Testing for Causality between Remittances and Inflation: Evidence from Central and Eastern Europe

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Summary: The goal of this study is to examine the impact of remittance inflow on inflation using the System Generalized Method of Moments (SGMM) and Dumitrescu-Hurlin Granger causality approach in countries from Central and Eastern Europe over the period 1994 to 2019. As the levels of economic and financial development vary considerably across these countries and some of them are member states of the European Union (EU), we split them into two more homogenous groups — EU member states and non-EU countries. The application of the SGMM approach reveals that remittances have a negative and significant impact on inflation in the non-EU countries, whereas they exert positive impact in the EU member states and in the whole region overall. The Granger causality test shows a unidirectional causal relationship between remittances and inflation in all country groups, whereas the existence of a positive causal relationship from remittances to inflation has been established in twelve countries.

Keywords: Inflation, Remittances, Central and Eastern European countries, Dumitrescu-Hurlin Granger causality approach, system GMM
JEL Classification: C23; E61.

1. Introduction

In this paper, we empirically explore the effects of remittances on inflation in a group of 20 countries from Central and Eastern Europe over to 2019. Central and Eastern Europe is one of the most relevant remittance-recipient regions in the world. This is mainly because of the large number of emigrants from this region predominantly as a result of economic motives and the strong ties that the emigrant population maintains with the families in their country of origin (Mihail Petkovski et al**.,** 2011). Considering that the economic and financial development vary considerably across countries and that some countries are member states of the European Union, we

find it convenient to split them into two groups — EU member states (EU-11) and non-EU countries(NEU-9) — which further enables us to study the differences and derive the characteristics that can be attributed to the EU membership. To test the relationship between remittances and inflation, we apply the System Generalized Method of Moments (SGMM), which takes into account the substantial number of parameters and allows to deal with the potential endogeneity problem.

This paper contributes to the economic literature in the following ways. First, it enriches the strand of literature on inflation with a study that identifies the remittance inflow as a potential factor, which may be of particular importance for future research on the topic. Second, it also enriches the literature on the topic covering the region of Central and Eastern Europe, especially because the countries in this region have higher emigration rates to the more developed countries and are thereby subject to higher levels of remittance inflow. Third, this paper may be helpful for policy makers because its intent to identify the factors leading to the established relationship may provide valuable knowledge in the process of conceiving specific economic policies.

The rest of the paper is organized as follows. Section 2 briefly reviews the related existing literature on the relationship between remittances and inflation. Sections 3 to 4 define the variables used in the model and describe the differences across countries and country groups, as well as the main trends in the time evolution of the variables. Section 5 presents the detailed methodology applied to investigate the relationship and Section 6 reports the main findings from the empirical analysis. Section 7 concludes with final remarks and explanations.

2. Literature review

This section gives a brief overview of the empirical literature concerned with the relationship between remittances and inflation. The reviewed literature consists of both papers studying single countries (Hiranya Nath and Ulyses Balderas, 2008; Anum Nisar and Saira Tufail 2013; Zakir Khan and Shamimul Islam, 2013) and papers analyzing panels of multiple countries (Nicolas Glytsos, 2002; Narayan et al., 2011; Christopher Ball et al.,2013; Ali Termos et al., 2013; Rashid Sbia and Hamdi Helmi 2020). In general, the literature examining the impact of remittances on inflation is recent and scarce, yet the findings in most of the studies are compatible with the existence of inflationary pressure caused by remittance inflows.

Glytsos (2002) builds a Keynesian-type econometric model for investigating the short- and long-term multiplier effects of remittances on consumption, investment, imports, and output using data on five Mediterranean countries. The author reveals that a uniform country performance of instability and uncertainty with great temporal and intercountry fluctuations of remittance effects. The findings point out to different intercountry priorities of remittance spending and to an asymmetric impact of remittance changes in the sense that the good done to growth by rising remittances is not as great as the bad done by falling remittances.

Using generalized impulse responses derived from a vector auto regression (VAR) model, Nath and Balderas (2008) examined the effects of remittances on inflation and the distribution of relative price changes in Mexico for the period 1980 to 2005. Their results show that remittances have little impact on inflation and relative price volatility throughout the entire period.

Using a sample consisting of 54 developing countries over the period 1995 to 2004, Narayan et al. (2011) analyzed the determinants of inflation based on the panel dynamic estimator developed by Manuel Arellano and Stephen Bond (1991) and the system GMM estimator by Manuel Arellano and Olympia Bover (1995).The results showed that remittances lead to an increase in inflation, and the effect becomes more obvious in the long run. Furthermore, openness, debt, current account deficits, the agricultural sector, and the short-term interest rate in the United States appeared to have a significant positive effect on inflation. An interesting result indicated that progress in democracy decreases inflation. However, this research was conducted using statistical data for a period of 10 years (1995–2004), and it pays no attention to the remittance inflows in the developing countries from Asia and the Pacific. In addition, this study does not go into an in-depth analysis of the causal effect between remittances and inflation during the research period.

Khan and Islam (2013) applied vector autoregressive (VAR) techniques to empirically analyze how remittance inflows affect the inflation rate in Bangladesh over the period 1972 to 2010. Their empirical results conclude that a 1% increase in remittance inflows causes the inflation rate to rise by around 2.48% in the long run, whereas no significant relationship is observable between these two variables in the short run.

By applying the cointegration technique developed by Søren Johansen (1988) and Søren Johansen and Katarina Juselius (1990) over the period 1970–2010, Nisar and Tufail (2013) investigated the impact of remittances on inflation, including food inflation, footwear and textile inflation as well as housing and construction inflation in Pakistan. The results show that remittances have a positive impact on inflation and its different categories.

The study conducted by Termoset et al. (2013) investigated the impact of remittance outflows on inflation in the countries of the Gulf Cooperation Council (GCC). In their study, the authors applied three panel estimations techniques, including ordinary least squares (OLS), fixed effects (FE) and the Anderson–Hsiao (AH) estimator. The empirical analysis revealed that the remittance outflows reduce the inflation pressures in the GCC countries. Furthermore, their results show that remittance outflows in the analyzed countries play a stabilization role.

Using panel vector auto regression techniques and quarterly data for 21 emerging countries, Ball et al. (2013) examined the effect of remittance on inflation. Their theoretical model predicts that remittances temporarily increase the domestic money supply and inflation under a fixed exchange rate regime while temporarily generating no change in the money supply, decreasing the inflation and appreciating the real exchange rate under a flexible exchange rate regime.

Khurshid et al. (2016) used the System Generalized Method of Moments (SGMM) and bootstrap panel Granger causality approach to analyze the effect of remittances on inflation in 58 countries from low-income, lower-middle–income, and middle-income groups. The results of the SGMM approach show that remittances have a negative and statistically significant impact on inflation in low-income and lower-middle–income countries, while positively influencing it in the middle-income ones. Furthermore, remittances used for consumption and saving cause inflationary situations only in low-income and lower-middle–income groups. The bootstrap panel Granger test results show that remittances have a strong impact on the prices in lower-middle–income countries.

Abosedra and Fakih (2017) have examined the impact of remittances and inflation in the case of Lebanon. The results indicated a long run significant rise in the prices of consumption items; however, on short run, positive shocks to remittances lower the prices of maximum consuming items.

Thapa and Acharya (2017) have carried out the research study in Nepal and concluded that it was a variation in different categories of consumption items; this showed that the rise in remittances had very important implication on relative prices.

Ghauri et al. (2019) investigate the effects of workers' remittances (WR) on long-term inflation in the case of Pakistan. The results of this research concluded a long-term association between remittances and general inflation (CPI and WPI) under a flexible exchange rate regime that shows that the long-term influence of remittances causes an inflationary effect in the economy when the type of change is included in the findings. The results of this study also concluded that workers' remittances cause the wholesale price index and the consumer price index because both the CPI and the WPI are the indicators of inflation, therefore, in the case of the Pakistani economy, remittances are responsible for increasing inflation in the country and the reason behind this inflation is the adverse use of these remittances.

Sbia and Hamdi (2020) investigated the impact of remittance outflows on inflation for a panel of 14 OPEC countries during the period 1980 to 2010. The empirical results of the bias-corrected least-squares dummy variable estimator reveal that remittance outflows have no effect on inflation rate, whereas trade openness and current account deficits have a positive impact. Additionally, the oil price appears to have no effect on inflation in the OPEC countries.

Unlike the results of most empirical studies, John Paulo Rivera and Tereso Tuallo Jr. (2020) argued that remittances were not necessarily inflationary in Philippines during January 2000 to October 2019 using a VAR model. Rivera and Tuallo Jr. found that the impact of any shock in remittances on inflation was absorbed in the short run, implying that there is no relationship between remittances and inflation.

Syed Margub Elahi and Hasanur Rahman (2021) using data from 1976 to 2019 have estimate the nexus between remittance and inflation in Bangladesh. The results of the Augmented Dickey Fuller (ADF) unit root indicate that the variables are stationary at mixed order like as I(0) and I(1). Through the ADF test, this study conducts a dynamic autoregressive distributed lag (ARDL) model while considering

the linear trend. The remittance has a significant and positive impact to raise inflation in the short run but is insignificant in the long run. The estimation found the speed of adjustment, error correction term (ECT) is 69% and bound testing criteria indicate the long-run association among the variable. This investigation also concludes that the exchange rate has a positive impact on inflation where the real exchange rate has no positive impact to raise inflation in Bangladesh.

Given the results from the foregoing studies, there seems to exist a research gap, and there is a room for more research with regard to the relationship between remittance inflows and inflation, especially in the case of the recipient countries from Central and Eastern Europe. Moreover, almost none of the past studies include countries from this region, especially countries that are not EU member states. The choice of statistical method is important in empirical analysis (Nazlioglu *et al*., 2011). The abovementioned empirical studies are mostly country-specific and suffer from data and methodological limitations. This study constructed a new remittances series by adding "past household consumption resulting from the remittance inflow," and "saving resulting from the remittance inflow worker remittances," to overcome the data limitation.

Because of a significant number of parameters, limited observations and the potential endogeneity problem, the use of ordinary least squares (OLS), fixed and random effects are not suitable in this case. Therefore, the use of system generalized method of moment regression (SGMM) can be more useful in this situation. Also, the economic and social conditions in each economy are different. Basically, monetary and fiscal policy, exchange rate regime and the level of unemployment, productivity and remittances as a share of the economy are different. So, the effect of remittances on prices may vary from country to country. This study fills this gap using bootstrap panel Granger causality test along with cross-sectional dependency and the slope homogeneity approach.

This study makes a contribution to the existing literature by providing further evidence of a relationship between inflation and remittance. It is the first research that examines the causality between the remittances and inflation taking countries from Central and Eastern Europe.

3. Data and variables

To determine the impact of remittances on inflation in Central and Eastern Europe, we construct a sample of 20 countries from this region — namely, Albania, Armenia, Bosnia and Herzegovina, Bulgaria, Belarus, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Montenegro, Macedonia, Moldova, Poland, Romania, Serbia, Slovakia, Slovenia, and Ukraine — and use a panel-regression analysis.

The selection of countries is mainly based on similarities in terms of not only historical and socioeconomic developments but also in the geographical and cultural familiarity between the sampled countries. On the other hand, there are also differences among countries that make them collectively a quite heterogenous group,

which mostly reflect through the high disparities observed with respect to the level of public debt, GDP growth, GDP per capita growth, EU membership, etc. Now that the economic and financial development considerably varied across the sampled countries and that some of them have become EU member states at various points of the analyzed period, we find it highly convenient to use the EU membership as a rationale to divide the sample into two subsamples. The first is a group of EU member states (EU-11), i.e., countries that have acceded to the European Union during the analyzed period, and it includes Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. The second is a group of non-EU countries (NEU-9), i.e., countries that have not been part of the European Union throughout the entire period, and it includes Albania, Armenia, Belarus, Bosnia and Herzegovina, Macedonia, Moldova, Montenegro, Serbia, and Ukraine. We note that the data series for Serbia and Montenegro are incomplete because they were part of a single country until 2006.

The variables that choose for the empirical model are in line with the related literature, such as Khurshid et al. (2016) and Sbia and Hamdi (2020).We use the personal remittance inflow as a measure of remittances; the consumer price index as a measure of inflation (the inflation rate is taken as a more convenient measure for the descriptive statistics and the study of the time evolution); and the annual GDP growth rate, foreign direct investment net outflow, gross national expenditure, gross domestic savings, household final consumption expenditure and trade as control variables. The data for the selected variables were obtained from World Bank's World Development Indicators (WDI) database. Table 1 presents the variables in the model in greater detail.

Table 1: Definition of variables.

Variable	Abbreviation	Unit	Source
Remittance inflow	REM	per cent of GDP	World Development Indicators
Consumer price index	CPI	index (2010 = 100)	World Development Indicators
Inflation	INF		World Development Indicators
Annual GDP growth rate	GDPG	per cent	World Development Indicators
Foreign direct investment net outflow	FDI	per cent	World Development Indicators
Gross national expenditure	GNE	per cent of GDP	World Development Indicators
Gross domestic savings	GDS	per cent of GDP	World Development Indicators
Household final consumption expenditure	HHFC	per cent of GDP	World Development Indicators
Trade	TRD	per cent of GDP	World Development Indicators
		per cent of GDP	

Notes: Consumer price index is used in the econometric model, while inflation is used in the descriptive statistics.

4. Descriptive statistics and trends

In this section, we present the descriptive statistics for all countries and the two country groups, and we additionally discuss the main trends in the evolution of the selected variables over time.

Table 2: Descriptive statistics.

Country group	Measure	Variable							
		REM	INF	GDPG	FDI	GNE	GDS	HHFC	TRD
NEU-9	Mean	10.2	17.9	3.3	4.9	117.8	7.2	75.5	94.1
	Median	9.9	5.2	3.6	3.7	117.9	6.3	76.3	94.9
	St. Dev.	8.3	69.8	5.9	4.4	12.1	12.2	12.7	25.7
	Min.	0.0	-1.6	-30.9	-0.4	94.5	-17.5	48.1	13.4
	Max.	48.2	891.2	22.9	37.3	153.3	38.4	106.1	158.0
	Obs.	202	224	219	204	215	216	216	226
EU-11	Mean	1.8	43.2	3.3	4.4	102.4	22.4	58.6	110.7
	Median	1.4	3.4	3.8	3.3	101.7	22.4	59.0	106.9
	St. Dev.	1.6	350.1	4.0	7.0	6.0	5.8	6.2	34.1
	Min.	0.0	-1.6	-14.8	-40.4	87.3	8.8	46.1	43.7
	Max.	8.1	5,273.4	13.0	54.2	120.7	34.8	77.5	190.5
	Obs.	286	279	282	285	282	282	283	282
All	Mean	5.3	31.9	3.3	4.6	109.0	15.8	66.0	103.3
	Median	2.5	3.8	3.7	3.5	105.7	18.7	62.8	99.3
	St. Dev.	6.8	265.0	5.0	6.1	11.9	11.9	12.7	31.7
	Min.	0.0	-1.6	-30.9	-40.4	87.3	-17.5	46.1	13.4
	Max.	48.2	5,273.4	22.9	54.2	153.3	38.4	106.1	190.5
	Obs.	202	503	501	204	215	216	216	226

The summary statistics are reported in Table 2. Noticeable differences between the EU member states and the non-EU countries can be observed with the respect to the remittance inflow. Namely, the average remittance inflow in the NEU-9 group accounts for 10.2% of GDP, whereas this share for the EU-11 group is only 1.8% of GDP over the entire period. Bosnia and Herzegovina has recorded the highest value of 48.2% of GDP in 1998, whereas Belarus had the lowest value of only 0.04% of GDP in 1994. Of the countries that joined the EU, Bulgaria received the maximum remittance inflow of 8.1% of GDP in 2003. The EU member states countries' average higher inflation rate of 43.2% against that of 17.9% for the non-EU countries. Countries from both groups have experienced hyperinflation in the second half of the 1990s, which is the primary factor for such high mean values. As for the annual GDP growth rate, both country groups have a mean growth rate of 3.3%. It is important to note that the volatility of the GDP growth rate has been larger in the group of non-EU countries. For instance, Moldova had a large slump of GDP by 30.9% in 1994, whereas Belarus experienced a GDP growth of 22.9% in 1997. The FDI net outflow is similar across country groups with a mean of 4.9% of GDP for NEU-9 and 4.4% of GDP for EU-11. The NEU-9 countries have somewhat higher gross national expenditure on average, although in both groups, it exceeds the amount of GDP. Furthermore, the NEU-9 countries also have higher household final consumption with

an average of 75.5% of GDP against the mean value of 58.6% in the EU-11 countries, whereas the EU-11 group has three times higher gross domestic savings. Finally, the EU member states have greater trade openness with a mean share of the trade to GDP of 110.7%, whereas the mean share for the non-EU countries is 94.1%. The last conclusion is not surprising at all given the trade liberalization resulting from the accession to the European Union.

The time evolution of the variables is depicted in Figures 1 to 8. In general, the trends are very similar across country groups for all variables, although there are some differences that need to be pointed out. First, the remittance inflow for the NEU-9 group has experienced two sudden pick-ups — the first one in 1998 and the second one in the mid-2000s — and has been decreasing in the 2010s. On the other hand, the EU-11 group records gradual increase over time with fairly constant levels during the 2010s. Second, the trend of the FDI net outflow for both groups has drastically changed after the global crisis of the late 2000s. Namely, the GDP growth rate of the non-EU countries has been more stable than the one of the EU member states experiencing frequent ups and downs. Third, the trade openness of both groups was evidently at the same level until 2004 when the trade of the EU-11 group started to grow rapidly and created a substantial gap with the NEU-9 group. This trend is not something unexpected given that the period coincides with the first wave of accession to the European Union, meaning that the EU member states began to reap the benefits regarding the trade liberalization from their EU membership thereafter.

Figure 1:Average remittance inflow over time .

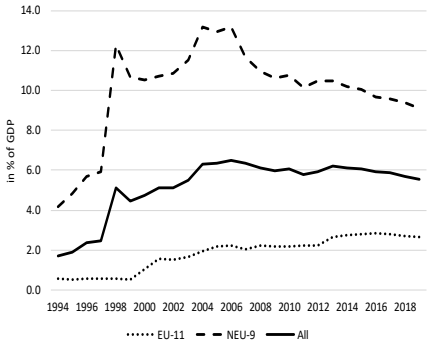


Figure 2:Average inflation rate over time.

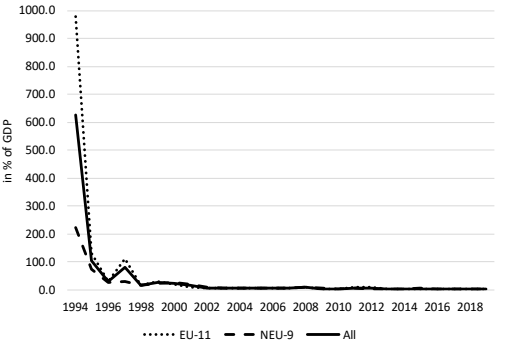


Figure 3:Average annual GDP growth

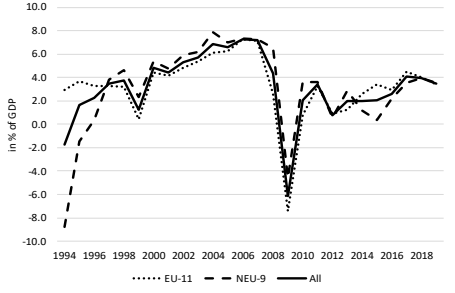


Figure 4: Average FDI net outflow over time rate over tim

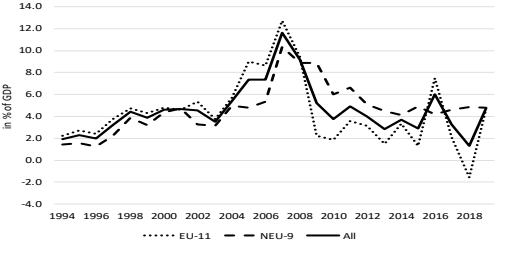


Figure 5: Average gross national expenditure over time

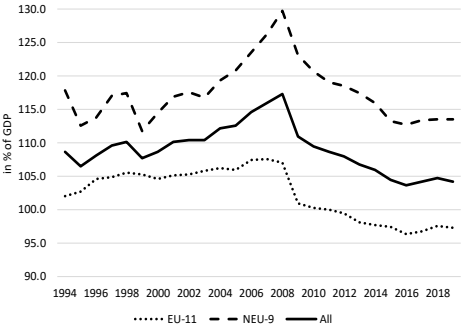


Figure 6: Average gross domestic savings over time

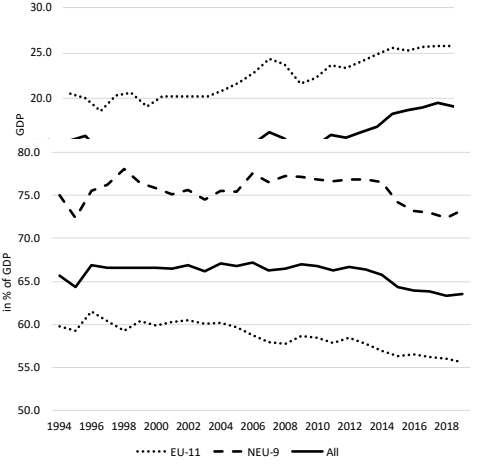


Figure 7: Average household final consumption expenditure over time.

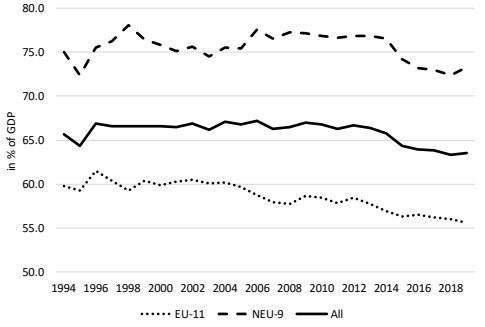
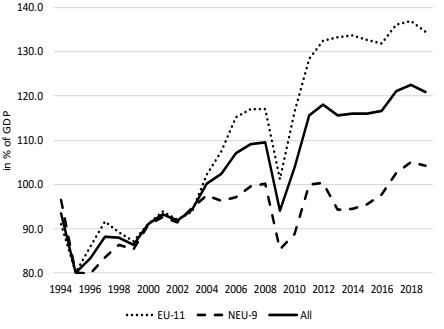


Figure 8: Average trade over time.



5. Methodology

This section explains the methodology used to empirically study the effect of remittances on inflation and we divide it into two parts. In the first part, we inspect the impact of remittances on inflation in each group. In the second part, we estimate the

causal relation between remittances and inflation in each group while also assessing the relation across individual economies.

5.1. Group Effect Using System General Method of Moments (SGMM)

To analyze the impact of remittance inflow on inflation in 20 countries from Central and Eastern Europe, we conducted a panel data analysis. Maddala, G.S, and Shaowen Wu (1999) argue that one of the main advantages of panel data compared with other types of data is that the approach allows for testing and adjustment of the assumptions that are implicit in cross-sectional analyses. In addition, Cheng Hsiao (2014) induces the following benefits of conducting a panel-regression analysis:(1) increasing degrees of freedom and reducing the problems of data multicollinearity, (2) constructing more realistic behavioral models and discriminating between competing economic hypotheses, (3) eliminating or reducing estimation bias, (4) obtaining more precise estimates of micro relations and generating more accurate micro predictions, (5) providing information on the appropriate level of aggregation, and (6) simplifying cross-sections or time series data inferential procedures.

In our analysis, we start with the pooled ordinary least squares (OLS) estimator. As noted in earlier studies, the process of estimation encounters the problems of heterogeneity and endogeneity, which produce inconsistent and biased estimates with the pooled ordinary least squares (OLS) estimator (Jaejoon Woo and Manmohan Kumar, 2010; Cathrine Pattillo et al., 2002). Namely, the regression model applying pooled OLS fails to account for the unobserved country-specific effects that vary across countries. Thereby, the result may be affected by an omitted variable bias (Pattillo et al., 2002) and the analysis continues with the evaluation of the models with fixed (FEM) and random effects (REM).

With the fixed-effects model, we assume that the units of interest (in our case, countries) are fixed, and that the differences between them are not of interest. On the other hand, with the random model, we assume that the units are a random sample extracted from a larger population. Accordingly, for our analysis of the 20 countries from Central, Eastern, and Southeastern Europe, the model of fixed effects will be adequate, because the data set covers almost all countries from this region and the conclusions drawn from this analysis will only apply to them. In addition, we will also conduct the statistical test of Hausman (1978) for distinguishing between the models of fixed and random effects.

The specification (1) of the empirical model with fixed effect is as follows:

$$y_{it} = x_{it}\beta + \tau_t + \delta_i + \varepsilon_{it} \qquad (1)$$

i and t are the indices of countries and years, respectively; τ_t's denote time effects to capture macroeconomic circumstances; δ_i's are called unobserved country fixed

effects; ε_{it}'s are all unobserved idiosyncratic errors (i.i.d); is the inflation of country *i* in period *t*,x_{it}'s contain control variables, and β is the coefficient vector that we are interested in. Thus, we estimate models with fixed effects estimator, allowing for the correlation between δ_i and x_{it}.

These econometric models control the heterogeneity in the sample and take into account the stationary FEM effects or specific modeled REM effects. However, the presence of a fixed effects panel estimation is likely to impose a correlation between the lagged endogenous variable and the residuals, thus rendering the results of the coefficient of the lagged initial level of CPI negatively biased (Pattillo et al., 2002). As a result, the use of OLS, FEM, and REM is not suitable in this case.

Bearing this in mind, we are more inclined to use a dynamic panel estimation (2) as follows:

$$y_{it} = \sum_{j=1}^{p} \alpha_j y_{i,t-j} + x_{it+}\beta + \tau_t + \delta_i + \varepsilon_{it} \quad (2)$$

This model includes lagged dependent variables, $y_{i,t-j}$. It also allows for the correlation between δ_i and x_{it} ($\text{cov}(\delta_i, x_{it}) \neq 0$). To capture the persistence of the assets of CPI and to eliminate the fixed effects (and their correlations), we difference the model and adopt the difference Generalized Method of Moments including the lagged difference of the dependent variable, was introduced by Arellano and Bond (1991).We use the one-step generalized method of moments estimator (GMM) developed by Arellano-Bond (1991), because according to Judson and Owen (1999), his estimator outperforms the two-step estimator both in terms of producing a smaller bias and a smaller standard deviation Then, we obtain

$$\Delta y_{it} = \sum_{j=1}^{p} \alpha_j \Delta y_{i,t-j} + \Delta x_{it+}\beta + \Delta\tau_t + \Delta\delta_i + \Delta\varepsilon_{it} \quad (3)$$

The dynamic model includes lagged dependent variables, $y_{i,t-j}$. It also allows for the correlation between δ_i and x_{it} ($\text{cov}(\delta_i, x_{it}) \neq 0$). In order to capture the persistence of the assets of OFI and to eliminate the fixed effects (and their correlations), we difference the model and adopt the difference Generalized Method of Moments including the lagged difference of the dependent variable, was introduced by Arellano and Bond (1991). We use the one-step generalized method of moments estimator (GMM) developed by Arellano-Bond (1991), because according to Judson and Owen (1999), his estimator outperforms the two-step estimator both in terms of producing a smaller bias and a smaller standard deviation. Then, we obtain

$$\Delta y_{it} = \sum_{j=1}^{p} \alpha_j \Delta y_{i,t-j} + \Delta x_{it+}\beta + \Delta\tau_t + \Delta\delta_i + \Delta\varepsilon_{it} \quad (4)$$

In the differenced model (4), there still exists a correlation between lagged values of dependent variable $\Delta y_{i,t-j}$ and the differenced errors, $\Delta \varepsilon_{it}$. According to Nickell (1981), the standard fixed effects estimator is not consistent, because this correlation produces biased estimates. Bearing this in mind, we employ the system-GMM estimator based on Arellano and Bover (1995) and Blundell and Bond (1998), which addresses the endogeneity problem caused by the correlation.

We deal with the potential problem of having too many instruments compared to the number of groups David Roodman (2009) by keeping the number of instruments lower than the number of countries. In the standard un-collapsed form, each instrumental variable creates one instrument for each time period and the lag attributable to that period; in the collapsed form, a single column vector of instruments is created instead of a whole matrix. Although collapsing can reduce the statistical efficiency in large samples, it can be a very helpful tool in avoiding the bias in finite samples, which are usually characterized by instrument proliferation. In other words, we control the number of instruments by limiting our analysis to two lags. The latter helps to avoid any bias because of the large number of instruments in a relatively small sample.

By applying this method, we assume that all the control variables are predetermined or endogenous. In this context, we follow Qiang Sun et al. (2016) and Khurshid et al. (2016) in adding one more variable — that is, age dependency ratio calculated as the share of young people of the working-age population — as an exogenous instrument in the regression equations, whereas the other variables are treated as predetermined or endogenous. The validity of the instruments selected can be tested using the Sargan test. In addition, we test the serial correlation in the residuals differentiated once[AR(1)] and twice[AR(2)]. According to Arellano and Bond (1991), the first-order autocorrelation in the differentiated residuals does not imply that the estimates are inconsistent but the second-order autocorrelation would imply that this is the case.

To estimate the impact of remittances on inflation, we follow Khurshid et al. (2016) and include two interaction terms with regard to CPI and add several other variables:

$$CPI_{i,t} = \alpha_0 + \alpha_1 CPI_{i,t-1} + \alpha_2 REM_{i,t} + \alpha_3 (REM \times HHCE)_{i,t-1} + \alpha_4 (REM \times GS)_{i,t} + \alpha_5 X_{i,t} + \varepsilon_{i,t} \quad (5)$$

where $CPI_{i,t-1}$ is the initial consumer price index, $REM_{i,t}$ denotes the remittance inflow, $(REM \times HHCE)_{i,t-1}$ is the past household consumption resulting from the remittance inflow, $(REM \times GS)_{i,t}$ represents the saving resulting from the remittance inflow, $X_{i,t}$ is a matrix comprising of the other explanatory variables — annual GDP growth, FDI net outflow, trade openness and final consumption expenditure — and $\varepsilon_{i,t}$ is the error term. As already mentioned before, we use the age dependency ratio as an

exogenous instrument in the regression equations. The estimation results of the equation given in (1) using the SGMM test are shown in Table 3.

5.2. Testing Cross-sectional Dependence

Before we move on to testing the causality in a panel framework suggested by Dumitrescu and Hurlin (2012), we first check the possible cross-sectional dependence across countries and subsequently apply the panel unit root test as per the procedure proposed by Mehmed Bölükbaş et al.(2018). In fact, we have witnessed significant cross-border movement of workers, financial integration, and international trade in the past decades, so it is reasonable to assume that a shock affecting one country can also affect the others in the panel. Hashem Pesaran (2006) indicates that ignoring the cross-section dependence — which implies that a shock that affects any of the units that make up the panel can affect other units as well —can lead to biased results. Taking this into account, it is important to see how the slope coefficients are treated —as homogeneous or heterogeneous. According to Clive Granger (2003), the causality running from one variable to another by imposing the joint restriction on the panel is the strong null hypothesis. Moreover, the homogeneity assumption for the parameter is unable to capture the heterogeneity because of the country-specific characteristics Jörg, Breitung and Samarjit Das (2005).

In the light of the foregoing elaboration and for the purpose of examining the cross-section dependence, we conduct the following three tests: the LM test Breusch Adrian Pagan, (1980), the CD test Pesaran (2004) CD test and the bias-adjusted LM test Pesaran et al., (2008).

To check for the presence of cross-sectional dependence, Breusch and Pagan (1980) proposed the Lagrange multiplier (LM) test. The technique of computing the LM test requires the estimation of the following model:

$$y_{i,t} = \alpha_i + \beta_i x_{i,t} + \varepsilon_{i,t} \text{ for } i = 1, \dots, N, t = 1, \dots, T \quad (2)$$

where i denotes the cross-section dimension, t is the time dimension, $x_{i,t}$ is a $k \times 1$ vector of the explanatory variables, α_i is the intercept and β_i is the slope coefficient. The null hypothesis assumes the absence of cross-sectional dependence, whereas the alternative hypothesis assumes its presence. Using mathematical notation, they can be described as

$$H_0: cov(u_{it}, u_{it}) = 0 \text{ for all } t \text{ and } i \neq j \quad (3)$$

$$H_1: cov(u_{it}, u_{it}) = 0 \text{ for at least one pair of } i \neq j \quad (4)$$

To test the null against the alternative hypothesis of cross-sectional dependence, Breusch and Pagan (1980) defined the LM-test statistic as

$$LM = T \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{p}_{ij}^2 \quad (5)$$

where $\hat{p}_{ij}^2$ represents the sample estimate of pairwise correlation from the OLS estimation ofequation (2) for each i and the LM-test statistic is asymptotically chi-square distributedwith $N(N-1)/2$ degrees of freedom under the null hypothesis. The

LM test is validwith relatively small N and comparatively large T. To solve the shortcomings of the LM test, Pesaran (2004) proposed a scaled version of the statistic that takes the form

$$CD_{LM} = \sqrt{\frac{N}{N(N-1)}} T \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} (T\hat{p}_{ij}^2 - 1) \quad (6)$$

for which the null hypothesis assumes standard normal distribution when$N \to \infty$ and $T \to \infty$. This extension of the test is applicable for large N and T but it exhibits size distortions when N is large and T is small. To overcome this problem, Pesaran (2004) proposed the calculation of the CD-test statistic as

$$CD = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{p}_{ij}^2 \quad (7)$$

for which the null hypothesis assumes asymptotic standard normal distribution for any value of N and T.

5.3. Testing Non-stationarity

The next step in our research is to apply the panel unit root test proposed by Im**,** Kyung et al. (2003) as well as the Fischer-type ADF test and the PP test as suggested by Maddala and Wu (1999). These tests allow for deterministic and dynamic effects differing across the countries included in the panel. According to Badi Baltagi (2001), the Fisher test has more advantages because of the following reasons: (1) the cross-sectional dimension can be either finite or infinite, (2) each group can have non-stochastic and stochastic components, and (3) the time-series dimension can vary for each cross-section. Another advantage of the Fisher test is that, unlike the IPS test, it does not require a balanced panel and it allows for the use of different lag lengths in the individual ADF regression. In our study, we prefer the Fisher-type test but we also report the results of the IPS tests to provide an additional robustness check.

5.4. Testing Non-Granger Causality

The causality between variables is examined at both panel and country level by applying the panel causality test suggested by Dumitrescu and Hurlin (2012). In fact, the test is an advanced version of the causality test introduced by Granger (1969) that can be applied to heterogeneous panels with or without cross-sectional dependence and it may be used in both cases when $T > N$ or $N > T$. The test uses two separate HNC distributions — asymptotic and semi-asymptotic. The former is used when $T > N$ and the latter when$N > T$. In this causality test, three separate statistics are calculated under the following panel data model:

$$y_{i,t} = \sum_{k=1}^{K} \gamma_i^{(k)} y_{i,t-k} + \sum_{k=1}^{K} \beta_i^{(k)} x_{i,t-k} + \varepsilon_{i,t} \tag{8}$$

where K indicates the lag length, $\gamma_i^{(k)}$ is the autoregressive coefficient, and $\beta_i^{(k)}$ is the regression coefficient. It is assumed that the two parameters are constant over time but they may vary with respect to units. The null hypothesis assumes that there is no Granger causality from x_i to y_i in all cross-sections, whereas the alternative hypothesis assumes that Granger causality from x_i to y_i exists in at least one cross-section. The hypotheses of the test can mathematically be expressed as

$$H_0: \beta_i = 0 \text{ for } \forall i = 1, \dots, N \text{ with } \beta_i = \beta_i^{(1)}, \dots, \beta_i^{(k)} \tag{9}$$

$$H_1: \beta_i \neq 0 \text{ for } \forall i = 1, \dots, N \text{ with } \beta_i \neq 0 \text{ for } \forall i = N_1 + 1, \dots, N \tag{10}$$

The statistic used to test the hypotheses is calculated as

$$W_{N,T}^{HNC} = \frac{1}{N} \sum_{i=1}^{N} \underbrace{(T - 2K - 1)\left(\frac{\tilde{\varepsilon}_i' \Phi_i \tilde{\varepsilon}_i}{\tilde{\varepsilon}_i' M_i \tilde{\varepsilon}_i}\right)}_{W_{i,t}}, i = 1, \dots, N \tag{11}$$

where $W_{i,t}$ is the mean Wald statistic calculated for the dimension t of the cross-sections. Although the individual Wald statistics approximate toward a chi-square distribution with K degrees of freedom, the authors state that the statistics converge to a standard normal distribution when $N \to \infty$ or when $T \to \infty$. The asymptotic statistic $Z_{N,T}^{HNC}$ and the semi-asymptotic statistic Z_N^{HNC} are generated using $W_{N,T}^{HNC}$ in the following expressions:

$$Z_{N,T}^{HNC} = \sqrt{\frac{N}{2K}}\left(W_{N,T}^{HNC} - K\right)_{T,N \to \infty} \xrightarrow{d} N(0,1) \tag{12}$$

$$Z_N^{HNC} = \frac{\sqrt{N}\left[W_{N,T}^{HNC} - 1/N \sum_{i=1}^{N} E(W_{i,T})\right]}{\sqrt{1/N \sum_{i=1}^{N} var(W_{i,T})}} \underset{N \to \infty}{\xrightarrow{d}} N(0,1) \tag{13}$$

After setting up the methodology, we start our empirical work with testing for cross-sectional dependence and the homogeneity of the slope across countries. Based on the outcomes of the tests, our intent is to decide which causality method should be

used to identify the direction of the causality relation between remittances and inflation. To test the causal relationship, we select all countries from the panel.

6. Results

The results from the empirical analysis using the methodology explained in the previous section are presented step by step hereafter.

6.1. SGMM Results

All regression coefficients representing the relationship among the variables are shown in Table 3. The main finding is the impact of remittances on inflation. As expected, the results signify a positive statistically significant relationship between remittance inflows and inflation for the NEU-9 group, whereas the direction of the relationship is negative for the NMS-11 group and for the entire sample. These findings confirm that remittance inflows create an upward pressure on inflation in the NEU-9 group. The flow of remittances helps in reducing the financial constraints and it meets the credit needs of the financial market. According to the impossible trinity theory, the countries need to sacrifice an independent monetary policy for free capital flows, including remittance inflows. Thereby, the growth of remittance inflows leads to higher complexity for the monetary policy in stabilizing both the exchange rate and inflation. Furthermore, this result provides a significant empirical evidence for these countries in their efforts to control the inflation in the context of an upward trend in remittance inflows. Rene Cáceres and Nery Nolvia (2006) argue that remittances increase consumption patterns with no increase in output growth as they boost commodity prices in the recipient economy. As a stable source, remittances positively contribute to the accumulation of foreign reserves, therefore causing a surplus in the balance of payment, and any failure to sterilize the growth of foreign reserves will result in a wider monetary base. As a result, Matteo Bugamelli and Franchesko Paternò (2009) opine that the prices will increase. On the other hand, the negative relationship for the NMS-11 countries can be because of the possibility to use remittances for small-scale production that increases the output and pushes the inflation down Javed Iqbal et al., (2013).

The results also suggest that ongoing inflation levels have a significantly positive relationship with past inflation levels, which reflects the existence of inertial inflation. Moreover, a relatively high inflation rate in the past leads to higher inflation equilibrium by making disinflation more expensive for backward-looking inflation expectations Carlo Cotarelli, (1998)

The past consumption has a positive and significant effect on the future prices in the NEU-9 countries, while the results are not significant for the NMS-11 countries. Furthermore, the results for savings based on remittance inflow show that they are statistically significant for the NMS-11 countries. The results of all samples show that

these determinants have a statistically significant and positive sign. This result is not surprising at all because the limited production capabilities in the NEU-9 countries incentivizes a major portion of remittances to be used for consumption, thus affecting the tradable sector and increasing the domestic prices and finally leading to higher inflation.

The results for the GDP growth rate indicate to a strong statistical significance with a negative sign in all three models. This result is consistent with Mihir Desai et al. (2003), who revealed a negative relationship between output growth and inflation for a panel of 100 countries. The same result was found by Aisen and Viega (2006), who explored the same relationship for a panel of 75 developing countries; Narayan et al. (2011), who confirmed a negative effect of the GDP growth rate on the inflation rate; and Sbia and Hamdi. (2020).

The trade openness has a positive and significant effect only when we include all countries. This finding is in line with the cost-push hypothesis, according to which, trade openness certainly does not decrease inflation but increases it. In other words, there is a positive effect of trade openness on inflation (Alfaro et al., 2004). However, the empirical literature on the relationship between trade openness and inflation is inconclusive. Namely, according to the spillover hypothesis, trade openness is associated with falling prices and therefore protectionism can be inflationary Gruben and Darryl McLeod (2002).

The government expenditure is statistically significant in two of the specifications — in the one with the NMS-11 countries and in the entire sample. The sign is positive as expected and it can be attributed to the governments' aim to stimulate economic growth through government expenditure. This generates higher inflation and government budget deficits. The budget deficit of the government is financed either by borrowing from domestic and foreign sources or by directing the central bank to increase the money supply by issuing money. According to Sulaiman Mohammad et al. (2009), the deficit financed by the government has liquidity effects, which can lead to a rise in the aggregate demand and it may generate inflationary pressure in the economy.

Finally, the results of the Sargan test confirm the validity of our instruments and the presence of autocorrelation. The AR(2) test exhibits no second-order serial correlation in the specified models.

Table 3:SGMM results.

Variable	Country group		
	NEU-9	EU-11	All
CPI(-1)	1.061***	0.916***	0.870 ***
	(0.013)	(0.012)	(0.014)
REM	0.590***	-1.391***	-0.239*
	(0.231)	(0.621)	(0.211)
GDPG	-0.319***	-0.199***	-0.255 ***
	(0.100)	(0.052)	(0.049)
GNE	0.122	0.127***	0.258**
	(0.086)	(0.058)	(0.144)
FDI	-0.127	0.021	-0.045

	(0.139)	(0.026)	(0.038)
TRD	0.029	0.020	0.159***
	(0.028)	(0.014)	(0.028)
REM×GDS	0.007	-0.001***	0.035***
	(0.028)	(0.004)	(0.010)
REM×HHFC(-1)	0.005***	-0.002	0.002**
	(0.005)	(0.004)	(0.001)
	-18.01*	-0.519	-29.71***
Constant	(10.82)	(6.784)	(17.48)
Sargan test (p-value) H_0: The instruments are valid.	0.258	0.432	0.195
Arellano-Bond test [AR (1)]	0.002	0.019	0.000
Arellano-Bond test [AR (2)]	0.548	0.973	0.470

Notes: The symbols ***, ** and * denote statistical significance at the level of 1, 5 and 10%, respectively.

6.2. Cross-sectional Dependence, Stationarity and Panel Causality Results

The results from the cross-sectional dependence test are reported in Table 4. Since the p-values are less than 0.01, we reject the null hypothesis of no cross-sectional dependence at significance level of 1% for all models and conclude that there is cross-sectional dependence between the variables. These findings imply that a shock occurring in one country can be transmitted to other countries in the sample.

Table 4: Cross-sectional dependence results.

Test	**Country group**					
	NEU-9		EU-11		All	
	REM	CPI	REM	CPI	REM	CPI
Breusch-Pagan LM test	230.58***	258.4***	240.4***	249.6***	1,100.2***	2,248.1***
Pesaran scaled LM test	26.01***	29.72***	16.59***	17.51***	45.66***	104.5***
Pesaran CD test	9.473***	11.59***	2.724***	1.939***	11.12***	38.81***

Notes: The symbols ***, ** and * denote statistical significance at the level of 1, 5 and 10%, respectively.

Next, we continue with the results of the panel unit root tests, which are shown in Table 5. These tests are conducted at level and first differences for all variables in the model. The presence of unit root has been confirmed in all time series using the IPS and ADF tests. Furthermore, the panel unit roots tests for PP support the hypothesis of a unit root in all variables across countries, except for the consumer price index in all three country groups as well as the hypothesis of a zero-order integration at the first differences. However, following the traditional null hypothesis of stationarity, the results consistently accept stationarity at first difference and reject stationarity at levels indicating that all series are $I(1)$.

Table 5: Cross-sectional dependence results.

Variable	Country group								
	NEU-9			EU-11			All		
	IPS test	ADF test	PP test	IPS test	ADF test	PP test	IPS test	ADF test	PP test
CPI	1.538	23.44	35.34***	-0.949	26.39	62.46***	0.951	42.56	123.1***
D(CPI)	-7.665***	84.36***	83.16***	-4.694***	62.05***	92.10***	-6.022***	110.2***	147.1***
FDI	-0.416	16.86	19.04	-2.688	39.58	29.85	-2.963	69.30	48.89
D(FDI)	-10.96***	125.1***	125.9***	-10.52***	139.5***	168.4***	-12.08***	214.1***	294.4***
GDPG	-2.356	17.34	16.25	-1.283	15.38	15.17	-2.936	34.61	33.28
D(GDPG)	-7.484***	84.75***	84.40***	-5.394***	69.29***	80.14***	-12.13***	303.2***	164.5***
GNE	-1.162	21.94	22.29	0.924	12.80	12.85	-0.659	43.85	45.14
D(GNE)	-11.56***	134.4***	167.1***	-9.151***	119.9***	164.7***	-12.31***	216.1***	331.7***
REM	-1.783	22.59	22.19	0.979	13.74	16.67	-0.144	44.99	42.41
D(REM)	-4.247***	60.17***	65.74***	-4.649***	60.59***	118.5***	-9.551***	170.1***	228.8***
TRDE	-1.182	28.44	27.75	1.271	12.56	16.20	0.154	44.33	44.75
D(TRDE)	-12.27***	144.1***	200.5***	-8.849***	114.8***	205.2***	-12.96***	229.4***	205.8***

Notes: The symbols ***, ** and * denote statistical significance at the level of 1, 5 and 10%, respectively.

The results of the panel Granger causality test suggested by Dumitrescu and Hurlin (2012) are shown in Table 6. We note that only the values of the asymptotic statistic $Z_{N,T}^{HNC}$ are reported because $T = 26 > N = 20$. According to the test results, the null hypothesis assuming no Granger causality between remittances and inflation is rejected at the significance level of 1% for the entire sample. In both cases for the subsampled country groups, the null hypothesis is not rejected and only the remittances have impact on inflation but not vice versa.

Table 6: Dumitrescu-Hurlin panel Granger-causality test results.

Direction	Country group		
	NEU-9	EU-11	All
CPI → REM	0.596	0.983	1.761***
	-0.856	1.652	2.407***

REM → CPI	5.415***	4.765***	3.723***
	9.365***	7.432***	8.612***

Notes: The symbols ***, ** and * denote statistical significance at the level of 1, 5 and 10%, respectively.

The country-specific Wald statistics were calculated in order to determine which hypothesis is valid in each of the selected countries. A summary of the test results is presented in Table 7. It can be inferred that the results of both tests are correlative. This finding can be regarded as an important criterion for the reliability of the results.

Table 7: Panel Granger-causality results across countries.

Countries	**Direction**			
	CPI → REM		REM → CPI	
	W-stat.	Prob.	W-stat.	Prob.
Albania	2.579	0.122	11.650	0.002
Armenia	0.265	0.611	0.206	0.653
Bosnia and Herzegovina	0.036	0.850	0.004	0.944
Bulgaria	0.046	0.831	1.952	0.176
Belarus	0.083	0.775	5.375	0.030
Croatia	0.828	0.372	1.448	0.241
Czech Republic	0.896	0.353	3.474	0.075
Estonia	5.296	0.031	0.361	0.553
Hungary	4.607	0.431	4.787	0.039
Latvia	4.981	0.036	0.005	0.981
Lithuania	4.220	0.530	3.476	0.075
Montenegro	1.286	0.268	6.349	0.019
Macedonia	0.642	0.431	3.475	0.075
Moldova	0.035	0.851	16.530	0.005
Poland	0.084	0.773	0.021	0.883
Romania	4.602	0.432	3.182	0.088
Serbia	0.568	0.458	2.048	0.016
Slovakia	0.212	0.649	4.527	0.044
Slovenia	3.943	0.596	5.547	0.027
Ukraine	0.007	0.933	0.038	0.847

The results indicate that there is no bidirectional causality between remittances and inflation in the selected countries. Nonetheless, inflation is only causing remittances in Estonia and Latvia, whereas remittances positively impact inflation in Albania, Belarus, Czech Republic, Hungary, Lithuania, Montenegro, Macedonia, Moldova, Romania, Serbia, Slovakia and Slovenia. In the other countries — namely, Armenia, Bosnia and Herzegovina, Croatia, Poland, and Ukraine — there is no impact

of either inflation or remittances on the other variable. In sum, remittances are an important determinant of inflation in many countries, but the results do not support this assumption universally. Therefore, we can cautiously say that the relationship between remittances and inflation varies from one to another country.

7. Conclusion

Remittances and inflation affect the economic activity of the recipient's economy and are of great importance for developing countries. The remittance inflow accelerates economic activity by increasing the personal income, improving the living standards and ultimately enhancing the aggregate demand for goods and services, thus exerting upward pressure on prices.

Our investigation of the relationship between remittances and inflation for a sample of 20 countries from Central and Eastern Europe and two subsamples consisting of EU member states (EU-11) and non-EU countries (NEU-9) for the period 1994–2019 using a SGMM estimation technique points out to a positive relationship between remittance inflow and inflation, with the impact being statistically significant for the countries that are EU member states and negative for the non-EU countries and the entire sample. These results confirm that remittance inflow creates an upward pressure on inflation in the EU member states. Such differences could be explained by the fact that remittances are mostly used for food consumption in the less developed countries and they therefore contribute to the health status of recipient households but uplift the prices in the recipient economy.

As for the other tested variables, the results are in line with the previous empirical literature. Ongoing inflation rates have positive statistically significant relationship with past inflation, which reflects the existence of inertial inflation. Past consumption resulting from remittance inflow has a positive statistically significant effect on future prices in the non-EU countries, while the results are not statistically significant for the EU member states. Levels of saving based on remittance inflow show that statistically significant relationship in the EU member states. The results for the GDP growth are strongly statistically significant with a negative sign in all three models, whereas the result for trade openness shows that this determinant has a positive and statistically significant effect only for the entire sample. The government expenditure is positive statistically significant in only two specifications — that is, the one for the EU member states and the entire sample.

The main findings of the panel causality test suggested by Dumitrescu and Hurlin (2012) reveal that remittances Granger-cause inflation in all country groups. Yet, the results indicate that there is no bidirectional causality between remittances and inflation in the countries selected and inflation is caused by remittances in Estonia and Latvia only. On the other hand, remittances have a positive impact on inflation in some countries, while no impact has been established in others.

This study has shed light on interesting policy implications for countries of Central and Eastern Europe As remittances, outflows have significant effect on inflation, it is imperative to implement policy constraining remittances. The governments in order to ensure price stability, must take serious policy measures regarding bumper stock of staple food and it is clear that additional steps to boost the supply of agricultural products and productivity are essential for the GDP growth.

In view of this, the study recommends that the government should formulate policies aimed at channeling the remittances for productive economic activities rather than for consumption. This could be done by improving public infrastructure and investment in education. Furthermore, government policy should be directed at encouraging savings that would boost private investment and economic growth. Finally, there should be mechanisms aimed at mobilizing remittances for investment through higher interest rates on term deposits, foreign currency denominated banking accounts, and tax incentives.

As such, to validate our findings, future research may also model inflation and remittances to include other factors like money supply, price of oil and exchange rate changes among others. Likewise, researchers and policymakers must pursue creative ways of investigating the impact of remittances on labor participation rate, real exchange rate, and other macroeconomic variables.

Beyond policy frameworks, we recommend further studies on other macroeconomic consequences of remittances to have a deeper understanding of their impact. There is also a need for policymakers to explore further how to manage remittances so that they can positively contribute to migrants' home economy.

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