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Dhyani Mehta[a], *Nikunj Patel*[b]

[a] Pandit Deendayal Energy University, Gandhinagar, India

[b] Nirma University, Ahmedabad, India

Asymmetric Effects of Trade Openness and National Income on Government Size in BRICS Countries: New Evidence for Wagner's Law [1]

Abstract. The growing economic prominence of BRICS nations (Brazil, Russia, India, China, and South Africa) has attracted considerable attention to the macroeconomic dynamics driving their development. As these economies grow rapidly and become more integrated into global markets, it becomes increasingly difficult to balance economic growth, trade liberalization, and sustainable fiscal policies. Government size, a key factor in fiscal management, tends to increase with national income (as suggested by Wagner's Law) and in response to trade openness (as outlined by the Compensation Hypothesis). Understanding these dynamics is crucial due to the unique fiscal pressures and global competitiveness faced by BRICS countries. This study investigates the validity of Wagner's law and the Compensation Hypothesis in the context of BRICS. Using a panel nonlinear autoregressive distributed lag model on annual panel data from 1999 to 2023, our findings confirm Wagner's law, showing a positive relationship between economic growth and government size. Additionally, the results support the Compensation Hypothesis, indicating that trade openness enhances government size. This study underscores the potential trade-offs between promoting economic growth and trade liberalization, as these strategies may inadvertently expand the government sector and affect fiscal stability. As BRICS economies continue to integrate into global markets, this research contributes to the discussion on Wagner's law and trade openness, offering new insights into sustainable fiscal policies, government expenditure optimization, and the pursuit of global competitiveness and economic growth within the BRICS framework.

Keywords: Panel NARDL, Trade Openness, Government Size, Wagner's law, Compensation Hypothesis, BRICS

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ИССЛЕДОВАТЕЛЬСКАЯ СТАТЬЯ

Д. Мехта[а)], *Н. Патель*[б)]

[а)] Энергетический университет Пандита Диндаял, Гандхинагар, Индия

[б)] Университета Нирма, Ахмадабад, Индия

Асимметричное влияние открытости торговли и национального дохода на численность правительства в странах БРИКС

Аннотация. Растущее экономическое влияние стран БРИКС (Бразилия, Россия, Индия, Китай и Южная Африка) привлекло значительное внимание к макроэкономической динамике, стимулирующей их развитие. Поскольку эти страны с быстро растущей экономикой все более интегрируются в глобальные рынки, становится все труднее сбалансировать их экономический рост, либерализацию торговли и устойчивую налогово-бюджетную политику. Согласно гипотезе компенсации, чем более открытой становится торговля в этих странах, тем выше национальный доход (как предполагает закон Вагнера) и численность правительства как ключевого механизма управления финансами. Для стран БРИКС, которые сейчас испытывают существенное фискальное давление и борются за глобальную конкурентоспособность, понимание этой динамики особенно важно. Цель настоящего исследования — подтвердить закон Вагнера и гипотезу компенсации в контексте БРИКС. С помощью панельной нелинейной модели авторегрессии с распределенным лагом на основе годовых панельных данных с 1999 по 2023 гг. удалось подтвердить закон Вагнера, продемонстрировав положительную взаимосвязь между экономическим ростом и численностью правительства. Кроме того, результаты исследования подтверждают гипотезу компенсации, указывая на то, что открытость торговли также приводит к росту численности правительства. Это исследование подчеркивает необходимость баланса между содействием экономическому росту и либерализацией торговли, поскольку каждая из этих стратегий может привести к раздуванию государственного сектора и повлиять на финансовую стабильность. Поскольку страны БРИКС продолжают интегрироваться в глобальные рынки, это исследование вносит вклад в дискуссию о законе Вагнера и открытости торговли, предлагая новое понимание устойчивой бюджетной политики, оптимизации государственных расходов, глобальной конкурентоспособности и экономическому росту в странах БРИКС.

Ключевые слова: панель NARDL, открытость торговли, численность правительства, закон Вагнера, гипотеза компенсации, БРИКС

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Introduction

Macroeconomic theory has long been both a fascinating and daunting field, primarily due to the lack of a universally accepted framework for understanding how economies function or determining the optimal role of government policy (Khan & Aziz, 2011). On the one hand, the classical view emphasizes that the self-equilibrating power of markets makes government policies unnecessary. On the other hand, the Keynesian school asserts that government actions are essential for fostering economic development and stability. Policies such as fiscal policy are crucial for long-term economic and social growth, ensuring a proper balance among government revenues, expenditures, and borrowings Khan & Aziz, 2011; Kirsanova et al., 2007; Kofi Ocran, 2011). The size of government influences the circulation of money, encourages investment and employment, and reduces tax avoidance. However, excessive government spending can lead to a fiscal deficit and rising debt. The scale of government and its impact on economic growth present significant fiscal management challenges, particularly for transitioning economies (Blanchard, 2009; Nworji et al., 2012).

Adolf Wagner, in 1883, posited that, as a country's economic productivity increases, so too should government spending. This concept, known as Wagner's law (Rani & Kumar, 2022), has spurred extensive discussion within the field of public finance. According to this law, as economies advance, the share of government expenditure relative to Gross Domestic Product (GDP) tends to rise over time (Mann, 1980; Musgrave, 1969; Peacock & Wiseman, 1979). Wagner's theory warrants further exploration in the context of the BRICS nations, particularly as these countries surpassed the G7 in terms of global GDP share based on purchasing power parity (PPP) in 2020. This shift underscores the importance of analyzing the evolution of government spending in rapidly

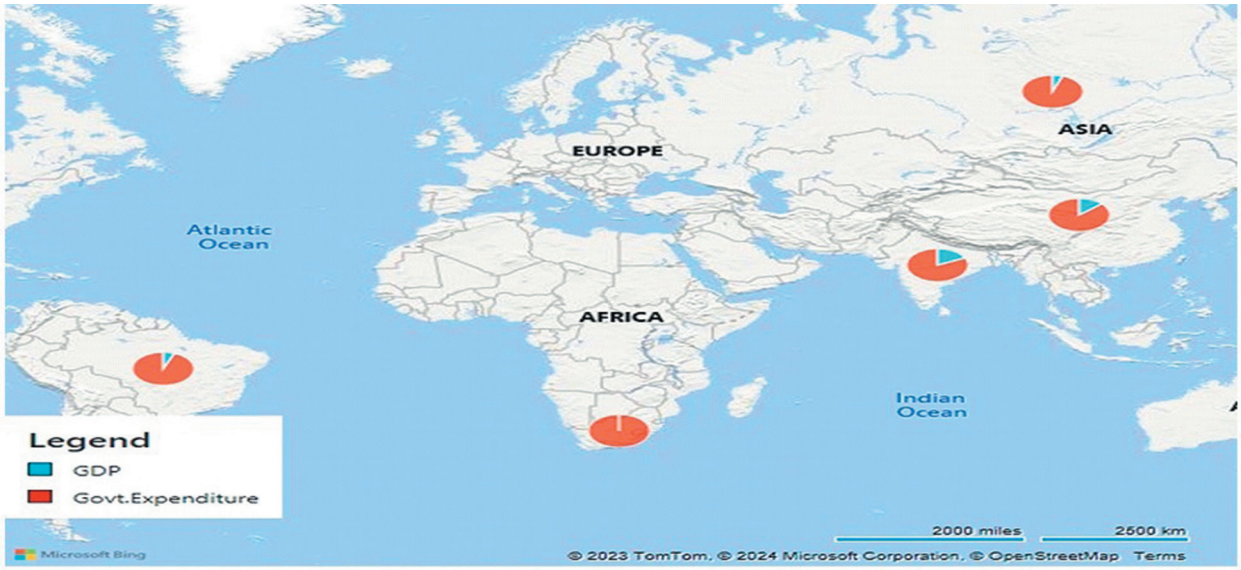

Fig. 1. *Proportion of GDP to Government Expenditure for BRICS countries*
Source: IMF-World Economic Outlook Data 2023, Retrieved from: https://www.imf.org/en/Publications/SPROLLS/world-economic-outlook-databases#sort=%40imfdate%20descending (Accessed on: 31.01.2024)

growing economies, such as those in the BRICS bloc.

Concurrently, government expenditure in BRICS nations has shown a clear upward trajectory, rising from 33.9 % of GDP in 2018 to 35.85 % in 2023. Following the COVID-19 pandemic, government spending surged to 38 % of GDP in 2019–2020 (see Figure 1). These trends highlight the evolving role of government expenditure in supporting economic growth and managing public finances in these rapidly expanding economies.

According to World Economic Outlook data, the gap had widened even more by 2023,[1] with the BRICS now controlling 32 % of global GDP, compared to the G7's 30 %. Concurrently, government expenditure in BRICS nations has shown a clear upward trajectory, rising from 33.9 % of GDP in 2018 to 35.85 % in 2023. Following the COVID-19 pandemic, government spending surged to 38 % of GDP in 2019–2020 (see Figure 1).

To enhance global trade involvement and integration, the BRICS countries have embraced open trade policies. These nations have demonstrated higher levels of trade openness compared to several neighbouring regions, such as the European Union and the G7 countries, which saw a decline in their economic complexity rankings in 2021[2] (see Figure 2). In Brazil, Russia, India, China, and South Africa, policymakers are working towards creating sustainable fiscal policies through prudent expenditure management. This requires balancing the principles of free trade with the goal of fostering economic growth. In this context, it is crucial to evaluate the relationship between trade openness, economic development, and government spending.

This research aims to assess the relationship between government size and economic growth, evaluating the relevance of Wagner's law. It also seeks to test the validity of the Compensation Hypothesis regarding the link between trade openness and government size within the BRICS nations.

Literature Review

Wagner's hypothesis has been widely tested in both developed and developing countries. Wagner and Weber (1977) found that Wagner's law can apply to any economy, with an equal probability of occurrence. Extensive literature supports the validity of Wagner's law (see Akitoby et al., 2006; Antonis et al., 2013; Chang, 2002; Karagianni et al., 2002; Keho, 2016; Kunofiwa and Odhiambo, 2013; Narayan et al., 2008; Oxley, 1994) However, some studies found no evidence supporting Wagner's law (Magazzino et al., 2015; Moore, 2016).

When contemporary time-series econometrics first came to light in the 1980s, there was a notable upsurge in empirical research that sought

[1] World Economic Outlook Data 2023, Published and complied by International Monetary fund (IMF). Retrieved from: https://www.imf.org/en/Publications/SPROLLS/world-economic-outlook-databases#sort=%40imfdate%20descending (Accessed on: 17.01.2024)

[2] The Economic Complexity Index (ECI) simplifies dimensions to predict and understand economic growth, income disparity, and greenhouse gas emissions. In this index, a rank of 1 indicates the most complex economy for that year. https://oec.world/ (Accessed on: 31.12.2023)

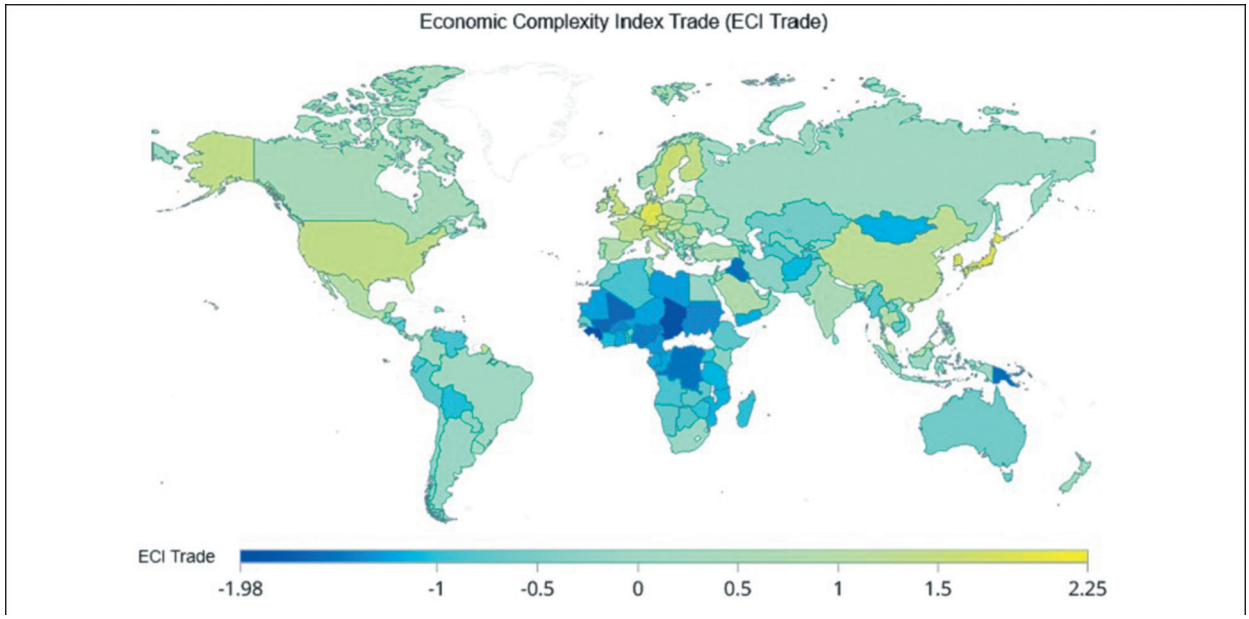

Figure 2: *Economic Complexity Ranking of BRICS compared to neighbouring countries.*
Source: Data obtained from The Observatory of Economic Complexity (OEC). Retrieved from https://oec.world/en (Accessed on: 01.02.2024)

to build on earlier findings by substituting basic linear regression models with time series analysis, VAR models, cointegration, error correction, and Granger causality analysis (see Ahsan et al., 1996; Holmes and Hutton, 1990; Kónya and Abdullaev, 2018; Magazzino, 2012; Magazzino et al., 2015; Samudram et al., 2009; Singh and Sahni, 1984; Thornton and Ulrich, 1999). Using the Johansen maximum likelihood approach, Granger causality tests, and the Engel-Granger cointegration technique, Karagianni et al. (2002) examined Wagner's law in fifteen European nations. The outcomes highlighted the importance of the approaches and procedures used to ascertain Wagner's law's validity. Between 1996 and 2013, Afonso and Alves (2017) investigated Wagner's law regarding public expenditure in fourteen European countries, finding that countries like Austria, France, the Netherlands, and Portugal adhered to the law. Jalles (2019) examined 61 advanced and developing economies between 1995 and 2015 to assess the empirical validity of Wagner's law.

There is limited evidence supporting Wagner's law in some countries, such as Australia, Canada, Thailand, and South Africa (Chang et al., 2004). However, the law has been validated in developed economies like the United States (Funashima and Hiraga, 2017; Mahdavi, 2011). In contrast, studies on Asian economies, including Malaysia, China, and Sri Lanka, have produced mixed results regarding the validity of Wagner's law (Chandran Govindaraju et al., 2011; Kesavarajah, 2012; Narayan et al., 2008). In many developing African nations, such as Nigeria, Ghana, Kenya, and South Africa, weak or no evidence was found to support the hypothesis that economic growth leads to increased government spending (Amadi and Dave, 2022; Ansari et al., 1997; Babatunde, 2011; Chang et al., 2004). In developing countries, governments typically use fiscal policy and other macroeconomic tools to support economic growth (Abdullah et al., 2009). Additionally, numerous studies have explored the impact of economic growth on the environment (Karedla et al., 2021; Patel et al., 2023).

Kargi (2016) explores the causal relationship between public sector expenditure and economic growth, while also delving into the applicability of Wagner's law in developing countries. The study introduces a new group of developing countries, termed "MATIK countries," and tests the validity of Wagner's law, concluding that it does not hold for either MATIK or BRICS countries. Ma and Qamruzzaman (2022) found mixed causal relationships between economic policy uncertainty, institutional quality, and government spending in BRICS nations. Additionally, studies conducted in India in the 1980s and 1990s support Wagner's law, indicating that higher economic growth leads to increased government spending (see Ahsan et al., 1996; Mohsin et al., 1995; Sahoo, 2001; Singh and Sahni, 1984).

There is substantial evidence of bilateral causation between public expenditure and GDP, supporting Wagner's theory for BRICS countries. Jain et al. (2021) examined the relationship between government spending and economic growth using two empirical models from 2007 to

2016. The first applied the system GMM technique to explore the Armey curve hypothesis, while the second used threshold regression with system GMM panel modelling. The results aligned with Wagner's law. In contrast, Buthelezi (2023) found that increased government expenditure in South Africa did not lead to economic growth. In lower economic states, government expenditure reduced growth, with expenditure shocks negatively impacting economic growth. However, it still supported Wagner's law and recommended increasing government spending in the short term.

Adil et al. (2017) analysed data from 1970 to 2013 in India to examine the long-run relationship between government spending and GDP. Using the ARDL model, they found only weak support for Wagner's law but identified a long-term link between GDP and government spending. In contrast, Kaur and Afifa (2017) found no evidence to support Wagner's law. Apurv and Uzma (2021) observed a negative relationship between development expenditure (such as infrastructure investment) and economic growth in India. However, Rani and Kumar (2022) used the ARDL and Granger causality models to find a significant relationship between government size and GDP growth, supporting Wagner's theory during the post-reform period. They also noted that, prior to reforms, the elasticity of government spending to economic growth was low.

Few comprehensive studies examine the relationship between government size and economic growth for the BRICS panel. There is a lack of clear evidence and sufficient data to either support or reject Wagner's law in the context of these countries. This gap can be attributed to differences in sample sizes, research durations, and methodologies used in empirical studies. Additionally, the Compensation Hypothesis (Rodrik, 1998), which explores the effect of liberal trade policies on government expenditure, is often overlooked in empirical research. According to this hypothesis, government spending increases in open economies to mitigate risks from exposure to international markets and economic fluctuations. Several empirical studies on BRICS nations have examined the impact of trade liberalization on economic growth and public spending, yielding diverse conclusions (Benarroch & Pandey, 2012; Chatterji et al., 2014; Dixit, 2014; Mallick, 2008; Mehta, 2023). This study uses the panel NARDL method to explore the asymmetric relationships between government size, economic growth, and trade openness in BRICS countries.

Methodology

3.1 Data

Table 1 represents the data description and measure of dependent and independent variables.

Panel data on government size, national income, and trade openness for BRICS nations from 1999 to 2023 were sourced from the IMF World Economic Outlook Data 2023.

3.2 Model

Prominent economists have proposed various formulations of Wagner's law (Goffman & Mahar, 1971; Musgrave, 1969; Peacock & Wiseman, 1961, 1979). This study uses the Peacock-Wiseman model (see Eq. (1)), which links government size to increases in real national income. Here, real national income measures economic growth, while government size is assessed in relation to total (real) government spending (see Afonso and Alves, 2017; Jalles, 2019; Kaur, 2018; Kaur and Afifa, 2017; Mallick, 2008; Palamalai, 2014; Rani and Kumar, 2022; Verma and Arora, 2010)

$$GS_{tj} = f\left(NI_{tj}\right) \quad (1)$$

where GS_{tj} is government size, and NI_{tj} is real national income at time t for jth country.

Compensation Hypothesis

According to the Compensation Hypothesis introduced by Rodrik (1998), trade openness also influences government size. This theory suggests that open economies tend to allocate more resources toward protecting domestic sectors from potential disruptions arising from trade liberalization and foreign markets (see Benarroch & Pandey, 2008; Dixit, 2014; Islam, 2004; Molana et al., 2011; Nguea, 2020). This study measures trade openness, defined as total exports, to assess how export promotion influences government spending (see Al-Yousif, 1997; Glasure and Lee, 1999; Okur and Soylu, 2015). Equation (2) is derived by incorporating total exports as a measure of trade openness into Equation (1).

$$GS_{tj} = f(NI_{tj}, TO_{tj}) \quad (2)$$

where TO_{tj} is trade openness at time t for j^{th} country.

3.3 Econometric model

We propose to use a panel non-linear ARDL (Odugbesan et al., 2021; Sheikh et al., 2020) model to capture the asymmetric relationship between national income (NI), trade openness (TO), and the interaction term (NITO) with government size (GS), as outlined in Equation (2). Importantly, for NARDL, no variable should be integrated at order

Table 1

Data Description and Measure of Dependent Variables

Dependent Variable	Variable Representation	Description & Measure
Government Size	*G*	Description: Total government expenditure included central government development and non-development expenditure. Measure: $$G = \frac{Total\ Government\ Expnditure}{Real\ GDP} \cdot 100$$
Independent Variable	Variable Representation	Description & Measure
Trade Openness	*TO*	Description: The aggregate value of exports is utilized to gauge the relative scale of trade in comparison to the domestic production of goods and services. Measure: $$TO = \frac{Total\ Exports}{Real\ GDP} \cdot 100$$
National Income	*NI*	Description: Per Capita GDP growth measures the impact of income growth. Measure: $$NI = \frac{Real\ GDP}{Total\ Population} \cdot 100$$
National Income & Trade Openness	*NITO*	Description: Interaction term for national income and trade openness as percentage of GDP. Measure: $$NITO = \frac{National\ Income}{Real\ GDP} \cdot \left[\frac{Fiscal\ Deficit}{Real\ GDP}\right]$$

Source: Compiled by the authors by using the data from IMF-World Economic Outlook Data 2023, Retrieved from: https://www.imf.org/en/Publications/SPROLLS/world-economic-outlook-databases#sort=%40imfdate%20descending (Accessed on: 21.12.2023)

I(2) (Bertsatos et al., 2022; Patel & Mehta, 2023; Pesaran & Smith, 1995). While some variables may show non-stationary trends at I(0) and others at I(1), the Panel NARDL model can still be estimated (Mensah & Abdul-Mumuni, 2023). The long-run panel NARDL equation, as specified in Equation (2), uses total government expenditure as a proxy for government size and includes the interaction term of national income and trade openness (NITO).

$$GS_{tj} = \sigma_0 + \sigma_1^+ NI_{tj} + \sigma_2^- NI_{tj} + \sigma_3^+ TO_{tj} + \sigma_4^- TO_{tj} + \\ + \sigma_5 NITO_{tj} + \varepsilon_t \quad (3)$$

Equation (3) is the panel NARDL equation representing the asymmetric impact of NI_{tj} and TO_{tj} on GS_{tj} at time t for jth country of BRICS panel, whereas $NITO_{tj}$ represents interaction term between national income and trade openness. In this equation, our parameters are $\sigma_0, \sigma_1^+, \sigma_2^-, \sigma_3^+, \sigma_4^-, \sigma_5$ and $NI_t = NI_{tj} + NI_{tj}^+ + NI_{tj}^-$, $TO_t = TO_{tj} + TO_{tj}^+ + TO_{tj}^-$. Here, positives and negatives represent the "partial sum of positive and negative variation" in NI_t, TO_t whereas *t* represents time and *j* is the index of BRICS country panel. The study uses the cointegration tests by Kao (1999) and Pedroni (1999, 2004) in Equation (5) to establish the long-run relationship.

The research uses the Pooled Group Mean (PMG) estimation techniques (Pesaran et al., 1999; Pesaran & Smith, 1995) to measure the association between the variables in Equation (3) in both the short and long term. PMG can be used as it captures less variation due to its lower level of heterogeneity and can estimate both error variances and short-run coefficients. The long-run equation further assumes a constant association between the dependent and independent variables (Mehta & Derbeneva, 2024; Qamruzzaman & Jianguo, 2020). Additionally, panel data analysis requires selecting the most appropriate unit root tests and determining the integration order of variables using CSD (Li et al., 2023).

The Dumitrescu and Hurlin (2012) test assesses the direction of the causal relationship between variables, identifies potential variations across cross-sections, and tests for cross-sectional dependency within the panel. It evaluates the null hypothesis of no causal link between variables *A* and *B*:

$$A_{it} = \hat{u}_i + \sum_{k=1}^{K} \phi_i^{(k)} A_{it-k} + \sum_{k=1}^{K} \aleph_i^{(k)} B_{it-k} + \varepsilon_{it} \quad (4)$$

In this context, *A* represents the dependent variable, while *B* symbolizes each distinct explanatory variable. The slope coefficient is represented by $\phi_i^{(k)}$ and $\aleph_i^{(k)}$, with $\hat{u}_i$ denoting the constant term. The panel NARDL model is used to investigate the asymmetric influence of explanatory variables. Equation (5) describes the estimation process of the panel NARDL model:

$$\begin{aligned}\Delta GS_{it} = {} & \sigma_{0i} + \sigma_{1t} GS_{it-1} + \sigma_{2i}^{+} NI_{t-1}^{+} + \sigma_{3i}^{+} NI_{t-1}^{-} + \sigma_{4i}^{+} TO_{t-1}^{+} + \\ & + \sigma_{5i}^{+} TO_{t-1}^{-} + \sigma_{6t} NITO_{it-1} + \sum_{J=1}^{M-1} \psi_{iJ} \Delta GS_{it-J} + \\ & + \sum_{J=0}^{N-1} \left(\Upsilon_{ij}^{+} \Delta NI_{ij}^{+} + \Upsilon_{ij}^{-} \Delta NI_{ij}^{-} \right) + \\ & + \sum_{J=0}^{O-1} \left(\delta_{ij}^{+} \Delta TO_{ij}^{+} + \delta_{ij}^{-} \Delta TO_{ij}^{-} \right) + \sum_{J=1}^{M-1} \psi_{iJ} \Delta NITO_{it-J} + \varepsilon_{it} \end{aligned} \quad (5)$$

where TO^{+} and TO^{-} stand for the positive and negative shock of trade openness, NI^{+} and NI^{-} represent the positive and negative shocks of national income. Equations (6) and (7) delineate the decomposition of *NI* and *TO* into positive and negative partial sums.

$$\begin{aligned} NI_t^{+} &= \sum_{j=i}^{t} \Delta NI_t^{+} = \sum_{j=i}^{t} Max\left(\Delta NI_j, 0\right) \mid NI_t^{-} = \\ &= \sum_{j=i}^{t} \Delta NI_t^{-} = \sum_{j=i}^{t} Min\left(\Delta NI_j, 0\right) \end{aligned} \quad (6)$$

$$\begin{aligned} TO_t^{+} &= \sum_{j=i}^{t} \Delta TO_t^{+} = \sum_{j=i}^{t} Max\left(\Delta TO_j, 0\right) \mid TO_t^{-} = \\ &= \sum_{j=i}^{t} \Delta TO_t^{-} = \sum_{j=i}^{t} Min\left(\Delta TO_j, 0\right) \end{aligned} \quad (7)$$

Equation (8) estimates the error correction model of Eq. (5):

$$\begin{aligned}\Delta GS_{it} = {} & \sum_{J=1}^{M-1} \tau_{ij} \Delta GS_{it-J} + \sum_{J=0}^{N-1} \left(\vartheta_{ij}^{+} \Delta NI_{ij}^{+} + \vartheta_{ij}^{-} \Delta NI_{ij}^{-} \right) + \\ & + \sum_{J=0}^{O-1} \left(\vartheta_{ij}^{+} \Delta TO_{ij}^{+} + \vartheta_{ij}^{-} \Delta TO_{ij}^{-} \right) + \sum_{J=1}^{M-1} \tau_{ij} \Delta NITO_{it-J} + \\ & + \rho_{ij} ECT_{t-1} + \varepsilon_{it} \end{aligned} \quad (8)$$

The panel NARDL model's error correction term (ECT), as indicated by Equation (8), measures the speed at which the short-run equation approaches its long-run equilibrium. The testable hypotheses, aligned with the research objective, are as follows: null hypothesis $H0_A$: $\sigma_2^{+} = \sigma_3^{-} = 0$ and $H0_B$: $\delta_{ij}^{+} = \delta_{ij}^{-} = 0$ will stand true if $\alpha_4^{+}, \alpha_5^{-}, \delta_{ij}^{+}, \text{and} \, \delta_{ij}^{-}$ values are zero, invalidating Wagner's law in both the long and short run. Alternate hypothesis $H1_A$: $\sigma_2^{+} \neq \sigma_3^{-} \neq 0$ and $H1_B$: $\delta_{ij}^{+} \neq \delta_{ij}^{-} \neq 0$ will stand true if $\alpha_4^{+}, \alpha_5^{-}, \delta_{ij}^{+}, and \, \delta_{ij}^{-}$ values are not zero, supporting Wagner's law in both the long and short run. Null hypothesis $H0_C$: $\sigma_4^{+} = \sigma_5^{-} = 0$ and $H0_D$: $\gamma_{ij}^{+} = \gamma_{ij}^{-} = 0$ will stand true if $\alpha_2^{+}, \alpha_3^{-}, \gamma_{ij}^{+}, \text{and} \, \gamma_{ij}^{-}$ values are zero, invalidating the Compensation Hypothesis. Alternate hypothesis $H1_C$: $\alpha_4^{+} \neq \alpha_5^{-} \neq 0$ and $H1_D$: $\gamma_{ij}^{+} \neq \gamma_{ij}^{-} \neq 0$ will stand true if $\alpha_2^{+}, \alpha_3^{-}, \gamma_{ij}^{+}, \text{and} \, \gamma_{ij}^{-}$ values are not zero, supporting the compensation hypothesis in both the long and short run.

Results and Discussion

Table 2 summarizes the descriptive statistics and presents the pairwise correlation between the variables for the panel data from the BRICS nations. The standard deviation of all variables exhibits consistent variation as it is smaller than the mean value. The statistical insignificance of the Jarque-Bera (JB) test suggests that all variables follow a normal distribution.

Moreover, the positive correlation estimates among government size, economic growth, and trade openness provide strong initial evidence of the beneficial effects of trade openness and economic growth on government size. The study tests for unit roots in the panel data to evaluate the null hypothesis of non-stationarity (see Breitung, 2000; Im et al., 2003; Levin et al., 2002; Mehta & Derbeneva, 2024; Patel et al., 2023).

All series demonstrate I(1) order of integration at a 1 % significance level, as confirmed by the Fisher-ADF and PP estimates, satisfying the panel NARDL criteria. The objective is to examine both short – and long-term associations while considering the heterogeneity and cross-sectional dependency of the panel data. In panel data analysis, "cross-sectional dependence" arises when observations from different countries are influenced by common economic factors (Breusch & Pagan, 1980; Gaibulloev et al., 2014; Pesaran, 2004).

Table 4 presents the estimates of the cross-section dependence tests. Cross-sectional dependency among the variables indicates that all BRICS nations have comparable structural characteristics. At a 1 % significance level, the

Table 2

Descriptive Statistics

	GS	NI	TO
Mean	31.78793	4.551552	5.926816
Median	30.16400	4.703000	4.785000
Maximum	49.91500	14.24700	31.47700
Minimum	15.02500	-7.821000	-17.02400
Std. Dev.	7.892376	3.913236	8.958850
Skewness	0.352657	-0.454840	0.580206
Kurtosis	2.701945	3.423633	3.773799
Jarque-Bera	3.053670	2.244696	1.13188
Observations	125	125	125
Pairwise Correlation			
GS	—		
NI	0.5651*	—	
TO	0.3443*	0.5987*	—

Note: *, **, and *** denote statistical significance at the 1 %, 5 %, and 10 % confidence levels, respectively. Source: Derived by the authors using data from IMF-World Economic Outlook Data 2023, Retrieved from: https://www.imf.org/en/Publications/SPROLLS/world-economic-outlook-databases#sort=%40imfdate%20descending (Accessed on: 21.12.2023)

Table 3

Panel Stationarity tests

Variables	Fisher-ADF	Fisher-PP
GS	13.4231	14.1551
Δ*GS*	57.9842*	123.244*
NI	19.5716**	40.7759*
Δ*NI*	74.7820*	559.627*
TO	23.7240***	45.6346*
Δ*TO*	82.3322*	419.705*
NITO	21.7045*	45.2678*
Δ*NITO*	79.2194*	400.321*

Note: *, **, and *** indicate significance at 1 %, 5 %, and 10 % levels of significance, respectively. Source: Authors' calculations from Eviews

Table 4

Cross-section dependency test

Cross-section	*GS*	*NI*	*TO*	*NITO*
LM Breusch-Pagan	81.0265*	93.1120*	91.7906*	73.0718*
LM Pesaran scaled	15.8820*	18.5844*	18.2889*	14.1032*
CD Pesaran	8.0792*	9.2971*	9.3399*	8.0348*

Note: *, **, and *** indicate significance at 1 %, 5 %, and 10 % levels of significance, respectively. Source: Authors' calculations from EViews

estimates reject the cross-sectional independent null hypothesis.

Table 5 displays the estimations from the panel cointegration tests. The Pedroni and KAO panel cointegration test findings validate the long-term cointegration of the variables by demonstrating statistical significance at both the 1 % and 5 % levels of significance.

The Dumitrescu-Hurlin causality test results for the BRICS panel indicate a significant unidirectional relationship between government size and economic development, supporting Wagner's law. Additionally, the compensation hypothesis is confirmed for the BRICS countries, as trade openness is shown to influence government size (see Table 6). Table 7 presents the long-run and short-run results from the panel NARDL analysis.

Impact of National Income on Government Size (Wagner's Law)

The coefficient of NI^+ and NI^- is significant and positive, which suggests a direct nonlinear

Table 5

Panel cointegration test

Pedroni Cointegration: Common AR coefficients (within-dimension)		
	Statistic	**Weighted Statistic**
Panel v-Statistic	–1.7208*	–1.6089*
Panel rho-Statistic	–0.4471*	–0.4318*
Panel PP-Statistic	–3.2768*	–2.9916*
Panel ADF-Statistic	–0.1237*	–0.5908*
Pedroni Cointegration: Individual AR coefficients (between-dimension)		
	Statistic	
Group rho-Statistic	0.5218*	
Group PP-Statistic	–3.1119*	
Group ADF-Statistic	–1.1354*	
KAO Cointegration		
ADF t-stat	–2.0226**	

Note: *, **, and *** indicate significance at 1 %, 5 %, and 10 % levels of significance, respectively.
Source: Authors' calculations from Eviews

Table 6

Results of Dumitrescu-Hurlin causality test for BRICS nations

Null Hypothesis:	W-Stat.	Z-Stat.	Conclusion
$NI \nRightarrow G$	5.3364*	–0.41057*	$NI \Rightarrow G$
$G \nRightarrow NI$	6.0086	–0.91048	
$TO \nRightarrow G$	5.3522**	–1.1168*	$TO \Rightarrow G$
$G \nRightarrow TO$	9.8985	–1.0830	

Note: *, **, and *** indicate significance at 1 %, 5 %, and 10 % levels of significance, respectively.
Source: Authors Calculation using EViews

relationship between national income shocks and government size (*GS*). The estimates confirm Wagner's law (supporting $H1_A$). Regarding the asymmetric influence of national income on government size, the findings show that positive shocks NI^+ cause *GS* to grow while negative NI^- shocks cause *GS* to decline. The positive impact of NI^+ shocks on *GS* is greater compared to the negative shock of NI^-; as a 1 percent change in national income leads to a 0.23 percent increase in government size (*GS*), while a reduction of 1 percent in national income leads to a corresponding decrease of 0.10 percent in government size (*GS*). National income plays a crucial role in shaping government expenditure, and the findings unequivocally show that government spending behaviours adapt in accordance with changes in national income. The outcomes are in line with earlier research that validated Wagner's law (see Chandran Govindaraju et al., 2011; Kaur, 2018; Kesavarajah, 2012; Narayan et al., 2008; Rani & Kumar, 2022; Verma & Arora, 2010).

Impact of Trade Openness on Government Size (Compensation Hypothesis)

Trade openness plays a very important role in determining government spending due to export subsidies and other promotional schemes. The significant and positive long-run estimate of trade openness (TO^+ shows that government size(*GS*)) increases by 0.45 percent for every percent change in TO^+. This shows that the governments of BRICS nations provide better promotional schemes to the domestic industries to expand their international presence. However, the government spends more when exports show a down-trend (results show that a 1 percent change in TO^- leads to an increase in *GS* by 0.47 percent). The outcomes are in line with earlier research that validated the Compensation Hypothesis (supporting $H1_C$) in BRICS (Bernaure & Achini, 2000; Rodrik, 1998; Shelton, 2007; Swank, 2001).

The study employs an interaction term between national income and trade openness to capture their combined impact on government size. The positive

Table 7

Panel NARDL Estimates

Variables	Long-run Coefficient	Short-run Coefficient
NI^+	0.2362**	—
ΔNI^+	—	0.8348**
$\Delta NI^+(-1)$	—	0.6087**
NI^-	0.1069*	—
ΔNI^-	—	0.5707*
$\Delta NI^-(-1)$	—	0.0446
TO^+	0.4538*	—
ΔTO^+	—	0.2907*
$\Delta TO^+(-1)$	—	-0.4394***
TO^-	–0.4716*	—
ΔTO^-	—	0.1235**
$\Delta TO^-(-1)$	—	0.9067**
NITO	0.3208***	—
$\Delta NITO$	—	0.0244*
$\Delta NITO(-1)$	—	0.0149*
Constant	–1.8190**	—
ECT(–1)	—	-0.2525*
Model Diagnostics		
WaldLR Asymmetry (*NI*)	33.282**	
WaldSR Asymmetry (*NI*)	3.177*	
WaldLR Asymmetry (*TO*)	29.148**	
WaldSR Asymmetry (*TO*)	4.334*	
Hausman test	1.8358(0.6072)	
Observations	120	
Log-likelihood	243.801	
Number of Cross Sections	5	

Note: *, **, and *** indicate significance at 1 %, 5 %, and 10 % levels of significance, respectively.
Source: Authors' calculations from Eviews

and significant coefficient indicates that an increase in both national income and trade openness raises government size by 0.32 percent in the long run and 0.02 percent in the short run. Additionally, Table 7 provides the error correction model estimates, which examine the short-term relationships between the variables. The short-run estimates indicate that a 1 percent upward shift in national income (ΔNI^+_t) corresponds to a 0.60 percent rise in government size, whereas a negative shock (ΔNI^-_t) leads to a 0.57 percent decrease in government size.Top of Form The short-run estimates of national income support Wagner's law. Furthermore, the short-run estimates of trade openness estimates support the Compensation Hypothesis as an increase in trade openness (ΔTO^+_t) will increase government size by 0.29 percent. The downward trend in the trade (ΔTO^-_t) will reduce government size by 0.90 percent. The error correction term within the dynamic model illustrates the pace at which the equilibrium relationship is restored. A 25.5 percent correction rate from short-term disparities to long-term equilibrium suggests a consistent long-term association among the variables. Additionally, the stability of the model is affirmed by the plots of CUSUM (Cumulative sum) and CUSUMSQ (Cumulative sum of Square) (refer to Figure 3). Furthermore, the significant Wald test validates the presence of asymmetric relationship. To evaluate the asymmetric impact of government size, national income, and trade openness in both the short and long term, the cumulative dynamic multiplier is utilized (refer to Figure 4 and Figure 5).

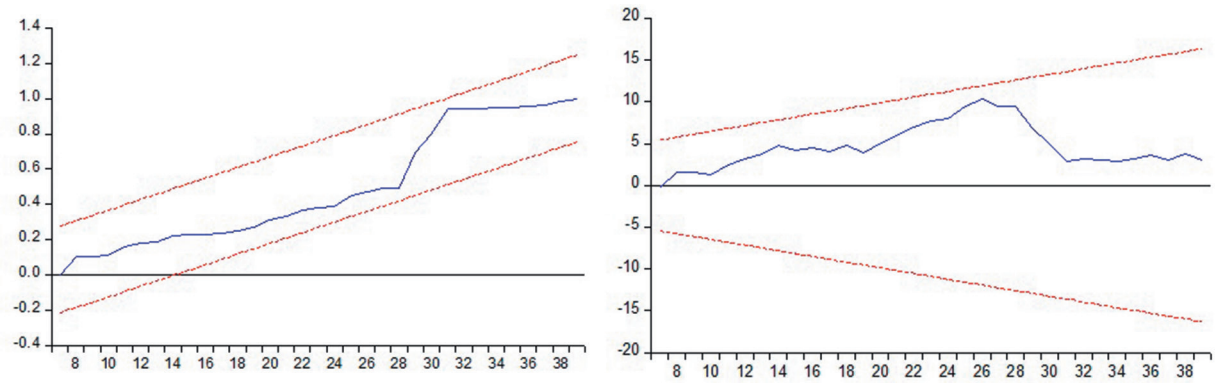

Figure 3: *CUSUM and CUSUMSQ for panel NARDL*
Source: Authors' Calculation using EViews

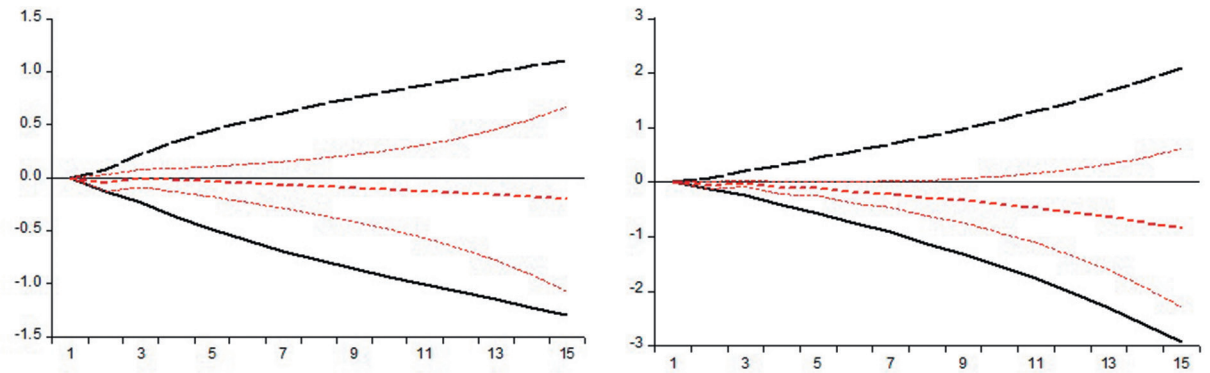

Figure 4: *Cumulative Dynamic Multiplier Graphs for National Income and Trade Openness Source: Authors' calculations from EViews*

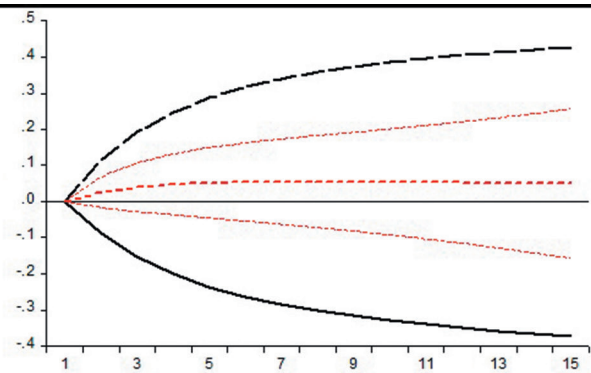

Figure 5: *Cumulative Dynamic Multiplier Graphs for Fiscal Deficit*
Source: Authors' calculations from EViews

Conclusion

This study examines the asymmetric long – and short-run relationships between trade openness, economic growth, and government size. Using annual time-series panel data from 1999 to 2023, the panel NARDL model was applied. The findings confirmed Wagner's law in the BRICS countries by analysing government size as the dependent variable, with national income and trade openness as independent variables. Both the long – and short-run estimates revealed a positive relationship between national income and government size, indicating that as income increases, government size expands, and vice versa. These results suggest that government expenditure adjusts in response to changes in income, thereby supporting Wagner's law and validating hypotheses H1A and H1B (Rani & Kumar, 2022; Wagner & Weber, 1977).

The results also support the Compensation Hypothesis within BRICS, demonstrating that the policies of BRICS nations effectively bolster domestic industries with higher exports, leading to an expansion of government size (validating H1C and H1D). Our findings show that a reduction in trade openness in BRICS countries is associated

with an increase in government size, suggesting that governments' Foreign Trade Policies (FTPs) actively promote exports even during the ongoing global economic crisis. However, balancing progressive goals with fiscal responsibility poses a challenge for BRICS nations. Efforts to implement social and economic programs may strain budgets, complicating the maintenance of long-term financial stability. The significant and negative error correction term further reveals that short-term discrepancies tend to converge toward long-term equilibrium at a rate of 25.5 percent.

While promoting open markets and economic freedom may appear advantageous for BRICS nations seeking economic growth and greater participation in the global market, it is essential to proceed cautiously. Overly liberal policies could lead to unintended consequences, such as fiscal imbalances that strain government finances. Furthermore, integrating domestic markets with the global market poses significant challenges for these countries.

The study highlights that increased government expenditure is a natural outcome of economic advancement. Policymakers in BRICS nations should leverage this by investing in initiatives that foster growth. This research contributes to the literature on Wagner's law and trade openness by offering new insights into balancing sustainable fiscal policies with the need to maintain international standing and economic progress.

Additionally, the findings suggest a need for further exploration of the relationship between government size, economic growth, and trade openness. Future research could expand this analysis by employing a comparative panel of countries or states, thereby broadening the understanding of these dynamics.

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About the Authors

Dhyani Mehta — Doctor of Economics, Assistant Professor of Economics, Department of Economics and Social Science, School of Liberal Studies; Pandit Deendayal Energy University; https://orcid.org/0000–0002-6783–0506; Scopus Author ID: 57206193899; (Gandhinagar — 382426, India, e-mail: dhyani.mehta@sls.pdpu.ac.in).

Nikunj Patel — Doctor of Finance, Associate Professor of Finance, Institute of Management, Nirma University; https://orcid.org/0000–0003-0693–3349 (Ahmedabad, 382481, India; e-mail: nikunj@nirmauni.ac.in).

Информация об авторах:

Мехта Дхиани — доктор экономики, доцент, Департамент экономики и социальных наук, Школа гуманитарных исследований, Энергетический университет Пандита Диндаял; https://orcid.org/0000–0002-6783–0506; Scopus Author ID: 57206193899; (Гандхинагар — 382426, Индия, электронная почта: dhyani.mehta@sls.pdpu.ac.in).

Патель Никундж — доктор финансов, доцент кафедры финансов, Институт менеджмента, Университет Нирма; https://orcid.org/0000–0003-0693–3349 (Ахмадабад, 382481, Индия; электронная почта: nikunj@nirmauni.ac.in).

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