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AN EMPIRICAL EVALUATION OF THE MIDDLE-INCOME TRAP AND IMMISERIZING GROWTH IN BRICS COUNTRIES

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This study explores the middle-income trap and immiserizing growth with a particular focus on BRICS countries, which are at the center of the global economy due to many economic aspects. The existence of a middle-income trap was investigated by testing the stationarity of the time series of each BRICS country's per capita income relative to the USA which has a balanced-growth path close to the global technology frontier's growth rate. The findings indicate that Russia is lying within the middle-income trap. Cointegration analysis and robust regression techniques were performed to explore the immiserizing growth effects of merchandise exports. The findings reveal evidence of immiserizing growth for India and South Africa.

Keywords: Middle-Income Trap, Immiserizing Growth, BRICS
JEL Classification: C10, C39, F14, F43, F63

1. INTRODUCTION

BRICS acronym represents a set of major developing countries which are central to the global economy, namely Brazil, Russia, India, China and South Africa. The role of BRICS countries cannot be ignored as they are sharing nearly 25% of the global GDP and 20% of the total world trade, are rich in environmental and natural resources, are home to more than 40% of the world's population and cover nearly 30% of the Earth's landmass (Pieterse, 2012; Siddiqui, 2016; Wu et al., 2017). During the first decade of the twenty-first century, BRICS countries were among the fastest-growing countries, and these economies were expected to have a significant impact on redrawing the world's economic landscape in the new millennium. However, it seems that some of the BRICS economies' growth fluctuated in the long-run in and slowed down after the 2008-2009 financial crisis (Bhoi, 2019).

An economic equilibrium situation which might not be influenced by short-term endogenous variables is traditionally defined as a trap. The middle-income trap

phenomenon was stated as a concept by Garrett (2004) for the globalization's missing middle-income countries, whose growth rates had been stationary for a long period of time. The term "MIT" was originally introduced into international economics literature by Gill and Kharas (2007) to characterize the middle-income economies of East Asia squeezed between competing with low-wage countries dominated by mature industries and rich counties dominated by knowledge-based industries. As a country moves closer to the middle-income group, the manufacturing production technologies used may become obsolete, higher profits tend to decline and growth rates may slow down. One of the challenges that countries have encountered during their efforts to escape this economic situation is the middle-income trap (MIT).

On the other hand, BRICS economies can face immiserizing growth (IG), another conjunction of unfavorable economic growth results, even if MIT is not in question. IG was introduced to the international economics literature by Bhagwati (1958) to emphasize the reduction in household welfare due to export-led growth leading to a country's decline in trade. Bhagwati had proposed that economic growth may lead to the loss of welfare by analyzing the production possibility curve together with an indifference curve. Later, Johnson (1967) theoretically demonstrated that if a country pursues a protective productivity policy towards an industry and/or if the factor accumulation is biased sufficiently in that industry toward production of the tariff-protected good, the real income of that country will reduce through a serious of changes determined by the degree of protection. The IG is a long-lasting situation which can arise in an economy when the social welfare losses of economic growth are greater than welfare benefits due to the adverse change effects of trade (Pryor, 2007). Shaffer et al. (2019) discuss the IG as an economic phenomenon that does not benefit, but in fact can harm the households.

This study aims to investigate whether the economic slowdowns faced by the BRICS economies are barriers or MIT and investigate the relevance of IG to BRICS countries, which are all developing economies. Another intention of this study is to provide policy implications in helping to escape from MIT and deal with IG. Although there are some studies investigating MIT and IG in Brazil, Russia, India, China, and South Africa, according to the information we have obtained, there is no study in the literature examining IG together with MIT in BRICS countries. This article contributes to literature as it is first in terms of the data set used and the country group examined. The structure of the remaining sections is as follows: the literature review is presented in the second section; section three describes the data and the methodology; section four provides empirical results, demonstrates the empirical analysis, and discusses the results. The last section summarizes the arguments and poses implications for future research.

2. LITERATURE REVIEW

2.1. Middle-income Trap

The word -trap- is traditionally used in economics literature to emphasize a stable economic status that is beyond a comparative static equilibrium and cannot be affected by normal external factors. In such a case, following the full emergence of the effect of a somehow unsustainable factor to improve per capita income, other restraining factors will start to work, this effect will be balanced, and per capita income will return to its original level (Cai, 2012). It is widely accepted that the slowdown in productivity growth in an economy in parallel with exhausting the gains from attaining middle-income status reflects *MIT* (Imbs and Warcziag, 2003; Eichengreen et al., 2011, 2014; Aiyar et al., 2013; Agénor and Canuto, 2015; Doner and Schneider, 2016).

Ohno (2009) stated that catching up with industrialization takes place in four stages. There is a simple production process under foreign guidance in the first phase. In the next phase, technology transfer takes place through a few different channels such as foreign direct investment, imports and licensing, and the development of supporting industries. The domestic companies gain expertise in management and technology to produce high-quality goods in the third phase. In the final phase most companies transform into technology-intensive organizations focused on product design and innovation. Being stuck between the second and third phases is characterized by Ohno as -a glass ceiling.

According to Andreoni and Tregenna (2020), the middle-income trap is associated with three specific structural factors. The first one is the involvement of concentrated industrial production, and the other is linking to global value chains and simultaneously linking back with local production systems. The third is an adaptation to technological change and the usage of modern technologies. Failure to overcome the combined effects of these three structural challenges is described by the authors as a middle-income technology trap.

When evaluated in terms of globalization, it may be expressed that countries at higher stages of economic development benefit from this process by gaining a comparative advantage in technology-intensive and capital-intensive industries through their technological innovation capabilities. One of the reasons for this is that the quantity of high skill positions is increasing with the global change in economic structures, as laborers in the countries at higher stages of economic development have superior skills and better technologies. On the other hand, poor countries can achieve faster growth in their manufacturing thanks to the increase in the number of unskilled jobs, even though they do not have a high level of technology or skills. That said, middle-income economies in between may drive less benefit from globalization if they do not gain comparative advantages in both respects. This unfavorable economic growth situation can be described as a “comparative advantage vacuum” causing *MIT* (Garrett, 2004; Eeckhout and Jovanovic, 2007; Cai, 2012).

The empirical literature focusing on the *MIT* can be divided into two: the studies to determine whether a country has been caught in the *MIT*, and the research investigating

the determinants of the *MIT*. Eichengreen et al. (2011) constructed a sample of cases wherein rapidly growing economies slowdown based on international data beginning in 1957 in constant 2005 international prices. They revealed that the growth rate in the fast-growing middle-income countries had significantly declined by at least 2% after reaching 17,000 USD per capita. Another finding they indicated was that growth slowdowns more presumably arise in the middle-income countries which are keeping the real exchange rates undervalued. The study findings of Felipe et al. (2012) showed that as of 2010, 35 of 52 middle-income economies had been caught in the *MIT*. The authors expressed the reasons why some countries get stuck in the *MIT* as the type of exported goods, changing structure and the diversification of the economy. Aiyar et al. (2013) considered demography, infrastructure, output structure, trade structure, macroeconomic environment, and the role of institutions as explanatory variables in their MIT research conducted on Asian economies. The findings of the simple time series test derived by Robertson and Ye (2013) revealed that the growth patterns of 19 out of 46 middle-income economies were consistent with their *MIT* definition. Eichengreen et al. (2014) found that the likelihood of the *MIT* is less in the countries which have a higher level of adult secondary and tertiary education, and in countries where the ratio of high-tech product exports to total exports is relatively high. Agénor and Canuto (2015) agreed on the slowdowns in productivity as being a reason of the *MIT* and highlighted the determinants of productivity growth constraints. The arguments that Agénor (2017) discussed in his study as the explanatory factors of the existence, and/or persistence of the *MIT* include the rate of diminishing marginal productivity; exhaustion of cheap labor and imitation gains; low capacity of human capital; weak contract enforcement mechanism; inadequate protection of intellectual property; distortion of incentives; talent and human capital misallocation; barriers to access to advanced infrastructure; and lack of adequate access to capital, particularly to venture capital. Bozkurt et al. (2016) examined the likelihood of *MIT* within upper middle-income economies by using panel data methods. The results revealed that there had been a high likelihood for the diverging economies of to be caught in the *MIT* as well as for the converging countries who are unable to realize structural economic reforms. Although Bulman et al. (2017) found empirical evidence that the drivers of economic growth differ between the low-income and high-income countries, no certain evidence revealing stagnation was found for the middle-income countries investigated. The results of the study revealed that the economies which managed to break away from the *MIT* had higher levels of human capital stocks, faster industrial transformation experiences, export-orientation consistency, efficiency in macroeconomic management, and sufficient growth-conducive demographic conditions. Han and Wei (2017) indicated that a large economically active population, sex ratio imbalance, macroeconomic stability, and financial development are likely to be the key explanatory factors of the *MIT*. Myant (2018) analyzed the relationship between dependent capitalism and the *MIT* in the Central European countries and indicated that transition from a middle-income economy to a higher-income country depends upon a sustainable growth model which needs

structural changes in the government economic policies. Andrianjaka and Rougier (2019) used mixed methods to identify thresholds in a five-year period panel of 132 countries covering the periods between 1950 to 2010 and tested various explanatory factors linked to productive change. Karhan (2019) conducted unit root tests to the data of the fragile five' in the years between 1968 and 2017 and revealed evidence that these countries were caught in the *MIT* during the period investigated.

As far as we know, few studies investigating *MIT* focus on BRICS specifically. Elsenhans and Babones (2017) examined the slowdowns in the economies of BRICS countries and presented a set of roadmaps to break out of the "low- or middle-income trap". Referring to the BRICS countries, Hartwell (2018) argued that the economic conjunction, formulated as a "trap" does not repackage some familiar structural problems while avoiding other important ones. According to the author, this is nothing new or particularly relevant. Through case studies of industrial policy interventions in China, Brazil and South Africa, Andreoni and Tregenna (2020) explored the structural and institutional configurations, which they conceptualize as the "middle-income technology trap". They also scrutinized the models and industrial policy packages of each country applied to escape this trap. Brada (2020) analyzed BRICS countries' growth experiences compared to the experiences of BRICS-like countries in previous periods and settler economies. The author concluded that the possibility of a *MIT* exists, in part in countries failing to change their development strategies or adopt appropriate policies. Taşar et al. (2020) investigated the existence of *MIT* in BRICS countries by using panel data approaches for the period from 1988 to 2018 and concluded that BRICS countries were not at risk of being caught in *MIT*.

Although they do not address the BRICS countries as a whole, some studies individually investigate MIT in Brazil, Russia, China, and South Africa or among country groups. By using qualitative methods, Woo (2012) identified five main factors vulnerable to growth slowdowns for China in his research: (1) the nonperforming loans leading to fiscal stress; (2) the frequent use of the macroeconomic stabilization instruments; (3) imperfect governance responses to socio-political issues; (4) ineffectiveness in managing environmental challenges; and (5) challenges in managing international economic tensions. Zhang et al. (2013) explored the challenges China faced in achieving a high-income economy considering the rising wage rates and high level of income inequality. By employing a quantile regression model, Bien et al. (2016) examined the influencing factors of growth in Brazil, Malaysia, Mexico, Chile and South Korea. The results reveal that Brazil had not escaped from *MIT* for 27 years. Liu et al. (2017) analyzed the initial innovation policy of China in addition to its emerging reorientation and determined the challenges of China amid trying to escape from the *MIT*. Yakovlev (2017) argued that one of the main factors constraining economic development in Russia and predetermining the country's entry into the *MIT* is the shortage of skilled labor in the manufacturing industry. Tıraşoğlu and Karasaç (2018) investigated the existence of the *MIT* in the E7 and found evidence that Russia was lying within the *MIT*. Albuquerque (2019) examined the *MIT* issue in Brazil with data from

1870 to 2016 and presented a theoretical framework about the increasing gap of Brazil with the leading economies on the axis of some external developments and internal factors. According to Yurchenko and Savelyeva (2019), the Russian economy entered a recession at the end of 2013, resulting from combined factors such as the political and economic decisions, and the drop in oil prices. Using a set of comparative graphs and correlation analysis methods, the authors demonstrated that the Russian economy became vulnerable to the *MIT*, which worsens resource dependence of the country, and stated the requirement of rejoining industrial policy as an essential instrument for regulating economic growth. Glawe and Wagner (2020) analyzed whether China is in the *MIT* based on *MIT* definitions in the literature and *MIT* trigger factors. Although most scenarios imply that China has not been caught in the *MIT*, it is on the border in some scenarios. *MIT* may be in question for China if it drops to a 3-4% annual growth rate, which is the most pessimistic projection in the literature. Andreoni and Tregenna (2021) stated that according to various indicators of industrial competitiveness, South Africa was stuck in the *MIT* and showed signs of an ongoing process of premature deindustrialization.

2.2. Immiserizing Growth

The concept of the *IG* has been more theoretically addressed in the international trade literature. Empirical studies are not numerous and as far as we know, there is no study investigating *IG* addressing BRICS countries as a whole. Matsuyama (1992) explored the assumption that the link between growth performance and agricultural productivity can be highly sensitive to the openness of an economy using the model he constructed. The model predicted a positive correlation between economic growth and agricultural productivity in closed economy form. However, in the small open economy form, a negative link was envisioned, suggesting that the openness of an economy should be an essential component of predicting the growth performance of the economy and designing a development strategy. Barrett and Dorosh (1996) empirically investigated the immediate distributional effects of the changes in the price of rice in Madagascar. Their findings reveal that increases in the price of rice had been negatively affecting the welfare of households in Madagascar in the period analyzed. Aghion and Bolton (1997) analyzed the trickle-down effect of capital accumulation by conducting a model of growth and income inequalities in the presence of imperfect capital markets and indicated that although the capital accumulation process had an initial impact of widening inequalities; it reduced them in later stages. Barret (1997) investigated the impacts of liberalization measures of reduced form estimates on prices of food commodities. The results of the study in which ARCH-M techniques were employed revealed that liberalization had an increasing effect on the variance and the mean of the prices of food. The fact that the abandonment of quantity ratio practices in the state marketing system caused differences between regions and seasons, and the sharp increases in price autocorrelation showed that the *IG* was valid for Madagascar.

Mainwaring (1998) explored the likelihood of *IG* with a non-neoclassical approach to the North-South model and concluded that the fact that the Northern economy had been the engine of growth, redistribution in favor of the South would benefit in the short-run, however, would have harmful effects on both regions in the long-run. A similar situation was valid in case of capital transfers. The long-run gain of the North from investments would be offset by a reverse flow of interest payments. Barrett (1999) investigated the immiserizing effects of deforestation on small farmers in the low-income tropics and concluded that net buyer agricultural households which are food insecure would respond rationally to the increase in stable food price distribution by allocating more labor to expanding agricultural lands. This would not lead to greater profit opportunities, but instead to a decline in welfare security and a vicious cycle of the immiserization of the agricultural workers. The results of Gilbert and Tower's (2002) study show that capital accumulation does not likely have a welfare-reducing effect even if the investment returns in a protected emerging economy where labor mobility is restricted. They emphasize the issue that in case of an imposition of sufficiently high tariffs, profit repatriations will cause *IG*. Mondal (2015) developed a simple research and development driven endogenous growth model for the public good funded by private entities and showed that the economies with a large endowment of population or resources tend to be more open to IG. Chesnokova (2007) constructed an open economy dynamic model based on the Cobb-Douglas production function and revealed that there is a likelihood of deindustrialization over time in an economy which has a comparative advantage in agriculture. If the comparative advantage is not large enough, deindustrialization reduces welfare wherein gains from trade are offset by the impacts of negative wealth distribution. Sawada (2009) examined the validity of the *IG* and identified 26 *IG* occurrences mainly in Latin American and African economies after World War II. Jawaid et al. (2021) investigated the existence of *IG* in the world's nine largest trading economies using annual data spanning from 1981 to 2017. The findings of the study reveal that *IG* prevails in Italy, Canada, the Netherland, the UK and Japan.

3. DATA AND METHODOLOGY

3.1. Exploring Middle-Income Trap

Various techniques have been used in the literature to find out whether a country is lying within the *MIT*. Felipe et al. (2012) adopted a procedure based on historical income transactions and determined the economies lying within the *MIT* by estimation of a threshold time. Aiyar et al. (2013) used absolute growth slowdown break point level of GDP per capita income in constant 2005 for classifying thresholds and examined the determinants of *MIT* by means of probit regressions. Using indices for determining *MIT* is another approach reviewed in the literature. Woo (2012) applied the Catch-Up Index to define the *MIT*. Eichengreen et al. (2014) followed the transition matrix approach in

which they classified countries into groups by relative income per capita using the United States as a benchmark. Bulman et al. (2017) classified the countries relative to the level of per capita gross domestic product in the USA. In recent literature, econometric analyses approaches have been used in which the requirement for an economy to be considered as lying within the *MIT* is the forecast of its long-run per capita income relative to a reference country. Robertson and Ye (2013) proposed a statistical dentition of the *MIT* based on the convergence, or divergence of the per capita income data of the home economy to the USA data over the sample period. Tıraşoğlu and Karasaç (2018) investigated whether the E7 countries had been caught in the *MIT* by performing unit root tests with single and two structural breaks. Karhan (2019) conducted unit root tests to the data of the fragile five' to determine whether these countries were caught in the *MIT* during the period investigated.

A similar method to Robertson and Ye's approach (2013), in which unit root tests were used to test the stationarity of time series of a country's per capita income relative to the reference country, was carried out for this research. The USA was taken as the reference country since it has a balanced-growth path which is close to the global technology frontier's growth rate. We used the World Bank dataset from 1989 to 2019 for Russia and from 1960 to 2019 for Brazil, India, China, South Africa and the USA. The *MIT* was defined by considering the GDP per capita range between the country examined and the reference country.

$$Y_t = \ln GDPPC_{X,t} - \ln GDPPC_{USA,t}, \tag{1}$$

where $\ln GDPPC_{X,t}$ is the natural logarithm of GDP per capita in Brazil, Russia, India, China or South Africa in year t, and $\ln GDPPC_{USA,t}$ is the natural logarithm of GDP per capita in the USA in year t.

H_0 which suggests that the examined country is not in the *MIT*, is rejected in case of Y_t time series variable to be non-stationary and possess a unit root. H_0 is accepted if Y_t series is stationary and has a unit root which reveals that the examined country has been caught in the *MIT*.

The presence of the *MIT* in BRICS countries was explored by applying the Augmented Dickey Fuller (ADF) unit root test (Dickey and Fuller, 1979, 1981) and by unit root tests with structural break(s) (Zivot and Andrews, 1992 and Narayan and Popp, 2010) since the long-run data can contain structural break(s) due to various economic and political events such as economic crisis and recessions periods. All unit root tests used in *MIT* evaluations were in EViews 10 and GaussView 6.0 analytical software's at the 5% statistical significance level.

The ADF test is based on estimating the test regression.

$$\Delta x_{i,t} = \mu' \mathrm{D}_{i,t} + \alpha\, x_{i,t-1} + \sum_{j=1}^{k} \psi_j\, \Delta x_{i,t-j} + \varepsilon_{i,t}, \tag{2}$$

where $x_{i,t-j}$ is the approximate structure of the errors. Under null hypothesis, $\Delta x_{i,t}$ is $I(0)$ which implies that $\alpha = 0$.

We further allowed for a break in the level and conducted the Zivot and Andrews unit root test which endogenously identifies each time series' most significant single structural break point. This approach pursues three models. The first model permits a one-time change in the level of time series.

$$\Delta x_{i,t} = \mu + \alpha x_{i,t-1} + \beta_{i,t} + \theta D_{i,t} + \sum_{j=1}^{k} \psi_j \Delta x_{i,t-j} + \varepsilon_{i,t}. \quad (3)$$

The second model permits a one-time change in the slope of the trend line,

$$\Delta x_{i,t} = \mu + \alpha\, x_{i,t-1} + \beta_{i,t} + \gamma D^*_{i,t} + \sum_{j=1}^{k} \psi_j \Delta x_{i,t-j} + \varepsilon_{i,t}. \quad (4)$$

Model three is the integration of one-time changes in the level of time series and the slope of the trend line between them.

$$\Delta x_{i,t} = \mu + \alpha\, x_{i,t-1} + \beta_{i,t} + \theta D_{i,t} + \gamma D^*_{i,t} + \sum_{j=1}^{k} \psi_j \Delta x_{i,t-j} + \varepsilon_{i,t}, \quad (5)$$

where the intercept dummy $D_{i,t} = 1$ if $t > t_b$ (time break) and zero otherwise, the slope dummy $D^*_{i,t} = t - t_b$ if $t > t_b$ (time break) and zero otherwise.

Finally, we applied the Narayan and Popp unit root test with two structural breaks by using two trend break models:

(1) Crash model (MA) consists of a linear trend with an intercept permitting for two breaks in level.

$$x_{i,t} = \mu + \alpha\, x_{i,t-1} + \psi^*_{i,t} + \theta_1 D(t'_b)_{1,t} + \theta_2 D(t'_b)_{2,t} + \gamma_1 D'_{1,t-1} + \gamma_2 D'_{2,t-1} \sum_{j=1}^{k} \psi_j \Delta x_{i,t-j} + \varepsilon_{i,t}. \quad (6)$$

(2) Changing growth linear trend model which permits for two breaks in level as well as slope with a change in slope of the linear trend and the two segments joined at the break date (Perron, 1989).

$$x_{i,t} = \mu + \alpha^* x_{i,t-1} + \psi^*_{i,t} + K_1 D(t'_b)_{1,t} + K_2 D(t'_b)_{2,t} + \delta^*_1 D'_{1,t-1} + \delta^*_2 D'_{2t-1} + \gamma_1 D'_{1,t-1} + \gamma_2 D'_{2,t-1} + \sum_{j=1}^{k} \psi_j \Delta x_{i,t-j} + \varepsilon_{i,t}. \quad (7)$$

3.2. Examining Immiserizing Growth

There are a few empirical studies on the *IG* phenomenon, which is considered more theoretically within the framework of international trade literature. Lin and Zhang (2007) and Sawada (2009) empirically compared the welfare movements using real per capita

data to determine *IG* assuming that declining welfare coinciding with positive economic growth indicates the *IG*. Zaman et al. (2020) examined the pro-poor-, antipoor-, and immiserizing growth phases of 124 countries by employing linear and non-linear relationships econometric models using poverty head count ratio, the Gini coefficient, and average mean income in dollars per month for the unified poverty line data. Jawaid et al. (2021) used the Laspeyres and Paasche quantity index for the welfare movement and applied logistic regression for the empirical *IG* estimates.

Bhagwati's (1958) "immiserizing growth" concept depends on the "Presbisch-Singer" hypothesis. Prebisch (1950) and Singer (1950) argued that the terms of trade of a country may deteriorate in the long-run if there is a larger dependence on exports of primary goods. According to Bhagwati, if the economic growth of a country is heavily dependent on exports commodities, the reduction in terms of trade may cause *IG*. In this context, it is assumed that the negative growth rate of per capita gross domestic product significantly coinciding with an increasing ratio of merchandise exports to total exports may be the evidence of *IG*. This study employed cointegration analysis and M-estimation, S-estimation, or MM-estimation regression techniques to compare the ratio of merchandise exports to total exports (*MECEX*) and the annual growth rate of per capita gross domestic product (*GDPGR*) data.

The controlling variables are trade openness (*TRDOP)*, gross fixed capital formation (*GFCAF),* real exchange rate (*REEXR),* and labor force participation (*LFPRT)*. *TRDOP*, as the ratio of the sum of exports and imports to domestic product, constitutes various aspects of international trade. The increase of international trade volume that emerges alongside openness in a country also increases economic activities, which are expected to cause economic growth. Since the investment is one of the channels affecting the economic growth, *GFCAF,* as the ratio of spending on land improvements; construction of roads, canals and railways, residential commercial and industrial buildings; purchases of plant, machinery, and equipment to GDP (constant 2010 USD) is included in the estimations. *REEXR,* as the weighted average value of each BRICS country's currency relative to the basket of major currencies (Index, 2010 = 100), is included in the estimations since it is especially important for export-led growth. The real appreciation of the currency may have negative effects on exports originating from the domestic economy. The last controlling variable, *LFPRT,* is the ratio of the civilian non-institutional population 15+ that is working or actively looking for work to total population. The annual data was obtained from the world open data indicators website of the World Bank (Worldbank, 2020). To explore the *IG* phenomenon in BRICS countries, the data for the period 1990-2019 was used in which all countries have complete series for the variables. The estimations were based on the Cobb-Douglas production function (C-D). The most standard form of the C-D is

$$Y = AK^{\beta_1}L^{\beta_2}e^{u_t}, \tag{8}$$

where *Y, A, K, L,* and e, respectively, represent the total production, total factor productivity, capital, labor, and white noise.

We expanded the model to include *MECEX*, *REEXR*, and *TRDOP*.

$$Y = AK^{\beta_1}L^{\beta_2}MECEX^{\beta_3}REEXR^{\beta_4}TRDOP^{\beta_5}e^{u_t}. \quad (9)$$

Finally, per capita gross domestic product, gross fixed capital formation and labor force participation variables were included in the model by excluding *Y*, *AK*, and *L* respectively.

$$\ln GDPGR_t = \beta_0 + \beta_1 \ln GFCAF_t + \beta_2 \ln LFPRT_t + \beta_3 \ln MECEXR_t + \beta_4 \ln REEXR_t + \beta_5 \ln TRDOP_t + u_t. \quad (10)$$

In the model, where natural logarithms were used to transform data, $\beta_0 = \ln A_0$ is the constant term and β_i $(i = 1, 2, 3, 4, 5)$ is the parameter that needs to be estimated.

The findings of the tests based on non-stationary time series may not be accurate since they likely specify the correlation of two variables, where one of them does not exist which may cause the statistical findings to lead to incorrect conclusions. The means and variances of the variables were investigated by conducting the ADF unit root test in constant, and constant and trend forms to detect whether they were constant over the period examined.

The Johansen process was employed to find the occurrence of cointegration relationships among the variables. The Johansen process is a maximum likelihood method which estimates the number of cointegrating vectors in a non-stationary time series Vector Autoregression (VAR) with restrictions imposed (Johansen, 1991, 1995). To find the number of cointegrating vectors we used two likelihood ratio tests: trace statistic testing $H(r_0): rk(\Pi) = r_0$ versus $\bar{H}(r_0): rk(\Pi) > r_0$ shown as

$$LR^0_{trace}(r_0) = -T \sum_{j=r_0+1}^{n} \log(1 - \lambda_j), \quad (11)$$

and the maximum eigenvalue testing $H(r_0): rk(\Pi) = r_0$ versus $H(r_0 + 1): rk(\Pi) = r_0 + 1$ indicated as.

$$LR^0_{max}(r_0) = -T \log(1 - \lambda_{r_0+1}). \quad (12)$$

Another requirement is the evaluation of the adequate lag structure of the models to proceed with cointegration analysis. The optimal length lags between the number of lags in the models is based the Schwarz's information criterion.

To estimate the size of the effects of the independent variables on *GDPGR*, robust regression analysis techniques were applied for the series that were determined to have a cointegration relationship. We analyzed the dataset via one of the M-estimation,

S-estimation and MM-estimation regression techniques which limited the impact of outliers and helped achieve stability. M-estimation is the extended form of the maximum likelihood method in which M-estimators are solutions of the vector equation (Huber, 1964, 1973; Hampel, 1974; Liang and Zeger, 1986). S-estimation, which is based on residual scale of M-estimation, uses the residual standard deviation to overcome the weaknesses of median (Rousseeuw and Yohai, 1984). The purpose of MM-estimation is to get estimates which have a high breakdown value (Susanti et al., 2014). We chose the estimation model which gave the largest coefficient of determination (R^2 and $R^2_{adjusted}$) and the smallest standard deviation for each country.

4. EMPIRICAL RESULTS

4.1. Middle-Income Trap

We empolyed unit root tests to find the integration properties of the variables. Unit root test probability values less than 0.05 (typically ≤ 0.05) indicate strong evidence against the null hypothesis. In our study, test results revealing consistent time series over the period examined indicate that the country is lying within the middle-income band. If the time series is not stationary, it is considered that the country is not caught in the *MIT*.

The results of the ADF unit root test (Table 1) indicated that the Russian data time series were stationary which reveal that Russia was caught to the *MIT*.

Table 1. Augmented Dickey Fuller (ADF) Unit Root Test Results

	Country	Critical Values		t statistic	p-value
		1%	*5%*		
Constant	Brazil	- 3.55	- 2.91	- 2.20	0.21
	Russia	- 3.74	- 2.99	- 4.52	0.00*
	India	- 3.57	- 2.92	1.24	0.10
	China	- 3.55	- 2.91	1.76	0.10
	South Africa	- 3.55	- 2.91	- 1.43	0.56
Constant and Trend	Brazil	- 4.12	- 3.49	- 1.33	0.87
	Russia	- 4.39	- 3.61	- 4.44	0.00*
	India	- 4.12	- 3.49	- 1.09	0.92
	China	- 4.12	- 3.49	- 2.21	0.47
	South Africa	- 4.12	- 3.49	- 2.13	0.52

Notes: * is the statistical significance at 1% level, maximum *length = 10,* the optimal lag length selection is based on *Schwarz information criterion.*

Based on the findings of Zivot and Andrews unit root test accounting one structural break, null hypothesis indicating the non-existence of the MIT was accepted for all BRICS countries at a statistical significance level of 5% (Table 2).

Table 2. Zivot and Andrews Unit Root Test Results

Country	M1		M2		M3	
	T. Statistic	TB	T. Statistic	TB	T. Statistic	yb
Brazil	- 3.81	1976	- 3.83	1980	- 5.04	1981
Russia	- 3.52	2010	- 3.26	2003	- 5.03	1999
India	- 3.74	2007	- 3.80	2001	- 3.79	2001
China	- 3.81	1976	- 3.83	1980	- 4.61	1976
South Africa	- 3.45	1983	- 2.70	1983	- 3.43	1999

Notes: M1 (Model 1): Structural break in the intercept.

M2 (Model 2): Structural break in the trend

M3 (Model 3): Structural break in both the intercept and trend.

Critical values are: -5.34*, -4.93** for the M1; -4.80 *, -4.42** for the M2 and -5.57*, -5.08** for the M3. * and ** are the statistical significance at 1% and 5 % levels respectively. yb is the year of the most significant structural break.

The results of the unit root test with two endogenous structural breaks proposed by Narayan and Popp (2010) indicate that Russia has stationary time series within the changing growth linear trend model. The times series of the remaining BRICS countries are found to be non-stationary in Narayan and Popp Unit Root Tests (Table 3).

Table 3. Results of Narayan and Popp Unit Root Tests

Country	MA					MB				
	Critical Value		k	T. Statistic	yb	Critical Value		k	T. Statistic	yb
	1%	5%				1%	5%			
Brazil	- 4.95	- 4.31	1	- 0.69	1992 1980	- 5.59	- 4.87	1	- 3.65	1978 1997
Russia	- 4.87	- 4.14	5	- 0.79	1968 1978	- 5.38	- 4.63	5	- 4.29*	1968 1978
India	- 4.89	- 4.17	0	- 1.67	1977 1998	- 5.59	- 4.87	0	- 2.46	1977 1987
China	- 4.85	- 4.14	1	- 1.77	1980 1987	- 5.39	- 4.61	1	- 4.46	1980 1987
South Africa	- 4.85	- 4.14	1	- 2.65	1978 1996	- 5.40	- 4.61	1	- 2.37	1978 1991

Notes: MA is the crash model including an intercept; MB is the changing growth linear trend model. k represents the optimum lag length determined by using Schwarz information criterion. yb(s) are the years of structural breaks. * and ** denotes the statistical significance at 1% and 5 % levels respectively.

When the results of the unit root tests were taken together (Table 4) it was seen that the Russian time series data was stationary in two of the models applied, and these findings are considered as evidence that Russia is stuck in the *MIT*. Tıraşoğlu and Karasaç (2018), and Andrianjaka and Rougier (2019) have found that Russia is stuck in the *MIT*, which is similar to our findings. As the time series data of the remaining BRICS countries was found to be non-stationary in all unit root tests applied, it was concluded that Brazil, India, China and South Africa are not facing *MIT*. Our findings which indicate Brazil not to be lying within the *MIT* are consistent with the findings of Tıraşoğlu and Karasaç (2018). However, the research results of Felipe et al. (2012), Aiyar et al. (2013), Karhan (2019), and Robertson and Ye (2013) reveal that *MIT* is an issue for Brazil. The findings regarding the nonexistence of the *MIT* in India coincide with the results of Felipe et al. (2012). The results revealing that China is not lying within the *MIT* are similar to the results of Aiyar et al. (2013), and Tıraşoğlu and Karasaç (2018). There are other studies such as and Woo (2012) and Egawa (2013) which claim the existence of the *MIT* in China. Im and Rosenblatt (2013) as well as this study indicate that South Africa is not stuck in the *MIT*. On the contrary, there are studies by Felipe et al. (2012), Aiyar et al. (2013), Robertson and Ye (2013), and Bozkurt et al. (2016), which indicate that South Africa is facing *MIT*. However, we emphasize that the studies examining the countries which include BRICS, whether they are lying in the *MIT* or the likelihood of being caught in the *MIT* cover different periods, and the methods used vary.

Table 4. *MIT* Estimation Results Based on Unit Root Tests

Country	ADF	ZA	NP
Brazil	χ	χ	χ
Russia	✓	χ	✓
India	χ	χ	χ
China	χ	χ	χ
South Africa	χ	χ	χ

Notes: ADF: augmented Dickey-Fuller test. ZA: Zivot and Andrews structural break unit root test. NP: Narayan and Popp two breaks unit root test. ✓ and χ indicate stationary and non- stationary time series respectively.

4.2. Immiserizing Growth

In the first stage of *IG* analysis the means and variances of the variables were investigated by conducting ADF Unit Root Tests. Findings indicate that the time series are non-stationary at level. A non-stationary time series may become stationary after removing the trend, or detrending. By applying differencing process the time series are transformed to stationary at first difference (Table 5).

Table 5. ADF Unit Root Tests for IG

	Country	ln*GDPGR*	ln*GFCAF*	ln*LFPRT*	ln*MECEX*	ln*REEXR*	ln*TRDOP*
Constant	Brazil	0.68	0.47	0.29	0.75	0.24	0.13
	Δ Brazil	0.00*	0.01*	0.00*	0.00*	0.00*	0.00*
	Russia	0.24	0.90	0.61	0.51	0.20	0.25
	Δ Russia	0.00*	0.04**	0.00*	0.00*	0.01*	0.00*
	India	0.424	0.965	0.842	0.385	0.209	0.478
	Δ India	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
	China	0.19	0.44	0.93	0.15	0.76	0.27
	ΔChina	0.00*	0.02**	0.09***	0.05**	0.00*	0.00*
	South Africa	0.15	0.51	0.20	0.80	0.59	0.19
	ΔSouth Africa	0.00*	0.03**	0.02**	0.00*	0.00*	0.00*
Constant and Trend	Brazil	0.25	0.57	0.84	0.68	0.55	0.11
	ΔBrazil	0.00*	0.030*	0.00*	0.01*	0.00*	0.02**
	Russia	0.44	0.74	0.93	0.74	0.56	0.63
	ΔRussia	0.00*	0.01*	0.00*	0.01*	0.04**	0.01*
	India	0.45	0.08***	0.45	0.44	0.21	0.99
	Δ India	0.00*	0.00*	0.03*	0.00*	0.04*	0.01*
	China	0.23	0.31	0.20	0.37	0.31	0.99
	ΔChina	0.00*	0.05**	0.02**	0.04**	0.00*	0.01*
	South Africa	0.49	0.63	0.53	0.29	0.15	0.42
	ΔSouth Africa	0.01	0.00*	0.08***	0.02**	0.00*	0.00*

Notes: Δ denotes first difference operator. *, **, *** denotes statistical significance at 1%, 5%, and 10% levels, respectively. The lag length selection is based on Schwarz information criterion.

We further employed the Johansen cointegration test to investigate the existence of a long-run equilibrium relationship between the variables. Findings obtained from the Johansen test conducted for BRICS countries indicate significant long-run cointegration relationships amongst the variables of each country (Table 6).

Finally, the size of the significant impacts of the independent variables on *GDPGR* was measured by Robust Regression analysis techniques. Those with the largest coefficient of determination (R^2 or $R^2_{adjusted}$) and the smallest standard deviation (s), presented in Table 7, were chosen as the most appropriate regression models to be employed. The results indicate that the models do not include useless variables and the appropriate regression models are S-estimation for India, M-estimation for Brazil and South Africa, and MM-estimation for Russia and China.

Table 6. Results of Johansen Cointegration Test (Trace)

Country	Hypotesis	Eigenvalue	Trace statistic[a]	Critical value	p value
Brazil	$r = 0$	0.84	119.49	95.75	0.00*
	$r \leq 1$	0.62	68.10	69.82	0.07
	$r \leq 2$	0.44	40.69	47.86	0.20
	$r \leq 3$	0.35	24.24	29.80	0.19
Russia	$r = 0$	0.88	140.82	95.75	0.00*
	$r \leq 1$	0.84	89.12	69.82	0.00*
	$r \leq 2$	0.69	44.52	47.86	0.10
	$r \leq 3$	0.36	16.39	29.80	0.68
India	$r = 0$	0.97	187.62	95.75	0.00*
	$r \leq 1$	0.75	90.63	69.82	0.00*
	$r \leq 2$	0.57	51.10	47.86	0.02**
	$r \leq 3$	0.40	28.14	29.80	0.08
China	$r = 0$	0.91	179.11	95.75	0.00*
	$r \leq 1$	0.80	109.10	69.82	0.00*
	$r \leq 2$	0.67	64.84	47.86	0.00*
	$r \leq 3$	0.57	33.92	29.80	0.02**
South Africa	$r = 0$	0.92	140.99	95.75	0.00*
	$r \leq 1$	0.62	68.73	69.82	0.06
	$r \leq 2$	0.58	41.62	47.86	0.17
	$r \leq 3$	0.33	17.42	29.80	0.61

Notes: Trace statistics [a] are at, 95% critical value. * and ** represent significance at the 1% and 5% levels, respectively. MacKinnon-Haug-Michelis (1999) p-values.

Table 7. Regression Coefficients

Country	R^2	$R^2_{adjusted}$	s	Estimation Model
Brazil	0.41	0.27	0.35	M-estimation
Russia	0.37	0.08	0.43	MM-estimation
India	0.23	0.07	0.01	S-estimation
China	0.69	0.62	0.06	MM-estimation
South Africa	0.47	0.36	0.19	M-estimation

The results obtained by using regression tehchniques reveal that gross fixed capital formation has a negative effect on the growth rate of per capita gross domestic product for Russia, China, and South Africa. The affect is statistically significant in Russia and China but non-significant in South Africa. There is a positive statistically non-significant relationship between gross fixed capital formation and per capita gross domestic production for Brazil and India. The increase in labor force participation rate has a positive significant effect on the growth rate of per capita gross domestic product in

Brazil. The changes in the real effective exchange rates in Brazil, Russia and China negatively affect economic growth - this effect is statistically non-significant in Brazil. It has been determined that trade openness has a positive effect on per capita income in all BRICS countries. While this effect is statistically significant for Brazil, Russia, China and South Africa, it is statistically non-significant for India. The merchandise exports positively affect the per capita gross domestic production and are statistically significant in China, yet the increase in merchandise exports has a negative significant effect on per capita gross domestic production in India and South Africa. Findings of the regression tests reveal evidence that *IG* occure in India and South Africa (Table 8).

Table 8. Regression Analysis Results

	Brazil	Russia	India	China	South Africa
Variables	ln*GDPGR*	ln*GDPGR*	ln*GDPGR*	ln*GDPGR*	ln*GDPGR*
ln*GFCAF*	0.18	- 1.38	0.267	- 0.41	- 0.51
	(0.82)	(0.04)**	(0.23)	(0.00)*	(0.11)
ln*LFPRT*	9.11	- 1.07	0.34	- 4.06	- 1.11
	(0.06)***	(0.29)	(0.95)	(0.08)***	(0.00)*
ln*REEXR*	- 1.01	- 2.30	0.33	- 0.51	1.51
	(0.13)	(0.02)**	(0.49)	(0.05)**	(0.00)*
ln*TRDOP*	2.74	1.60	0.09	0.69	5.68
	(0.00)*	(0.00)*	(0.95)	(0.00)*	(0.00)*
ln*MECEX*	- 2.02	- 2.51	- 3,030.76	1,775.63	- 6,467.83
	(0.78)	(0.13)	(0.00)*	(0.00)*	(0.01)*
c	- 1.09	- 1.64	0.71	1.11	- 1.84
	(0.00)*	(0.00)*	(0.09)***	(0.02)**	(0.00)*

Notes: *,**,*** denotes the statistical significance at 1%, 5%, and 10% levels respectively. The numbers presented in parentheses indicate the standard errors of the regression coefficients.

One of the most relevant components of economic growth is the gross fixed capital in which the value of acquisitions of existing or new fixed assets by private and public sector institutions are included, however the value of financial assets is excluded. Gross fixed capital formation provides a basis for estimating the determinants of change in economic growth and enables international comparisons. Some studies in the recent literature reveal evidence that fixed capital formation influences a country's economic growth rate (Dao, 2008; Bond et al., 2010; Heylen et al., 2013; Uneze, 2013; Satti et al., 2014; Meyer and Sanusi, 2019; Awodumi and Adewuyi, 2020; Ekren et al., 2020). According to the regression estimates, there is a significant and negative relationship between per capita gross domestic product and gross fixed capital formation in Russia and China. The significant negative effect may originate from the public or private sector, as well as direct foreign capital. Private sector investments in a country are closely related to the level of technological advancement, economic stability, investment policy, and the degree of trade openness in the related country. Moreover, it should be considered that not only

physical capital formation, but also human capital items are important for growth (Moreno-Dodson and Bayraktar, 2015).

The labor force is another important and relevant component of economic growth. While the size of the working-age population determines the maximum level of economic output that can be reached in the long term, the level of employment and productivity of human resources determines how close the maximum output level is to achieve success. Therefore, a high labor force participation rate and a high level of employees' knowledge and skill are predicted as necessary conditions for a stable growth path. However, although this is theoretically possible, some periods have also been observed where growth was possible without creating employment. The robust findings of the regressions indicate that the change in labor force participation rate affects the change in per capita income in the same direction as Brazil. However, this effect moves in the opposite direction in China and South Africa. Labor productivity plays a fundamental role in the dynamics of economic growth. If a negative effect is due to labor productivity in China and South Africa, policies to strengthen the qualifications of human resources should be developed, schooling rates at all educational levels should be increased, and training opportunities should be maximized to increase the overall performance of the labor force.

The use of real exchange rate to encourage the shifting of resources to manufacturing provides a boost to national income if higher production efficiency can be achieved than in agriculture. However, there are some possible costs of keeping the real exchange rate low in the long-run such as fanning tensions with other countries and a serious likelihood of inflation (Kruger, 1998; Hausmann et al., 2005; Kochhar et al., 2006; Rodrik, 2008). Although the findings of our study indicate that the changes in real exchange rate in South Africa can create an effect on per capita income in the same direction, this significant relationship is in opposite direction in Russia and China.

According to Rodrik et al. (2004), trade openness contributes to income per capita only indirectly, via its positive effect on institutions. Once institutions (property rights, rule of law - instrumented with settlers' mortality) are controlled, trade has no effect on income per capita. The findings of our study indicate that trade openness has a *significant positive effect* on per capita income in Brazil, Russia, China and South Africa.

International trade is based on mutual gain and benefits mostly all incumbents as well as generating substantial value for the trading partners' economies. Some countries grow much faster than others after opening up to trade, but others actually see their growth decline (Wacziarg and Welch, 2008; Li and Huang, 2019). Export-led growth is mainly about the advantages of keeping the prices of exports high enough to make it attractive to shift resources to their production. However, export-led growth driven by merchandise exports may be immiserizing in the long-run if the gains are insufficient enough to outweigh the losses as a result of the decline in the ratio of export prices to import prices (Barret, 1997, 1998; Matsuyama, 1992; Chesnokova, 2007). Similarly, empirical findings of our study reveal that merchandise exports have immisirezing effects in India and South Africa. As far as we know, there is no direct study investigating the *IG* in BRICS countries. However, in some studies conducted for country groups where agriculture was

liberalized including India, Brazil, and South Africa, it was determined that growth accompanied welfare reduction (Finkelshtain and Chalfant, 1991; Barrett and Dorosh, 1996; Aghion and Bolton, 1997; Barrett and Carter, 1999).

5. CONCLUSION

In this study, the immiserizing growth and middle-income trap issues were empirically investigated in BRICS countries covering the period between 1960 to 2019. BRICS countries are all developing economies and draw attention with their high-speed growths, acceleration of domestic consumption and increased volume of foreign trade. Considering the literature review it can be said that there has been no study conducted to examine *IG* together with *MIT* in BRICS countries.

The existence of a middle-income trap in BRICS countries was examined by applying conventional and structural break unit root tests. Findings of the unit root tests reveal that Brazil, India, China, and South Africa are not lying in the middle-income trap and are close to closing the income per capita gap with the US. Whether this trend will continue in the long run or when the deficit may be closed is based on the growth performances of these economies. Evidence obtained from unit root tests indicated that Russia has some challanges in closing the income per capita gap relative to the US.

Determining a growth strategy based on total factor productivity may be supportive for the countries lying within the middle-income band to escape the *MIT*. Qualitative transformation of a country's education system will increase total factor productivity and be advantageous for these countries. Another important component to break away from the *MIT* is specialization wherein gaining a greater degree of efficiency is possible by focusing on the production of a limited scope of goods. It will be beneficial for Russia to reach new foreign markets by developing and introducing new products as well as increasing their export sales by diversifying product lines. In addition, there may be some challanges in financing manufacturing in the countries stuck in the *MIT*. In this context, Russia facing the middle-income trap should expand the sources of funding and strengthen the financial infrastructures to promote growth.

The immiserizing effects of economic growth in BRICS countries were investigated by using the data on gross fixed capital formation, labor force participation, real exchange rate, trade openness, and merchandise exports. The regression estimates of our study indicated that there is a statistically significant and negative relationship between per capita gross domestic product and gross fixed capital formation in Russia and China. The findings of the regressions indicate that the change in labor force participation rate affects the change in per capita income in the same direction in Brazil. However, this effect moves in the opposite direction in China and South Africa. Although the regression estimates reveal that there is a positive relationship between real exchange rate and per capita income in South Africa, the changes in real exchange rate in Russia create an effect on per capita income in the opposite direction. The findings of regression tests indicate that the relationship between trade openness and per capita

income in Brazil, Russia, China, and South Africa is significantly positive. Finally, empirical findings of our study reveal that merchandise exports have immisirezing effects in India and South Africa. The further studies investigating the causalities of negative relationship between the changes in the level of merchandise exports and the level of per capita gross domestic product in Russia and China will be worthwhile.

The BRICS countries have gone through significant structural changes during the sample period selected for this study. Within the framework of the middle-income trap and immiserizing growth, future studies investigating the effects of these changes by using dynamic general equilibrium models will be complementary to this article.

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