeconomic stability, governments respond to adjust accordingly. With changing market conditions and policies, foreign exchange rates change to reflect increases or decreases in macroeconomic variables, such as inflation, interest, and spot rates. In the context of Russia and Ukraine, we predict that changes will follow periods of heightened conflict in market conditions. Prior to the conflict, we anticipate greater stability in macroeconomic variables. Different events throughout the time frame will be reflected in drastic changes in foreign exchange rates, contributing to high volatility levels.

H2: Russia-Ukraine conflict will result in increasing volatility of foreign exchange rates (₴/₽) from the first date of invasion, February 24, 2022, to post-invasion.

The conflict between Russia and Ukraine led to significant food and supply shortages in Ukraine, and an increased demand for financing both domestically and internationally. Ukraine is a leading exporter in the agricultural sector, but the conflict drastically impacted both imports and exports. As a result, we anticipate that during the height of conflict, these issues will lead to an increase in inflation rates. Inflationary pressures distort the purchasing power of consumers in Ukraine, particularly for common goods such as food. As the Ukrainian government and Central Bank aim to stabilize inflation with recovery efforts and policies, we expect inflation rates to decrease gradually towards the end of 2023. This helps explain H1, as anticipated inflationary pressures influence the expected spot rates of the Hryvnia relative to the Ruble.

H3: The Russia-Ukraine conflict will gradually increase Ukrainian inflation rates for several months post-conflict, followed by a decrease in inflation rates until the end of 2023.

3. Data and Methodology

International parity relationships are manifestations of the law of one price that must hold to avoid arbitrage opportunities between different markets. Purchasing Power Parity (PPP) and the International Fisher Effect (IFE) are two measures of international parity relationships commonly used to evaluate exchange rates. To analyze exchange rate movements, we first examine the expected Ukrainian Hryvnia to Russian Ruble (₴/₽) spot rates using Purchasing Power Parity, and then the International Fisher Effect similar to the methods used by Dixon and Jo (2017) and Eun et al. (2024). Although these approaches use slightly different measures, we expect to observe a similar effect on the exchange rate.

3.1 Purchasing Power Parity

Using data from The Wall Street Journal, we obtained a sample of the weekly ₴/₽ spot prices for the period 2nd February 2020 to 25th December 2023. We chose this time frame to analyze how spot rates fluctuated from two years prior to the first invasion of Ukraine until conflicts started to slow. To ensure that we could understand the long-term and recent effects of the Russian invasion, we analyzed data on the Russia-Ukraine conflict up until the end of the 2023 calendar year. We also use the Trading Economics (2024) to obtain Russian and Ukraine interest rates and inflation rates during 2/2/2020 – 12/25/2023.

The exchange rates between two currencies are in equilibrium when the purchasing power is the same in each nation. For example, based on the definition of purchasing power parity, if prices are decreasing in the home country, Ukraine, then the currency of Russia must appreciate to maintain equilibrium, or vice versa. The inflation differential between two nations must equal the forward-to-spot exchange rate differential for ₴/₽ rates to be parity. This is illustrated in the formula for Purchasing Power Parity:

$$\frac{I_h - I_f}{1 + I_f} = \frac{F - S}{S} = \frac{E(S) - S}{S}$$

In this PPP formula, I_h refers to the inflation rate of Ukraine, and I_f denotes the inflation rate of the foreign country, Russia. The forward rate, F, is substituted with the expected spot rate, E(S), as this is what we are looking to calculate.

Weekly data for the Ukrainian and Russian inflation rates were obtained from Trading Economics. Using the spot rate, S, and both inflation rates, we can rearrange this formula to forecast the future spot rate E(S):

$$(S) = S \times \{(I_h - I_f) / (1 + I_f)\} + S$$

Our calculations of the expected spot rate for the ₴/₽ using PPP will be analyzed to identify any significant patterns or trends in the value of the Ukrainian Hryvnia and Russian Ruble. For example, an increase in the spot rate based on PPP over this time frame will indicate the depreciation of the Hryvnia against the Ruble.

3.2 International Fisher Effect

To corroborate our results of the Purchasing Power Parity forecasting method of the spot rate (₴/₽), we analyze the spot rate using the International Fisher Effect. According to Eun *et al.*, the IFE suggests that the nominal interest rate differential reflects the expected change in the exchange rate. This differs from the PPP as IFE uses interest rates, rather than inflation rates, to predict the expected spot rate, E(S). To be in parity, the interest rate differential between the home nation and the foreign nation must equal the forward-to-spot exchange rate differential for ₴/₽.

The formula for International Fisher Effect is as follows:

$$\frac{i_h - i_f}{1+i_f} = \frac{F-S}{S} = \frac{E(S)-S}{S}$$

In this IFE formula, i_h refers to the interest rate of Ukraine, and i_f denotes the interest rate of the foreign country, Russia. Interest rate data for both the Ukrainian and Russian interest rates were obtained from Trading Economics. In order to predict the expected spot rate, E(S), we use the following calculation:

$$(S) = S \times \{(i_h - i_f) / (1 + i_f)\} + S$$

From calculations of international parity relationships using PPP and IFE, we expect to see a period of increase in the expected spot rate, ₴/₽, during the height of conflict between Russia and Ukraine. We also anticipate that E(S) using both of these measures will reflect a similar trend, which will be illustrated visually with a graph of the trends.

4. Results

The expected future spot rates from our calculations of the international parity relationships identified above are compiled in Table 1 and plotted in Figure 2 versus actual spot rates. It is clear that, relative to the actual spot rates for ₴/₽, both PPP and IFE estimations follow a similar directional trend. From a visual glance at Figure 2 and Figure 4, it is evident that the PPP estimations track actual spot rates slightly better than the IFE estimations. Spot rate estimations using PPP in Figure 4 show a very close alignment with the actual spot rates, both pre-and-post invasion. This emphasizes the accuracy that Purchasing Power Parity, in particular, has in estimating spot rate value trends. To quantify the margin between PPP and IFE estimates, we calculated the difference of each estimated spot rate to compare the difference in the results of the PPP and IFE relationships:

$$Margin = E(S_{IFE}) - E(S_{PPP})$$

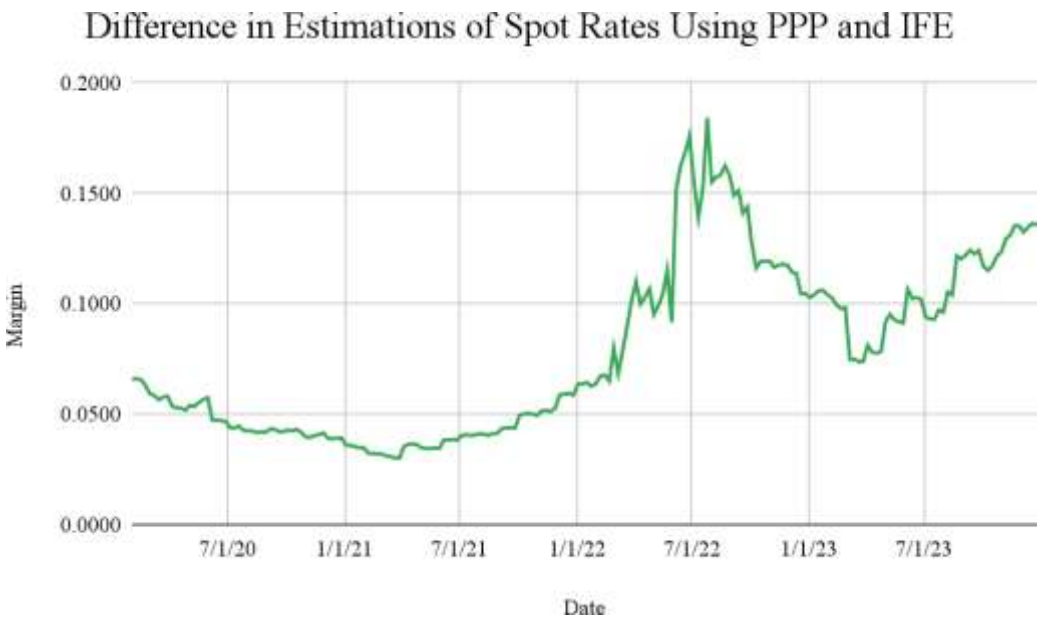


Figure 1. Margins between PPP and IFE Spot Rate Estimates

Looking at the margins for the two parity relationships in Figure 1 reveals that the International Fisher Effect does not corroborate our results of the Purchasing Power Parity forecasting method. The average margin of 0.1108 ₴/₽ is significant enough to suggest that the estimations may not support the same conclusions regarding foreign exchange rates between Ukraine and Russia.

Thus, we cannot confirm that the IFE is an appropriate tool for predicting the future spot rates in this study. However, it should be noted that the trend of the estimated spot rates over time is relatively consistent between the PPP and the IFE. Therefore, we should still consider the spot rate estimations of both the PPP and the IFE in terms of evaluating our hypothesis H2 regarding the volatility of foreign exchange rates.

Figure 2 illustrates the actual spot rates, PPP estimations, and IFE estimations. Immediately following the onset of this conflict, it is clear that the spot rate ₴/₽ reaches an absolute minimum during this time frame (PPP: 0.2047 ₴/₽, IFE: 0.2731 ₴/₽, Date: 03/07/2022). This initial decrease suggests a significant drop in the value of the Russian Ruble, although this changes in the coming months. Focusing specifically on PPP, the absolute minimum spot value of 0.2047 ₴/₽ is followed by the gradual increase in the exchange rate. From 03/07/2022 to 10/03/2022, the expected spot rate steadily increases to an absolute maximum of 0.7122 ₴/₽. From 10/03/2022 to 12/26/2022, the spot rate remains in the range of 0.6115 ₴/₽ to 0.7122 ₴/₽. To summarize, from 03/07/2022 to 12/26/2022, it is evident that the Ukrainian Hryvnia drastically depreciated in value.

Based on these initial observations, we suggest that there are three distinct phases that should be considered in evaluating the foreign exchange rate:

Phase 1 (P1): 02/02/2020 - 02/28/2022

This time frame illustrates stability in the spot rate ₴/₽, with slight fluctuations but no clear trend of depreciation or appreciation. This is followed by a sudden decrease after the initial invasion of Ukraine on 02/24/2022. During this short period of time, the Ukrainian Hryvnia strengthened relative to the Russian Ruble. This, however, is extremely temporary and solely due to the immediate impact of Russia's invasion.

Phase 2 (P2): 03/07/2022 - 12/26/2022

This time frame shows the significant weakening of the Ukrainian Hryvnia relative to the Russian Ruble. After reaching a minimum on 03/07/2022, the expected spot rate ₴/₽ continues to increase. This can be attributed to the hardships facing Ukrainian society during conflict, such as food and supply shortages that demanded an increased money supply. The impact of these factors on inflation rates are evaluated further below.

Phase 3 (P3): 01/02/2023 - 12/25/2023

This time frame shows the gradual decrease of the spot rate ₴/₽ after reaching a maximum on 10/03/2022 until the end of the calendar year. The strengthening of the Ukrainian currency relative to the Ruble suggests progress in recovering the Ukrainian economy, although the nations are still facing the challenges of conflict.

These phases across the time frame support our hypothesis H1, which postulates that Russia-Ukraine conflict will result in the depreciation of the Hryvnia relative to the Ruble. Although Phase 3 reflects a decrease in the spot rate ₴/₽, and the gradual strengthening of the value of the Ukrainian Hryvnia, we can conclude that the value of the Hryvnia has weakened significantly overall.

Table 1. Actual spot rate and predicted rates based on IFE and PPP

Date	Actual Spot rate (UAH/RUB)	Ukraine (weekly) Inflation Rate	Russia (weekly) Inflation Rate	Spot Rate Based on PPP	Ukraine i (annualized interest rates)	Russia i (annualized interest rates)	Spot Rate Based on IFE
2/2/20	0.3831	2.40%	2.30%	0.3835	11.00%	6.25%	0.4492
2/9/20	0.3852	2.40%	2.30%	0.3856	11.00%	6.25%	0.4516
2/16/20	0.3819	2.40%	2.30%	0.3823	11.00%	6.25%	0.4478
2/23/20	0.3677	2.40%	2.30%	0.3681	11.00%	6.25%	0.4311
3/1/20	0.3643	2.30%	2.55%	0.3634	10.00%	6.00%	0.4226
3/8/20	0.3599	2.30%	2.55%	0.359	10.00%	6.00%	0.4175
3/15/20	0.3479	2.30%	2.55%	0.3471	10.00%	6.00%	0.4036
3/22/20	0.3556	2.30%	2.55%	0.3547	10.00%	6.00%	0.4125
3/29/20	0.3578	2.30%	2.55%	0.3569	10.00%	6.00%	0.415
4/5/20	0.37	2.10%	3.10%	0.3664	8.00%	5.50%	0.42
4/12/20	0.3655	2.10%	3.10%	0.362	8.00%	5.50%	0.4148
4/19/20	0.3639	2.10%	3.10%	0.3604	8.00%	5.50%	0.413
4/26/20	0.3576	2.10%	3.10%	0.3541	8.00%	5.50%	0.4059
5/3/20	0.3656	1.70%	3.02%	0.3609	8.00%	5.50%	0.415
5/10/20	0.3617	1.70%	3.02%	0.3571	8.00%	5.50%	0.4105
5/17/20	0.3737	1.70%	3.02%	0.3689	8.00%	5.50%	0.4241
5/24/20	0.3827	1.70%	3.02%	0.3778	8.00%	5.50%	0.4344
5/31/20	0.3887	1.70%	3.02%	0.3837	8.00%	5.50%	0.4412
6/7/20	0.385	2.40%	3.21%	0.382	6.00%	5.50%	0.4293
6/14/20	0.3839	2.40%	3.21%	0.3809	6.00%	5.50%	0.428
6/21/20	0.3834	2.40%	3.21%	0.3804	6.00%	5.50%	0.4275
6/28/20	0.38	2.40%	3.21%	0.377	6.00%	5.50%	0.4237
7/5/20	0.3838	2.40%	3.37%	0.3802	6.00%	4.50%	0.4241
7/12/20	0.3819	2.40%	3.37%	0.3783	6.00%	4.50%	0.422
7/19/20	0.39	2.40%	3.37%	0.3863	6.00%	4.50%	0.431
7/26/20	0.3731	2.40%	3.37%	0.3696	6.00%	4.50%	0.4123
8/2/20	0.3751	2.50%	3.58%	0.3712	6.00%	4.25%	0.4135
8/9/20	0.3753	2.50%	3.58%	0.3714	6.00%	4.25%	0.4138
8/16/20	0.3682	2.50%	3.58%	0.3644	6.00%	4.25%	0.4059
8/23/20	0.3719	2.50%	3.58%	0.368	6.00%	4.25%	0.41
8/30/20	0.3695	2.50%	3.58%	0.3656	6.00%	4.25%	0.4074
9/6/20	0.3745	2.30%	3.67%	0.3696	6.00%	4.25%	0.4129
9/13/20	0.373	2.30%	3.67%	0.3681	6.00%	4.25%	0.4112
9/20/20	0.3628	2.30%	3.67%	0.358	6.00%	4.25%	0.4
9/27/20	0.3638	2.30%	3.67%	0.359	6.00%	4.25%	0.4011
10/4/20	0.3693	2.60%	3.99%	0.3644	6.00%	4.25%	0.4072
10/11/20	0.3657	2.60%	3.99%	0.3608	6.00%	4.25%	0.4032
10/18/20	0.372	2.60%	3.99%	0.367	6.00%	4.25%	0.4101
10/25/20	0.3595	2.60%	3.99%	0.3547	6.00%	4.25%	0.3963
11/1/20	0.3648	3.80%	4.42%	0.3626	6.00%	4.25%	0.4022
11/8/20	0.3638	3.80%	4.42%	0.3616	6.00%	4.25%	0.4011
11/15/20	0.372	3.80%	4.42%	0.3698	6.00%	4.25%	0.4101
11/22/20	0.3753	3.80%	4.42%	0.3731	6.00%	4.25%	0.4138
11/29/20	0.3825	3.80%	4.42%	0.3802	6.00%	4.25%	0.4217
12/6/20	0.3835	5.00%	4.91%	0.3838	6.00%	4.25%	0.4228
12/13/20	0.382	5.00%	4.91%	0.3823	6.00%	4.25%	0.4212
12/20/20	0.3841	5.00%	4.91%	0.3844	6.00%	4.25%	0.4235
12/27/20	0.3861	5.00%	4.91%	0.3864	6.00%	4.25%	0.4257
1/3/21	0.3827	6.10%	5.19%	0.386	6.00%	4.25%	0.4219
1/10/21	0.3829	6.10%	5.19%	0.3862	6.00%	4.25%	0.4221
1/17/21	0.3753	6.10%	5.19%	0.3785	6.00%	4.25%	0.4138
1/24/21	0.3706	6.10%	5.19%	0.3738	6.00%	4.25%	0.4086
1/31/21	0.3717	6.10%	5.19%	0.3749	6.00%	4.25%	0.4098

Table 1 Cont'd. Actual spot rate and predicted rates based on IFE and PPP

Date	Actual Spot rate (UAH/RUB)	Ukraine (weekly) Inflation Rate	Russia (weekly) Inflation Rate	Spot Rate Based on PPP	Ukraine i (annualized interest rates)	Russia i (annualized interest rates)	Spot Rate Based on IFE
1/10/21	0.3829	6.10%	5.19%	0.3862	6.00%	4.25%	0.4221
1/17/21	0.3753	6.10%	5.19%	0.3785	6.00%	4.25%	0.4138
1/24/21	0.3706	6.10%	5.19%	0.3738	6.00%	4.25%	0.4086
1/31/21	0.3717	6.10%	5.19%	0.3749	6.00%	4.25%	0.4098
2/7/21	0.3795	7.50%	5.67%	0.3861	6.00%	4.25%	0.4184
2/14/21	0.3775	7.50%	5.67%	0.384	6.00%	4.25%	0.4162
2/21/21	0.3761	7.50%	5.67%	0.3826	6.00%	4.25%	0.4147
2/28/21	0.3746	7.50%	5.67%	0.3811	6.00%	4.25%	0.413
3/7/21	0.3802	8.50%	5.79%	0.3899	6.50%	4.25%	0.4211
3/14/21	0.3745	8.50%	5.79%	0.3841	6.50%	4.25%	0.4148
3/21/21	0.3698	8.50%	5.79%	0.3793	6.50%	4.25%	0.4096
3/28/21	0.367	8.50%	5.79%	0.3764	6.50%	4.25%	0.4065
4/4/21	0.361	8.40%	5.53%	0.3708	7.50%	5.00%	0.4061
4/11/21	0.371	8.40%	5.53%	0.3811	7.50%	5.00%	0.4174
4/18/21	0.3733	8.40%	5.53%	0.3835	7.50%	5.00%	0.42
4/25/21	0.3699	8.40%	5.53%	0.38	7.50%	5.00%	0.4161
5/2/21	0.3763	9.50%	6.02%	0.3887	7.50%	5.00%	0.4233
5/9/21	0.3736	9.50%	6.02%	0.3859	7.50%	5.00%	0.4203
5/16/21	0.3728	9.50%	6.02%	0.385	7.50%	5.00%	0.4194
5/23/21	0.3764	9.50%	6.02%	0.3888	7.50%	5.00%	0.4235
5/30/21	0.374	9.50%	6.02%	0.3863	7.50%	5.00%	0.4208
6/6/21	0.376	9.50%	6.50%	0.3866	7.50%	5.50%	0.4249
6/13/21	0.3757	9.50%	6.50%	0.3863	7.50%	5.50%	0.4245
6/20/21	0.3788	9.50%	6.50%	0.3895	7.50%	5.50%	0.428
6/27/21	0.375	9.50%	6.50%	0.3856	7.50%	5.50%	0.4238
7/4/21	0.3662	10.20%	6.50%	0.3789	8.00%	6.50%	0.4193
7/11/21	0.3679	10.20%	6.50%	0.3807	8.00%	6.50%	0.4212
7/18/21	0.3662	10.20%	6.50%	0.3789	8.00%	6.50%	0.4193
7/25/21	0.3671	10.20%	6.50%	0.3799	8.00%	6.50%	0.4203
8/1/21	0.3675	10.20%	6.68%	0.3796	8.00%	6.50%	0.4208
8/8/21	0.3649	10.20%	6.68%	0.3769	8.00%	6.50%	0.4178
8/15/21	0.3601	10.20%	6.68%	0.372	8.00%	6.50%	0.4123
8/22/21	0.3679	10.20%	6.68%	0.38	8.00%	6.50%	0.4212
8/29/21	0.3687	10.20%	6.68%	0.3809	8.00%	6.50%	0.4222
9/5/21	0.3655	11%	7.40%	0.3778	8.50%	6.75%	0.4212
9/12/21	0.367	11%	7.40%	0.3793	8.50%	6.75%	0.423
9/19/21	0.3689	11%	7.40%	0.3813	8.50%	6.75%	0.4252
9/26/21	0.3667	11%	7.40%	0.379	8.50%	6.75%	0.4226
10/3/21	0.3683	10.90%	8.13%	0.3777	8.50%	7.50%	0.4272
10/10/21	0.3726	10.90%	8.13%	0.3821	8.50%	7.50%	0.4322
10/17/21	0.3748	10.90%	8.13%	0.3844	8.50%	7.50%	0.4348
10/24/21	0.3714	10.90%	8.13%	0.3809	8.50%	7.50%	0.4308
10/31/21	0.3675	10.90%	8.13%	0.3769	8.50%	7.50%	0.4263
11/7/21	0.3615	10.30%	8.40%	0.3678	8.50%	7.50%	0.4193
11/14/21	0.3625	10.30%	8.40%	0.3689	8.50%	7.50%	0.4205
11/21/21	0.3593	10.30%	8.40%	0.3656	8.50%	7.50%	0.4168
11/28/21	0.3697	10.30%	8.40%	0.3762	8.50%	7.50%	0.4289
12/5/21	0.3669	10.00%	8.39%	0.3723	9.00%	8.50%	0.4311
12/12/21	0.3687	10.00%	8.39%	0.3742	9.00%	8.50%	0.4332
12/19/21	0.3713	10.00%	8.39%	0.3768	9.00%	8.50%	0.4363
12/26/21	0.3657	10.00%	8.39%	0.3711	9.00%	8.50%	0.4297
1/3/22	0.3668	10.00%	8.73%	0.3711	10.00%	8.50%	0.4347
1/10/22	0.3674	10.00%	8.73%	0.3717	10.00%	8.50%	0.4354
1/17/22	0.3714	10.00%	8.73%	0.3757	10.00%	8.50%	0.4401
1/24/22	0.361	10.00%	8.73%	0.3652	10.00%	8.50%	0.4278

Table 1 Cont'd. Actual spot rate and predicted rates based on IFE and PPP

Date	Actual Spot rate (UAH/RUB)	Ukraine (weekly) Inflation Rate	Russia (weekly) Inflation Rate	Spot Rate Based on PPP	Ukraine i (annualized interest rates)	Russia i (annualized interest rates)	Spot Rate Based on IFE
1/31/22	0.3679	10.00%	8.73%	0.3722	10.00%	8.50%	0.436
2/7/22	0.3707	10.70%	9.20%	0.3758	10.00%	9.50%	0.443
2/14/22	0.3732	10.70%	9.20%	0.3783	10.00%	9.50%	0.446
2/21/22	0.3583	10.70%	9.20%	0.3632	10.00%	9.50%	0.4282
2/28/22	0.2791	10.70%	9.20%	0.2829	10.00%	20.00%	0.3628
3/7/22	0.2101	13.70%	16.70%	0.2047	10.00%	20.00%	0.2731
3/14/22	0.2414	13.70%	16.70%	0.2352	10.00%	20.00%	0.3138
3/21/22	0.2761	13.70%	16.70%	0.269	10.00%	20.00%	0.3589
3/28/22	0.3111	13.70%	16.70%	0.3031	10.00%	20.00%	0.4044
4/4/22	0.3527	16.40%	17.80%	0.3485	10.00%	20.00%	0.4585
4/11/22	0.3539	16.40%	17.80%	0.3497	10.00%	17.00%	0.4495
4/18/22	0.3655	16.40%	17.80%	0.3612	10.00%	17.00%	0.4642
4/25/22	0.4045	16.40%	17.80%	0.3997	10.00%	15.20%	0.5064
5/2/22	0.4167	18.00%	17.10%	0.4199	10.00%	13.60%	0.515
5/9/22	0.4336	18.00%	17.10%	0.4369	10.00%	13.60%	0.5359
5/16/22	0.4573	18.00%	17.10%	0.4608	10.00%	13.60%	0.5652
5/23/22	0.5045	18.00%	17.10%	0.5084	10.00%	13.60%	0.6236
5/30/22	0.4617	21.50%	17.10%	0.479	10.00%	13.60%	0.5707
6/6/22	0.4795	21.50%	15.90%	0.5027	25.00%	11.43%	0.6542
6/13/22	0.5138	21.50%	15.90%	0.5386	25.00%	11.43%	0.701
6/20/22	0.5324	21.50%	15.90%	0.5581	25.00%	11.43%	0.7264
6/27/22	0.5562	21.50%	15.90%	0.5831	25.00%	11.43%	0.7588
7/4/22	0.5277	22.20%	15.10%	0.5603	25.00%	10.57%	0.7154
7/11/22	0.4728	22.20%	15.10%	0.502	25.00%	10.57%	0.641
7/18/22	0.5184	22.20%	15.10%	0.5504	25.00%	10.57%	0.7028
7/25/22	0.6265	22.20%	15.10%	0.6651	25.00%	10.57%	0.8493
8/1/22	0.5849	23.80%	14.30%	0.6335	25.00%	9.81%	0.7885
8/8/22	0.5939	23.80%	14.30%	0.6433	25.00%	9.81%	0.8006
8/15/22	0.5976	23.80%	14.30%	0.6473	25.00%	9.81%	0.8056
8/22/22	0.6129	23.80%	14.30%	0.6638	25.00%	9.81%	0.8263
8/29/22	0.5968	23.80%	14.30%	0.6464	25.00%	9.81%	0.8045
9/5/22	0.5991	24.60%	13.70%	0.6565	25.00%	9.46%	0.8055
9/12/22	0.6078	24.60%	13.70%	0.6661	25.00%	9.46%	0.8172
9/19/22	0.6151	24.60%	13.70%	0.6741	25.00%	7.50%	0.815
9/26/22	0.6282	24.60%	13.70%	0.6884	25.00%	7.50%	0.8324
10/3/22	0.6334	26.60%	12.60%	0.7122	25.00%	7.50%	0.8393
10/10/22	0.5791	26.60%	12.60%	0.6511	25.00%	7.50%	0.7673
10/17/22	0.5939	26.60%	12.60%	0.6677	25.00%	7.50%	0.7869
10/24/22	0.5944	26.60%	12.60%	0.6683	25.00%	7.50%	0.7876
10/31/22	0.5939	26.60%	12.60%	0.6677	25.00%	7.50%	0.7869
11/7/22	0.5956	26.50%	12.00%	0.6727	25.00%	7.50%	0.7892
11/14/22	0.6004	26.50%	12.00%	0.6781	25.00%	7.50%	0.7955
11/21/22	0.6033	26.50%	12.00%	0.6814	25.00%	7.50%	0.7994
11/28/22	0.6006	26.50%	12.00%	0.6784	25.00%	7.50%	0.7958
12/5/22	0.5905	26.60%	11.90%	0.6681	25.00%	7.50%	0.7824
12/12/22	0.5877	26.60%	11.90%	0.6649	25.00%	7.50%	0.7787
12/19/22	0.5394	26.60%	11.90%	0.6103	25.00%	7.50%	0.7147
12/26/22	0.5405	26.60%	11.90%	0.6115	25.00%	7.50%	0.7162
1/2/23	0.519	26.00%	11.80%	0.5849	25.00%	7.50%	0.6877
1/9/23	0.5256	26.00%	11.80%	0.5924	25.00%	7.50%	0.6964
1/16/23	0.5345	26.00%	11.80%	0.6024	25.00%	7.50%	0.7082
1/23/23	0.5357	26.00%	11.80%	0.6037	25.00%	7.50%	0.7098
1/30/23	0.5256	26.00%	11.80%	0.5924	25.00%	7.50%	0.6964
2/6/23	0.5139	24.90%	11.00%	0.5783	25.00%	7.50%	0.6809
2/13/23	0.4973	24.90%	11.00%	0.5596	25.00%	7.50%	0.6589

Table 1 Cont'd. Actual spot rate and predicted rates based on IFE and PPP

Date	Actual Spot rate (UAH/RUB)	Ukraine (weekly) Inflation Rate	Russia (weekly) Inflation Rate	Spot Rate Based on PPP	Ukraine i (annualized interest rates)	Russia i (annualized interest rates)	Spot Rate Based on IFE
2/13/23	0.4973	24.90%	11.00%	0.5596	25.00%	7.50%	0.6589
2/20/23	0.4894	24.90%	11.00%	0.5507	25.00%	7.50%	0.6485
2/27/23	0.4918	24.90%	11.00%	0.5534	25.00%	7.50%	0.6516
3/6/23	0.4889	21.30%	3.50%	0.573	25.00%	7.50%	0.6478
3/13/23	0.4891	21.30%	3.50%	0.5732	25.00%	7.50%	0.6481
3/20/23	0.4822	21.30%	3.50%	0.5651	25.00%	7.50%	0.6389
3/27/23	0.4828	21.30%	3.50%	0.5658	25.00%	7.50%	0.6397
4/3/23	0.4705	17.90%	2.30%	0.5422	25.00%	7.50%	0.6234
4/10/23	0.4525	17.90%	2.30%	0.5215	25.00%	7.50%	0.5996
4/17/23	0.45	17.90%	2.30%	0.5186	25.00%	7.50%	0.5963
4/24/23	0.4536	17.90%	2.30%	0.5228	25.00%	7.50%	0.601
5/1/23	0.4579	15.30%	2.50%	0.5151	25.00%	7.50%	0.6067
5/8/23	0.4754	15.30%	2.50%	0.5348	25.00%	7.50%	0.6299
5/15/23	0.4632	15.30%	2.50%	0.521	25.00%	7.50%	0.6137
5/22/23	0.459	15.30%	2.50%	0.5163	25.00%	7.50%	0.6082
5/29/23	0.456	15.30%	2.50%	0.5129	25.00%	7.50%	0.6042
6/5/23	0.4573	12.80%	3.30%	0.4994	25.00%	7.50%	0.6059
6/12/23	0.4393	12.80%	3.30%	0.4797	25.00%	7.50%	0.5821
6/19/23	0.4407	12.80%	3.30%	0.4812	25.00%	7.50%	0.5839
6/26/23	0.4377	12.80%	3.30%	0.478	25.00%	7.50%	0.58
7/3/23	0.4128	11.30%	4.30%	0.4405	22.00%	7.50%	0.5346
7/10/23	0.4081	11.30%	4.30%	0.4355	22.00%	7.50%	0.5285
7/17/23	0.4077	11.30%	4.30%	0.4351	22.00%	7.50%	0.528
7/24/23	0.4085	11.30%	4.30%	0.4359	22.00%	8.50%	0.5331
7/31/23	0.4041	11.30%	4.30%	0.4312	22.00%	8.50%	0.5274
8/7/23	0.3864	8.60%	5.20%	0.3989	22.00%	8.50%	0.5043
8/14/23	0.3809	8.60%	5.20%	0.3932	22.00%	8.50%	0.4971
8/21/23	0.3952	8.60%	5.20%	0.408	22.00%	12.00%	0.5296
8/28/23	0.391	8.60%	5.20%	0.4036	22.00%	12.00%	0.5239
9/4/23	0.3814	7.10%	6.00%	0.3854	20.00%	13.00%	0.5073
9/11/23	0.3887	7.10%	6.00%	0.3927	20.00%	13.00%	0.517
9/18/23	0.3835	7.10%	6.00%	0.3875	20.00%	13.00%	0.5101
9/25/23	0.388	7.10%	6.00%	0.392	20.00%	13.00%	0.516
10/2/23	0.373	5.30%	6.70%	0.3681	16.00%	14.00%	0.4849
10/9/23	0.3674	5.30%	6.70%	0.3626	16.00%	14.00%	0.4776
10/16/23	0.3741	5.30%	6.70%	0.3692	16.00%	14.00%	0.4863
10/23/23	0.3878	5.30%	6.70%	0.3827	16.00%	14.00%	0.5041
10/30/23	0.3938	5.30%	6.70%	0.3886	16.00%	14.00%	0.5119
11/6/23	0.3891	5.10%	7.50%	0.3804	16.00%	15.00%	0.5097
11/13/23	0.3944	5.10%	7.50%	0.3856	16.00%	15.00%	0.5167
11/20/23	0.4071	5.10%	7.50%	0.398	16.00%	15.00%	0.5333
11/27/23	0.407	5.10%	7.50%	0.3979	16.00%	15.00%	0.5332
12/4/23	0.3995	5.10%	7.40%	0.3909	15.00%	16.00%	0.5233
12/11/23	0.4062	5.10%	7.40%	0.3975	15.00%	16.00%	0.5321
12/18/23	0.4115	5.10%	7.40%	0.4027	15.00%	16.00%	0.5391
12/25/23	0.4093	5.10%	7.40%	0.4005	15.00%	16.00%	0.5362

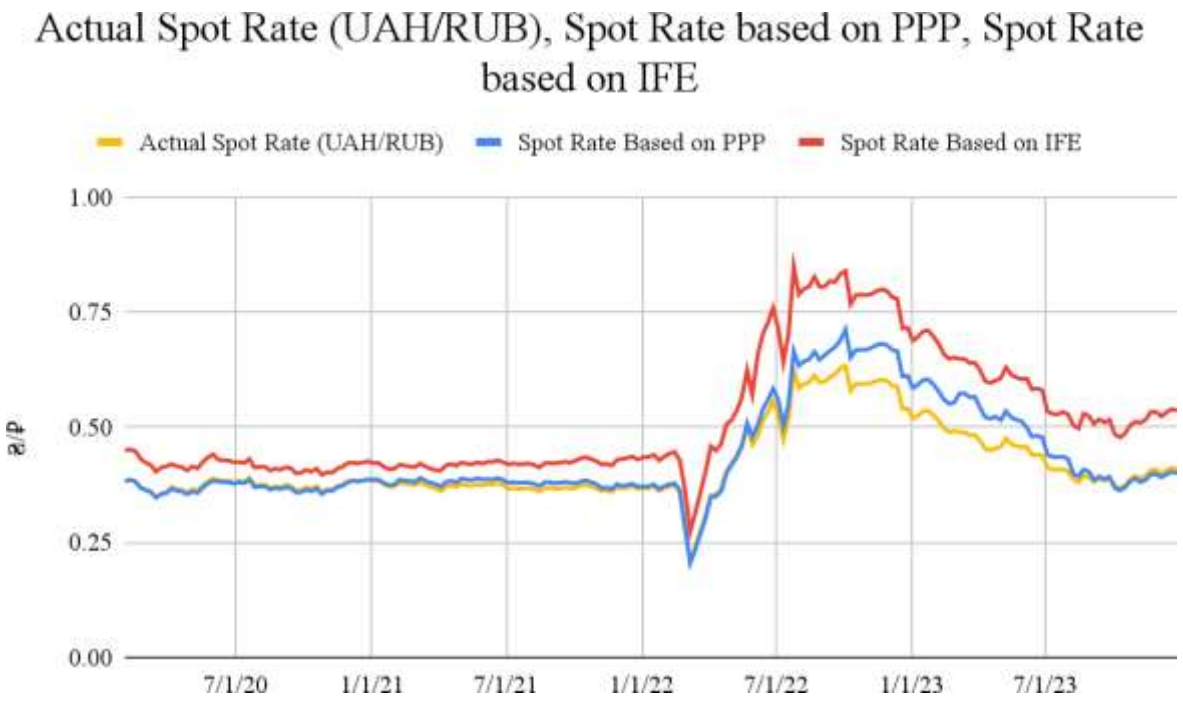


Figure 2. Actual, PPP and IFE spot rate estimations

Figure 3. PPP and IFE estimations of future spot rates

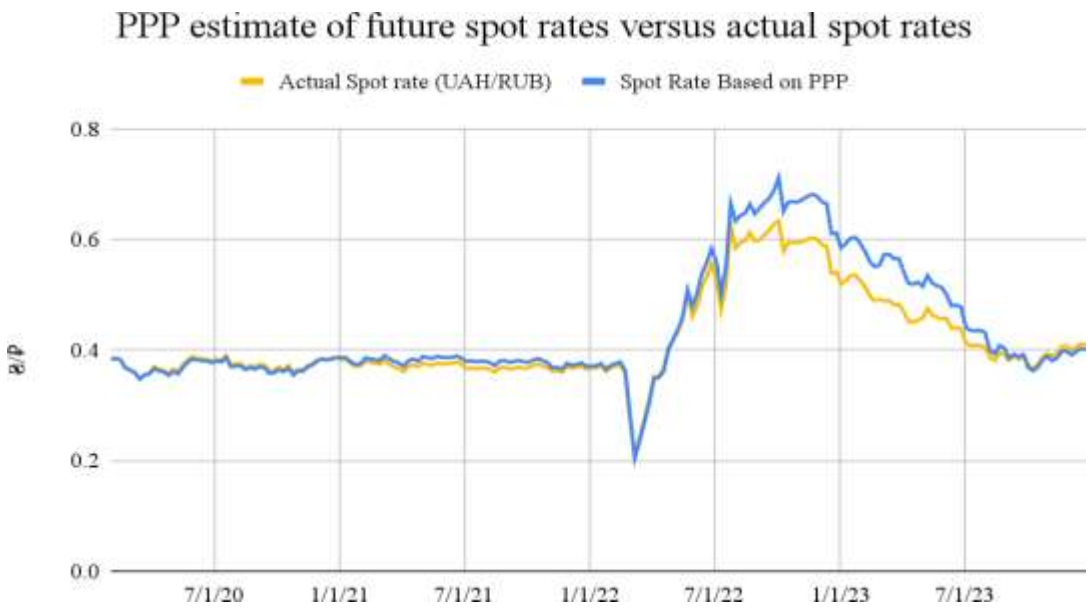


Figure 4. PPP estimates of future spot rates versus actual spot rates

Although the PPP, and particularly the IFE, do not precisely confirm actual future spot rates, these estimations support that inflation rate and the inflation rate differential between the home nation (Ukraine) and foreign nation (Russia) are factors contributing to the change in future exchange rates. From an analysis of Table 1 and Figure 4, it should be noted that the spot rate responds to the change in the inflation rate differential between the two countries. This can be concluded as actual spot rate and expected spot rate using PPP (a measure of inflation rate differential) follow a very close directional trend. The data in Table 1 shows that inflation rates in the home country gradually increase and then decrease. In order to analyze the influence on exchange rates, we looked at the inflation rate differential trend and the actual spot rates in Figure 5. The inflation rate differential was calculated using the following calculation:

$$Inflation\ rate\ differential = \frac{I_h - I_f}{1+I_f}$$

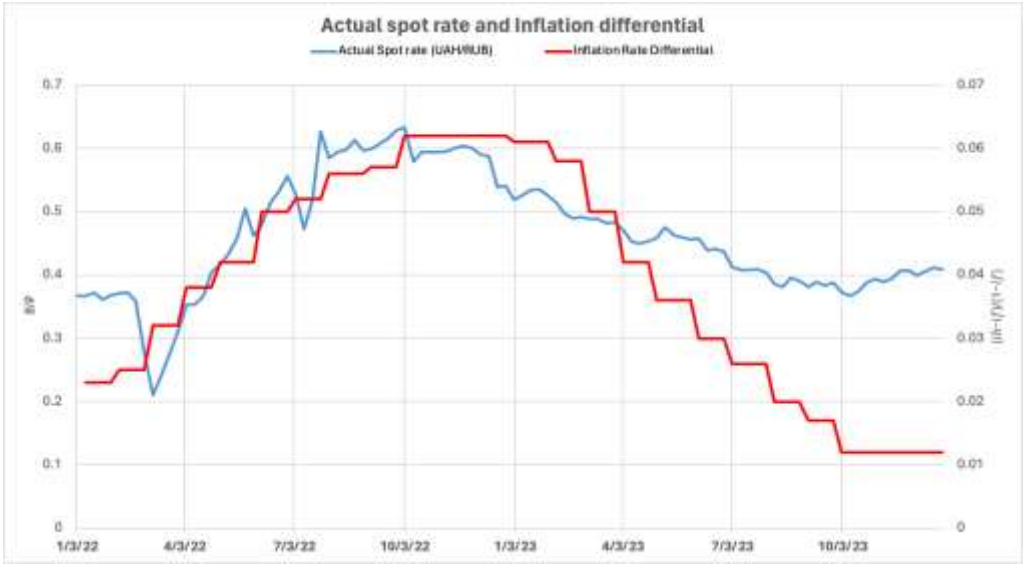
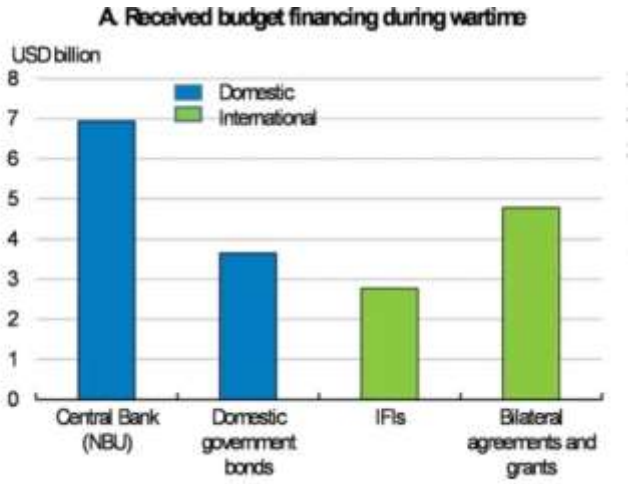


Figure 5. Actual spot rate and Ukraine inflation trend

Several findings are evident from the correlation between actual spot rate and inflation rate differential in Figure 5, which observes the inflation rate differential during the height of conflict (from the beginning of 2022 to the end of 2023). When the inflation rate differential between Ukraine and Russia is increasing, it is clear that the value of the Hryvnia relative to the Ruble is decreasing. That is, the spot rate is increasing. Conversely, a decrease in the inflation rate differential is followed by the appreciation of the Hryvnia, and gradually decreasing spot rates. Overall, the increasing spot rate ₴/₽ reflects the depreciation of the Hryvnia relative to the Ruble and an increasing inflation rate differential. This supports our hypothesis H3, which postulates that the depreciation of the Hryvnia correlates with the increasing inflation rate in Ukraine.

In order to more accurately evaluate the cause of rising inflation rates in Ukraine as a factor in increasing the spot rate ₴/₽, we considered the relationship between the increase in Ukraine's financing due to conflict and the implications for the value of the Ukrainian Hryvnia. The conflict between Russia and Ukraine caused significant shortages in supplies and food. Ukraine is a leading exporter in grain. Exports of wheat plummeted after the initial invasion of Ukraine, increasing the price of food within the nation and causing widespread food insecurity. According to the Organization for Economic Co-operation and Development, approximately 30% of Ukraine's crops were not planted in 2022 due to labor shortages and reduced incomes. With imports and exports at an all-time low, financial pressures rose, which increased inflation rates.

In addition, the Central Bank of Ukraine increased budgeting during wartime in order to support macroeconomic stability, as illustrated in Figure 6.



Note: Panel A: State budget financing between February 24 and June 22, 2022.

Figure 6. Domestic and International financing during conflict

In the short term, the large amount of financial inflows from domestic and international sources creates inflationary pressures, which is evident from our analysis. While the increase in financial inflows is necessary to maintain short-term stability, the lack of production and increasing labor shortages within Ukraine exacerbated inflationary pressures. As the OECD shares, Ukraine must establish a long-term strategy to mitigate sustained inflationary pressures. As the data in Table 1 shows, inflation rates gradually decreased towards the end of 2023 (Phase 3).

Considering these factors, the increasing inflationary pressures due to supply disruptions and an increase in budget financing can be considered a significant contributing factor in the future spot rates ₴/₽, as hypothesized in H3.

From an analysis of Table 1 and Figure 2, it is clear that the spot rates ₴/₽ fluctuate during the specified time frame. To evaluate the volatility of spot rates, we calculated the standard deviation of actual spot rates, spot rates based on PPP, and spot rates based on IFE using the following equation:

$$Volatility = \sqrt{\frac{\Sigma(x_i - \mu}{N}}$$

The volatility of actual spot rates, spot rates based on PPP, and spot rates based on IFE are 9.46%, 12.10%, and 13.49%,

respectively. The high levels of volatility can be attributed to the uncertainty in different factors during the Russia-Ukraine conflict, and reflects the sensitivity of spot rates relative to these factors. The volatility of actual spot rates (9.46%) is influenced by political events, such as new policies implemented to mitigate instability. Volatility is also influenced by traders' perceptions of the value of the foreign exchange market during the war.

The inflation strongly influences the volatility of estimated spot rates using PPP (12.10%) rate differential, as discussed above. Volatile shifts in the availability of goods contribute to these fluctuations. The volatility of estimated spot rates using IFE (13.49%) is influenced by the changes in interest rates, and particularly interest rate policies implemented throughout conflict. Looking at Ukrainian annualized interest rates in Table 1, it should be noted that interest rates remain constant for several months at a time. For example, from 01/03/2022 to 05/30/2022, the interest rate is at an annual rate of 10.00%. From 06/06/2022 to 06/26/2023, the interest rate rose to an annaul rate of 25.00%. It can be concluded that interest rates spike after the invasion, and continue to rise until June 2023. According to the Center for Global Development, efforts to fight inflationary pressures often include interest rate hikes. We can observe that towards the end of 2023, interest rates are gradually decreasing, as Ukraine has implemented fixed interest costs. Overall, these observations confirm hypothesis 2, which postulates that conflict will result in volatility of exchange rates.

5. Conclusion and Discussion

The focus of this study was to explore the impact of the Russian invasion of Ukraine on foreign exchange rates, especially on Russian Ruble with regard to Ukraine Hryvnia. Our conclusions support our initial hypotheses. However, some potential limitations should be discussed. In collecting data on inflation rates and interest rates to predict spot rates based on PPP and IFE, we encountered some difficulties in finding accurate data, particularly for Ukrainian and Russian interest rates. This is likely due to the government restrictions on privacy. This is an important limitation to consider, as there could be discrepancies in the credibility of the data collected. In general, the availability of accurate data in areas of high conflict can be limited, and the completeness of the data can be affected.

Additionally, we concluded that inflation rates were directly impacted by decreased food and supplies and increased financial budgeting. It should be noted that additional factors may have an influence on spot rate fluctuations, which were not explored in our research. Further research must be conducted to evaluate the potential impact of political instability and specific government policies as contributing factors to the depreciation of the Hryvnia. Despite these limitations, we believe that our analysis provides significant reason to conclude that the conflict between Russia and Ukraine has had an impact on trade and supply, with consequences of rising inflation contributing to the depreciation of the Ukrainian Hryvnia relative to the Russian Ruble.

Ukraine has continued to implement policies to mitigate macroeconomic challenges due to the war. The damage to Ukraine’s economy requires a long-term process to recovery. Our analysis shows that actual spot rates have gradually decreased, but are still not at the same level as before the conflict. As of May 2024, the actual spot rate ₴/₽ is 0.4382. Although this is greater than the exchange rate pre-conflict, there has been more stability in the spot rate for the last year. Conflict has amplified the economy's weaknesses, and these challenges are expected to ensue.

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Authors’ contributions

Dr. Hoje Jo was responsible for study design, writing and revising of the paper. Olivia Venderby was responsible for study design, data collection, empirical analysis, and writing of the paper. All authors read and approved the final manuscript. Both authors contributed equally to the study.

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Competing interests

The authors declare that we have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Obtained.

Ethics approval

The Publication Ethics Committee of the Sciedu Press.

The journal and publisher adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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