Analyzing Spatial Disparities In Economic Development:
A Core-Periphery Approach of the National Capital Region's Urban
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A Core-Periphery Approach of the National Capital Region's Urban Fringe

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Abstract

Purpose: This study examines the influence of Household Final Consumption Expenditure (HFCE), Provincial Inflation, Higher Educational Institutions (HEI), and Transportation and Storage to the Gross Regional Domestic Product (GRDP) of three Philippine regions: the National Capital Region (NCR), Region III (Central Luzon), and Region IV-A (CALABARZON). These regions were selected due to their distinct roles in the core-periphery model, with the National Capital Region as the economic "core" and Regions III and IV-A as the peripheral regions with economic interconnections to the core. The study uses regional-level data from the Philippine Statistics Authority and the Commission on Higher Education from 2004 to 2021.

Methodology: The study employed Ordinary Least Squares (OLS) for region-specific analysis of the variables and Random Effects Generalized Least Squares (GLS) for the panel dataset, which combines the data across the three regions over time.

Findings: The findings reveal that HFCE positively and significantly impacts GRDP in NCR, Region III and Region IV-A. The number of graduates from HEIs shows a positive and significant relationship with GRDP only in Region III (Central Luzon). The other variables, provincial inflation and transportation and storage does not show a significant relationship to GRDP in the regional level and in all of the regions combined. In the panel dataset, the results highlight that only HFCE has a positive and significant impact on GRDP, suggesting that the economic influence of the core (NCR) extends to the periphery through this variable.

Unique Contribution to Theory, Policy and Practice: The findings suggest policies aimed at stimulating household consumption in both the core and peripheral regions to foster balanced economic growth.

Keywords: *Core-Periphery, Gross Regional Domestic Product, Household Final Consumption Expenditure, Regional Economics*

I. INTRODUCTION

1.1 Background of the Study

Urbanization is the expansion or the growth of cities in terms of physical infrastructure, population, and economic expansion, and is the clustering of people and societal functions into high-density areas. Moreover, urbanization is driven by population growth, alongside economic, social, and technological changes that drive people to relocate to places that offer more opportunities (Gotham & King, 2019). It is commonly linked with the specialization, industrialization, and development, and is often perceived as a territorial transition driven by structural shifts in the economy (Narayan, 2014). According to Chandrasekhar & Sharma (2015), urbanization is characterized by a distinctive division of labor, the use of technology in producing goods, extensive trade in various goods and services, significant levels of spatial and economic interaction, and a relatively dense and diverse population. In the wake of urbanization and industrialization, the contrast between the rural decline and urban prosperity has garnered growing attention across various regions. While urbanization can sometimes lead to challenges for rural areas, urban and rural communities are highly interdependent and rely on each other in many ways as rural and urban areas depend on each other for economic growth, commerce, information exchange, goods and services, and education. Urban areas rely on rural areas for food production, raw materials, labor, and recreation, while rural areas increasingly depend on urban areas for jobs, technology, healthcare, and amenities (Ann et al., 2014).

In recent decades, there has been a significant trend of rural-to-urban migration, resulting in more than half of the total population of the world now residing in urban areas (Ritchie, 2018). High-income nations have witnessed substantial urbanization with over 80% of their population residing in urban areas, while developing countries are currently undergoing rapid urbanization (Gu, 2019). This is evident in countries belonging to the Organization for Economic Co-operation (OECD) having levels of urbanization of 70% or higher, with developed countries such as Belgium, Germany, Iceland, and the United Kingdom experiencing the highest levels of urbanization. In the Southeast Asian region, ASEAN countries display varying levels of urbanization, and only Singapore, Malaysia, and Brunei are considered to be urbanized countries with urbanization levels of more than 70%, while the rest of the countries have lower urbanization levels.

In the Philippine context, the country has been rapidly urbanizing as its urban population increased by 50 million over the past five decades. It is projected that by the year 2050, an estimated 65% of its population will be residing in cities. This shift has driven Manila, the capital city of the Philippines, to be part of the top 30 urban agglomerations globally (Zhao et. al., 2017).

While urbanization has been attributed to positively affect economic growth, there are concerns about the implications of this effect on inequality (Nguyen & Nguyen, 2018). From a rural perspective, urbanization and industrialization often come at the expense of human quality of life and agricultural environments, hindering efforts to localize agriculture and diversify the local

International Journal of Economic Policy

ISSN: 2788-6352 (Online)

Vol. 5, Issue No. 1, pp 34 - 65, 2025

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economy. This trend has exacerbated the urban-rural divide and the imbalance between the urban and rural areas has led to the overconcentration of populations in urban centers in developing countries (Kim, 2015).

Despite the acknowledged benefits of urbanization, studies have shown that urbanization has been linked to a rise in inequality. Kanbur & Zhuang (2013) highlighted urbanization caused a 300% increase in inequality in the Philippines at the national level. This disparity is largely attributed to the concentration of economic activities in urban centers, where efficiency is higher compared to isolated areas. As a result, this leads to uneven patterns of growth and development, driven by scale economies and factor mobility, resulting in differential patterns of growth (Mendoza, 2017). The concentration of economic activities in urban centers is prominent in the Philippines where the National Capital Region (NCR) accounts for 32% of the country's GDP in 2020 and 12% of the country's total population while only covering 0.2% of the Philippines' total land area (Philippine Statistics Authority, 2023a; Raflores & Regmi, 2015). Furthermore, NCR also has the lowest poverty incidence in the Philippines with 2.2% in 2021, as compared to its neighboring regions, Region III and Region IV-A with a poverty incidence of 8.3% and 7.2%, respectively (Philippine Statistics Authority, 2022).

This urban expansion has led to spatial transformations and interactions between urban and rural land uses in the urban fringes surrounding the National Capital Region, as urban fringe areas are distinguished by having a mix of agricultural and non-agricultural activity (Chakraborty et al., 2019; Padilla, 2006; Murakami and Palijon, 2005). Additionally, the urbanization of the National Capital Region has now spread towards the neighboring provinces that are part of Central Luzon and CALABARZON (Boquet, 2017).

Fig. 1. *Map of the National Capital Region*

Bordered to the west by Manila Bay, the National Capital Region is surrounded by Bulacan to the north, which is part of Region III (Central Luzon), Rizal to the east, Laguna to the south, and Cavite to the southwest, which are part of Region IV-A (CALABARZON) (Raflores & Regmi, 2015). This study will consider these surrounding regions as the urban fringe of the Philippines for analysis.
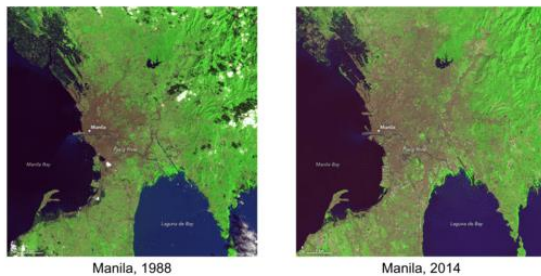

Fig. 2. The growth of Manila from 1988 to 2014.

1.1.1 Urban Fringe

Manila has seen significant growth in recent decades, as illustrated in Figure 2, which shows its expansion into neighboring provinces from 1988 to 2014 (NASA Earth Observatory, 2015). The provinces surrounding or bordering the National Capital Region have experienced significant population growth and economic development in recent decades. The provinces in Region IV-A bordering Metro Manila in the east, south, and southwest are Rizal, Laguna, and Cavite, respectively. The Rizal province has had a significant increase in its population from 1.7 million residents in 2000 to over 3.3 million residents in 2020, and this province accounts for 11.6% of Region IV-A's total GRDP. Meanwhile, the province of Laguna has the highest share of GRDP in Region IV-A, accounting for 33.7% of the region's total GDP, and has the highest share in the industry sector of the region (Philippine Statistics Authority, 2021).

Cavite's population has seen a rise from 24,406 individuals between 1975 and 1980 to 29,970 between 1985 and 1990. Correspondingly, Cavite's population surged from 771,320 in 1980 to 1,610,324 in 1995. Notably, the recent growth rate stands at 6.47%, and the population density is recorded at 1,251 persons per hectare. Region IV-A, where Cavite is situated, led the nation in terms of land use conversion applications between 1980 and 2000, totaling 753 applications, which comprised 30% of the country's total. Of these, 696 were granted approval, encompassing a total land area of 14,422 hectares (Malaque III & Yokohari, 2007, as cited in Baragis, 2022). From the said data, the province of Cavite has seen net migration from the National Capital Region, increasing from 24,406 between 1975 and 1980 to 29,970 between 1985 and 1990. Additionally, Cavite's population significantly rose from 771,320 in 1980 to 1.6 million in 1995, and to 4.8 million in 2020. Its most recent average growth rate was 3.97% annually from 2015 to 2020 (Baragis, 2022). Additionally, Cavite province accounts for 24.9% of Region IV-A's gross

domestic product (GDP), and is the highest in the services sector in the region (Philippine Statistics Authority, 2021).

Bordering the National Capital Region in the north, the province of Bulacan's population grew tremendously in the recent decade by 31.42% from 2.82 million in 2007 to 3.71 million in 2020 (Philippine Statistics Authority, 2023b). This province accounts for 27.7% of Region III - Central Luzon's total GRDP and is the highest among all of the provinces in Central Luzon in the industry and services sector (Philippine Statistics Authority, 2023c).

The growth of these areas can be attributed to the improvements in transportation infrastructure and road network, such as the Manila-Cavite Expressway (CAVITEX), South Luzon Expressway (SLEX), and North Luzon Expressway (NLEX), improving the accessibility of these provinces and boosting its economic growth (Boquet, 2017).

Beyond the provinces that are bordering the National Capital Region, its economic influence extends further to Batangas (Region IV-A), Pampanga (Region III), and Zambales (Region III) as these provinces are contributing to the operations of NCR with key infrastructures such as the Batangas port, Clark International Airport, and export processing zones in Clark and Subic Bay (Boquet, 2017).

1.2 Research Aims and Objectives

Applying the core-periphery framework to the National Capital Region's urban fringe, this research seeks to analyze spatial disparities in economic development and explore the implications of urbanization on inequalities. The study examines key indicators such as gross regional domestic product (GRDP), transportation and storage, provincial inflation, higher educational institutions, and consumer spending. Specifically, this research aims to:

1. Examine how interconnectivity influences economic growth in the National Capital Region and in its urban fringe, as measured by the contribution of Transportation and Storage to GRDP;

2. Evaluate the contribution of tertiary education on economic growth in the National Capital Region and in its urban fringe, as measured by the number of graduates in Higher Educational Institutions;

3. Analyze how variations in the provincial inflation rates, as measured by the consumer price index (CPI), influence economic growth in the National Capital Region and in its urban fringe; and

4. Examine the impact of consumer spending on economic growth in the National Capital Region and its urban fringe, as measured by the Household Final Consumption Expenditure (HFCE).

1.3 Hypotheses

H_o: Expenditures on interconnectivity, measured by the contribution of transportation and storage to GRDP, do not have a significant effect on economic growth in the National Capital Region and its urban fringe.

H_o: The contribution of tertiary education, as measured by the number of graduates in Higher Educational Institutions (HEI) does not have a significant effect on economic growth in the National Capital Region and its urban fringe.

H_o: Provincial inflation rates, as measured by the Consumer Price Index (CPI), do not have a significant effect on economic growth in the National Capital Region and its urban fringe.

H_o: Consumer spending, as measured by the Household Final Consumption Expenditure (HFCE), does not have a significant effect on economic growth in the National Capital Region and its urban fringe.

1.4 Theoretical Framework

The core-periphery model, as conceptualized by John Friedmann, aims to explain the spatial disparities in socioeconomic development within a core-periphery framework, where economic activities tend to concentrate in core areas while peripheral regions experience lower levels of development. In this theory, the "core" regions experience advancements in innovation and economic growth, whereas the "periphery" regions face lagging development. The periphery regions may also depend on the core's demand for resources to sustain their growth. Additionally, the further the region is from the "core", the lower its level of development (Klimczuk & Klimczuk-Kochańska, 2019).

To understand disparities in development within the core-periphery framework, the power dynamics and resource flows between core and periphery areas should be well understood. Core regions possess significant advantages due to their concentration of power, wealth, and resources since these areas have better road networks and infrastructure to facilitate economic activities. These regions also have greater access to resources necessary for their growth. On the other hand, regions in the periphery face limited economic opportunities due to lower levels of investment in their infrastructure. These also face resource exploitation from the core, hindering their own development.

1.5 Conceptual Framework & Simulacrum

The conceptual framework adopts a core-periphery approach to examine the spatial disparities in economic development within the National Capital Region's urban fringe. In this framework, the core represents the urban center, which is the National Capital Region, while the periphery includes the adjacent regions of Central Luzon and CALABARZON, which exhibit varying levels of economic development. The study aims to assess the impact of the four independent variables to economic growth, measured by the Gross Regional Domestic Product (GRDP). These independent variables are (1) the contribution of Transportation and Storage to GRDP, which

reflects the role of interconnectivity in the economy; (2) the number of graduates in Higher Educational Institutions (HEIs), which measures the influence of education on human capital and economic productivity; (3) Provincial Inflation as measured by the Consumer Price Index (CPI), which shows how inflationary pressures affect regional purchasing power, and (4) Household Final Consumption Expenditure (HFCE), which captures regional consumer spending patterns.
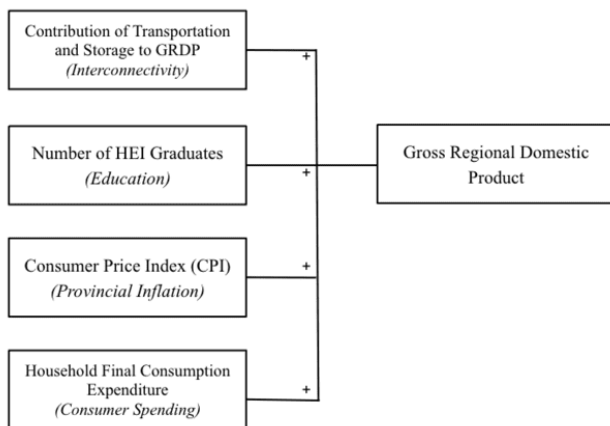

Fig. 3. Research simulacrum.

The researchers will examine three regions, the National Capital Region, Region III (Central Luzon), and Region IV-A (CALABARZON) for this study.

For the following sections, the researchers will discuss the review of related literature about the variables used for this study in Section 2. In Section 3, the researchers will present the model, data, and method that will be used. Section 4 will discuss the results and interpretation of the study, while Section 5 concludes the study with recommendations for future research.

II.   REVIEW OF RELATED LITERATURE

This section seeks to thoroughly analyze the related literature regarding the relationships among the explanatory variables–Transportation and Storage, Higher Educational Institutions, Provincial Inflation, and Household Final Consumption Expenditure–and how these influence the dependent variable which is economic growth, as measured by the Gross Regional Domestic Product.

2.1 Economic Growth

Economic growth reflects whether the economy is contracting or expanding over a defined timeframe, thereby gauging the overall economic health of a specific area (Jain et al., 2015). It is also a local economy's increased capability to produce goods and services (Raisová & Ďurčová, 2014).

Within a core-periphery framework, economic activities are concentrated in the core regions, leading to spatial inequalities as most of the areas in the periphery experience lower economic growth (Klimczuk & Klimczuk-Kochańska, 2019; Davis, 2019; Caraveli, 2016). In this context,

core regions experience more growth, while the growth of periphery areas often depends on the demand for resources from the core (Missos et al., 2024). This dependency may lead to the exploitation of the periphery, increasing the wealth of the core disproportionately (Pleasant & Spalding, 2021; Pascariu & Ţigănaşu, 2017). Furthermore, propellers of economic growth are located at the core, leading to a disparity in research and policy attention compared to the periphery (Hayter et. al., 2003, as cited in Pugh & Dubois, 2021).

2.2. Transportation and Storage to Economic Growth

The relationship between the contribution of transportation and storage to economic growth has been extensively studied in recent years. Transportation is a vital component of infrastructure that is significant for a country's socio-economic development and serves as the primary facilitator of accessibility as it connects resources and people to distant areas (Pan et al., 2024; Weiss et al., 2018; Percoco, 2015; Sreelekha et al., 2016; Meijer et al., 2018, Jiao et. al., 2020). Additionally, Rokicki & Stępniak (2018) suggested that changes in the accessibility of areas may result in the relocation of economic activities.

Investment in transportation networks can yield to different outcomes and may either increase agglomeration or lead to the dispersion of activities (Iacono & Levinson, 2016). Furthermore, it positively affects urbanization and largely contributes to the economic growth of urban areas (Liu & Su, 2021). In rural areas, transport networks with greater capacity and connectivity have a substantial impact on economic growth and have the capacity to transform economic opportunities (Chakrabarti, 2018; Asher & Novosad, 2020). Additionally, rural income and productivity depend on network investments as it amounts to a major portfolio of public investment in rural areas (Khandker et al., 2009, as cited in Berg, 2016).

The uneven distribution of investments in infrastructure also contributes to spatial disparities as resources and activities are concentrated in some areas, resulting in a gap in regional development (Chen et al., 2021). A study by Banerjee et al. (2020) found that accessible transportation networks have a positive causal effect on the country's per capita GDP levels. The transportation network has been shown to not only boost productivity but also affect income levels as it enables the flow of goods, services, and people to different locations. This, in turn, increases market access and integrates previously inaccessible areas into the broader economic system (Gibbons et al., 2019; Wudad et al., 2021). Additionally, a study by Aggarwal (2018) emphasized the importance of investment in transportation infrastructure as this has great economic benefits such as greater market integration, increased use of agricultural technologies, and enrollment gains. Transportation infrastructure is a significant reflection of the country's economic growth as this is important for smooth operations, enabling individuals to carry out tasks without many delays, and accessibility improvements significantly affect the economy due to transport flows and market integration (Nawir et al., 2023; Garcia-López et al., 2023).

Additionally, a study by Givoni (2017) postulated that there is a core-periphery pattern in transportation, suggesting that the core area is highly interconnected, while the periphery is primarily connected to the core. Their research emphasized that socio-economic activities are concentrated in the core and decrease towards the periphery, and that people in the core can access places more easily through the road network, compared to those living in the periphery.

However, Baum-Snow et al. (2017) found that network infrastructure decreases central city industrial GDP as it relocates people from central cities to suburban areas in China. In contrast, although investments in infrastructure connect core areas to peripheral regions, industrial growth is actually reduced among connected peripheral regions compared to non-connected ones instead of dispersing production from core areas to the periphery (Faber, 2014).

2.3 Higher Education Institutions to Economic Growth

Universities are recognized as pivotal institutions in bolstering human capital. The ongoing evolution of universities to meet contemporary challenges is underway, characterized by a quest for adaptable models, particularly amidst 21st-century phenomena like migration, declining confidence in scientific institutions, and rapid socio-economic shifts. Consequently, universities are integral partners in various transformations and catalysts for strategic shifts in cities, regions, and nations (Khalid et al., 2021; Volchik et al., 2018). According to Wieczorek (2018) higher educational institutions could have an impact on both inbound and outbound academic mobility that could contribute to the direct and indirect development of partnership in an economy. Evidently, universities and other higher education institutions (HEIs)—collectively referred to as universities—are intricate entities engaged in a range of activities that can significantly influence the regional economy (Ramaswamy et al., 2021). Moreover, a professor's job effectiveness encompasses the degree to which educators fulfill their instructional and pedagogical responsibilities to impart knowledge and foster positive behavior in students, ultimately contributing to their self-betterment and societal advancement. It serves as the cornerstone of educational and extracurricular activities within schools, providing students with the means to acclimate to the school environment and enhance their academic achievements (Owan et al., 2019). Overall, education consistently serves as a crucial factor in the growth and development of a country (Tupas & Linas-Laguda, 2020).

Wang & Liu (2016) underscores the beneficial influence of tertiary education on economic growth while noting that primary and secondary education lack a notable impact on economic growth. Encouraging more students to complete and pursue postsecondary degrees as it could yield substantial advantages for individuals, communities, states, and the nation. Higher Educational Institutions (HEIs) have become crucial to operate efficiently and contribute positively to the economy, benefiting their surrounding communities and key stakeholders (Vaiciukevičiūtė et al., 2017). There is an impact on the universities and the economy since there is an appreciable growth in GDP and employment (Martin, 1998, as cited in Guerrero et al., 2015). According to Gupta and

Kaur (2014), through the Higher Education Institutions (HEIs), it could generate professions that would help the economy improve. Moreover, the Commission on Higher Education (CHED) in the Philippines urges higher education institutions (HEIs) to actively participate in the developmental activities as it could help to further study the global development challenges in the country (Quimbo & Sulabo, 2014).

2.4 Provincial Inflation to Local Economy Growth

Economic prosperity in different regions is influenced by income levels and the cost of living. While wages and earnings are shaped by economic growth, productivity, demographics, and institutions, income's purchasing power ultimately impacts household well-being (Campbell & James, 2020). As the cost of living refers to the total expenses individuals incur for goods or services, alongside their financial responsibilities, to maintain a specific quality of life (Yepez-Garcia et al., 2021). According to Muehlenbachs et al. (2015), real wages alone may not accurately reflect local well-being, particularly when resource booms in a local economy. The term 'cost-of-living crisis' (CoLC) in the United Kingdom denotes a circumstance wherein the costs of indispensable commodities and services escalate more rapidly than individuals' earnings, thereby rendering it challenging for them to meet fundamental necessities like housing, food, and utilities (Harari et al., 2023).

It is crucial to acknowledge that challenges with the cost of living can stem from factors beyond national borders, such as the Ukraine conflict. These external factors can also diminish the actual worth of resources accessible to states, often beyond the control of any single nation (Nolan, 2023). For many families, a significant worry revolves around their expenses in obtaining the necessary goods to maintain a certain standard of living (Defeyter et al., 2022). A high cost of living combined with a low stipend will remain comparatively low, and it can increase the overall economic strain (Ertreo et al., 2021).

The strain of rising living costs contributes to increased food insecurity, defined as limited or uncertain access to nutritionally adequate and safe food. In the UK, the most recent survey, Food and You 2 by the Food Standards Agency revealed that 25% of households were grappling with food insecurity (Armstrong et al., 2023), marking the highest prevalence since the survey's inception in late 2020 when only 16% of households reported such insecurity (Armstrong et al., 2021). The cost of living crisis is disproportionately affecting low-income households, which may have less resilience against sudden price hikes. Consequently, the ongoing economic crisis exacerbates pre-existing challenges that poorer households face, potentially widening socioeconomic disparities (Johnstone & Lonnie, 2023). There has been an increase in the prices of food and other commodities in recent years as global prices surged (Stone et al., 2024).

Given that the Philippines has maintained a unitary-centralized political system since its independence, development is predominantly concentrated in the capital area, with underdevelopment increasing as one moves further away from its center. This centralization results

from the concentration of political, economic, and social power in the central government. Additionally, most unitary-centralized states have a single core area, which limits growth in the peripheral regions (Glassner & Fahrer, 2004, as cited in Tusalem, 2019). Moreover, as distance from the center increases, it is anticipated that some delivery of the public goods and services will deteriorate. The spatial economic disparities can also result in welfare disparities, as regions in the Philippines that are 'spatially' isolated tend to experience poorer human development outcomes (Tusalem, 2019).

2.5 Household Final Consumption Expenditure to Economic Growth

Household final consumption expenditure (HFCE) plays a pivotal role in driving local economic growth by influencing aggregate demand and stimulating production activities. In the study of Meyer & Shera (2017), household final consumption expenditure has a positive impact on economic growth. Empirical studies have consistently shown a positive relationship between HFCE and economic growth across various contexts. According to Bakari (2018), the final consumption significantly impacts economic growth in its role in enhancing total demand and encouraging business expansion. In the dynamics of final consumption expenditure or consumer spending, one of the key factors that highlights its role is by achieving the sustainability of its economical performance (Ceesay et al., 2021). Household Final Consumption Expenditure (HFCE) plays a crucial role in determining aggregate savings. The availability of national capital supply depends on the flow of savings through the financial system (Ezeji & Ajudua, 2015). Consequently, the combined effects of saving and consumption have a significant long-term influence on the productive economy's capacity (Bonsu & Muzindutsi, 2017). According to Sari & Nayir (2020), household consumption expenditures become one of the references to be able to increase the economic growth of the country; they suggested that the government be able to create as many jobs as possible so as to increase people's income so that people can pay taxes. Household Final Consumption Expenditure (HFCE), which encompasses total household spending on goods and services, plays a significant part in the Philippines' GDP. Data from the Philippine Statistics Authority indicates that HFCE expanded by 4.6% year-on-year in the second quarter of 2024, with notable growth observed in sectors like transport (11.8%) and housing (6.0%), ultimately having an impact on increasing local generated revenue.

III. RESEARCH METHOD

This research aims to determine the spatial disparities in economic development in the National Capital Region's urban fringe by analyzing the regions that border NCR, which are Region III (Central Luzon) and Region IV-A (CALABARZON).

3.1 Method

The researchers will conduct an Ordinary Least Squares (OLS) regression to analyze the effects of the independent variables, Transportation and Storage, Higher Educational Institutions, Provincial

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Inflation, and Consumer Spending, on the dependent variable, Gross Regional Domestic Product (GRDP). The effects of these independent variables to the dependent variable will be done for each of the regions individually, which are the National Capital Region, Region III (Central Luzon), and Region IV-A (CALABARZON). Subsequently, a panel data regression analysis will be conducted for all of the regions combined to observe the collective effects of the independent variables on the dependent variable within the core-periphery framework. This two-stage approach allows for a more nuanced understanding of the significance of the variables for each region individually, while capturing the economic interaction between the core and its periphery.

3.2 Scope and Limitation/ Data

The study uses a total of four (4) independent variables from the years 2004 to 2021, with secondary data sourced from the Philippine Statistics Authority (PSA) and the Commission on Higher Education (CHED) due to the availability of data. The dependent variable, Gross Regional Domestic Product (GRDP) was sourced from the PSA's regional accounts. Furthermore, the independent variables, Transportation and Storage as measured by the nominal contribution of Transportation and Storage to GRDP, Provincial Inflation as measured by CPI (base = 2018), and Consumer Spending as measured by the nominal Household Final Consumption Expenditure, was also sourced from the regional accounts of PSA. Additionally, Higher Educational Institutions (HEIs), as measured by the number of graduates, was sourced from CHED.

The researchers will study the National Capital Region (NCR), Region III (Central Luzon), and Region IV-A (CALABARZON), with Regions III and IV-A serving as the periphery in this study because of their geographical proximity to NCR as the core region.

3.3 Model for Ordinary Least Squares

$$GRDP = \beta_0 + \beta_1 TRANSPO + \beta_2 HEI + \beta_3 CPI + \beta_4 HFCE + \varepsilon$$

Eq. 1. Equation on the Effect of Transportation and Storage, Higher Educational Institutions, Provincial Inflation, and Household Final Consumption Expenditure to Gross Regional Domestic Product

Wherein:

- β_0 – intercept
- $\beta_1 TRANSPO$ – Regression Coefficient of Transportation and Storage
- $\beta_2 HEI$ – Regression Coefficient of Higher Educational Institutions
- $\beta_3 CPI$ – Regression Coefficient of Provincial Inflation
- $\beta_4 HFCE$ – Regression Coefficient of Household Final Consumption Expenditure
- ε - error term

3.4 Model for Panel Least Squares

$$GRDP_{it} = \beta_0 + \beta_1 TRANSPO + \beta_2 HEI + \beta_3 CPI + \beta_4 HFCE + \varepsilon$$

Eq. 2. Equation on the Effect of Transportation and Storage, Higher Educational Institutions, Provincial Inflation, and Household Final Consumption Expenditure to Gross Regional Domestic Product

Wherein:

- i – location
- t – time
- β_0 – intercept
- $\beta_1 TRANSPO$ – Regression Coefficient of Transportation and Storage
- $\beta_2 HEI$ – Regression Coefficient of Higher Educational Institutions
- $\beta_3 CPI$ – Regression Coefficient of Provincial Inflation
- $\beta_4 HFCE$ – Regression Coefficient of Household Final Consumption Expenditure
- ε - error term

3.5. Diagnostic Tests

To further see the robustness of the model, the researchers will use the Breusch-Godfrey statistic to test for autocorrelation, White's Test for heteroskedasticity, Breusch-Pagan for heteroskedasticity, Jarque-Bera test for normality of residual, Ramsey's RESET for specification errors, Variance Inflation Factor (VIF) for multicollinearity, and CHOW's Test for structural break. For the panel least squares analysis, the

Hausman Test will be used to test whether fixed effects or random effects are more appropriate, the Breusch-Pagan test to assess heteroskedasticity, the Joint Test on Named Regressors to evaluate the significance of the independent variables, Jarque-Bera to test for normality of residuals, and the Woolridge Test to detect autocorrelation

RESULTS AND DISCUSSION

This study examined the effects of Household Final Consumption Expenditure, Provincial Inflation, Number of Graduates in Higher Educational Institutions, and Contribution of Transportation and Storage to GRDP on the Gross Regional Domestic Product of three (3) regions, which are namely, the National Capital Region, Region III (Central Luzon), and Region IV-A (CALABARZON) using ordinary least squares and random effects generalized least squares. The researchers were able to determine the effects of these variables on the nominal Gross Regional Domestic Product of the three regions for the years 2004 to 2021. The researchers gathered data from the Philippine Statistics Authority and the Commission on Higher Education.

A. *Ordinary Least Squares (OLS) Model of the National Capital Region*

● *Model 1: OLS, using observations 2005-2021 (T = 17)*

Dependent variable: d_l_GRDP

Table 1. Regression Results for the National Capital Region

Variables	Coefficient	Std. Error	t-ratio	p-value	
const	0.0252972	0.0109663	2.307	0.0397	**
d_l_TRANSPO$_{NCR}$	0.187869	0.0903195	2.080	0.0596	*
d_l_HEI$_{NCR}$	−0.00318247	0.0235405	−0.1352	0.8947	
d_l_CPI$_{NCR}$	0.0984821	0.314374	0.3133	0.7595	
d_l_HFCE$_{NCR}$	0.501298	0.228304	2.196	0.0485	**

Mean dependent var	0.074220		S.D. dependent var	0.044704
Sum squared resid	0.004111		S.E. of regression	0.018510
R-squared	0.871417		Adjusted R-squared	0.828556
F(4, 12)	20.33129		P-value(F)	0.000028
Log-likelihood	46.65931		Akaike criterion	−83.31862
Schwarz criterion	−79.15255		Hannan-Quinn	−82.90450
rho	−0.526689		Durbin-Watson	3.007799

The constant has a coefficient of 0.0252, which is significant at 0.05 alpha level, indicating an upward trend in the dependent variable, which is the Gross Regional Domestic Product (GRDP). Among the exogenous variables, Household Final Consumption Expenditure (HFCE) exhibits a positive and significant relationship with GRDP, with a coefficient of 0.50 at the 0.05 alpha level. This means that a 1% increase in the HFCE leads to a 0.501% increase in GRDP. This result is consistent with the study of Meyer and Shera (2017), which states that HFCE has a positive effect

on economic growth. As the National Capital Region is highly urbanized, having a wide variety of goods and services, consumer spending, or specifically household final consumption expenditures are highly significant and have a critical role in driving economic growth.

B. Ordinary Least Squares (OLS) Model of Region III - Central Luzon

- Model 2: OLS, using observations 2006-2021 (T = 16)

  Dependent variable: d_d_GRDP

Table 2. Regression Results for Region III - Central Luzon

Variables	Coefficient	Std. Error	t-ratio	p-value	
const	−1.78026e+06	1.11828e+07	−0.1592	0.8764	
d_d_HFCE$_{IIII}$	1.73410	0.239841	7.230	<0.0001	***
d_d_CPI$_{III}$	−5.61150e+06	5.42115e+06	−1.035	0.3228	
d_d_HEI$_{III}$	1314.24	517.824	2.538	0.0276	**
d_d_TRANSPO$_{III}$	3.99190	2.73126	1.462	0.1718	

Mean dependent var	8546918		S.D. dependent var	1.87e+08
Sum squared resid	2.17e+16		S.E. of regression	44398738
R-squared	0.958443		Adjusted R-squared	0.943331
F(4, 11)	63.42403		P-value(F)	1.58e-07
Log-likelihood	−301.4450		Akaike criterion	612.8900
Schwarz criterion	616.7530		Hannan-Quinn	613.0878
rho	−0.097022		Durbin-Watson	2.155713

The Ordinary Least Squares (OLS) regression analysis for Central Luzon examines the factors affecting Gross Regional Domestic Product (GRDP) changes from 2006 to 2021. The findings reveal that household final consumption expenditure (HFCE) and higher education institutions (HEIs) are key drivers of economic growth in the region. HFCE has a significant positive impact

on GRDP with a p-value of <0.0001 which is significant at 0.01 alpha, highlighting the vital role of consumer spending in stimulating economic activity. Likewise, 0.0276 enhances HEIs, which human display is significant and positive at output. Moreover, 0.05 is the significant alpha finding relationship, highlighting that the p-value of investing in growth education in the Luzon economy is anchored centrally on consumption and education.

On the other hand, transportation infrastructure (TRANSPO) and the Consumer Price Index (CPI) were not statistically significant, though TRANSPO's positive coefficient suggests that better infrastructure may yield indirect or long-term benefits. CPI's negative coefficient indicates possible inflationary pressures that could hinder growth.

The importance of HFCE in Capital Central Region Luzon (NCR) is where consumers' line expenditure is the trend's major observed component in the National determination of economic growth because of the large population and high demand for merchandise. In Central Luzon, the importance of HEIs shows how the region is a center of education and how education can enrich the workforce. Additionally in CALABARZON there is no statistical significance of some variables like HEIs or CPI this is because of the variation in the economic structure, or environment. This finding also emphasize the need for a contextual analysis when planning for interventions to address particular growth drivers and barriers in various areas.

C. *Ordinary Least Squares (OLS) Model of Region IV-A - CALABARZON*

- Model 3: OLS, using observations 2005-2021 (T = 17)

  Dependent variable: d_GRDP

Table 3. Regression Results for Region IV-A - CALABARZON

Variables	Coefficient	Std. Error	t-ratio	p-value	
const	−4.65637e+07	3.83485e+07	−1.214	0.2480	
d_TRANSPO$_{IV-A}$	3.81092	5.83337	0.6533	0.5259	
d_HEI$_{IV-A}$	330.107	977.239	0.3378	0.7414	
d_CPI$_{IV-A}$	5.18746e+06	1.16324e+07	0.4459	0.6636	
d_HFCE$_{IV-A}$	1.20433	0.327758	3.674	0.0032	***

Mean dependent var	1.12e+08		S.D. dependent var	1.26e+08

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Sum squared resid	3.50e+16		S.E. of regression	54031014
R-squared	0.861134		Adjusted R-squared	0.814845
F(4, 12)	18.60354		P-value(F)	0.000044
Log-likelihood	−323.8475		Akaike criterion	657.6950
Schwarz criterion	661.8611		Hannan-Quinn	658.1091
rho	0.052338		Durbin-Watson	1.740562

The OLS regression analysis for Region IV-A (CALABARZON) evaluates the factors influencing changes in Gross Regional Domestic Product (GRDP) from 2006 to 2021, with Transportation Infrastructure (TRANSPO), Higher Education Institutions (HEI), the Consumer Price Index (CPI), and Household Final Consumption Expenditure (HFCE) as explanatory variables. Among these, only HFCE shows a statistically significant relationship with GRDP, with a positive coefficient of 1.20433, with a significant p-value of 0.0032, significant at 0.05 alpha.. This finding suggests that a one-unit increase in household consumption results in a 1.20433-unit rise in GRDP, highlighting the critical role of consumer spending in driving economic growth in the region.

Moreover, the TRANSPO, HEI, and CPI variables were insignificant as these had a slight or no direct impact on GRDP during the study period. However, these variables might still have some delayed or indirect influence. The importance of HFCE in CALABARZON is consistent with the findings in the National Capital Region (NCR), where household consumption has been identified as one of the key engines of growth due to high population density and high consumer demand. In contrast, the significance of HEIs in Region III (Central Luzon) reflects the region's role as a center for education and workforce development, which translates into tangible economic benefits. Meanwhile, in CALABARZON, as HEIs are not statistically significant, realizing the full potential of these sectors may be attributed to differences in the region's economic structure or it may be realized after a certain period. These findings highlight the importance of developing localized plans so that efforts are directed towards enhancing consumer expenditure in the CALABARZON area and methods of extracting the best economic return from infrastructure and education projects in the long run.

   D. *Random Effects Generalized Least Squares (GLS) Model*

   ● Model 4: Random-effects (GLS), using 51 observations

      Using Nerlove's transformation

Included 3 cross-sectional units

Time-series length = 17

Dependent variable: d_l_GRDP

Table 4. Regression Results for Random Effects GLS

Variables	Coefficient	Std. Error	t-ratio	p-value	
const	−0.00904916	0.0108786	−0.8318	0.4055	
d_l_TRANSPO	0.0469194	0.0730066	0.6427	0.5204	
d_l_HEI	0.0297479	0.0156262	1.904	0.0569	*
d_l_CPI	−0.105384	0.221586	−0.4756	0.6344	
d_l_HFCE	1.06713	0.147740	7.223	<0.0001	***

Mean dependent var	0.073264		S.D. dependent var	0.056560
Sum squared resid	0.035536		S.E. of regression	0.027497
Log-likelihood	112.9945		Akaike criterion	−215.9891
Schwarz criterion	−206.3299		Hannan-Quinn	−212.2980
rho	−0.114120		Durbin-Watson	1.954686

'Between' variance = 5.11067e-05

'Within' variance = 0.000663031

theta used for quasi-demeaning = 0.342101

The Random Effects Generalized Least Squares (GLS) regression model for panel data was used to account for variability across regions and over time, and to examine the relationships that are present between the independent variables and the dependent variable, GRDP. The logarithmic first difference of GRDP has a coefficient of -0.009, but is not statistically significant, with a p-value of 0.4055. This indicates that there is no fixed trend in GRDP when other variables are held

constant. Furthermore, among all of the independent variables, only HFCE has shown a positive and significant relationship with GRDP. HFCE has a coefficient of 1.06713, indicating that a 1% increase in HFCE corresponds to a 1.067% increase in GRDP. This variable has a critical role in driving economic activity between the core and the periphery, with NCR as the core region, and Region III and Region IV-A as the peripheral regions.

Meanwhile, the other independent variables which are CPI, HEI, and TRANSPO do not show a significant relationship with GRDP. This indicates that in the context of the core-periphery model, CPI, HEI, and TRANSPO do not significantly contribute to the economic activity linkages between NCR, which is the core, and Region III and Region IV-A, the peripheral regions.

The variance decomposition of the random effects GLS model shows that the within variance is 0.000663, while the between variance is 5.11067e-05. As the within variance is greater than the between variance, the variability of the data occurs over time rather than across regions. This indicates that most of the changes in GRDP are driven by time variations, rather than differences between the regions. In the context of the core-periphery model, the low 'between' variance indicates that disparities in GRDP between the core and peripheral regions are relatively small in comparison to the 'within' variance that shows that GRDP disparities are time-related, rather than spatial.

E. *Regression Diagnostics of Ordinary Least Squares (OLS) Model of the National Capital Region*

Table 5. Regression Diagnostic Test Results for the National Capital Region

Diagnostic Test	P-value	Results	Interpretation
Variance Inflation Factors (VIF)	-	-	No evidence of excessive collinearity
White's Test for Heteroskedasticity	0.376923	P-value is > 0.05	No heteroskedasticity error
Breusch-Pagan Test for Heteroskedasticity	0.842151	P-value is > 0.05	No heteroskedasticity error
Test for Normality of Residual	0.14013	P-value is > 0.05	Normality of residual is achieved
CHOW Test for Structural Break at Observation 2013	0.679908	P-value is > 0.05	No structural break at year 2013

Breusch-Godfrey Test For First-Order Autocorrelation	0.0597464	P-value is > 0.05	No presence of autocorrelation
RESET Test for Specification (Squares and Cubes)	0.35	P-value is > 0.05	No misspecification error
RESET Test for Specification (Squares Only)	0.182	P-value is > 0.05	No misspecification error
RESET Test for Specification (Cubes Only)	0.145	P-value is > 0.05	No misspecification error

F. Regression Diagnostics of Ordinary Least Squares (OLS) Model of Region III - Central Luzon

Table 6. Regression Diagnostic Test Results for Region III (Central Luzon)

Diagnostic Test	P-value	Results	Interpretation
Variance Inflation Factors (VIF)	-	-	No evidence of excessive collinearity
White's Test for Heteroskedasticity	0.280094	P-value is > 0.05	No heteroskedasticity error
Breusch-Pagan Test for Heteroskedasticity	0.608451	P-value is > 0.05	No heteroskedasticity error
Test for Normality of Residual	0.536783	P-value is > 0.05	Normality of residual is achieved
CHOW Test for Structural Break at Observation 2013	0.272258	P-value is > 0.05	No structural break at year 2013
Breusch-Godfrey Test For First-Order Autocorrelation	0.852033	P-value is > 0.05	No presence of autocorrelation
RESET Test for Specification (Squares and Cubes)	0.232	P-value is > 0.05	No misspecification error

| RESET Test for Specification (Squares Only) | 0.084 | P-value is > 0.05 | No misspecification error |
| RESET Test for Specification (Cubes Only) | 0.0329 | P-value is > 0.05 | No misspecification error |

G. Regression Diagnostics of Ordinary Least Squares (OLS) Model of Region IV-A - CALABARZON

Table 7. Regression Diagnostic Test Results for Region IV-A (CALABARZON)

Diagnostic Test	P-value	Results	Interpretation
Variance Inflation Factors (VIF)	-	-	No evidence of excessive collinearity
White's Test for Heteroskedasticity	0.332438	P-value is > 0.05	No heteroskedasticity error
Breusch-Pagan Test for Heteroskedasticity	0.708236	P-value is > 0.05	No heteroskedasticity error
Test for Normality of Residual	0.0637557	P-value is > 0.05	Normality of residual is achieved
CHOW Test for Structural Break at Observation 2013	0.0774783	P-value is > 0.05	No structural break at year 2013
Breusch-Godfrey Test For First-Order Autocorrelation	0.756499	P-value is > 0.05	No presence of autocorrelation
RESET Test for Specification (Squares and Cubes)	0.26	P-value is > 0.05	No misspecification error
RESET Test for Specification (Squares Only)	0.442	P-value is > 0.05	No misspecification error
RESET Test for Specification (Cubes Only)	0.0927	P-value is > 0.05	No misspecification error

H. Regression Diagnostics of Random Effects Generalized Least Squares (GLS) Model

Table 8. Regression Diagnostic Test Results for Random Effects GLS

Diagnostic Test	P-value	Results	Interpretation
Variance Inflation Factors (VIF)	-	-	No evidence of excessive collinearity
Joint Test on Named Regressors	6.83446e-35	P-value is < 0.05	Independent variables significantly impact the dependent variable
Breusch-Pagan Test for Heteroskedasticity	0.809288	P-value is > 0.05	No heteroskedasticity error
Hausman Test	0.569054	P-value is > 0.05	Random effects model is appropriate
Normality of Residual	0.304224	P-value is > 0.05	Normality of residual is achieved
Woolridge Test for Autocorrelation	0.832483	P-value is > 0.05	No presence of autocorrelation

Tables 5, 6, and 7 present the results of the regression diagnostic tests for the Ordinary Least Squares (OLS) models applied to the National Capital Region, Region III - Central Luzon, and Region IV-A, respectively. Table 8 summarizes the regression diagnostic test results for the Random Effects Generalized Least Squares (GLS) model used in the panel data analysis. Together, these diagnostic test results affirm the robustness and reliability of the OLS and GLS models.

For all OLS models, the Variance Inflation Factors (VIF) test reveals no evidence of excessive collinearity among the variables, ensuring the absence of multicollinearity issues and the reliability of coefficient estimates. White's Test and the Breusch-Pagan Test for Heteroskedasticity produce p-values greater than 0.05, supporting the null hypothesis that heteroskedasticity is absent in the models across all regions. Additionally, the Normality of Residual Test confirms that the residuals are normally distributed.

The CHOW Test for Structural Break detects no significant structural breaks in any region, confirming that the models are stable throughout the observed period. The Breusch-Godfrey Test

for First-Order Autocorrelation finds no evidence of autocorrelation, indicating that residuals are independent over time. Lastly, the RESET Test for Specification demonstrates the absence of misspecification errors in the models, with all p-values exceeding 0.05.

The Random Effects GLS model's suitability for this study is confirmed by the Hausman Test, with a p-value of 0.569054 (greater than 0.05), validating the appropriateness of the Random Effects approach. Diagnostic tests for the GLS model further support its reliability: the Variance Inflation Factors (VIF) show no excessive collinearity, indicating sufficient independence among the independent variables. The Breusch-Pagan Test for Heteroskedasticity confirms the absence of heterogeneity, the Normality of Residual Test validates the normal distribution of residuals, and the Wooldridge Test for Autocorrelation confirms no autocorrelation in the model. Overall, these diagnostic tests support the validity of the regression models across all regions and in the panel data analysis, confirming their robustness and reliability.

V.   CONCLUSION AND RECOMMENDATIONS

This study examined the effects of Household Final Consumption Expenditure (HFCE), Provincial Inflation (CPI), the number of graduates in Higher Educational Institutions (HEI), and the contribution of Transportation and Storage (TRANSPO) on the Gross Regional Domestic Product (GRDP) across the three regions of the Philippines. These regions are, namely, the National Capital Region (NCR), Region III (Central Luzon), and Region IV-A (CALABARZON) from 2004 to 2021. The analysis utilized multiple regression analysis using Ordinary Least Squares (OLS) and Random Effects Generalized Least Squares (GLS) regression models to assess the relationships between these variables and to assess which variables are statistically significant or insignificant to GRDP.

The findings show that HFCE is a driver of regional and economic growth with a positive and significant relationship to GRDP in all three regions, signifying the importance of consumer spending in fueling economic performance, with implications for policies aimed at boosting household consumption. While the number of graduates in higher educational institutions significantly influenced GRDP in Region III (Central Luzon), the effects of this variable was not statistically significant in NCR and Region IV-A (CALABARZON), suggesting that the effects of HEIs in these regions may operate with a lag or there may be other variables that influence its effectiveness. The other independent variables, provincial inflation (CPI) and transportation and storage (TRANSPO), were also not statistically significant in any of the three regions, suggesting that there may be other factors that influence GRDP more than these variables.

In the panel dataset, only HFCE showed a positive and significant relationship with GRDP, showing economic linkages between the core region, which is the National Capital Region, and the peripheral region, which are Regions III and IV-A. Since the variance decomposition of the within variance is greater than the between variance, disparities between the regions are primarily time-related, rather than spatial differences between the core and periphery regions. These results

align with the core-periphery model as this shows the interconnectedness of the core (NCR) and the periphery (Regions III and IV-A), with the peripheral regions benefiting from HFCE from the core which is driving the interconnectedness of the regions through the flow of goods, services, and labor. Furthermore, the peripheral regions benefit from the economic activity that is being generated in the core through HFCE, while also contributing to meet the core's demands, reinforcing mutual economic dependencies.

The focus must be on increasing household final consumption expenditure (HFCE) in all the regions. HFCE was identified as the leading factor driving the growth of the regional economy and the importance of strategies to enhance consumer spending. To achieve this, the government should create stable employment opportunities to increase the amount of income of workers. Specific measures like subsidizing basic necessities or providing conditional cash transfers to households, such as the Pantawid Pamilyang Pilipino Program (4Ps) may be useful in increasing household spending and, in turn, the overall economic growth.

Furthermore, as HEI has a significant and positive impact on Region III (Central Luzon) the region should prioritize enhancing its educational sector as the results show that higher educational institutions have a significant and positive impact on GRDP. Thus, improving the quality and accessibility of education will significantly affect human capital, leading to a more skilled and efficient workforce. To support the enhancement of HEIs, the government should increase its funding, including providing scholarships to help students pursue higher education and alleviate financial burdens to education.

To conclude, this study shows the importance of household final consumption expenditure (HFCE) on the gross regional domestic product (GRDP) to stimulate economic growth across regions. Rooted in the core-periphery model, the study shows that economic activities in the core (NCR) significantly influence the periphery (Regions III and IV-A) through household consumption, fostering mutual economic dependencies. The findings emphasize the need for policies that increase consumption such as providing stable employment opportunities and providing conditional cash transfers to increase spending

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