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Can FDI explain the growth disparity of the BRIC and the non-BRIC countries? Theoretical and empirical evidence from panel growth regressions

Seefat-E-Rabbi Khan [a], Dimitrios Asteriou [b,*], Claudia Jefferies [a]

[a] City, University of London, UK
[b] Oxford Brookes University, Oxford, UK

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ABSTRACT

The aim of this paper is to explain the growth disparity between the four major emerging economies that are widely known with the acronym BRIC (Brazil, Russia, India, and China) and the non-BRIC countries. There is ample evidence in the literature that FDI is growth enhancing, however there is little discussion whether FDI is the main driving factor of growth disparities between different countries. We utilise a balanced panel dataset for the BRICs and 50 other developing economies from 1980 to 2020. Our findings advocate that foreign direct investments, gross capital formation, human capital, and infrastructure are particularly important for economic growth. However, foreign direct investments, gross capital formation and human capital are observed to be more efficacious in BRICs. Also, the relative significance of foreign direct investments seems to be conditional on the presence of better-quality human capital and higher levels of domestic investments in BRICs, thus explaining the growth disparities.

1. Introduction

The role of FDI on economic growth has been a topic of intense debate over the years. Some authors advocate a direct relationship, where causation is predicted through various causality tests. According to Basu et al. (2003), Choe (2003), Hansen and Rand (2006), Chowdhury et al., 2006, Combes et al. (2019) and Owusu-Nantwi and Erickson (2019) a two-way link exists between FDI and growth, which stems from the fact that increased FDI inflow promotes growth, whereas brighter growth prospect attracts increased inward FDI, the latter being more apparent of the two. Also, there are a number of factors essential for a country to competitively attract and maintain FDI inflows for further development including stable macroeconomic environment (Alguacil et al., 2011; Adeleke, 2014), better labour force (Borensztein et al., 1998; Noorbakhsh et al., 2001; Li and Liu, 2005), low trade barriers (Xu et al., 2021), economic freedom (Azman-Saini et al., 2010a, 2010b) and a highly developed financial sector (Ibrahim and Acquah, 2021; Ologorun et al., 2020).

Conversely, there are studies who suggest a possible negative link from FDI to growth. Hayat (2018) highlights that the impact of FDI inflows on economic growth alters with the size of the natural resource sector and beyond a certain threshold, any further expansion leads to a negative effect. Liu (2008) highlights that spillovers from FDI reduces short term productivity level but boosts long term rate of productivity growth in the domestic firms. Finally, although there is a third group of researchers who especially at firm-level point towards limited or no efficiency spillovers from FDI (Wheeler and Mody, 1992; Haddad and Harrison, 1993; Aitken and Harrison, 1999; and Herzer et al., 2008), more recent studies on the field reinstate the importance of FDI as a source of productivity enhancement for local firms (Bournakis et al., 2018; Bournakis, 2021).

Concluding, it is worth noting that although there is a wide consensus in the literature that FDI may contribute to overall economic growth, the comparative role of FDI as a growth enhancing factor is still worth exploring. To this end, the aim of this paper is to investigate empirically

* Corresponding author. Oxford Brookes University, Headington Campus, Oxford, OX3 0BP, UK.
E-mail addresses: Seefat-e-rabbi.Khan@city.ac.uk (S.-E.-R. Khan), dasteriou@brookes.ac.uk (D. Asteriou), Claudia.Jefferies.1@city.ac.uk (C. Jefferies).

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the role of FDI in explaining the growth disparity between the fastest growing emerging markets in the world that are widely known with the acronym BRICs (i.e., Brazil, Russia, India and China) and the non-BRIC countries (henceforth non-BRICs).[1] To this end we take into consideration some of the key macroeconomic factors that explain growth based on an augmented neoclassical growth model that has FDI and human capital as additional determinants. The rationale for the research is driven by Fig. 1 (for BICs excluding Russia) and 2 (for all BRICs), which depict the evolution of average log GDP per capita and net FDI inflow over the past 40 years. Wilson and Purushothaman (2003) and Cheng et al. (2007) suggest that there is a link between inward FDI and growth, with BRICs attracting higher quality FDI over time compared to other developing countries. However, we observe no conclusive evidence of a notable difference in net FDI inflow despite the incredible growth of the BICs (excluding Russia) between 1980 and 2015. The inflow of FDI becomes more apparent with the inclusion of Russia (following its independence from Soviet Union in the late 1991) when comparing the BRICs and non-BRICs over the shorter time interval (see Fig. 2).

Hence, it begs the question, whether FDI is growth enhancing and more importantly, whether quality FDI is responsible for the growth disparity between the BRICs and non-BRICs. The current literature so far has sparingly addressed this problem. More specifically, Vijayakumar et al. (2010), Ranjan and Agrawal (2011) and Kaur et al. (2013) examine the determinants of FDI in BRICs; Mercan et al. (2013) discusses the effect of trade openness in BRIC-T economies, and Mlachila and Takebe (2011) examine the impact of FDI outflow from BRICs to LICs. However, none of these papers has focused on the influence of inward FDI on the growth potential of the BRICs which is something we are interested in. Lim (2001) advocates that whilst substantial support exists for positive spillovers from FDI, there is no strong consensus on the associated causality or magnitude. Furthermore, Li and Tanna (2019) suggest that the degree of complementarities and substitutions between FDI and domestic investment and the ability and efficiency with which the individual economy can diffuse it to their national productive systems, determine the extent to which FDI can be growth enhancing. Thus, we take this opportunity to empirically evaluate the relationship between FDI and growth by incorporating a model that controls for the country-specific institutional characteristics and uncovers the mechanism through which FDI accounts for the observed growth disparity.

Therefore, the contribution of the current paper to the literature is threefold: First, we derive an augmented Solow model which provides a framework to combine the different forms of capital investment namely, domestic, foreign and human within the Cobb-Douglas production function. This model allows us to evaluate the competence of the factor inputs through the country-specific institutional characteristics such as trade openness, infrastructure and freedom as well as mimic the gradual convergence compatible to a small open economy with partial capital mobility. Second, we conduct an extensive empirical study involving 40 years of panel data on 54 developing countries where the impact of FDI on growth is examined by correlated random effects (CRE). This technique is particularly useful when standard Hausman test cannot be exercised or where Hausman test rules in favour of fixed effects (FE) and the researcher is interested in the time-invariant parameters. Finally, we analyse the key growth determinants to explain the disparity in per capita GDP between the BRICs and non-BRICs. Our interest is particularly on the role of FDI since a greater influence in BRICs will provide support to the premise that the BRICs over time have effectively induced quality FDI, which possibly contributed towards their successful growth.

Our results support the universal view that after controlling for other factors, FDI affects growth positively in the developing countries, where on average, a 1% increase accounts for 0.012% increase in per capita GDP. However, FDI on its own cannot influence economic growth. Furthermore, FDI has been more efficacious in BRICs compared to the developing economies in the sample and as such, led to the disparity in per capita GDP equivalent to 0.060%. Thus, we provide empirical support to the premise that BRICs over time may have attracted quality FDI. In terms of the other growth factors, we perceive that gross capital formation (GCF), the education index and telephone lines per capita affect growth positively, where the contribution to per capita GDP is 0.148%, 0.020% and 0.003% for every 1% increase in those respective regressors. However, only GCF and the education index seems to play integral roles in the growth discrepancy. Specifically, both have been far more effective for the BRICs, leading to the disparity in per capita GDP equivalent to 0.437% and 0.042%. Moreover, we conclude that GCF is the most potent growth determinant in the developing countries, followed by human capital, FDI and infrastructure respectively.

The remainder of the paper is organized as follows: Section 2 discusses the database and explain the adopted methodology. Section 3 presents the empirical results and statistical analysis. Finally, in Section 4, we offer policy implications, limitations of the study, suggestions for future research and concluding remarks.

2. Empirical methodology and data set

2.1. Empirical methodology

In this study, our aim is to evaluate the influence of different types of capital investment, notably FDI in the growth of developing economies. In addition, we hope to identify the possible causes behind the growth disparity observed between the BRICs and non-BRICs over the period 1980–2020. Hence, we estimate a regression model that connects GDP per capita (Y_{it}), with the main determinants of GDP, such as physical capital (K_{it}), FDI (F_{it}), human capital (H_{it}), as well as some further important factors that are prominent in the FDI-driven growth literatures (see Fatehi-Sedeh and Safizadeh, 1989; Rappaport, 2000; Alfaro et al., 2004; Vijayakumar et al., 2010 among others), such as trade openness (T_{it}), infrastructure (I_{it}, and civil and political instability (C_{it}).[2]

Taking natural logs of all variables, we obtain the following unobserved effects model as shown below:

$$ln\ y_{it} = \beta_0 + \beta_1\ ln\ k_{it} + \beta_2\ ln\ f_{it} + \beta_3\ ln\ h_{it} + \beta_4\ ln\ T_{it} + \beta_5 I_{it} + \beta_6 C_{it} + \alpha_i + \mu_{it} \tag{1}$$

where the coefficients $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$ and β_6 are the output elasticities to be estimated, β_0 is the intercept, α_i is the unit-specific effect for all time-invariant unobserved heterogeneity, and μ_{it} is the idiosyncratic error for all unobserved factors that vary over time and may affect output, y_{it}.

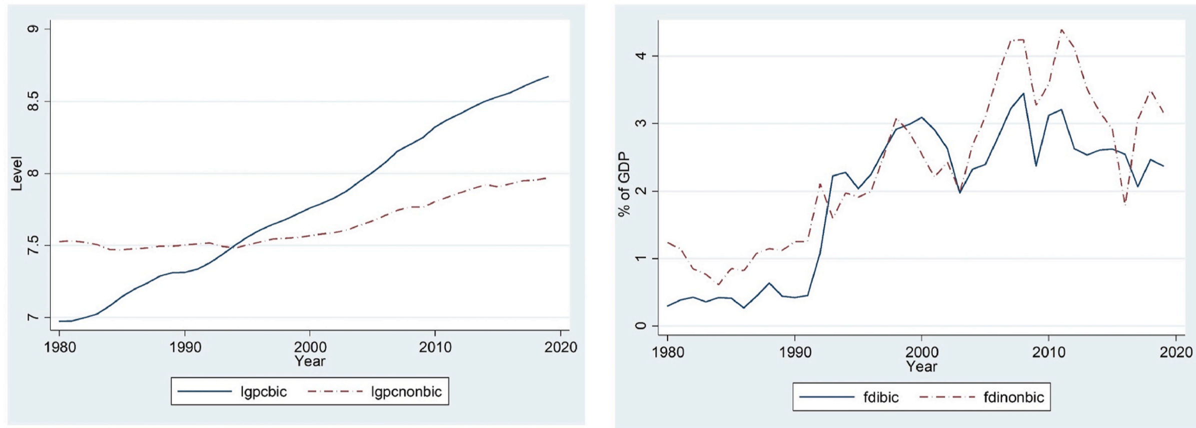
Next, we take first difference of equation (1) and yield the following:

$$\Delta ln\, y_{it} = \delta_0 + \beta_1 \Delta ln\, k_{it} + \beta_2 \Delta ln f_{it} + \beta_3 \Delta ln\, h_{it} + \beta_4 \Delta ln\, T_{it} + \beta_5 \Delta I_{it} + \beta_6 \Delta C_{it} + \Delta\mu_{it} \tag{2}$$

where Δ denotes the difference operator. This transformation removes the unit-specific effect, α_i from equation (1). Thus, as long as the error term is uncorrelated with the new independent variables, the estimators should be unbiased. Differentiating the variables as above has three key benefits: First, it eliminates the unobserved heterogeneity in the estimated data, and thereby, the error term is uncorrelated with the explanatory variables correcting for any possible endogeneity issues. Second, it gets rid of unit roots. Third, it explicitly enables us to observe

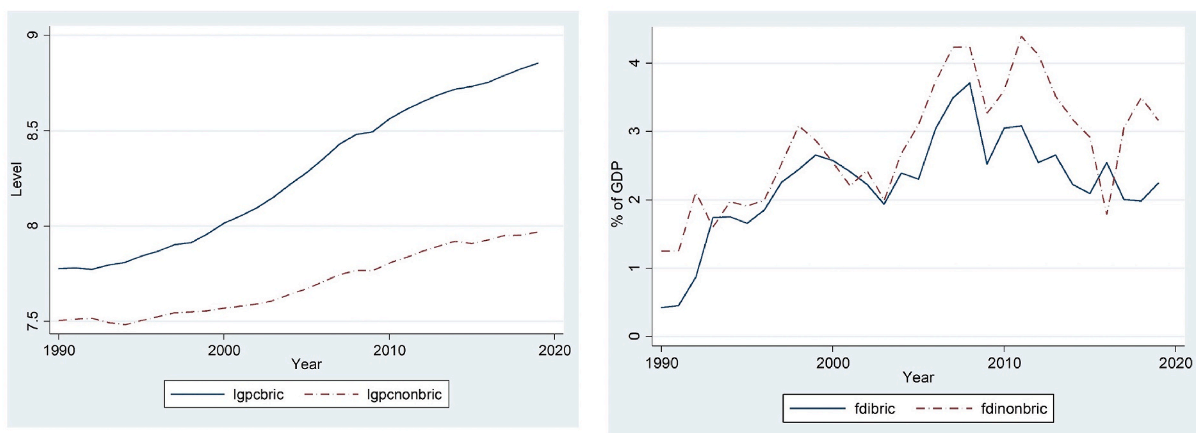
[1] We want to clarify that we investigate only the first four countries that constitute BRICs, without including the latest country that was added in this group, namely South Africa. This is due to the fact that we want to examine the growth disparities at a time period spanning from 1980 to 2020. South Africa joined BRIC (to make BRICS) in 2010, hence it makes more sense to concentrate to the original four countries that have achieved phenomenal growth almost two decades before South Africa has joined the fray.

[2] An analytical theoretical model is provided in the Appendix of this paper.



Note: Authors' calculations based on World Bank & OECD National Accounts.

Fig. 1. Evolution of average log GDP per capita and net FDI inflow – BIC Vs. non-BIC (excluding Russia). Note: Authors' calculations based on World Bank & OECD National Accounts.



Note: Authors' calculations based on World Bank & OECD National Accounts.

Fig. 2. Evolution of average log GDP per capita and net FDI inflow – BRIC Vs. non-BRIC
Note: Authors' calculations based on World Bank & OECD National Accounts.

how changes in the stock of capital per effective labour as well the level and growth rate of country-specific institutional characteristics affect the changes in per capita GDP.

In the growth literature, cross-country panels are frequently estimated through fixed effects (FE) or random effects (RE) because they are generally more efficient when dealing with heterogeneity bias. Traditionally, the choice between FE and RE is guided by the Hausman test where H_0 ruminates both models to be systemically close and consistent, whilst H_1 considers only RE to be biased and inconsistent. Unfortunately, the standard Hausman test cannot be implemented if either the robust standard errors are applied or standard errors are clustered to control for heteroskedasticity and serial correlation respectively which are often common problems associated to macro panels with long time series (usually over 20–30 years). On top of that, if the Hausman test rules in favour of FE, all time-invariant indicators will be lost which may be of interest for the study.

To address the aforesaid challenges, CRE is employed which basically allows us to unify both FE and RE estimation techniques to analyse the cross-country growth regressions (see Wooldridge, 2019). CRE has the advantage that retains all time-constant indicators whilst delivering those FE estimates on the time-varying covariates and as such, provides an alternative route to researchers who are interested in the predictive capability of the time-invariant variables in situations where the Hausman test rules in favour of FE.

2.2. The data set

The research utilises the latest available annual data between1980[3] and 2020. The database for all data is the World Bank - World Development Indicators for the BRICs and 50 other developing economies, consisting of a group of 15 from Asia & Middle East, 19 from North & Sub-Saharan Africa, and 16 from Central & Latin America. All countries used in our study are listed in Table 1.[4] All data are converted to 5-year averages to dilute cyclical influence and obtain greater variability. In cases of missing variables for a set of 5-years, we omitted this observation from our empirical analysis that will be reported below. Table 2 summarizes the full set of variables utilised in the econometric analysis

[3] Shafaeddin (2005) explains that trade liberalization and market-oriented economic reforms started in most developing countries in the early 1980s and it came in 3 stages. The move towards dynamic industrial and trade policies were first initiated by the countries in Asia, followed by the reform programs designed and dictated through the international financial institutions (IFIs) in Africa and later in Latin America. As a result, our investigation is conducted from 1980 onwards.

[4] The choice of the countries to be included in our empirical analysis was determined first by the World Bank classification of countries as low-income and middle-income and secondly by data availability for the selected variables over the period of time under examination.

Table 1
List of the 54 developing countries.

BRIC countries	Non-BRIC countries		
	Asia & Middle East	North & Sub-Saharan Africa	Central & Latin America
Brazil	Bangladesh	Algeria	Argentina
Russia	Cambodia	Botswana	Belize
India	Indonesia	Burundi	Bolivia
China	Iran	Cameroon	Colombia
	Jordan	Cote d'Ivoire	Costa Rica
	Malaysia	Egypt	Dominican Republic
	Mongolia	Eswatini	Ecuador
	Nepal	Gabon	El Salvador
	Pakistan	Ghana	Guatemala
	Papua New Guinea	Kenya	Guyana
	Philippines	Morocco	Honduras
	Sri Lanka	Niger	Mexico
	Tajikistan	Rwanda	Nicaragua
	Thailand	Senegal	Paraguay
	Vietnam	South Africa	Peru
		Togo	Venezuela
		Tunisia	
		Zambia	
		Zimbabwe	

Table 2
Definition of variables and data sources.

Symbol	Variable	Source of data
y_{it}	GDP per capita (constant 2005 US$)	World Bank estimates
k_{it}	Gross capital formation (% of GDP)	World Bank estimates
f_{it}	Foreign direct investment, net inflows (% of GDP)	World Bank estimates
h_{it}	Education index (1 = highest level of education) = (expected years of schooling +mean years of schooling)/2	UNDP Human Development reports
T_{it}	Openness index (% of GDP) = total exports + total imports	World Bank estimates
I_{it}	Infrastructure (fixed telephone subscriptions per 100 people)	World Bank estimates
C_{it}	Freedom rating (1 = highest degree of freedom) = (political rights + civil liberties)/2	Freedom House reports

Table 3
Summary statistics for all countries.

Variable	Group	Obs	Mean	Std. Dev.	Min	Max
lny_{it}	**All**	477	7.2113	0.9910	4.8373	9.0635
	BRICs	34	7.4931	1.1349	5.3956	8.7412
	Non-BRICs	443	7.1897	0.9772	4.8373	9.0635
lnf_{it}	**All**	457	0.2814	1.4537	−5.5215	3.0265
	BRICs	32	0.0368	1.4557	−3.5756	1.7475
	Non-BRICs	425	0.2863	1.4552	−5.5215	3.0265
lnk_{it}	**All**	477	2.9285	0.4360	−0.0471	4.1551
	BRICs	34	3.1710	0.3879	2.4343	3.7167
	Non-BRICs	443	2.9099	0.4343	−0.0471	4.1551
h_{it}	**All**	484	0.4705	0.1535	0.0600	0.8430
	BRICs	36	0.5293	0.1543	0.2400	0.8280
	Non-BRICs	448	0.4657	0.1526	0.0600	0.8430
lnT_{it}	**All**	473	4.1468	0.5549	2.4463	5.5294
	BRICs	34	3.4807	0.5364	2.6068	4.3365
	Non-BRICs	439	4.1983	0.5225	2.4463	5.5294
I_{it}	**All**	478	5.7596	6.6284	0.0330	38.1530
	BRICs	36	10.8589	9.6136	0.2140	31.3860
	Non-BRICs	442	5.3443	6.1556	0.0330	38.1530
C_{it}	**All**	479	4.1079	1.5454	1	7
	BRICs	33	4.1161	1.8317	2	7
	Non-BRICs	446	4.1081	1.5245	1	7

and the various sources from which data is accumulated.

Based on our theoretical model and empirical methodology presented above, to observe the impact of FDI on economic growth, real GDP per capita is selected as the dependant variable (y_{it}) and net FDI inflows (f_{it}) as the key independent variable. We also control for other variables that influence growth such as GCF (k_{it}), human capital (h_{it}) proxied by the education index[5] and other institutional characteristics like trade openness (T_{it}), telephone lines per capita (I_{it}) as a proxy for infrastructure[6] and the Freedom House's freedom rating (C_{it}) as a proxy for civil and political instability.[7]

3. Empirical results

3.1. Descriptive statistics

As a starting point to our empirical analysis, we obtain summary statistics for all countries, and similarly for the BRICs and non-BRICs sub-groups. From these preliminary results (presented in Table 3), we observe considerable cross-country variations in the sample. For instance, the average growth in GDP per capita (lny_{it}) is 7.21% for all countries with a standard deviation of 0.99. However, the BRICs are above average (7.49%) with a standard deviation of 1.13, whilst the non-BRICs are much closer to the average (7.18%) with a standard deviation of 0.97. Max lny_{it} attained by the BRICs is 8.74% and Min is 5.39%. In contrast, Max lny_{it} attained by the non-BRICs is 9.06% and Min is 4.83%. With regards to the physical capital, we observe that the average growth in FDI (lnf_{it}) and GCF (lnk_{it}) are 0.28% and 2.92% correspondingly, with the former being more volatile over the past 40 years. Interestingly, the BRICs are significantly below average for lnf_{it} (0.03%), whilst above average for lnk_{it} (3.17%). Considering that these are the fastest growing emerging markets in the world, one possible explanation may be that the growth in FDI has been unable to keep pace with the exponential growth in GDP. Conversely, the non-BRICs are similar to the average for both lnf_{it} (0.28%) and lnk_{it} (2.90%).

In terms of the human capital, we find that the average education index (h_{it}) is 0.47. The education index takes values between 0 and 1; where 1 indicates the highest level of education. Thus, a value of 0.45 is deemed as quite low for all countries in the sample. On the other hand, the average growth in trade openness (lnT_{it}) is 4.14% for all countries concerned. Given that the BRICs are above average for h_{it} (0.52) compared to the non-BRICs who are slightly below (0.46), it sheds some light on the absorptive capabilities of the BRICs. However, we find that the BRICs are below average for lnT_{it} (3.48%), whilst the non-BRICs are above average (4.19%). Finally, the average number of telephone lines per capita (I_{it}) and freedom rating (C_{it}) for the sample countries are 5.75 and 4.10 respectively, where for the latter, 1 indicates the highest degree of political and civil freedom (economic freedom is measured on a scale between 1 and 7). We observe that the BRICs are notably above average for I_{it} (10.85), but below average for C_{it} (4.07). Conversely, the non-BRICs are slightly below average for I_{it} (5.07), but slightly above average for C_{it} (4.11). With better infrastructure complemented by lesser civil and political unrest, it is not surprising that over time, the BRICs

[5] According to Breton (2002), the average level of schooling assumes that within a country all years of education have the same investment cost which may underestimate the difference in the relative quality of human capital between the countries. Alternatively, public spending on education is even more dubious which may overestimate the true value of investment in corrupt economies where funds are often diverted elsewhere. To overcome these problems, we employ the UN's education index for h_{it} which is a weighted average of the expected and mean years of schooling.

[6] Bougheas et al. (2000) reveal that unlike rival indicators, telephone lines per capita incorporate the direct impact of production cost and as such is less susceptible to comparability issues across economies. Thus, we opt for telephone lines per capita to represent I_{it}.

[7] The Freedom House is an NGO that conducts research and reports annually on each nation's democracy, political freedoms, human rights, and civil liberties. Hence, it made all the sense to characterize C_{it} with freedom rating.

have enjoyed better living standards.

3.2. Correlation analysis

Table 4 shows the correlation matrix of all our variables over the period 1980–2020. It is worth noting that none of the coefficients are substantially high to cause multicollinearity. We perceive that overall Δlny_{it} has a positive correlation with other variables and in most cases highly significant. It makes perfect sense, since investment, trade and infrastructural development play instrumental roles in economic growth and thereby, raises a country's per capita GDP. Civil and political instability is found to be non-significantly correlated with growth. Although Δlnk_{it} also has a positive relationship with other variables (expect for Δlnf_{it}), it is merely significant for Δlny_{it}, Δh_{it} and ΔlnT_{it}. Conversely, Δlnf_{it} is mostly positively correlated and significant for Δlny_{it} and ΔlnT_{it}. Growth theory implies that improved infrastructure and trade induces domestic investment as well as FDI (often through MNE settlement in the host economies).

With regards to Δh_{it}, a positive correlation is observed with other variables (except for Δlnf_{it} and ΔC_{it}) which are predominantly significant. One possible way to explain the negative linkages is that these developing countries are poor with often limited resources, and as such, encounter greater trade-offs when setting policies to develop either human capital or other sectors of the economy to attract inward FDI. This is further aggravated by civil and political instability which they usually experience. Finally, we perceive that both ΔI_{it} and ΔlnT_{it} generally have positive relationship with other variables and often significant. On the other hand, ΔC_{it} is negatively correlated with Δh_{it} and ΔlnT_{it}, whilst being positively correlated with Δlny_{it}, Δlnf_{it}, Δlnk_{it} and ΔI_{it}, but never significant.

3.3. Panel data regression analysis

As discussed in the methodology section previously, we adopt CRE to analyse the panel data and regress equation (17) in difference where, by default, the coefficients are that of FE estimate. Initially, only the influence of FDI on per capita GDP is considered as in Model 1 (denoted in the table as M1), presuming the base year to be 1980. This is followed up by the sequential adding of the control variables so that by M6, we have the complete model. Next, alternative panel models are proposed that are variations of the original to explain the growth disparity between the BRICs and non-BRICs. For instance, in M7, a country dummy is implemented, whilst from M8 to M13, numerous interaction terms are employed. Tables 5 and 6 summarise the panel estimations. Wooldridge (2019) argues that there is a possibility for error variance to change over time giving rise to heteroskedasticity in the error term, but the robust standard errors and test statistics are nevertheless valid. To further confirm this, the feasible generalized least square (FGLS) estimator is applied to the final model (see M13 and M14), since asymptotically it is more efficient when series exhibit heteroskedasticity. Finally, note that throughout the investigation, we substitute Δlnh_{it} by Δh_{it}, since h_{it} is an index with low variability and as such, log differencing will prevent the variable to have any notable effect. Also, when interpreting the coefficients, we convert the output semi-elasticities into elasticities for comparison purposes.[8]

We start with M1 where Δlnf_{it} is the only regressor and takes advantage of all the available data points (395 observations). It yields an estimated coefficient of 0.006 implying that in the sample developing countries, on average, a 1% increase in FDI accounts for 0.006% increase in per capita GDP. However, the coefficient is not statistically significant. This is in line with Carkovic and Levine (2005), who suggest that FDI on its own cannot influence economic growth. Thus, one by one the control variables are introduced to observe the change in magnitude and significance of FDI in the presence of other growth determinants. We perceive that the coefficient on Δlnf_{it} increases to 0.007% with the addition of Δh_{it} in M2, increases to 0.009% with the inclusion of Δlnk_{it} in M3, increases to 0.011% with the addition of ΔlnT_{it} in M4, increases to 0.012% with the inclusion of ΔI_{it} and remains stable at 0.012% with the addition of ΔC_{it} in M6. Notice that FDI is almost always significant when in the company of other growth factors except in M2 and M3 when it barely lies outside the 10% criterion.

Thereafter, the focus is shifted towards the other forms of capital to evaluate their roles in the growth of developing economies. We observe that Δh_{it} affects growth positively in support of the hypothesis that the human capital and knowledge are the ultimate engines of growth, and it is statistically significant. The estimated coefficient ranges from 0.587 to 0.723, indicating that on average, a 1% increase in education index accounts for 0.019% (i.e., 0.5872*0.0326) to 0.024% (i.e., 0.7229*0.0326) increase in per capita GDP. Likewise, Δlnk_{it} affects growth positively, and with a coefficient that is not only highly significant, but also conjures the strongest impact across the estimated models. We perceive that on average, a 1% increase in GCF accounts for 0.140% increase in per capita GDP in M3, which increases to 0.150% in M4, further increases to 0.159% in M5 and remains the same in M6. Looking at the magnitude of these effects, it may well be argued that domestic investment is far more effective in fostering growth as proposed by Tsai (1994).

As we continue adding other growth determinants between models M4 and M6, there is a slight reduction in the number of observations, but this is compensated by a considerable improvement in the model's goodness of fit. With regards to the variables representing country-specific institutional characteristics, ΔlnT_{it} is found to affect growth negatively but the coefficient is never significant. An explanation on trade openness is put forward by Spilimbergo et al. (1999) and Rodrik et al. (2004), stating this puzzling sign to represent the adverse effects of trading in primary products. Specifically, if the total trade is broken down into manufacturing and non-manufacturing components, it is the latter that enters as negative. On the other hand, ΔI_{it} affects growth positively and the coefficient is significant across the estimated models. We observe that in the sample developing economies on average, a 1% increase in telephone lines per capita accounts for 0.004% (i.e., 0.0046*0.7934) increase in per capita GDP in M5, as well as in M6. Also, ΔC_{it} appears to affect growth positively, but again, the coefficient is not significant.

The final model in Table 5 (model M7) estimates the complete model with the additional dummy controlling for the BRIC countries. We find that the dummy variable has a significant positive impact on the overall regression. More importantly, the regressors which were found to be significant in the earlier estimations, stay significant in this model as well. It indicates that the BRICs have clearly a higher growth trajectory compared to the rest of the developing countries in the sample, and this is estimated to be around 2.881%.

At this juncture, some variations of the complete model (M6) are employed to observe if there are fundamental changes to the estimates, and also, to identify better the driving forces behind the BRICs' better economic performance. To this end, Table 6, presents estimations of seven additional models, involving interaction terms with the BRIC dummy variable. We find that the country dummy (BRIC) remains positive and significant for all models (M8 to M13). With regards to the interaction terms, Δlnf_{it}*BRIC, Δlnk_{it}*BRIC and Δh_{it}*BRIC are in general significant between M8 and M13, suggesting that these are the variables that help explain the growth differences between the BRICs and non-BRICs. To be exact, there is a positive coefficient on Δlnf_{it}*BRIC, Δlnk_{it}*BRIC and Δh_{it}*BRIC, suggesting that both FDI and GCF, as well as

[8] In a log-linear relationship, the slope coefficient, β i.e. semi-elasticity is given by $\frac{\Delta lnY}{\Delta X} = \left(\frac{1}{Y}\right)\left(\frac{\Delta Y}{\Delta X}\right)$. Therefore, to obtain elasticity, we simply multiply the slope coefficient by $\overline{X}$.

Table 4
Correlation matrix.

	Δlny_{it}	Δlnf_{it}	Δh_{it}	Δlnk_{it}	ΔlnT_{it}	ΔI_{it}	ΔC_{it}
Δlny_{it}	1.0000						
Δlnf_{it}	0.0986*	1.0000					
Δh_{it}	0.2271***	−0.0620	1.0000				
Δlnk_{it}	0.3659***	−0.0364	0.1584***	1.0000			
ΔlnT_{it}	0.1113**	0.1652***	0.0255	0.2637***	1.0000		
ΔI_{it}	0.1897***	0.0836*	0.1884***	0.0648	0.1004**	1.0000	
ΔC_{it}	0.0501	0.0062	0.0311	0.0065	−0.0603	−0.0061	1.0000

Note: Each row shows the correlation coefficient for the macroeconomic variables of all countries in study. ***, ** and * indicates the significance of each at 1%, 5% and 10% respectively.

Table 5
CRE model results.

Depending variable: Δlny_{it}							
	CRE						
	[M1]	[M2]	[M3]	[M4]	[M5]	[M6]	[M7]
Intercept	−0.0582 (0.0556)	−0.0631 (0.0538)	−0.0543 (0.0524)	−0.0679 (0.0535)	−0.0507 (0.0536)	−0.0511 (0.0536)	−0.0570 (0.0539)
Δlnf_{it}	0.0061 (0.0050)	0.0071 (0.0049)	0.0094 (0.0058)	0.0111* (0.0062)	0.0124* (0.0065)	0.0124* (0.0066)	0.0124* (0.0066)
Δh_{it}	–	0.7229* (0.3739)	0.5891* (0.3376)	0.6033* (0.3369)	0.5914* (0.3402)	0.5923* (0.3410)	0.5872* (0.3413)
Δlnk_{it}	–	–	0.1399*** (0.0446)	0.1500*** (0.0456)	0.1590*** (0.0451)	0.1590*** (0.0454)	0.1590*** (0.0453)
ΔlnT_{it}	–	–	–	−0.0964 (0.0753)	−0.1133 (0.0749)	−0.1130 (0.0758)	−0.1135 (0.0759)
ΔI_{it}	–	–	–	–	0.0046*** (0.0015)	0.0046*** (0.0015)	0.0046*** (0.0015)
ΔC_{it}	–	–	–	–	–	0.0009 (0.0069)	0.0008 (0.0069)
BRIC	–	–	–	–	–	–	2.8812*** (0.1797)
Observations	395	395	395	392	389	389	389
R-squared							
Within	0.2077	0.2266	0.3223	0.3437	0.3563	0.3563	0.3564
Between	0.3646	0.3765	0.3947	0.3959	0.3918	0.3917	0.4664
Overall	0.2662	0.2813	0.3403	0.3524	0.3577	0.3577	0.3962

Note: M denotes model, for instance, M1 is Model 1 and so on. Each row shows the average coefficient along with the robust standard error in parenthesis for the macroeconomic variables of all countries in study.
***, ** and * indicates the statistical significance at the 1%, 5% and 10% levels, respectively.

human capital have been instrumental in the growth of BRICs. On average the discrepancy in per capita GDP range between 0.054 and 0.060% for FDI, 0.425–0.437% for GCF and 0.038–0.042%[9] for human capital. Hence, domestic investment seems to be the most important determinant, followed by foreign investment and human capital development accordingly. Furthermore, there are other structural differences (not in consideration) that have contributed to the growth disparity as accentuated by the positive coefficient on the country dummy.

Furthermore, note that those regressors significant in M6 (see Table 5) have maintained their level of significance, signs and to some extent magnitude consistently between M8 and M13, reinforcing their importance in economic growth. For our key variable, we observe that on average, a 1% increase in Δlnf_{it} accounts for 0.012% increase in per capita GDP steadily across the estimated models. However, on average the contribution to per capita GDP seems to vary between 0.148 and 0.153% with regards to Δlnk_{it}, 0.019–0.020%[10] with regards to Δh_{it}, and 0.003–0.004%[11] with regards to ΔI_{it} for every 1% increase in those regressors.

To analyse the validity of our FE estimates, the robust Hausman test is conducted on M13. The test statistic is 9694.00, and it is highly significant at 1%. Therefore, we clearly conclude in favour of FE over RE as it was expected. This implies that only FE produce estimates that are unbiased and consistent. In addition, we apply robust standard errors to control for heteroskedasticity, cluster standard errors by country to control for serial correlation and include year dummies to capture the influence of aggregate trends in each of the aforesaid regressions.

3.4. Robustness checks

To further verify the validity and robustness of our findings, we perform a series of robustness checks. First, we re-estimate the final model (M13) with FGLS. The results are reported in Table 6 (M14). Overall, the coefficients display the same signs as those in M13, but with a few differences related to the level of significance and magnitude. To be specific, our fundamental variable remains significant, and we perceive that on average, a 1% increase in Δlnf_{it} accounts for 0.009% increase in per capita GDP. However, comparing the original control variables from the previous models, we now observe that ΔI_{it} is no longer significant, whilst ΔlnT_{it} is found to be significant for the first time in all our models. Although GCF is undoubtedly the most dominant factor in nurturing growth, freedom rating seems to imply that growth may be sustainable, in spite of civil and political unrest, but the evidence for this latter argument is rather insufficient. Furthermore, we observe that both the country dummy, BRIC and interaction terms, Δlnf_{it}*BRIC, Δh_{it}*BRIC and Δlnk_{it}*BRIC are highly significant, which reinforce that along with other structural differences (not in consideration), FDI, GCF and human capital has played integral role in the growth disparity between the BRICs and non-BRICs where on average the discrepancy in per capita GDP is 0.055%, 0.370% and 0.040%[12] respectively.

[9] The interval is computed using the technique discussed in footnote 8 i.e., (1.1622*0.0326)-(1.2956*0.0326)% = 0.038–0.042%.

[10] The interval is computed using the technique discussed in footnote 8 i.e., (0.5777*0.0326)-(0.6020*0.0326)% = 0.019–0.020%.

[11] The interval is computed using the technique discussed in footnote 8 i.e., (0.0039*0.7934)-(0.0046*0.7934)% = 0.003–0.004%.

[12] The elasticity is computed using the technique discussed in footnote 8 i.e., (1.2333*0.0326)% = 0.040%.

Table 6
CRE/FGLS model results (continuation).

Depending variable: Δlny_{it}							
	CRE						FGLS
	[M8]	[M9]	[M10]	[M11]	[M12]	[M13]	[M14]
Intercept	−0.0570 (0.0539)	−0.0572 (0.0540)	−0.0562 (0.0541)	−0.0562 (0.0542)	−0.0559 (0.0543)	−0.0557 (0.0543)	−0.1223*** (0.0183)
Δlnf_{it}	0.0124* (0.0066)	0.0123* (0.0066)	0.0123* (0.0065)	0.0123* (0.0065)	0.0123* (0.0065)	0.0123* (0.0066)	0.0089* (0.0046)
Δh_{it}	0.5872* (0.3415)	0.5777* (0.3479)	0.6014* (0.3497)	0.6020* (0.3508)	0.5957* (0.3526)	0.5989* (0.3537)	0.4041** (0.2023)
Δlnk_{it}	0.1532*** (0.0458)	0.1533*** (0.0458)	0.1479*** (0.0478)	0.1480*** (0.0482)	0.1480*** (0.0483)	0.1480*** (0.0484)	0.0877*** (0.0213)
ΔlnT_{it}	−0.1137 (0.0763)	−0.1137 (0.0763)	−0.1134 (0.0784)	−0.1141 (0.0814)	−0.1142 (0.0815)	−0.1142 (0.0816)	−0.0441* (0.0245)
ΔI_{it}	0.0046*** (0.0015)	0.0045*** (0.0015)	0.0039*** (0.0014)	0.0039*** (0.0015)	0.0042** (0.0018)	0.0042** (0.0018)	0.0030 (0.0019)
ΔC_{it}	0.0007 (0.0070)	0.0007 (0.0070)	0.0006 (0.0070)	0.0006 (0.0070)	0.0006 (0.0071)	0.0009 (0.0072)	0.0066 (0.0046)
BRIC	2.8813*** (0.1800)	2.8615*** (0.1806)	2.7970*** (0.1806)	2.7849*** (0.1748)	2.7950*** (0.1731)	2.8069*** (0.1729)	2.9871*** (0.3167)
Δlnf_{it}*BRIC	0.0030 (0.0228)	0.0038 (0.0242)	0.0548*** (0.0098)	0.0539*** (0.0103)	0.0557*** (0.0130)	0.0602*** (0.0108)	0.0553*** (0.0168)
Δh_{it}*BRIC	–	0.4042 (0.6824)	1.1622*** (0.3437)	1.1633*** (0.3437)	1.2653*** (0.3438)	1.2956*** (0.3396)	1.2333** (0.6249)
Δlnk_{it}*BRIC	–	–	0.4266*** (0.1609)	0.4251*** (0.1641)	0.4354** (0.1795)	0.4370** (0.1848)	0.3701*** (0.0861)
ΔlnT_{it}*BRIC	–	–	–	0.0132 (0.0664)	0.0203 (0.0680)	0.0221 (0.0677)	−0.0195 (0.0541)
ΔI_{it}*BRIC	–	–	–	–	−0.0015 (0.0029)	−0.0018 (0.0029)	−0.0013 (0.0030)
ΔC_{it}*BRIC	–	–	–	–	–	−0.0129 (0.0150)	−0.0145 (0.0182)
Observations	389	389	389	389	389	389	389
R-squared							
Within	0.3564	0.3566	0.3734	0.3734	0.3737	0.3739	–
Between	0.4664	0.4665	0.4664	0.4664	0.4660	0.4660	–
Overall	0.3962	0.3964	0.4054	0.4054	0.4054	0.4055	–

Note: M denotes model, for instance, M8 is Model 8 and so on. Each row shows the average coefficient along with the robust standard error in parenthesis for the macroeconomic variables of all countries in study.
***, ** and * indicates the statistical significance at the 1%, 5% and 10% levels, respectively.

As a second robustness check, we re-estimate the full baseline model (M6), this time breaking the sample into two (i.e. BRICs and non-BRICs) instead of utilizing the BRIC dummy. The results obtained from this estimation confirm that the BRICs on average have a higher GDP growth by nearly 5.717% compared to the other developing countries in the sample. Also, it is evident that GCF is the most important determinant, followed by FDI for both sub-groups of countries, whilst in both cases, the magnitude of the coefficients is substantially higher for the BRICs compared to the rest of the countries. Breaking the sample further to examine in more details the effects of the variables on the sub-group of countries as defined in Table 1, yielded similar results.[13]

Additionally, since the existence of bi-directional causality between variables (in our case we might have bi-directional causality between GDP and FDI), that can lead to endogeneity, as a third robustness test, we utilise the Generalized Method of Moments (GMM) estimator that was developed to overcome such shortcomings (see Blundell and Bond, 1998). This method is very well suited for datasets with small T and larger N, such as our data. Following Holtz-Eakin et al. (1988), Arellano and Bond (1991) developed a GMM estimator that instruments the differenced variables with all their available lags in levels. A problem with this estimator is that lagged levels are poor instruments for first differences if the variables are close to a random walk. System GMM is an augmented version developed by Blundell and Bond (1998) that overcomes this issue by employing both levels and differences as instruments, whilst the assumption is that these differences are uncorrelated with the country-specific effects. Difference and System GMM are applied in one and two step variants. The two-step variants use a weighting matrix that makes two-step GMM asymptotically efficient. In this paper we employ the system GMM estimator proposed by Roodman (2009) using a two-step approach and obtain robust standard errors with Windmeijer's (2005) finite sample correction. The results of this method of estimation are reported in Table 7, where in similar manner as in Table 5, we estimate alternative models starting with a model that includes only the change in FDI as regressor, to a full model that has the BRIC dummy variable as well. The results for the GMM method are in line with those obtained with the CRE method. Furthermore, we have many variables that show increased statistical significance (such as the FDI variable, and the human capital proxy). The BRIC dummy is again positive and statistically significant as expected. These re-postulates that the BRICs have clearly a higher growth trajectory compared to the rest of the developing countries in the sample, and this is now estimated to be around 2.28%, which is slightly smaller (compared to the 2.88% of the CRE results), but still of high magnitude and significance. For all estimated models, we provide results for the robustness and sensitivity of the instruments and coefficients, and report Hansen's test of instrument validity and overidentifying restrictions, as well as the Arellano and Bond test of serial correlation. All obtained results suggest that those models have a good fit and provide robust estimates.

In view of the robust results obtained across different models and estimation methods, the choice of a preferred output is relatively harmless. Given that model M13 provides the best fit to the data with estimated coefficients that are mostly significant, if we are to choose a set of results, those from M13 would be our choice. Thus, our conclusions are generally based on the findings of this model.

4. Conclusions and policy recommendations

In this paper, we have carried out an extensive empirical study involving 40 years of panel data on 54 developing countries to shed

[13] Tables and results of those regression models are not presented here for economy of space, but they are available from authors upon request.

Table 7
Two-step system GMM results.

Depending variable: Δlny_{it}	CRE						
	[M1]	[M2]	[M3]	[M4]	[M5]	[M6]	[M7]
Intercept	0.0543*** (0.0132)	−0.0288 (0.0467)	0.01885 (0.0170)	0.0211 (0.0181)	0.0335** (0.0174)	0.0388 (0.0159)	0.0282 (0.0191)
Δlnf_{it}	0.0132* (0.0073)	0.0173* (0.0102)	0.0135* (0.0077)	0.0140* (0.0071)	0.0091* (0.0504)	0.0078** (0.0038)	0.0068** (0.0031)
Δh_{it}	–	2.4809** (1.2125)	1.4469*** (0.4705)	1.4355*** (0.4769)	1.0571*** (0.5084)	0.9493** (0.4986)	0.9259*** (0.4416)
Δlnk_{it}	–	–	0.2984*** (0.0485)	0.2937*** (0.0516)	0.2978*** (0.0455)	0.2958*** (0.0435)	0.3096*** (0.0317)
ΔlnT_{it}	–	–	–	−0.0268 (0.0181)	−0.0684 (0.1189)	−0.0850 (0.1095)	−0.1089 (0.1071)
ΔI_{it}	–	–	–	–	0.0082*** (0.0036)	0.0083** (0.0032)	0.0072*** (0.0029)
ΔC_{it}	–	–	–	–	–	0.0141 (0.0227)	0.0050 (0.0210)
BRIC	–	–	–	–	–	–	2.2888*** (1.1480)
Observations	395	395	395	392	389	389	389
AR(1) p-value	0.001	0.001	0.000	0.000	0.001	0.001	0.001
AR(2) p-value	0.175	0.162	0.989	0.917	0.699	0.724	0.802
Hansen p-value	0.862	0.828	0.8403	0.8524	0.835	0.857	0.839
Number of instruments	14	14	14	14	14	14	14

Note: M denotes model, for instance, M1 is Model 1 and so on. Each row shows the average coefficient along with the robust standard error in parenthesis for the macroeconomic variables of all countries in study. All estimations are based on a two-step estimation procedure and Windmeijer's corrected standard error.
***, ** and * indicates the statistical significance at the 1%, 5% and 10% levels, respectively.

some light on the drawn-out debate regarding FDI's impact on the growth potential of the developing countries. We estimate a growth model that incorporates three types of capital investment – domestic, foreign, and human along with some country-specific institutional characteristics, namely, trade openness, infrastructure and freedom as inputs in the Cobb-Douglas production function. We go further and examine whether FDI has been more effective in BRICs, and eventually responsible for the growth disparity between the BRICs and non-BRICs observed in the world today.

Our results across different empirical models and estimation methodologies are robust, and unanimously support the universal view that after controlling for other factors, FDI positively affects growth in the developing countries. We observe that on average, a 1% increase in FDI accounts for 0.012% increase in per capita GDP. However, FDI on its own cannot influence economic growth; a finding that is consistent with Carkovic and Levine (2005), Azman-Saini et al. (2010a, b), Hayat (2018), and Tsaturai (2019) among others. Moreover, all models agree to the fact that FDI has been more effective in BRICs, and as such, led to the disparity in per capita GDP equivalent to 0.062%. Thus, we provide empirical support to the premise by Wilson and Purushothaman (2003), and Cheng et al. (2007) that the BRICs over time may have attracted quality FDI. Singh & Jun (1995) explain that more intensive research is required to fully grasp the causes behind this growth discrepancy, since historically, economies that have high or low FDI inflows are structurally different. Nevertheless, we believe that ultimately the outcome may depend on the degree of complementarities and substitutions between FDI and other country-specific factors that are instrumental towards growth.

With regards to the other forms of capital investment, we observe that not only GCF affects growth positively, but it also conjures the strongest impact where on average, a 1% increase in investment accounts for 0.148% increase in per capita GDP. Furthermore, all models confirm that GCF has been far more efficacious in BRICs, and as such, led to the disparity in per capita GDP equivalent to 0.437%. Comparing these coefficients with those from FDI, it may be argued that GCF is more potent in fostering growth in the developing countries. In fact, the relationship between FDI and growth in theory may be overstated, as emphasized by Tsai (1994). Similarly, we perceive that the education index affects growth positively, in support of the hypothesis that human capital and knowledge are the ultimate engines of growth. Across the various specified models, the contemporaneous effect is found to be significant, where on average, a 1% increase in the education index accounts for 0.020% increase in per capita GDP. Moreover, human capital appears to have a greater impact in the BRICs, leading to the discrepancy in per capita GDP equivalent to 0.042%.

In terms of the country-specific institutional characteristics, we observe that across the different specifications, infrastructure is consistently significant and affects growth positively, where on average, a 1% increase in telephone lines per capita accounts for 0.003% increase in per capita GDP. However, neither freedom rating nor trade openness seem to have a stable relationship with economic growth. The positive coefficient on the former implies that growth may be sustainable despite civil and political unrest.[14] The negative coefficient on the latter, although inconsistent with the export-led growth theory, may be interpreted as the adverse effects of trading in primary products. Spilimbergo et al. (1999) and Rodrik et al. (2004) reveal that if the total trade is broken down into manufacturing and non-manufacturing, it is the latter that enters as negative, but again, the contemporaneous effect is never found to be significant.

To conclude, the research project to us seems to be a success. Utilizing a variety of models and estimation techniques, we have not only determined the influence of FDI on growth in the developing countries, but also, its significance along with other factors in explaining the growth discrepancy between the BRICs and non-BRICs. However, since both CRE and FGLS approaches depict only the average effect, country-specific studies may be more useful to ascertain the relevant determinants in their respective growth. Moreover, we observe that the country dummy is consistently significant and affect the BRICs positively, implying that there are other structural differences between the BRICs and non-BRICs, which have contributed to the growth disparity.

[14] The inconclusive evidence may be due to the lack of variation in the time series – a major drawback documented by early researchers, who have used freedom rating as proxy. Unfortunately, a suitable alternative that could cover our entire period of interest is not available.

The empirical results reported herein should be considered in the light of some limitations. First, it could be of interest for future scholars to improve on the results by exploring other growth determinants such as government consumption, inflation, taxation, black market premium, etc. Alternatively, the sample size and/or time-period may be altered, or different theories of growth may be adopted, such as endogenous or Schumpeterian, complemented by estimation techniques, including, seemingly unrelated regression (SUR) and dynamic panel models to discern whether the limitations of our model choice has biased any of the findings. Finally, the empirical study can be further extended by examining the possible effects of FDI on income inequality, as it is the case in a different strand of literature. We leave these topics for future research, as the growing body of empirical literature on the role of FDI and the growth potential of BRICs continues to evolve.

Several policy implications can be drawn from the empirical results, that are insightful for governing authorities and policy makers. This is of particular importance for the developing economies, since emphasis is often focused on implementing various programs and domestic policies for the benefit of foreign investments, often at the expense of domestic investments in other important sectors (for example, health and education), believing all along, that FDI is the primary source of higher growth and knowledge spillovers. Thus, the finding that FDI is more effective when it is accompanied by high levels of human capital and domestic investments, suggests that the improvement of those sectors is of primary importance for the low- and middle-income countries. This is because those sectors will help to improve the absorptive capacity of FDI, as well as lead to a greater effectiveness of the effect of FDI on economic growth. Second, given the strong positive effect of human capital, proxied by the education index, suggests clearly that policies that enhance public and private investment in education will help promote economic growth, even independently of high levels of FDI. Finally, the fact that domestic investments seem to play an important positive role in economic growth disparity of the BRICs compared to other developing countries, suggests that there are lessons to be learned, by observing the good practices of the BRICs in applying policies that utilise effectively domestic investments without neglecting the role of foreign investments at the same time.

Declaration of competing interest

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

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.econmod.2023.106306.

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