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Causality relationship between foreign direct investments and economic improvement for developing economies: Russia case study

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Abstract. Foreign direct investment (FDI) can have a significant impact on economic development in developing economies like Russia. FDI can bring in capital, technology, and management expertise that can stimulate economic growth, increase employment, and improve productivity. In the case of Russia, FDI has played a vital role in the country's economic development. A study conducted by the World Bank in 2019 found that FDI inflows have contributed significantly to Russia's economic growth and led to increased productivity, employment, and exports. The article analyzes the relationship between foreign direct investment and economic growth in Russia using ARDL cointegration and Toda–Yamamoto causality analysis test. The results reveal that there is no causality relation between GDP growth and foreign direct investment inflow in Russia. Overall, foreign direct investment effectively contributes to economic growth in Russia in the short term and not really in the long run.

Key words and phrases: foreign direct investment, economic growth, ARDL, Toda–Yamamoto causality

1. Introduction

Foreign direct investment (FDI) can play a significant role in economic development, particularly for developing economies. In the case of Russia, FDI has been seen as an important source of capital inflows and a means to improve the country's economic conditions. According to some economists, FDI contributes to the increase in the productive capacity of the economy and can also serve as a vector for the dissemination of technologies or knowledge [1, 2]. There is a causal relationship between foreign direct investment and economic improvement in Russia. FDI can bring in new technology, increase competition, create employment opportunities, and increase productivity in the host country. Russia has been successful in attracting FDI in recent years, and this has contributed to the growth of various sectors of the economy, such as oil and gas, metals, and telecommunications. This brings up to date the debate on the effect of FDI on the economic growth of developing countries [3]. However, the relationship between FDI and economic development in Russia is not without challenges. One of the main challenges is the country's dependence on natural resources, particularly oil and gas. While FDI in the natural resource sector has contributed to the country's economic growth, it has also made the economy vulnerable to fluctuations in commodity prices. Some authors argue that FDI, i.e., investments carried out abroad by transnational or multinational companies with a view to acquire assets and manage production and marketing activities in host countries, positively affect economic growth [4].

Still others demonstrate that FDI only stimulates economic growth subject to the fulfillment of certain conditions, namely human capital, trade openness and good institutional governance [3, 5].

The objective of this article is therefore on the one hand to evaluate the relationship between FDI and economic growth in Russia, and on the other hand to highlight proposals from which the policies of economic improvement can rely on. The rest of the article is presented as follows: related works, material and methods, results and conclusion.

2. Related works

For years, extensive study has been conducted to determine the relationship between FDI entry into host nations and economic progress. The causal relationship between GDP growth and FDI, in theory, can go either way. One the one hand, FDI inflows can boost growth for the host countries through the expansion of the capital stock, the creation of new jobs, and the transfer of technology [6]. On the other hand, expanding economies draw new investment possibilities, including FDI inflows, to the host nation [7]. Despite the fact that more studies support the positive, a smaller number of studies indicated that domestic investment competition has a detrimental impact on economic growth.

Co-integration and panel Granger causality analyses in panel data was used to examine the connection between foreign direct investment and economic growth in 65 countries [8]. The findings reveal a discrepancy in the co-integration of the panel study's relationship. The findings also point to a one-way causal relationship between FDI and GDP, which may be useful in prioritizing the allocation of resources across sectors to encourage FDI.

The paper [9] explores the causal relationship between foreign direct investment and exports using annual data for 19 emerging economies in Asia from 1980 to 2015. China, Republic of Korea, Indonesia, Singapore, and Turkey have causality from export to FDI at 1% significant level, according to the first part of Granger Causality results. At a 5% level of significance, Nepal, Sri Lanka, the Philippines, Thailand, and Oman have a causal relationship between export and FDI. At a 10% level of significance, it is plausible to conclude that Bangladesh and India have a causal relationship between export and foreign direct investment, even though the likelihood value is extremely close to the 5% significance threshold. Sri Lanka, Indonesia, and Turkey have a causality from FDI to export at a 1% significant level, while India, Nepal, and Thailand have a causality from FDI to export at a 5% significance level, according to the second portion of the Granger causality association tests. Eventually, at a 10% level of significance, Hong Kong, Bangladesh, Singapore, Bahrain, Oman, and Saudi Arabia were determined to have a causal association between FDI and export. In a nutshell, the export-led growth hypothesis holds true for Asian countries' growing economies.

Granger causality test based on the vector error correction model was used to investigate the causal relationship between the two variables throughout the time span 1980–2014 [10]. The empirical findings offer compelling evidence for FDI's causal role in Cambodia's economic growth (GDP). The study does not, however, support a direct causal relationship between GDP and FDI. The growth impact of FDI is thus properly supported in Cambodia, it can be inferred. The study [11] looks at the connection between trade, FDI, and economic growth in Greece from 1960 to 2002. There may be an equilibrium relationship over the long term, according to the cointegration study. The Granger causality test results demonstrated that there is a causal relationship between the variables under investigation. Under the open-door policy, economic growth, trade, and Investment seem to be mutually reinforcing.

The authors of [12] determine whether there is a causal link between foreign direct investments and economic growth for developing countries. The 30 developing nations with the highest GDP growth rates in 2016 are taken into account in this context. Additionally, Dumitrescu Hurlin panel causality analysis is used to examine annual data for these nations for the years 1991 through 2015. It has been determined that foreign direct investments and economic growth are related causally. In other words, it is acknowledged that FDI plays a significant role in driving economic expansion. This instance demonstrates how a country's economy might grow by luring foreign investors to make direct investments there. In the paper [13] the relationship between foreign direct investment (FDI) and the expansion of 117 nations throughout seven regions are investigated. The Granger causality approach and panel VAR/block exogeneity test were used to conduct predictive analysis among the panel series on a more recent panel dataset covering the years 2010–2020. In order to explore the interaction effects of the variables, which have not yet gained widespread acceptance in the field being examined, wavelet coherence techniques were also modified. The empirical findings show that FDI and economic growth both globally and in the Asian area are causally related in both directions. Contrarily, in the American region, the causality is unidirectional. For the majority of developed and emerging economies in the regional analysis, the results imply no causality.

The causal association between foreign direct investments and economic development in Togo from 1991 to 2009 was studied in [14]. They tested and established the causal link between FDI and Togo's economic growth using the Granger-causality. The study discovered a one-way link between FDI and GDP using time series data. It is possible to conclude that FDI causes GDP.

The relationship between foreign direct investment (FDI) and economic growth in the nations of the Organization of Eastern Caribbean States (OECS) is experimentally examined in [15]. The research estimates a dynamic panel growth model using the generalized method of moments employing panel data consisting of annual data covering the period 1988–2013 from 34 countries, including the six OECS economies. The empirical findings indicate that while FDI has a beneficial impact on growth, on its own, it has very little of an effect. Its considerable impact is therefore primarily indirect. Moreover, infrastructure improvement and FDI interact favorably to boost economic growth, whereas FDI discourages local investment.

According to the analysis of previous literature, no study on Russia has yet been done on the causal relationship between foreign direct investment and economic improvement for developing economies.

3. Materials and methods

3.1. Data Description

The analysis makes use of Russian economic annual data from 1990 through 2020 from The World Development Indicator (WDI) provided by the World Bank. The level of GDP, inflows of foreign direct investment, population growth, inflation, government consumption, financial development, and investment are included in the considered statistics (see tables 1, 2).

Table 1

Definition of variables

Variables	Definition
GDPG	The growth rate of the GDP
FDI	Inflow of Foreign Direct Investment in percentage of GDP
GGFCE	General Government Final Consumption Expenditures
INF	The Consumer Price Index
POPG	The growth rate of the population
DCPS	Domestique Credit to Private Sector

Table 2

Descriptive and summary statistics

Variables	Mean	Standard Deviation	Minimum	Maximum
GDPG	0.736661	6.251199	-14.53107	10.00007
FDI	23.21095	1.494542	20.35158	25.69407
GGFCE	18.06510	1.715673	13.85744	21.067110
INF	109.4699	302.7925	2.878297	1481.166
POPG	-0.079966	0.228914	-0.460024	0.286681
DCPS	28.98768	19.67446	3.077914	59.96833

The most commonly used indicators for gauging economic success of a nation are its GDP and GDP per capita, which can be measured in terms of level or growth. Many metrics, including commonly used income statistics like GDP or GDP per capita, can be used to assess the economic success of a nation or region (measured either in level or growth terms). These metrics do have certain drawbacks, most notably the fact that they tend to overestimate national wealth and do not take into consideration overall welfare. Despite these problems, we employ per capita real GDP growth as the yardstick for measuring economic activity.

3.2. Methodology

We conducted an empirical research using cointegration and causal analysis to determine the relationship between foreign direct investments and economic growth in Russia. This method enables us to assess the impact of foreign direct investment on economic development over the long term as well as the short term.

In a single equation framework, auto regressive differentiated lag (ARDL) models are frequently used to investigate dynamic relationships with time series data. The differentiated lags element of the model allows the dependent variable's present value to depend on both its own historical realizations, or the autoregressive part, and the present and past values of other explanatory variables. Variables might be either stationary, non-stationary, or both. The ARDL model can be used to distinguish between long-term and short-term impacts, as well as to test for cointegration or, more broadly, the presence of a long-term relationship, in its portrayal of Error Correction (EC) term between the relevant variables. There will be answers to frequently asked questions and a step-by-step guide for doing the boundaries test to determine whether a long-term relationship exists [16]. This test is implemented as a post-estimate command that displays recently determined critical values for finite samples and approximative p-values.

To achieve our goals, we used a time series autoregressive distributed lag model (ARDL) as proposed by Pesaran, Shin, and Smith in their papers to estimate economic growth using a linear function that controls the interest variable, which is foreign direct investment.

3.2.1. Unit root tests

It is necessary to identify the order of integration of variables in any econometrics research. Verifying that the variables in the regression are either integrated of order zero I(0) or, at most, integrated of order one I(1) is essential for estimating an ARDL model. Each cross sectional series unit root test has an Augmented Dickey Fuller (ADF) regression as its default baseline:

$$\Delta y_t = y_{t-1} + \sum_{j=1}^{p} \phi_j \Delta y_{t-j} + \epsilon_t, \tag{1}$$

where $y = \rho - 1$.

The tests assess the null of unit root H_0: $y = 0$ $(\rho = 1)$ against the alternative of stationarity H_1: $y < 0$ $(\rho < 1)$.

3.2.2. The bounds test or cointegration test approach

Cointegration between series presupposes the existence of one or more long-term equilibrium relations between them, and these relations can be integrated with these series' short-term dynamics in an error-correction (vector) model that looks like this:

$$Y_t = AY_{t-1} + \sum_{i=1}^{p} B_i \Delta Y_{t-i} + U_t, \tag{2}$$

where Y_t is vector of stationary variables under study (whose dynamics are explained); B_i is matrix whose elements are parameters associated with ΔY_t; A is matrix of the same dimension as B_i (where $r(A)$ is the number of co-entering relations); Δ is the first difference operator.

To test the existence or not of cointegration between series, the econometric literature provides several tests or approaches including the test of Engle & Granger [17], those of Johansen [18] and Pesaran [16]. The cointegration test of Engle & Granger [17] only helps to verify the cointegration between two integrated series (1) of the same order (i.e. order of integration = 1), it is therefore adapted to the bivariate case and is thus proves to be less effective for multivariate cases. The cointegration test by Johansen was created for multivariate instances and allows the cointegration on more than two series to be verified. The Engle and Granger test's drawbacks for the multivariate case are addressed by the Pesaran test, which is based on vector error correction autoregressive modeling (VECM). However, this test also calls for all series or variables to be integrated in the same order, which is not always the case in actual use. So, we can utilize the cointegration test of Pesaran known as the "bounds test to cointegration" when we have several integrated variables of various orders (I(0), I(1)). If we use the Pesaran cointegration test to verify the existence of one or more cointegrating relationships between the variables in an ARDL model, we will say that we are using the "ARDL approach to cointegrating" or that we apply the test of cointegration by the staggered delays. The model that serves as the basis for the test of cointegration by staggered delays (test of Pesaran) is the following cointegrated ARDL specification (it takes the form of an error correction model or a VECM), when studying the dynamics between two series "X_t: and Y_t"

$$\Delta Y_t = \lambda_1 Y_{t-1} + \lambda_2 X_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta Y_{t-i} + \sum_{j=0}^{q-1} b_j \Delta X_{t-j} + \pi_0 + \pi_1 + e_t. \tag{3}$$

This specification presents the ARDL model, i.e. relation (3), in the form of an ECM or a VEC, which assumes the existence of cointegration relations between series. Relation (3) can also be written as follows:

$$\Delta Y_t = \pi_0 + \pi_1 + \sum_{i=1}^{p} \alpha_i \Delta Y_{t-i} + \sum_{j=0}^{q-1} b_j \Delta X_{t-j} + \Theta U_{t-1} + e_t, \tag{4}$$

where Θ is the error correction term, adjustment coefficient or restoring force. Based on relation (3), after estimation, we will conclude that there is a cointegration relation between Y_t and X_t if and only if: $0 < |\hat{\Theta}| < 1$ and rejection $H_0 : \Theta = 0$ ($\hat{\Theta}$ is statistically significant). There are two steps to follow to apply the Pesaran cointegration test, namely:

(i) the determination of the optimal lag first (AIC, SIC) and

(ii) the use of Fisher's test to verify the hypotheses (Cfr relation (3)):

$H_0 : \lambda_1 = \lambda_1 = 0$: existence of a cointegration equation;

$H_0 : \lambda_1 \neq \lambda_1 \neq 0$: absence of cointegration equation.

The test process requires that the Fisher values produced be compared to the critical values (limits) that Pesaran et al. simulated for various scenarios and thresholds. It should be noted that for the critical values, the lower limit (1st set) relates to the variables I and the upper limit (2nd set) takes up the values for which the variables are integrated of order 1.

Thereby:

— if *Fisher* > *Upper bound*: cointegration exists;
— if *Fisher* < *Lower bound*: cointegration does not exist;
— if *Lower bound* < *Fisher* < *Upper bound*: no conclusion.

An error correction model can assist in confirming the existence or absence of cointegration between variables thanks to the method of Pesaran. Under the framework of our investigation, this model will assume the following shape:

$$\Delta \mathrm{GDPG}_t = \Bigg(a_0 + \sum_{i=1}^{p} a_{1i} \Delta GDPG_{t-1} + \sum_{i=0}^{q} a_{2i} \Delta LOGFDI_{t-1} + \\ + \sum_{i=0}^{q} a_{3i} \Delta POPG_{t-1} + \sum_{i=0}^{q} a_{4i} \Delta INFL_{t-1} + \sum_{i=0}^{q} a_{5i} \Delta GGCE_{t-1} + \\ + \sum_{i=0}^{q} a_{6i} \Delta GCPS_{t-1} + \sum_{i=0}^{p} a_{7i} \Delta GFCF_{t-1} + \Theta U_{t-1} + e_t \Bigg). \quad (5)$$

Relations (1) and (2) will be the subject of estimates. But first of all, we will:

— Determine the degree of integration of the variables (stationarity test): Augmented Dickey–Fuller/ADF test.
— Test the possible existence of a cointegration relationship between variables: cointegration test of Pesaran or bound cointegration test.
— Test the causality between the variables under study: causality test in the sense of Granger, causality test in the sense of Toda and Yamamoto.

In addition, let us specify that the ARDL model is not applicable for integrated variables of order > to 1.

3.2.3. Autoregressive distributed lag model

This dynamic model allows for the inclusion of temporal influences (such as adjustment times, expectancies, etc.) in the explanation of a variable. In a dynamic model, a dependent variable's (Y_t) lagged values, the independent variables' (X_t) present values, and their time-lagged values all contribute to its explanation (X_{t-1}). The forms are as follows:

$$Y_t = \phi + \sum_{i=1}^{p} a_i Y_{t-i} + \sum_{j=0}^{q} b_j X_{t-j} + e_t. \tag{6}$$

Note that b_0 reflects the short-term effect of X_t on Y_t. To calculate the long-term effect of X_t on Y_t (i.e., λ), starting from the following long-term or equilibrium relation: $Y_t = K + \lambda X_t + u$ and then:

$$\lambda = \frac{\sum_{j=0}^{q} b_j}{1 - \sum_{i=1}^{p} a_i}.$$

As with any dynamic model, the information criteria (AIC, SIC and HQ) will be used to determine the optimal shift (p^* or q^*); an optimal lag is one whose estimated model offers the minimum value of one of the stated criteria. These criteria are: that of Akaike (AIC), that of Schwarz (SIC) and that of Hannan and Quinn (HQ). Their values are calculated as follows:

$$\mathrm{AIC}(p) = \log|\hat{\Sigma}| + \frac{2}{T} n^2 p, \tag{7}$$

$$\mathrm{SIC}(p) = \log|\hat{\Sigma}| + \frac{\log T}{T} n^2 p, \tag{8}$$

$$\mathrm{AIC}(p) = \log|\hat{\Sigma}| + \frac{2 \log T}{T} n^2 p. \tag{9}$$

Using the variables $\hat{\Sigma}$ variance-covariance matrix of estimated residuals, T: the number of observations, p: the offset or lag of the estimated model, and n, the number of regressors. Any of these dynamic models can be used to visualize both the short-term dynamics and the long-term impacts of one or more explanatory variables on a variable that needs to be explained. This can only happen if the studied time series are cointegrated, allowing for the estimate of an error correction/ECM model. Two series are really said to be "cointegrated" if they are integrated of the same order, while a series is said to be "integrated of order d" if it requires differentiation "d" times in order to become stationary.

A stationary series is stationary in mean and in variance, if its mean $(E(Y_t) = c)$ remains invariant or constant over time and its variance does not increase over time $(\mathrm{Var}(Y_t) = \sigma)$ the same for its covariances $(\mathrm{Cov}(Y_t - c)(Y_{t-p} - c) = y_t)$. A few econometric issues, such as collinearity between explanatory variables (as in the DL model) and autocorrelation of errors (as in the AR model), make it difficult to estimate an ARDL model using Ordinary Least Squares (OLS). Robust estimating methods are typically employed. In our study, we aim to identify the effects of foreign direct investment (FDI: variable of interest) on GDP growth (GDPG: dependent variable), accounting for other crucial control variables such as population growth (POPG), inflation (INFL), government consumption (GGFCE), and financial development (DCPS).

Thus, we suggest that the following function (linear functional form) will be estimated using an ARDL model: GDPG=f (LOGFDI, POPG, INFL, GGCE, DCPS). The ARDL representation of the function will be as follows if we want to capture both the immediate and long-term effects of the aforementioned explanatory variables on economic growth:

$$\Delta GDPG_t = \Bigg(a_0 + \sum_{i=1}^{p} a_{1i} \Delta GDPG_{t-1} + \sum_{i=0}^{q} a_{2i} \Delta LOGFDI_{t-1} + \\ + \sum_{i=0}^{q} a_{3i} \Delta POPG_{t-1} + \sum_{i=0}^{q} a_{4i} \Delta INFL_{t-1} + \sum_{i=0}^{q} a_{5i} \Delta GGCE_{t-1} + \\ + \sum_{i=0}^{q} a_{6i} \Delta GCPS_{t-1} + b_1 GDPG_{t-1} + b_2 LOGFDI_{t-1} + b_3 POPG_{t-1} + \\ + b_4 INFL_{t-1} + +b_5 GGCE_{t-1} + b_6 GCPS_{t-1} + e_t \Bigg), \quad (10)$$

where Δ is the first difference operator; a_0 is the constant; $a_1, a_2, \dots a_6$ are short-term effects; $b_1, b_2, \dots, b_6$ are long-term dynamics of the model; $e \sim id(0, \sigma)$ is an error term (white noise).

Like with any dynamic model, we will utilize parsimony (2) to estimate the ideal shifts (p, q) of the ARDL model using the information criteria (Akaike-AIC, Shwarz-SIC, and Hannan-Quin, Adjusted R-square). Designing an ARDL model as described above (relation 1) assumes that the variables have a cointegration connection, which even affects how these variables' short- and long-term coefficients are estimated. The Pesaran cointegration test can be applied in two steps:

(iii) determination of the optimal offset above all (AIC, SIC);

(iv) use the Fisher test to verify the hypotheses:

$H_0 : b_1 = b_2 ... b_9 = 0$: existence of cointegration relation;

$H_1 : b_1 \neq b_2 ... b_9 \neq 0$: absence of cointegration relation.

3.2.4. Causality test: tests Toda–Yamamoto approach

Some detractors, who situate the Granger causality test mostly on the passive side of traditional causality tests, praise the Granger causality test's efficacy in the sense of Toda & Yamamoto [19].

Remembering that the Granger test only applies to stationary (stationarized) series makes it imperative to run preliminary analyses of the series' cointegration or stationarity prior to confirming any causal relationships. Unit root tests are not always impartial and are less effective on small samples. Additionally, by continuing to transform the series by the first difference in order to achieve stationarization or cointegration, we lose information about the level of the series, which level information should not be suppressed since it is beneficial to understanding the dynamics of the model under study (series).

So, for small samples, the Johansen cointegration test is susceptible to some choice parameters that are likely to weaken it: lag or shift (risk of estimating an underparameterized VAR) and existence (absence) of deterministic trend in the VAR and/or the cointegration space (risk of loss in degree of freedom). When the hypothesis of no cointegration (H_0) is true, these characteristics frequently contribute to biases that cause the hypothesis to be rejected.

Due to this flaw in the cointegration results and the biased nature of unit root tests, the Granger causality test (random outcome) is less successful and non-sequential approaches to assess the causality between series are proposed by Toda & Yamamoto [19]. These two authors proposed to estimate a VAR in corrected level (over-parameterized), to serve as a basis for the causality test, under the hypothesis of a potential probable cointegration between series that they integrate. According to these authors, the preliminary tests of stationarity and cointegration (sequential Granger procedures) are of little importance for the economist who must instead worry about testing the theoretical restrictions (they secure the level information) (explicitly).

The following is the Granger causality test approach suggested by Toda and Yamamoto:

— find the maximum integration order of the series under study ($d_{\max}$) by resorting to stationarity tests;
— determine the optimal lag or offset of the VAR at the level under study (k) or autoregressive polynomial (AR) using the information criteria (AIC, SIC and HQ);
— estimate a VAR in increased level of order $p = k + d_{\max}$.

Concerning the estimation of the VAR in increased level, the stationarity conditions of the series will define the number of lags to add to the VAR. In fact, for stationary series in level, no lag is added to the VAR (standard test procedure); on the other hand, for series I(1), a delay will be added to the VAR, and so on. By way of illustration, if we want to test the causality between two series h_t and m_t in the sense of Toda and Yamamoto, we will have to estimate the increased VAR as follows:

$$\Delta h_t = \Bigg(a_0 + \sum_{i=1}^{k} a_{1,i} h_{t-1} + \sum_{j=k}^{p=k+d_{\max}} a_{2,j} h_{t-1} + \\ + \sum_{i=1}^{k} a_{1,i} m_{t-1} + \sum_{j=k}^{p=k+d_{\max}} a_{2,j} m_{t-1} + u_{1,t} \Bigg), \quad (11)$$

$$\Delta m_t = \Bigg(b_0 + \sum_{i=1}^{k} b_{1,i} m_{t-1} + \sum_{j=k}^{p=k+d_{\max}} b_{2,j} m_{t-1} + \\ + \sum_{i=1}^{k} b_{1,i} h_{t-1} + \sum_{j=k}^{p=k+d_{\max}} b_{2,j} h_{t-1} + u_{2,t} \Bigg). \quad (12)$$

Testing limits on the first k coefficients of such an enhanced or purposefully over-parameterized VAR will serve as the causality test, with all other parameters set to zero (they reflect a probable cointegration between series in the VAR). The test is based on the Wald statistic W, which is distributed according to x^2 a with n degrees of freedom, where n is the number of restrictions. This statistic is independent of the order of integration of the series and their cointegration. Accordingly, in the sense of Toda and Yamamoto, the test hypotheses are as follows:

$H_0 : a_{1i} = 0(x_c^2 < x_t^2)$, p is value $x^2 > 5\%$: m_t cause h_t at short term;

$H_0 : b_{1i} = 0(x_c^2 < x_t^2)$, p is value $x^2 > 5\%$: m_t cause h_t at short term.

It will be ensured that the order of maximum integration does not exceed the optimal lag $d_{\max}$ of the AR polynomial of the VAR to apply this test.

4. Results

4.1. Unit root test

As it's crucial to make sure that the order of integration is either zero or one for ARDL modeling, the empirical analysis should begin with the execution of the unit root test (see the table 3). For the purpose of looking for indications of stationarity, the Augmented Dickey Fuller (ADF) unit root tests are performed. Overall, the findings show that the variables analyzed have integration orders of I(0) or I(1), therefore we may use an ARDL model to estimate our relationship. Nevertheless, bound cointegration tests will be used to evaluate the null hypothesis of cointegration.

Table 3

Unit root test results

Variables	Level	First difference	Conclusion
GDPG	−2.508997	−7.375739***	I(1)
FDI	−2.501577	−5.544038***	I(1)
GGFCE	−4.228480***		I(0)
INF	−1.467817	−8.258210***	I(1)
POPG	−3.030919**		I(0)
DCPS	0.356963	−3.097987**	I(1)

Note in the table 3: *; **; *** indicate statistical significance at the 10%, 5%, and 1% level.

4.2. Cointegration test

The ARDL model must be estimated previously for the Pesaran cointegration test (see the table 4). The critical values (which constitute boundaries) will be compared to the derived test statistic, Fisher's F-value, as follows:

— if *Fisher* > *Upper bound*: cointegration exists;
— if *Fisher* < *Lower bound*: cointegration does not exist;
— if *Lower bound* < *Fisher* < *Upper bound*: no conclusion.

Table 4

Cointegration test results

Variables	GDPG, LOGFDI, GGFCE, DCPS, INFL, POP	
F-STAT	4.966073	
	Born <	Born>
10%	2.08	3
5%	2.39	3.38
1%	3.06	4.15

The results of the cointegration test at the limits confirm the existence of a cointegration relationship between the series under study (the value of F-stat is > that of the upper limit), which gives the possibility of estimating the long term of GDPG, LOGFDI, GGFCE, DCPS, INFL, POPG.

4.2.1. ARDL (error correction form) estimation

After confirming that the five variables are not integrated of an order equal or greater than I(2) and that the series are co-integrated, the next step is to estimate the panel ARDL regression as specified in ECM equation. The suitable lag length is selected based on the AIC lag selection criteria. The table 5 presents the empirical results on public debt and economic growth nexus conditioned on other explanatory variables in Russia and for the full sample period, 1990–2020 (in the tables 5, 6 $*$; $**$; $***$ indicate statistical significance at the 10%, 5%, and 1% level).

Table 5

Error correction model estimation (long-run coefficients)

Variables	ARDL esttimations	
	Coefficient	Standard Error
LOGFDI	1.081203	0.034941
GGFCE	−1.826693***	0.004357
INFL	−0.025460	0.075845
POPG	−0.036743***	0.231617
DCPS	−2.933879	0.200808

With regard to the tests which help to diagnose the estimated ARDL model, we note the absence of autocorrelation of the errors, there is no heteroscedasticity and there is normality of the errors (see the table 7).

Table 6

Error correction model estimation (short-run coefficients)

Variables	ARDL esttimations	
	Coefficient	Standard Error
ECT(-1)	−3.281689**	0.375258
D(GDPG(-1))	0.646779**	0.179682
D(LOGFDI)	1.598383**	0.461876
D(LOGFDI(-1))	0.046155	0.552017
D(LOGFDI(-2))	3.599007***	0.600330
D(GGFCE)	−1.982127***	0.181506
D(GGFCE(-1))	1.144808***	0.369579
D(GGFCE(-2))	1.322160**	0.217360
D(DCPS)	0.755284***	0.138276
D(DCPS(-1))	−0.410554**	0.152367
D(DCPS(-2))	0.412383**	0.139994
D(INFL)	−0.172183***	0.018028
D(INFL(-1))	0.036264***	0.004688
D(INFL(-2))	0.005463**	0.001819
D(POPG)	37.91637***	7.129612
D(POPG(-1))	3.309460	7.920245
D(POPG(-2))	−54.70903***	9.940868

Table 7

Estimated ARDL model diagnostic test results

Test hypothesis	Tests	Value (probability)
Autocorrelation	Breusch–Godfrey	2.90 (0.23)
Heteroskedasticity	Breusch–Pagan–Godfrey	0.23 (0.99)
Heteroskedasticity	Arch-test	0.52 (0.22)
Normality	Jarque–Bera	1.03 (0.53)

The error correction coefficient (ECT) illustrates how quickly the dynamic model will change to restore equilibrium after a disturbance. This coefficient, which is −3.28 in the full panel ARDL regression, indicates that equilibrium is attained in about 0.3 years. This ECT coefficient, which is both highly significant and negative, lends support to the idea that economic growth and the regressors have a consistent, long-term relationship. Government spending and population expansion have a substantial long-term impact on economic growth. The negative coefficients indicate that the GDP will grow less as the variable increases. Foreign direct investment is not a factor that can be used as macroeconomic tools to improve growth in the long term.

Foreign direct investment has a large and immediate impact on economic growth in the short run. The cumulative effect of FDI is 5.22, which indicates that, all other things being equal, a 1% increase in FDI will result in an increase in GDP growth of 0.00522%. An increase in foreign direct investment will help the economy in the short term because the effect is favorable. Government spending immediately has a negative impact on growth, but the overall short-term impact is good.

4.3. Causality

Many empirical studies that examine the two-way causation between foreign direct investment and economic growth as well as macroeconomic observational data and previous studies have produced conflicting findings. The Toda–Yamamoto test, which is performed in the last section of the analysis, is shown in the table 8.

The Toda–Yamamoto causality test is employed to determine the causal direction. The test compares the null hypothesis—that there is no causality to an alternative that suggests causality. With a 95% level of confidence, the findings show that there is no causal relationship between new GDP growth and foreign direct investment inflow in Russia. We can also assume that there is a bidirectional causal relationship between new GDP growth and population increase at a 90% confidence level. Also, we can observe that foreign direct investment contributes to inflation, contrary to popular belief.

5. Conclusions

In order to assess the impact of foreign direct investment in identifying causal variables of economic growth in Russia through macro-economic factors on the period 1990–2020, we used Russian data from the World Development Index of the World Bank. Overall, according to the study's findings, foreign direct investment positively impacts Russia's economy, even if only temporarily and not in the long run. The Autoregressive Distributed Lag (ARDL) modeling approach that we utilized was an intriguing tool for decision-makers to examine the factors that could support Russia's economic progress. In the long run, population expansion and government consumption have detrimental repercussions, according to our findings. The Toda–Yamamoto causality tests, on the other hand, show that there is no causal relationship between foreign direct investment and economic growth. We can also assume that there is a bidirectional causal relationship between new GDP growth and population increase at a 90% confidence level. Finally, we may observe a bidirectional causal relationship between domestic lending to the private sector and foreign direct investment.

Table 8

Toda–Yamamoto causality test

Null hypothesis	Chi-sq	p-value
LOGFDI does not Cause GDPG	0.403745	0.8172
GDPG does not Cause LOGFDI	2.528015	0.2825
INFL does not Cause GDPG	1.357337	0.5073
GDPG does not Cause INFL	1.357337	0.5073
POPG does not Cause GDPG	5.278680	0.0714
GDPG does not Cause POPG	7.580598	0.0226
DCPS does not Cause GDPG	4.108184	0.1282
GDPG does not Cause DCPS	4.358495	0.1131
GGFCE does not Cause GDPG	0.408538	0.8152
GDPG does not Cause GGFCE	0.248191	0.8833
INFL does not Cause LOGFDI	1.279775	0.5274
LOGFDI does not Cause INFL	11.14007	0.0038
POPG does not Cause LOGFDI	6.020798	0.0493
LOGFDI does not Cause POPG	3.874079	0.1441
DCPS does not Cause LOGFDI	17.08424	0.0002
LOGFDI does not Cause DCPS	5.618667	0.0602
LOGFDI does not Cause GGFCE	2.296316	0.3172
GGFCE does not Cause LOGFDI	1.842384	0.3980

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Причинно-следственная связь между прямыми иностранными инвестициями и экономическим ростом в развивающихся странах: российский опыт

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Аннотация. Прямые иностранные инвестиции (ПИИ) могут оказать значительное влияние на экономическое развитие развивающихся стран, таких как Россия. ПИИ привлекают капитал, технологии и управленческий опыт, что может стимулировать экономический рост, увеличить занятость и повысить производительность. В случае России ПИИ сыграли жизненно важную роль в экономическом развитии страны. Исследование, проведенное Всемирным банком в 2019 году, показало, что приток ПИИ в значительной степени способствовал экономическому росту России и привел к повышению производительности, занятости и экспорта. В статье анализируется взаимосвязь между прямыми иностранными инвестициями и экономическим ростом в России с использованием метода коинтеграции ARDL и подхода к причинно-следственному анализу Тода–Ямамото. Результаты нашего анализа показывают отсутствие причинно-следственной связи между притоком прямых иностранных инвестиций в Россию и ростом ВВП. Однако в целом прямые иностранные инвестиции эффективно способствуют экономическому росту в России в краткосрочной перспективе.

Ключевые слова: прямые иностранные инвестиции, экономический рост, модель ARDL, причинно-следственная связь Тода–Ямамото