The effect of output level, exchange rate and interest rate on inflation in BRIC-T countries

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Abstract

Purpose – In this study, it is analyzed the validity of the exchange rate pass-through (ERPT) effect and the effect of interest rate and output level on the inflation rate (IR) in Brazil, Russia, India, China and Turkey (BRIC-T) between the years 1995Q1 and 2022Q4.

Design/methodology/approach – The methods such as the panel unit root test developed by Westerlund (2012), the LM bootstrap panel cointegration test developed by Westerlund and Edgerton (2007), the common correlated effects (CCE) estimator developed by Pesaran (2006) and the augmented mean group (AMG) estimator developed by Eberhardt and Bond (2009) that take into account the cross-section dependency are applied for analysis.

Findings – As a result of the findings, it is determined that the ERPT effect is valid in Turkey, Brazil, Russia, India and China and the cost channel is valid only in China. Finally, it is found out that output level positively affects inflation in Turkey, Brazil, Russia, India and China.

Practical implications – All these results indicate that the economies of Turkey, Russia, Brazil and India have a fragile structure, especially in terms of inflation. Therefore, the central bank of these countries should maintain exchange-rate stability to implement the inflation-targeting strategy successfully. In this context, central bank independence should be increased in these countries in achieving this objective. Also the results indicate that it is still early to consider whether BRIC-T countries and accordingly the Belt and Road Initiative will be an alternative against the domination of the USA and European Union (EU) on international trade system or it will substitute them.

Originality/value – In this study, it is tested that the impact of interest-rate (NIR), exchange-rate (FER) and output level (IPI) on general level of prices. Besides, it is analyzed that whether production level affects the IR. Also, the study investigates the economic issues such as ERPT effect and cost channel. The study analyzes whether China's Belt and Road Initiative is successful or not. In this study, we used the panel data methods that allow for structural breaks and cross-section dependency. For these reasons, this study differs from other studies in the literature both in terms of scope and methods used.

Keywords Pass-through effect, Cost channel, Output level, CCE estimator, AMG estimator, BRIC-T

Paper type Research paper

1. Introduction

Recently, central banks have increased the interest rates to decrease the inflation rates (IRs). The interest rate, which has a significant impact on prices, theoretically has two effects. The first effect is the cost effect through the cost channel. The cost channel refers to the fact that an increase in the interest rate increases the costs of firms by increasing input costs and therefore increases the IR. The effect of monetary policy on prices through the cost channel depends on the source of inflation. If the Producer Price Index (PPI) is more volatile than the Consumer Price Index (CPI) in an economy and the share of financing costs in a firm's cost items is high, the effect of an interest rate hike on prices through the cost channel will also be

high. However, in a country where the CPI is higher than the PPI and the share of financing costs in a firm's cost items is low, the effect of an interest rate hike on the price level through the cost channel will be low. Depending on the increase in costs, the prices of goods and services and the IR raise. According to the cost channel, increased interest rates cause to increase in the cost of marginal production and, ultimately, high inflation. That is, the cost channel is the supply-side effect of the interest rate (Sims, 1992). The second effect of the interest rate is the foreign trade effect. The central bank's contractionary monetary policy leads to foreign exchange inflows by increasing the interest rate, which in turn increases the supply of foreign exchange and leads to a fall in the exchange rate. A fall in the exchange rate leads to a fall in the prices of imported goods and hence a fall in the CPI. Therefore, the exchange rate, together with the interest rate, can have an impact on prices. This channel influences the cash flow, consumption preferences, saving and aggregate demand of economic agents by changing the marginal cost of borrowing money. That is, the interest rate channel has a demand-side effect on the economy (Cottarelli and Kourelis, 1994). Change in the domestic interest rate might impact foreign capital flow since it might affect the return of the capital. As the supply of foreign exchange will change depending on the foreign capital flow, the exchange rate is affected by this situation. The exchange rate can also affect inflation in four ways: (1) by affecting prices of the consumer goods which are imported and directly added to the consumer price index (2) by increasing imported input costs which affect domestic product costs (3) by affecting the total demand through the fluctuations in exchange rates which affect current accounts and inclusion of this into domestic prices (4) by affecting prices of domestic and import-substitute goods (Woo, 1984). Apart from the exchange rate and interest rate, production level can also affect the general level of prices. Since the rise in the production level increases the aggregate supply, it is expected to decrease the general level of prices. However, if imported inputs rate in production is high and exchange rate increases, the input cost and consequently the general level of prices increase. Therefore, whether an increase in production will increase inflation depends on the rate of imported inputs used for production.

The impacts of exchange rate, interest rate and output level on general level of prices in BRIC-T countries are analyzed in this study. In this context, it was analyzed the validity of exchange rate pass-through (ERPT) and cost channel in BRIC-T countries. Also, it is expected that this study aids central banks that implement the inflation-targeting strategy [1] to determine the variables to be applied to arrive at the targeted IR. BRIC-T countries are the status of emerging countries. The economy of emerging countries [2] is growing faster than developed and underdeveloped countries. Such a classification was made because this group of countries differed from other countries in terms of rapid growth. It is an important issue whether the growth of countries whose economy is growing faster than other countries creates inflation. If rapid growth accelerates the increase in inflation, the sustainability of this growth is a matter of debate. However, if the IR shows a normal course as a result of high growth, the economy that grows in this way is expected to have solid foundations. Therefore, the results of the study are important as they provide an opportunity to evaluate whether the growth performance of the BRIC-T countries is based on solid foundations. On the other hand, analyzing only the IR, interest rate, exchange rate and industrial production index (IPI) variables may not give sufficient information regarding these countries' economies. However, these variables can be adequate to inform about the fragility of these countries' economies. The fragility of the economy, where the dependency of the inflation on the exchange rate is high, is more when compared to the countries where the dependency of inflation on the exchange rate is low. The results of this study are expected to contribute to the review of whether the economy of BRIC-T countries has a fragile structure. The BRIC-T country group is an attempt to search for an alternative system against the international system under the domination of the USA and European Union (EU), led by China, which started with the

Shanghai Five and continued with the Belt and Road Initiative [3]. BRIC-T countries are among the countries with the biggest economy in the Belt and Road initiative. Therefore, the BRIC-T country group has been analyzed as it is thought that this group represents the Belt and Road Initiative the best. Thereby, since the results of this study provide information regarding the sustainability of economic growth and the fragility of the BRIC-T countries' economies, which is thought as an alternative against the US and EU-centric international system, it might give an idea of whether this initiative can be successful. Thus, this study is important since the results might inform us whether these initiatives, beginning with Shanghai Five and progressing with BRIC-T and the Belt and Road Initiative, can succeed.

The possible contribution of the study to the literature can be summarized under several headings: (1) In the literature, in some studies (Kara and Ogunç, 2012; Bawa *et al.*, 2016; Ha *et al.*, 2020) it was analyzed that whether the ERPT effect is valid, and in some studies (Mann, 1989; Gagnon and Ihrig, 2004; Choudhri and Hakura, 2006; Cologni and Manera, 2008; Wu and Ni, 2011; Lagoa, 2014), the impact of the exchange rate and the oil prices on the general level of prices and the reason of the ERPT effect on the prices were analyzed. However, the only variable is not the exchange rate to affect inflation. Therefore, these studies are inadequate to determine the dynamics of inflation. In some studies (Golinelli and Rovelli, 2005; Ali and Anwar, 2016; Akbas, 2020) both the ERPT effect and the impact of cost channel on the IR were analyzed. Although both issues have been examined in these studies, the gap in determining the source of inflation has not been fully filled. This gap also could not be eliminated for the BRIC-T countries. In this study, the impact of interest rate and output level on the general level of prices, together with pass-through effect, is tested. Therefore, it has been tried to specify whether the interest rate or the exchange rate and output level are effective on inflation in BRIC-T countries. For this reason, it is thought that this study will contribute to the reduction of the deficiency to determine the inflation dynamics of the pass-through effect studies. The dependence of the IR on the exchange rate in BRIC-T countries was tested and whether economic growth caused inflation in this study. Therefore, the results of this study can also determine whether the BRIC-T countries' economies have a fragile structure and whether their economic growth is sustainable. As these studies mentioned above do not allow these reviews, the results of the study are expected to contribute to the literature. (2) It is evaluated that whether BRIC-T countries and accordingly the Belt and Road Initiative will be an alternative against the domination of the US and EU on the international trade system or to substitute them in this study. In the pass-through studies in the literature, the evaluation of the search for alternative systems has not been taken into account. Only the pass-through effect is valid or not, the reason for the pass-through and the impact of oil prices on the IR has been analyzed. In this study, in addition to these analyzes of pass-through studies, the success of searching for alternative systems is also evaluated. (3) In the study, instead of traditional methods such as vector autoregression (VAR) and generalized method of moments (GMM) that do not allow for cross-section dependence, heterogeneity and structural shifts, we applied the methods that allow for heterogeneity, cross-section dependence and structural shifts. In the event of these econometric issues, estimating without considering these issues can lead to bias results. Therefore, the study contributes to the literature in terms of the different methods used in the study.

The main aim of this study is to analyze the effect of ERPT on IR in BRIC-T countries. Also, our sub-target is to find out whether the interest rate and output growth increase the IR in these five countries. Therefore, it is tried to specify whether the economies of BRIC-T countries are fragile and the growth of these countries' economies are sustainable. The reason of the analysis of the BRIC-T countries is that as stated in the third footnote, BRIC formation constitutes the economic stage of the formation that China is trying to occur against its dominance on the international system centered by US and EU. Depending on these results,

another sub-target of this study is to evaluate whether BRIC-T countries, and accordingly, the Belt and Road Initiative is an alternative to the US and EU-centric international system.

The study is organized as follows: The introduction part is included in the first part. In the second section, the literature about the pass-through effect is found. In the third section, the data and methods are explained. In the fourth part, the empirical findings are involved, and the results and policy recommendations are provided in the last section.

2. Literature review

In the literature, the authors have focused on the ERPT in recent years as fragility has increased in many economies. Studies that focus on the pass-through effect of exchange-rate can be divided into three classifications. The studies in the first classification investigate the variables which cause the ERPT effect on the general level of prices. These researches emphasize that different factors cause the ERPT effect. For instance, Ha *et al.* (2020) domestic demand shocks caused exchange-rate pass-through. Núñez *et al.* (2023) examined the rigidities in wholesale food prices and ERPT with daily data between 16.05.2012 and 16.05.2019 in their studies. Market price and exchange rate data were used in the analysis. They used cross-section, time series and non-linear autoregressive distributed lag (NARDL) analyses in the study. They concluded that ERPT exists. Bayır and Orak (2023) examined the 2003–2020 periods with the structural VAR method in their study on globalization and inflation in Turkey. Global output gap, global energy prices, domestic output gap, exchange rate, money supply and inflation data were used in the analysis. They concluded that globalization affects price developments through changes in global demand, input prices and exchange rate fluctuations. They also concluded that the main factor determining inflation is inflation inertia.

The studies in the second classification analyze whether the exchange-rate pass-through is valid or not (Ha *et al.*, 2020; Kotil, 2020; Bozkurt and Mutlu Çamoğlu, 2021; Beirne *et al.*, 2024). For example, Ha *et al.* (2020) examined the relationship between inflation and exchange rate depending on the nature of shocks for 55 countries. Most of the analyses were conducted with quarterly data for 1998–2017. The variables used in the analysis are global output growth, global inflation, oil price growth, country-specific inflation, country-specific output growth, domestic interest rates and nominal effective exchange rate changes. The factor-augmented vector autoregression (FAVAR) model is used in the study. The analysis reveals that domestic shocks have a significant impact on exchange rate fluctuations in most countries and that they have significantly different pass-through with inflation according to their characteristics. In particular, countries with less flexible exchange rate regimes and without inflation-targeting central banks are generally found to have above-average pass-through to domestic monetary shocks. However, negative and mostly insignificant pass-through rates were observed for domestic demand shocks due to the stabilizing effects of growth and exchange rate channels. The analysis also suggests that global shocks have less impact on exchange rate movements. Kotil (2020) investigated the impact of exchange rate changes in Turkey on producer and consumer prices using the VAR model. Output gap, nominal exchange rate, producer price index and consumer price index variables were used in the study. The results obtained from the study showed the degree of transition with impulse-response functions and how prices were affected by variance decomposition using monthly data from 2005 to 2019. Accordingly, the pass-through effect was valid in Turkey and the reaction of the CPI (consumer price index) to the change in the nominal exchange rate was greater than the PPI (producer price index). Bozkurt and Mutlu Çamoğlu (2021) analyzed the monetary transmission mechanism in Turkey for the periods 2002:01–2011:12 and 2011:01–2020:12. They used Structural VAR (SVAR) model in the study. Interbank overnight average interest rate, the central bank average funding interest rate, real effective exchange rate,

consumer price index, total domestic credit volume, IPI variables were used in the analysis. The analysis results for both periods concluded that interest rate is the most important determinant of fluctuations in credits and exchange rates and that credit and exchange rate channels also affect inflation. Beirne *et al.* (2024) analysed the ERPT to both producer and consumer prices for nine emerging Asian economies by using a time-varying parameter SVAR model over the period 1994 to 2021. In the study, variables such as nominal effective exchange rate, producer price index, consumer price index, output gap and domestic interest rates were used. The findings of analysis indicated that ERPT effect was incomplete and mostly higher for ERPT to producer than consumer prices. Also, the authors found out that longer-term ERPT to producer and consumer prices was mostly greater in magnitude than shorter-term ERPT and exchange rate pass-through had declined for most Asian EMEs since around 2010. The last findings obtained from the analysis is that oil price and global output shocks mostly affected longer-term producer price exchange rate pass-through in emerging Asia.

The third classification includes the studies that analyze the impact of the exchange-rate on import prices or the general level of prices (Balcilar and Usman, 2021; Kaytanci and Kaytanci, 2021; Mien, 2022; Ding *et al.*, 2023; Assogba and Zhang, 2023). Balcilar and Usman (2021) tested the exchange rate and oil price pass-through in the BRICS (Brazil, Russia, India, China, South Africa, Iran, Egypt, Ethiopia and the United Arab Emirates) countries through the analysis of the Diebold-Yilmaz spillover index and rolling-windows by using the monthly frequency data from 1999:M01-2019:M11. Consumer price index, exchange rate, output growth, spot crude oil price variables were used in the study. The empirical findings indicated that there was a strong evidence of directional spillovers across the countries. Also, the total spillovers were low, with Russia (China) having the highest (lowest). This situation indicated that there was a low pass-through across the countries. Besides, the authors found that the net spillovers of oil price and exchange rate were positive in Brazil, Russia and South Africa, while in India, they were both negative. The last results obtained from the analysis showed that the net spillovers of inflation and output growth were positive in India, while in China, the net spillover of inflation was negative with oil price and output growth had positive net spillovers. Kaytanci and Kaytanci (2021) examined the ERPT effect on import prices in Turkey for the periods 2002M01-2010M12 and 2011M01-2019M12 using the autoregressive distributed lag (ARDL) bounds testing approach. Consumer price index, exchange rate, import unit value index, total IPI variables were used in the study. According to the results of the analysis, exchange rates and import prices positively affected consumer prices in both periods. Total industrial production affected consumer prices positively in the long run and negatively in the short run only for the period 2011M01-2019M12. In addition, exchange rates and import prices affected consumer prices in the long run by 2 times higher for exchange rates and 0.54 times higher for import prices in the 2002M01-2010M12 period compared to the 2011M02-2019M12 period. Mien (2022) investigated the effects of oil price and production on inflation in CEMAC countries for the period 1995Q1-2019Q4 in terms of the pass-through effect and Dutch disease. In the study, analysis was made with consumer price index, deposit interest rate and nominal bilateral exchange rate, oil price and oil production data. Dynamic Ordinary Least Squares and Autoregressive Distributed Lag models were applied in the study. It was concluded that the pass-through effect was in the countries of Cameroon, Chad and the Republic of Congo, while the Dutch disease effect was in Equatorial Guinea. Ding *et al.* (2023) analysed the exchanged pass-through effect on oil prices in China over the period from 1 January 2010 to 1 July 2022 by using VAR and GARCH model. In the study, variables such as exchange rate, oil price, consumer price index were used. As a result of the analysis, the authors found out that there was a strong comovement between the exchange rate and oil price based on the dynamic conditional correlation-generalized autoregressive conditional heteroskedasticity (DCC-GARCH) model. Assogba and Zhang (2023) investigated the effect of

the exchange rate on U.S. softwood plywood imports from Brazil between 2010 and 2021 by using the Equilibrium Displacement Model. Variables such as prices of plywood, exchange rate, plywood consumption of the USA, local plywood production of the USA, supply quantities representing imports from Brazil and the rest of the world were used in the study. As a result of the analysis, the authors determined that the pass-through effect of the U.S. Dollar's appreciation was more perceptible to U.S. consumers when facing a relatively elastic export supply curve from Brazil. Also, their results suggest that although the U.S. Dollar's strengthening against the Brazilian Real had a detrimental effect on domestic producers of softwood plywood, the consumer's gains more than offset those losses.

Apart from these studies, limited studies examine the effects of both interest-rate and exchange-rate on general level of prices (Akbas, 2020; Yelghi *et al.*, 2021). Akbas (2020) analyzed the impact of the interest-rate and exchange-rate on the general level of prices between 1996Q4-2015Q4 in India, Brazil, Indonesia, Turkey and South Africa by using the panel common correlated effects mean group (CCEMG) model. In the study, output gaps, domestic IR, short-term nominal interest rate and the nominal exchange rate variables were used. Findings indicated that both the interest-rate and exchange-rate pass-through effect were valid in these countries. Yelghi *et al.* (2021) examined the relationship between inflation, exchange rate and interest rates in Turkey using monthly data between 2007 and 2019. In the study, consumer loan, housing, commercial, vehicle and consumer loan interest rates, commercial interest rate, inflation and exchange rate variables were used. ARDL (Autoregressive Distributed Lag) bound test was applied in the study. According to the findings, the authors found out a relationship between inflation and interest rates of determined loan types in Turkey and the authors could not relationship between exchange rates and the interest rates of the loan types determined.

3. Data and methodology

It is tested that the impact of interest-rate (NIR), exchange-rate (FER) and output level (IPI) on IR from 1995Q1 [4] to 2019Q4 in the BRIC-T countries in this study. That is, the study investigates the economic issues such as ERPT effect and cost channel. Besides, it is analyzed that whether production level affect the IR. For the IR, we used the consumer prices index. Also, we used the money market rate as a proxy of the interest-rate except for Turkey. Since money market rate data for Turkey are not available in both Central Bank of Republic of Turkey (CBRT) and other databases, discount rate is used in the analysis for Turkey. Finally, we used IPI of economic activity for proxy of production level. All of the data was procured from International Monetary Fund (IMF) electronic database (International Financial Statistics (IFS)). CPI, IPI and FER data were logarithmic; NIR data was the level value. That was NIR data was the proportional data (%). In this study, we used the panel data methods that allow for structural breaks and cross-section dependency. Gauss [5] and Stata econometric programs were used for the analysis.

3.1 Panel unit root test with multiple breaks

Panel unit root test prepared by Westerlund (2012) was used in this study. When it is compared to other panel unit root tests, there are some advantages to this method. Firstly, structural changes in level as well as in slope can be taken into consideration. Secondly, the cross-sectional dependence induced is effectively eliminated by permitting for common factors. Finally, there is no restriction of zero for constant and slope. The model of this method, bases on Amsler and Lee (1995), is as follows:

$$y_{i,t} = \alpha_i + \beta_i(t - \rho_i) + \delta_i' + D_{it} + u_{it} \tag{1}$$

where D_{it} is an ri-dimensional vector of break dummies, B_{ji} expresses the location of break number j. α_i expresses the level of the series before any break occurs. δ_{ji} expresses the alteration in the level at the time of break j.

It was not imposed restriction to the number of breaks. Thereby, the break structure expressed in the model is very flexible.

The error u_{it} is defined as follows:

$$u_{it} = \lambda'_i f_t + e_{it} \tag{2}$$

where f_t, λ_i and e_{it} represent the m-dimensional vector of common factors, the common component of u_{it} and the idiosyncratic component respectively. These can be defined as:

$$\Delta f_t = \prod f_{t-1} + v_t \tag{3}$$

$$\Delta e_{it} = \rho_i e_{it-1} + \omega_{it} \tag{4}$$

In time series test, a null hypothesis of non-stationarity ($H_0 : \rho_i = 0$) is analyzed versus alternative hypothesis ($H_0 : \rho_i < 0$). This restriction can be analyzed by using the LM test. Test statistic of this method is as follows:

$$\tau_{\rho i} = \frac{\sum_{t=p_i,2}^{T} QxS_{it-1}}{\widehat{\sigma}_i \sqrt{\sum_{t=p_i+2}^{T} (QxS_{it-1})^2}} \tag{5}$$

In equation 5, Q_X is operator of least squares residual operator. S_{it} is obtained by subtracting of y_{it} from the right side of the equation in Equation (1). $(S_{it} = y_{it} - \widehat{\alpha}_{it} - \widehat{\beta}_i(t - \rho_i)$ $- \widehat{\delta}_t D_{it} - \lambda'_i f_t)$. $\widehat{\alpha}_i = y_{i\rho_i+1} - \widehat{\beta}_i - \widehat{\delta}_i D_{i\rho_i+1} - \widehat{\lambda}'_i f_{\rho_i+1}$ is the restricted maximum likelihood estimator of α_i. $\widehat{\sigma}_i^2$ is the estimated error variance.

For panel statistics, normalized cross-sectional average of the individual $\tau_{\rho i}$ statistics is applied for each panel unit:

$$\tau_\rho = \frac{1}{\sqrt{N}\sigma\tau} \sum_{i=1}^{N} (\tau_{\rho_i} - \mu_\tau) \tag{6}$$

where μ_τ and σ_τ^2 are the mean and variance of the limiting distribution of Equation (5). τ_ρ has a standard normal distribution.

3.2 Panel cointegration test
In this study, the panel cointegration test developed by Westerlund and Edgerton (2007) that is based on the Lagrange Multiplier (LM) procedure. Also, this test allows for cross-sectional dependency and autocorrelation. In addition, this test can be used in both existence and non-existence of cross-sectional dependency. For the cross-section dependency, bootstrap method is used and the Mccoskey And Kao (1998) is used in the non-existence of cross-section dependency. The null hypothesis of this test is no cointegration and alternative hypothesis is cointegration. Hypothesis testing with the LM statistic can be done as follows:

$$LM_{NT^2}^+ = \sum_{i=1}^{N} \sum_{t=1}^{T} \widehat{\omega}_{it}^{-2} S_{it} \tag{7}$$

In equation 7, S_{it} represents the error term and $\widehat{\omega}_{it}^{-2}$ is estimation of long-term variance.

3.3 CCE and AMG estimators

Pesaran (2006) prepared the common correlated effects (CCE) estimator allows for cross-section dependence and heterogeneity. Also, the researchers can apply the CCE estimator when $T > N$ as well as in $T < N$ situation. Test procedure of CCE estimator is calculated by least squares.

$$Ln[y_{i,t}] = \alpha_i + \mu_i X_{i,t} + \gamma_1 \overline{\ln[y_{i,t}]} + \gamma_2 \overline{X}_t + \varepsilon_{i,t} \; i = 1, \ldots N; \; t = 1, \ldots T \qquad (8)$$

$$[y_{i,t}] = \alpha_i + \beta_i X_{i,t} + \phi_1 \overline{[y_{i,t}]} + \phi_2 \overline{X}_t + \varepsilon_{i,t} \; i = 1, \ldots \ldots N; \; t = 1, \ldots T \qquad (9)$$

In equation 9, ϕ_1 and ϕ_2 express the elasticity of Y and X respectively. Accordingly, IR is included in Y. Also, $[IPI]$, $[FER]$, and $[NIR]$ are included in X. Lastly, ε_{it} determines the error term. The CCE estimator has two different applications. These are the CCEMG estimator and the CCE pooled estimator (CCEP). CCEMG estimator takes into consider the heterogeneity. On the other hand, CCEP estimator assumes the homogeneity of cross-section units in the panel. Therefore, when cross-section units in the panel have heterogenous structure, the CCEMG estimator can be applied (Pesaran, 2006, p. 970–973).

The CCEMG estimator can be calculated as follows:

$$\widehat{\mu}CCEMG = \sum_{i=1}^{N} CCE_i \left/ N \text{ and } SE_{\left(\widehat{\mu}CCEMG\right)} = \frac{\left[\sum_{i=1}^{N\sigma}\left(\widehat{\mu}CCE_i\right)\right]}{\sqrt{N}} \right. \qquad (10)$$

$\widehat{\mu}CCEMG$ and $SE_{\left(\widehat{\mu}CCEMG\right)}$ express the estimated coefficients CCEMG estimator and standard deviations of these coefficients, respectively.

In the study, the augmented mean group (AMG) estimator was also used for the robustness of the results of the CCE estimation. The AMG estimator developed by Eberhardt and Bond (2009) also takes into account cross-section dependency and homogeneity problems. The AMG estimation is derived as averages of the individual country estimates as follows:

$$AMG - Stage(i) \; \Delta y_{it} = \phi' \Delta X_{it} + \sum_{t=2}^{T} c_t \Delta D_t + e_{it} \qquad (11)$$

$$\Rightarrow \widehat{c}_t = \widehat{\mu}_t^{\bullet} \qquad (12)$$

$$AMG - Stage(ii) \; y_{it} = \gamma_i + \phi'_i X_{it} + c_i t + d_i \widehat{\mu}_t^{\bullet} + \omega_{it} \qquad (13)$$

$$\widehat{\phi}_{AMG} = N^{-1} \sum_i \widehat{\phi}_i \qquad (14)$$

In Equation (14), γ_i is constant and e_{it}, ω_{it} are error terms of stage (1) and stage (2), respectively.

4. Empirical findings

It was applied the descriptive statistics and correlation matrix tests for evaluating the data of variables better. After these analyses, it is tested that there was a cross-section dependency problem. Then, the unit root tests were used to test the stationarity of the series in BRIC-T countries. Lastly, CCEMG estimator was applied to specify whether there was a significant long-run relationship among IR, exchange rate, interest rate and output level.

The results of descriptive statistics and correlation matrix for BRIC-T countries are indicated in Table 1. The maximum value of IR is 5.5534. Also, the minimum value of inflation is 0.636. Moreover, the standard deviation is 0.7712. These results determine that IR does not

Correlation	IR	NIR	FER	IPI
IR	1	−0.4806	0.2511	0.5141
NIR	−0.4806	1	−0.2952	−0.4513
FER	0.2511	−0.2952	1	0.0574
IPI	0.5141	−0.4513	0.05746	1
Sample size	540	540	540	540
Median	4.6570	1.99011	1.95013	4.6015
Mean	4.4512	2.15719	2.05164	4.55565
Std. dev	0.7712	0.80266	1.50859	0.22813
Min	0.63657	0.06765	−2.813411	3.95258
Max	5.5534	5.6720	4.53110	3.9740
Skewness	1.859790	1.704947	−0.35783	1.94958
Kurtosis	4.48947	4.09639	2.3084	5.39499
Source(s): Created by authors				

change significantly across the BRIC-T countries. Besides, the mean and median are 4.4512 and 4.6570, respectively. These results indicates the absence of significant outliers. Exchange rate, interest rate and IPI show similarity with inflation in terms of descriptive statistics. Besides, the maximum and minimum values of these three variables are small and close to each other. Besides, the standard deviation values of these three variables are quite low. These results determine that IR does not change significantly across the BRIC-T countries. Besides, the median and mean values of the three variables are close to each other. These results indicates the absence of significant outliers. Also, the Skewness and Kurtosis values of IR, NIR, FER and IPI variables are not between −1.5 and + 1.5. Therefore, it is concluded that the variables do not have a normal distribution (Tabachnick and Fidell, 2013). Also, most of the variables are positively skewed and skewness values are greater than one except for FER, and in the case of Kurtosis, most of the variables are Leptokurtics as the values are greater than 3 except for FER (Ullah *et al.* (2021).

Moreover, the values of correlation coefficients among variables are low. This result indicates the absence of significant multicollinearity problems. Finally, there are no missing observations. This result is also indicates that the data used in the model is balanced panel.

After the analysis of descriptive statistics and correlation matrix, the cross-sectional dependency tests were applied. In this study, CDLM tests of Breusch and Pagan (1980) and Pesaran *et al.* (2008) were used to analyze whether there is a cross-sectional dependency. According to Table A1, the null hypothesis expresses that no cross-section dependence for the variable is rejected both in BRIC-T countries. After determining the cross-sectional dependency, panel unit root test was used for testing the stationarity of the variables. The results of panel unit root tests related to the IR, interest-rate and exchange-rate are shown in Table 2.

According to Table 2, the null hypothesis, which states that there is a unit root for the IR, cannot be rejected for Turkey, Brazil and India except China and Russia. When we investigated Turkey, four structural breaks were estimated. Two of these breaks in the early 2000s corresponding to observations 2001Q1 and 2002Q2 appeared to be consistent with the economic crises that happened in 2000. One of these breaks appeared in 2008Q1 is consistent with global economic crisis. Lastly, the structural break appeared in 1998Q2 is consistent with the political crisis in Turkey. Also, it was observed that structural breaks were occurred in the 1998Q2 and 2000Q4 periods in Brazil, India and Russia. These breaks showed similarity with the Asian crisis, Russia crisis and Argentine crisis from a historical point.

Unit root test				Estimated breakpoints		
	$\tau^1_{\rho i}$	$\tau^2_{\rho i}$	$\tau^3_{\rho i}$	$\widehat{\beta}^1$	$\widehat{\beta}^2$	$\widehat{\beta}^3$
Turkey	−1.32	−2.25	−1.69	2008Q3	1998Q2, 2001Q1, 2008Q3	1998Q2, 2001Q1, 2002Q1,
Brazil	−1.78	−2.75	−2.71	2008Q3	1998Q3, 1999Q3, 1999Q2, 2000Q4	1998Q3, 1999Q3, 1999Q2, 2000Q4
China	−1.60	−4.87**	−3.93	2007Q4	0	0
India	−2.25	−2.74	−2.29	1998Q4, 2008Q3,	1998Q4	1998Q4
Russia	−1.71	−7.64**	−3.09	1998Q3, 1999Q3, 2008Q3, 2008Q4	1998Q2, 1998Q3, 1998Q4, 1999Q3, 1999Q4.	1998Q2, 1998Q3, 1999Q2, 1999Q3, 1999Q4

Table 2.
The result of panel unit root for IR

Note(s): **shows the significance at 5% level
Source(s): Created by authors

Besides, the structural breaks in 2007Q4 and 2008Q3 indicate the beginning of the global economic crisis.

According to Table 3, the null hypothesis, which states that there is a unit root for interest-rate, cannot be rejected for all countries. Many of the structural shifts were found in different periods. For instance in Turkey, there were six structural breaks between the 1999Q4 and 2016Q4 periods. These periods are consistent with the structural breaks periods of IR except

Unit root test				Estimated breakpoints		
	$\tau^1_{\rho i}$	$\tau^2_{\rho i}$	$\tau^3_{\rho i}$	$\widehat{\beta}^1$	$\widehat{\beta}^2$	$\widehat{\beta}^3$
Turkey	−162	−2.71	−1.60	1999Q4, 2000Q3, 2000Q4, 2009Q2, 2015Q4, 2016Q4,	0	1999Q4, 2000Q4, 2009Q2
Brazil	−2.42	−1.11	−1.84	1997Q3, 1998Q1, 2002Q1, 2009Q1.	1997Q3, 1998Q2, 2002Q1	2002Q1, 1997Q3, 1998Q2
China	−1.73	−2.29	−1.88	1997Q4, 1999Q1, 2007Q4, 2008Q3	1997Q4, 1999Q1, 2007Q4, 2008Q3	1997Q4, 1999Q1, 2007Q4, 2008Q3
India	−0.99	−1.23	−1.34	1997Q4, 1997Q1, 2000Q1, 2009Q4,	1997Q1, 1997Q4, 2000Q1	1997Q1, 1997Q4, 2009Q4,
Russia	−2.59	−1.46	−1.62	1996Q3, 1997Q1, 1998Q1, 1998Q2, 2009Q4,	1998Q1, 1999Q4	1998Q1, 2009Q4

Table 3.
The result of panel unit root for NIR

Note(s): The critical value (−3.02) was obtained from Schmidt and Phillips (1992)'s Table 1A
Source(s): Created by authors

the breaks appeared in 2015Q4 and 2016Q4. In these periods, there were political tension in Turkey. In Brazil, four structural breaks were determined between 1997Q3 and 1998Q2 periods. Also, the structural break appeared in 2002Q1 shows the date of Argentine crisis. Besides, one structural break was found in 2009Q1. The dates of structural breaks for China, India and Russia show similarity with the dates of structural breaks for IR in these three countries. These dates are consistent with tha beginning dates of the Asian crisis, Russia crisis and global financial crisis.

According to Table 4, the null hypothesis, which states that there is a unit root in foreign exchange-rate, is accepted for all of the countries except India. The structural breaks happened between 1997Q2 and 2001Q4 are consistent with Asian, Russia and Argentine Crisis. Also, the structural breaks appeared between 2007Q4 and 2009Q2 are consistent with the global economic crisis. Finally, the structural break in 2016Q4 indicates the year, when the political tension occurred in Turkey.

According to Table 5, the null hypothesis, which states that there is a unit root in IPI, is accepted for all of the countries except China. The structural breaks happened between the 1996Q2 and 2009Q1 are consistent with the Asian crisis, Russia crisis, Argentine crisis and the global economic crisis. The structural break in 2017Q1 shows the year, when the political tension occurred in Turkey.

According to Table 6, the null hypothesis of unit root is accepted for all variables. Therefore, IR, interest-rate, exchange-rate and industrial production include unit root in BRIC-T countries.

Unit root test				Estimated breakpoints	
	$\tau_{\rho i}^1$	$\tau_{\rho i}^2$	$\tau_{\rho i}^3$	$\widehat{\beta}^1$	$\widehat{\beta}^2$	$\widehat{\beta}^3$
Turkey	−0.90	−1.19	−1.18	2009Q1, 2016Q4	2001Q1, 2016Q4	1995Q2, 2016Q4
Brazil	−1.49	−1.51	−1.29	1998Q4, 2008Q3	1998Q3, 2001Q4	1998Q2, 1998Q3, 2001Q4
China	−1.31	−1.49	−1.51	2007Q4, 2008Q3	2009Q1, 2007Q4	2007Q4, 2009Q1
India	−2.30	−3.49**	−2.88	1997Q2, 2009Q2	1997Q2, 2009Q2	1997Q2, 2009Q2
Russia	−1.57	−1.51	−1.80	1998Q2, 1998Q3, 2007Q1, 2007Q4	1998Q2, 1998Q3, 2007Q4	1998Q2, 1998Q3, 2007Q4

Note(s): **shows the significance at 5% level. The critical value (−3.02) was obtained from Schmidt and Phillips (1992)'s Table 1A
Source(s): Created by authors

Table 4.
The result of panel unit root for FER

Unit root test				Estimated breakpoints	
	$\tau_{\rho i}^1$	$\tau_{\rho i}^2$	$\tau_{\rho i}^3$	$\widehat{\beta}^1$	$\widehat{\beta}^2$	$\widehat{\beta}^3$
Turkey	−0.61	−1.39	−1.11	2009Q2, 2017Q1	2001Q3, 200Q4, 2017Q1	2001Q3, 2002Q2, 2017Q1
Brazil	−0.59	−1.38	−1.41	2008Q3 30	1998Q4, 1999Q2, 2001Q4, 1998Q2	1998Q4, 1999Q2, 2001Q4, 2001Q1, 1998Q2
China	−3.28**	−6.91**	−4.90**	2008Q1	2008Q1	2008Q1
India	−1.77	−0.89	−1.72	2008Q3, 1998Q4	1998Q4	1998Q4
Russia	−1.85	−1.81	−1.74	2008Q3, 1998Q3, 1999Q3, 1996Q2, 1996Q3, 2008Q4, 2009Q1	1998Q3, 1999Q3, 1999Q2, 1999Q4, 1998Q2, 1996Q2	1998Q3, 1999Q3, 1999Q4, 1998Q2, 1999Q2, 1996Q2

Note(s): **shows the significance at 5% level
Source(s): Created by authors

Table 5.
The result of panel unit root for IPI

After the stationarity of the variables was tested, we analyzed the cointegration relationships between the variables in Table 7.

According to Table 7, the null of no-cointegration hypothesis is rejected for either the bootstrap or the asymptotic standard deviation. For this reason, it is concluded that there is a long-term relationship among the IR, the interest rate, real exchange rate and the output level.

After the cointegration test, we estimated the coefficients of exchange-rate, interest-rate and IPI in Table 8.

Table 8 indicates that the interest-rate is statistically significant and negative in Turkey. Besides, the exchange-rate and IPI are also statistically significant and positive. According to these results, if the interest-rate rises by 1%, the IR decreases by 0.351%. If the exchange-rate rises by 1%, the IR increases by 0.173%. Also, if the industrial production increases by 1%, the IR increases by 0.076. The interest-rate, the exchange-rate and the IPI are statistically significant and positive for Brazil. The interest-rate, exchange-rate and the IPI coefficients are 0.088, 0.850 and 0.091, respectively. Accordingly, a 1% rise in the interest rate rises the IR by 0.088%. A 1% rise in the exchange-rate increases the IR by 0.850%. A 1% rise in the IPI increases the IR by 0.091%. The interest-rate, the IR and the IPI are statistically significant in Russia. The interest-rate, the exchange-rate and the IPI coefficients are −0.241, 0.127, 0.0620 respectively. Finally, the exchange-rate and the IPI in India are statistically significant. If the exchange-rate rises by 1%, the IR increases by 0.421%. Also, A 1% rise in the IPI increases the IR by 0.061%. The interest-rate is not significant; therefore, only the exchange-rate and industrial production are effective on the IR in India. None of the variables used in the analysis are not significant in China. Therefore, interest-rate, exchange rate and IPI are not influential on inflation in China. According to these results, the ERPT is valid in four countries except China. Also, output growth increases the IR in these four countries except China.

Variable	τ_ρ^1	Prob. value	τ_ρ^2	Prob. value	τ_ρ^3	Prob. value
CPI	0.78	0.70	1.86	0.96	1.36	0.74
NIR	−0.67	0.27	0.56	0.60	1.18	0.90
FER	1.65	0.93	0.78	0.67	0.86	0.81
IPI	1.35	0.79	1.41	0.72	0.52	0.74

Table 6.
The result of panel unit root for panel

Note(s): The critical value 1.96 at 5% level is a standard normal distribution
Source(s): Created by authors

LM statistic	Bootstrap p-value	Asymptotic p-value
9.5733	0.000[***]	0.000

Table 7.
The result of panel cointegration test

Note(s): *** shows the significance at 1% level
Source(s): Created by authors

Variable	Turkey	Brazil	China	India	Russia
NIR	−0.351[***] (0.075)	0.088[*] (0.051)	0.132[*] (0.070)	0.856 (0.734)	−0.241[***] (0.051)
FER	0.173[***] (0.0452)	0.850[***] (0.20)	−0.325 (0.620)	0.421[***] (0.120)	0.127[***] (0.0339)
IPI	0.076[**] (0.038)	0.091[**] (0.045)	0.0530 (0.0760)	0.0612[*] (0.0351)	0.0620[*] (0.0350)

Table 8.
Individual country results of CCE estimator

Note(s): The values in the parenthesis are standard errors. ***, ** and * show the significance level at 1, 5 and 10%, respectively
Source(s): Created by authors

After the estimation of coefficients by CCE estimator, AMG estimator is applied for the robustness of the CCE results. Accordingly, the results of AMG estimator is shown in Table 9.

Table 9 shows that the exchange rate has a significant and negative effect on inflation in four countries except China. Accordingly, the ERPT effect is valid in these four countries. This result confirms the results of the CCE estimator. The other results of the AMG estimator are similar to those of the CCE estimator. Only the interest rate results for Brazil and industrial production results for China differ. Apart from that, the results of the two estimators confirm each other. Since the AMG method is newer than the CCE method, the results of the AMG estimator may be preferred. Accordingly, the positive effect of the increase in industrial production on the IR in China can be explained by Chinese exports. China is the largest exporter country in the World in 2023. At the same time, China accounts for a significant share of the world's population. If the increase in production in China fails to keep up with the increase in population, prices in the domestic market may increase due to supply-demand imbalance. Therefore, an increase in industrial production may put pressure on the IR.

5. Conclusion
In this study, we analyzed the validity of exchange-rate pass-through and cost channel and the effect of output level on inflation between 1995 Q1–2022 Q4 in BRIC-T countries. Methods taking cross-section dependency and structural breaks into account were applied in this study. The results of the analysis show that the exchange rate has a negative effect on the IR in four countries except China. Also, the findings of the analysis indicated that the interest rate was effective in lowering the rate of inflation in Turkey and Russia. On the other hand, it was found that the interest-rate positively affected the IR in China. Therefore, we conclude that ERPT is valid in these four countries (Turkey, Russia, Brazil and India). On the other hand, cost channel is efficient on inflation in China. Also, we found out that the IPI affected the IR in all of five countries. Since the IPI coefficient is positive, the output growth increases the IR in Turkey, Russia, Brazil, India and China. Among these five countries, the dependency of the IR on the exchange-rate is higher in Turkey, Brazil, Russia and India. Therefore, because of the high IR, it depends on the stability of the exchange-rate whether there will be uncertainty in these countries or not. Also, the output growth rises the price level in Turkey, Russia, Brazil and India. According to these results, the economy of Russia, Brazil, Turkey and India among the BRIC-T countries, has a fragile structure. Therefore, it is still early to consider whether the formation, pioneered by China can be an alternative to an international system centered by USA and EU and whether it can replace the system centered by US and EU. These results are similar to the studies of Ha *et al.* (2020), Kotil (2020) and Beirne *et al.*, which examine the ERPT effect, and Akbas (2020), which investigate the impact of the cost channel on inflation in addition to the ERPT. However, this study is not only analyzes the exchange rate and interest rate pass-through like Akbas (2020), who examined exchange rate and interest rate pass-through in the fragile five countries, but also examines the output growth causes inflation in the fragile five countries. Therefore, this study also evaluates whether the economies of the fragile five countries have a fragile structure and whether the

Variable	Turkey	Brazil	China	India	Russia
NIR	−0.0042*** (0.00151)	−0.000310 (0.04225)	0.01120** (0.0052)	−0.00309 (0.00290)	−0.000877*** (0.000203)
FER	0.00412*** (0.00093)	0.04252*** (0.0018)	−0.07562 (0.256)	0.6209*** (0.1010)	0.3702*** (0.02723)
IPI	0.0016*** (0.00067)	0.52209*** (0.1135)	0.1624*** (0.0475)	0.8920*** (0.151)	0.0323*** (0.00116)

Note(s): The values in the parenthesis are standard errors. *** and ** show the significance level at 1 and 5%, respectively
Source(s): Created by authors

Table 9.
The results of AMG estimator

China-led Belt and Road initiative will be successful. For this reason, the results obtained in this study fill the gap in the study of Akbas (2020), which only examines the exchange rate and interest rate pass-through in the Fragile Five countries.

The pass-through effect in Turkey, Brazil, India and South Africa may be due to the extreme volatility of exchange rates in these four countries. Also, Turkey, Russia, Brazil and India have applied an inflation-targeting strategy and flexible exchange rate regime. To implement the inflation-targeting strategy successfully, the central bank of these countries in these countries should maintain exchange-rate stability. Central bank independence is of great importance in achieving this objective. Highly independence of central banks in terms of implementation of the policy will increase the stability in the money market and also in the exchange-rate market. Thus, an increase in central bank independence is important to decrease the fragility of the economy. However, only the central bank independence is not sufficient for the stability of the exchange-rate. The stability of the exchange-rate also depends on the stability of the foreign exchange supply. Activities of the foreign capital are very important regarding the stability of foreign exchange supply. China and India are very successful in terms of being attractive to foreign capital, but Russia, Turkey and Brazil are weak on this issue and are not yet competitive compared to US and EU countries. For these reasons, central bank independence should be increased for stability of exchange rate, especially in these four countries. Besides, institutional arrangements on about ensuring economic and political stability, strengthening the rule of law and reducing bureaucracy should be actualized for regular capital inflows into the country. Although China and India can attract adequate foreign capital, they should not leave from the implementations to have stability in foreign capital inflow. All these implementations can aid BRIC-T countries to increase foreign investments by lowering the risk premium Credit Default Swap (CDS) and stabilizing the exchange-rate.

Another result obtained in the study is that the negative effect of the interest rate on inflation in Turkey and Russia and the positive impact in China may be due to the fact that the monetary transmission mechanism is functional in Turkey and Russia, while in China, financing costs are high among the costs of firms. A negative relationship between the interest rate and the IR indicates that the monetary transmission mechanism is functional and the central bank can successfully use the interest rate channel to fight inflation. The successful functioning of the monetary transmission mechanism depends on high central bank independence. Therefore, especially in these two countries, central bank independence should be given importance in order for the monetary transmission process to be successful and to reduce inflationary pressures. For these reasons, it is of great importance to increase central bank independence in Turkey and Russia in order to reduce the pressure of the interest rate on the IR. Therefore, central bank independence should be increased in these two countries. In China, in order to reduce the negative impact of interest rates on the IR, policymakers should reform to lower real interest rates. Moreover, since the exchange rate in China is stable, policy authorities should also prefer the external borrowing so that the IR is not adversely affected by fluctuations in the domestic interest rate. This situation may not be possible at first. First, the inflation level should be brought down to a reasonable level. Policy authorities should implement their policies decisively.

Finally, the last result obtained in the study is that the positive effect of the level of production on the IR in the four countries except China may be related to the high use of imported inputs in the production process or the low production of high value-added products in the production process. If the exchange rate increases when the rate of imported inputs in production is high, the input costs and consequently the general level of prices increase. Thereby, whether an increase in production will increase inflation depends on the rate of imported inputs used for production. Therefore, policymakers should implement the policies that encourage to reduce the use of imported inputs in production and to increase the use of domestic inputs in production. Especially, production of high-technology product in domestic production are more important in

the prevention of over fluctuation of exchange rates and inflation. By increasing of the production of high-technology products in domestic production, the fragility of the economy may decrease. Production of high-tech products is quite low in BRIC-T countries, except for China. For example, the share of exported high-tech products in total exports in China [6], is higher than what is in the US and EU. For this, in order to reduce volatilities in the economies of BRIC-T countries, policymakers should implement policies that encourage domestic production and the production of high value-added products in domestic production.

Notes

1. Brazil, Russia, India and Turkey have applied the inflation-targeting strategy. See the website of IMF for looking at the countries that have implemented an inflation-targeting strategy.

2. See the website of Morgan Stanley Capital International (MSCI) for looking at the list of emerging countries.

3. The Belt and Road Initiative is one of the most important international economic strategies in the 21st century. Although the Belt and Road Initiative was declared in 2013, it was shaped through the trade investments, international treaties and multinational organizations that China carried out previously in the world. Shanghai Cooperation Organization in 2001 and BRIC (Brazil, Russia, India and China) countries in 2004 are among these organizations. The Belt and Road Initiative, beginning with Shanghai Five and progressing with BRIC-T, is an attempt to search for an alternative system against the international system under the domination of the US and EU. In this context, BRIC in the field of economy, Shanghai in the field of security and Belt and Road initiative in the commercial field constitute the divisions of the initiative created by China against the global dominance of the US and the EU (Huang, 2016, p. 314). The Belt and Road Initiative is the biggest economical target of China and it aims to promote economic development in a large area comprising the sub-regions in Asia, Europe and Africa, which covers 64% of the world population and 30% of the world's gross domestic product (GDP). The Belt and Road Initiative was strategically designed to sustain and restructure the powerful growth of China in external sectors. Although the infrastructure development center plays an important role, the Belt and Road Initiative is extremely extensive that includes obstacle-free trade, financial support, people-to-people exchange and policy dialog (Cheng, 2016, p. 309–310).

4. The reason of the analysis the 1995Q1-2019Q4 period in the study is that the liberalization movements in the markets began to gain momentum in the 1990s. The fact that all five countries are members of the World Trade Organization (WTO) shows the importance of the WTO on market liberalization. Even if the liberalization of the markets creates a competitive situation for the economies, flexible exchange rate regimes and similar implementations may increase the fragility of economies. Although China does not apply floating exchange rate regimes, the other four countries implement flexible exchange rates. Since these developments are of great importance in terms of affecting the economic structure of countries, we preferred the year 1995, when the WTO was founded. Besides, due to the COVID-19 pandemic in 2020, there was a great recession in the economies around the world. Since this situation negatively affects many macroeconomic variables, it was thought that analyzing the data in this period would adversely affect the estimation results. Therefore, data from 2020 and beyond were not attached to the analysis.

5. The codes of the methods used in the analysis can be provided upon request from the authors.

6. According to the information obtained from World Development Indicator (WDI) electronic data base, high-tech product export share in manufacturing industry share is as follows: India: 10.30%, Turkey: 3.2%, Brazil: 13.28%, China: 30.79%, USA: 18.97%, EU countries, having high level of income: 24%.

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(The Appendix follows overleaf)

Appendix

Variables	CD$_{LM}$			CD$_{LMadj}$	
	Statistic	p-value		Statistic	p-value
CPI	6.495	0.000		6.120	0.000
NIR	6.735	0.000		6.845	0.000
FER	7.376	0.000		7.218	0.000
IPI	7.230	0.000		7.160	0.000

Table A1.
The results of cross-section dependence test for variables

Note(s): *** shows the significance level at 1%
Source(s): Created by authors

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