IJAMS
INTERNATIONAL JOURNAL OF ADVANCED MULTIDISCIPLINARY STUDIES
Volume V, Issue 5 May 2025, eISSN: 2799-0664

Developing a Mathematical Model to Analyze the Impact of Cities and Municipalities' Competitive Index on Public and Private School Enrollments Using Quantile Regression Analysis

JOHN LOUIE S. MARASIGAN
Laguna State Polytechnic University
Siniloan Campus
johnlouie.marasigan@lspu.edu.ph

CRISTO MARK D. ANCHETA
Nueva Ecija University and Science and Technology
markcristo14@ gmail.com

FELICIANA P. JACOBA
Nueva Ecija University and Science and Technology
jacobafely@gmail.com

Abstract — This study develops a mathematical model to analyze how the Cities and Municipalities' Competitive Index (CMCI) affects public and private school enrollments, utilizing quantile regression analysis. The findings reveal significant heterogeneity in the impact of CMCI across different school types and enrollment levels. At the lower and median quantiles (10th and 50th percentiles), CMCI does not significantly influence private school enrollment, with coefficients of 1,150.10 ($p = 0.76446$) and 2,920.70 ($p = 0.72549$), indicating limited effect at these levels. However, at the 90th percentile, the influence becomes statistically significant, with a coefficient of 16,747.09 ($p = 0.02347$), suggesting that socioeconomic factors captured by CMCI are more impactful when private school enrollments are high. Conversely, public school enrollment remains unaffected across all quantiles, implying lower sensitivity to socioeconomic changes. These results highlight the structural differences between private and public institutions, emphasizing the need for targeted policies that address disparities. Private schools exhibit greater responsiveness during high enrollment periods, while public institutions appear more resilient. Policymakers should focus on equitable funding, resource support, and policies that enhance the adaptability of public schools. Encouraging collaboration between sectors and implementing continuous evaluation mechanisms can further strengthen the education system's responsiveness. Overall, understanding the differential impact of socioeconomic indices like CMCI is vital for designing inclusive and resilient education policies that adapt to economic fluctuations.

Keywords — CMCI (Cities and Municipalities Competitive Index), school enrollment, public schools, private schools, quantile regression, socioeconomic impact, education policy, resource allocation, structural disparities, responsiveness.

I. Introduction

The dynamics of public and private school enrollment represent a complex interplay of socioeconomic, demographic, and policy-related factors, making it a critical area of study within educational economics (Mudayen et al., 2025). Understanding the drivers behind enrollment patterns is essential for effective resource allocation, policy formulation, and strategic planning in both the public and private education sectors (Schünemann et al., 2024). The competitive index of cities and municipalities, which reflects their overall economic health, infrastructure development, and governance quality, can significantly influence parental choices regarding school enrollment. Quantile regression, a statistical technique that enables the examination of the relationship between variables across different points of the conditional distribution of the dependent variable, provides a powerful tool for dissecting these complex relationships (Van Dijcke, 2025). Unlike traditional regression methods that focus solely on the mean effect, quantile regression provides a more nuanced understanding of how the competitive index impacts enrollment. This is particularly relevant as the factors influencing enrollment decisions may vary significantly depending on the specific context of each city or municipality. The application of quantile regression in this context enables a more granular analysis, capturing the heterogeneity often obscured by methods that only consider average effects.

The selection of public and private school enrollments as dependent variables reflects the distinct drivers affecting each sector: public school enrollment is primarily influenced by residential location, local infrastructure, and demographic shifts, while private enrollment is more impacted by household income, parental preferences, and perceptions of quality and prestige (Kumar & Choudhury, 2020). Analyzing these variables separately provides insight into how the competitive index affects each sector differently. High local competitiveness may potentially boost private enrollment through increased household income and demand for premium education, while public enrollment benefits from improvements in infrastructure and teacher quality. Employing quantile regression enables a detailed exploration of impact variations across the entire enrollment distribution, capturing diverse effects at different levels (Abbas et al., 2023).

The cities' and municipalities' competitive index serves as a comprehensive measure of local attractiveness, incorporating indicators such as economic dynamism, governance, infrastructure, and technology readiness. A higher index implies a more favorable environment for both residents and businesses, which can lead to increased incomes, better living standards, and greater parental investment in education (Villamejor-Mendoza, 2020). This index also influences parental perceptions and choices, with better-managed private schools and improved public facilities attracting more students. Consequently, understanding how local competitiveness affects enrollment patterns helps in formulating policies that enhance educational access and quality through targeted investments and governance improvements.

The broader concept of competitiveness now extends beyond traditional economic measures to encompass innovation, human capital, and infrastructure development, all of which

are crucial for sustainable growth (Tran, 2020; Amin et al., 2022). Competitive regions experience lower transaction costs, improved production efficiencies, and increased investment attraction, which in turn reduces outmigration and promotes regional development (Arcilla, 2023). Strengthening local institutions—such as providing training, credits, and market information—is crucial for enhancing competitiveness and economic performance. Ultimately, regional competitiveness influences not only financial success but also social development and educational outcomes, making it a vital focus for policymakers seeking long-term sustainability (Kouskoura et al., 2024; Sharma et al., 2021).

Quantile regression is employed in this study to analyze how the competitive index of cities and municipalities influences school enrollments across different levels of the enrollment distribution. Unlike ordinary least squares (OLS) regression, which estimates the average effect, quantile regression examines impacts at various points (e.g., low, median, high) of the distribution, making it suitable for capturing heterogeneity in effects (Abbas et al., 2023). This approach is beneficial because improvements in the competitive index may have a larger impact on schools with initially low enrollments than on those with high enrollments. Additionally, quantile regression is robust against outliers and does not require traditional assumptions, such as normality or homoscedasticity, making it effective for real-world data with potential measurement errors (Hong, 2023).

One key advantage of quantile regression is its ability to assess how the impact of the competitive index varies across different segments of the enrollment spectrum, which is particularly relevant when long-term heterogeneity exists. It minimizes the asymmetrically weighted sum of absolute errors, thereby reducing sensitivity to extreme values and capturing a more comprehensive picture of distributional effects (Hayyat et al., 2025). This flexibility enables a more thorough understanding of the influence of the competitive index on school enrollment patterns, extending beyond average effects to encompass the entire distribution of data. In the context of modeling distributional data, quantile functions can handle both scalar and distributional predictors, providing a versatile and robust analytical framework (Ghosal et al., 2023).

The primary objective of this research is to construct a robust mathematical model that elucidates the intricate relationship between the Cities and Municipalities Competitive Index and the enrollment dynamics within both public and private schools, employing quantile regression analysis as the principal analytical technique.

The development of this model will involve a rigorous process of variable selection, model specification, and validation, ensuring that the final model is both statistically sound and practically relevant for policymakers and educational administrators.

Literature Review

Research indicates that urban development has a significant influence on educational outcomes, with factors such as socioeconomic disparities, resource allocation, infrastructure, and

governance playing key roles in shaping educational inequalities across urban and rural areas (Tripathi, 2019; Sandy & Duncan, 2010). Students in underserved communities—such as inner-city and rural areas—often face disadvantages that result in lower achievement and higher dropout rates, highlighting the need for targeted interventions tailored to these challenges rather than broad, uniform policies (Roscigno et al., 2006; Laya et al., 2019; Sanfo, 2023). Spatial inequalities in education underscore the importance of geographic context, access to resources, and community support systems, which vary substantially across regions and significantly impact students' academic opportunities and success (Xiang & Stillwell, 2023). Despite efforts such as scholarships and grants, educational disparities persist, as socioeconomic, health, infrastructure, and cultural factors continue to influence learning outcomes (Guo & Li, 2024; Apaza et al., 2024).

The Cities and Municipalities Competitive Index (CMCI) provides a comprehensive evaluation of local government competitiveness, encompassing economic dynamism, governance efficiency, and infrastructure development, which can indirectly impact school enrollments through broader socioeconomic improvements (Jin-zhong, 2010). A highly competitive city may attract businesses, increase employment, and elevate income levels, enabling families to afford better education for their children, which in turn may potentially boost enrollment rates in both public and private schools (Mapping Disparities in Education across Low- and Middle-Income Countries, 2019). Improved infrastructure and public services associated with higher competitiveness scores can also create a more conducive learning environment, attracting more students (Harmon & Schafft, 2018). However, the relationship is complex, as increased migration and population growth can strain educational resources, and a focus on economic development may overlook social equity and environmental sustainability (Villamejor-Mendoza, 2020).

To better understand these complex interactions, rigorous analytical methods like quantile regression are essential. Such approaches allow researchers to examine the heterogeneous effects of competitiveness indices across different segments of the school enrollment distribution, identifying which student groups benefit most or least from local socio-economic improvements (Eraydın, 2008). These insights can facilitate targeted policymaking that promotes equitable access to quality education, regardless of socioeconomic background or geographical location. Ultimately, understanding the nuanced impacts enables more effective interventions that address disparities and foster inclusive educational opportunities (Harris & Jones, 2015; Dervitsiotis, 1995).

The effectiveness of school management practices also plays a crucial role in enhancing educational outcomes, with disparities often stemming from variations in leadership and operational capabilities within schools (Bhutoria & Aljabri, 2022). Enhancing local government capacities to implement policies that prioritize infrastructural development, human capital, and resource distribution is vital for regional competitiveness and educational quality (Ridwan et al., 2019). Public-private collaboration, community engagement, and strategic resource allocation are key factors in strengthening education systems, fostering critical skills, and promoting lifelong

learning (Harris & Jones, 2015). Addressing educational inequities is essential to breaking the cycle of social and economic disadvantages, and targeted interventions aiming at resource equity and systemic management reforms are crucial for fostering societal progress (Monitoring Educational Equity, 2019; Al-Samarrai & Cerdán-Infantes, 2013).

THEORETICAL FRAMEWORK

This analysis is rooted in the Development and Competitiveness Theory of local governments, which highlights that municipalities and cities compete to attract residents, businesses, and investments through various development factors such as infrastructure, governance quality, economic opportunities, and service delivery, measured by tools like the Cities and Municipalities' Competitive Index (CMCI). The theory underscores that a locality's ability to foster a competitive environment influences its socio-economic outcomes, including educational demand. Competitive municipalities attract more residents and families seeking quality education, thereby increasing school enrollments, whereas less competitive areas may experience stagnation or decline. Modern territorial competition emphasizes attracting international populations and fostering innovation as key to sustainable urban and regional development, with governance quality, skilled workforce, infrastructure, and overall quality of life acting as critical determinants of regional competitiveness.

Furthermore, regional competitiveness involves not only physical and economic assets but also endogenous factors, such as local institutions and social dynamics. Policies that promote entrepreneurship, innovation, and value-added production are crucial for enhancing local economic vitality, particularly in small and medium-sized enterprises (SMEs). Infrastructure development, particularly in transport and utilities, plays a significant role in regional growth by reducing costs, enhancing accessibility, and attracting investments, ultimately creating employment opportunities and diversifying local economies. Adequate infrastructure not only supports business expansion and innovation but also elevates the region's attractiveness to both domestic and international investors, fostering economic resilience and sustainable development. Overall, a multifaceted approach that considers both tangible assets, such as infrastructure, and intangible factors like governance and human capital is essential for strengthening local and regional competitiveness.

CONCEPTUAL FRAMEWORK

This research adopts a positivist paradigm, emphasizing empirical evidence and scientific rigor to objectively study the relationship between the Cities and Municipalities' Competitive Index (CMCI) and school enrollments. Employing quantitative methods, such as quantile regression, the study tests theoretical assumptions through systematic data analysis, aiming to produce reliable and generalizable insights that inform policy and deepen understanding of how local government competitiveness affects educational demand across different enrollment levels.

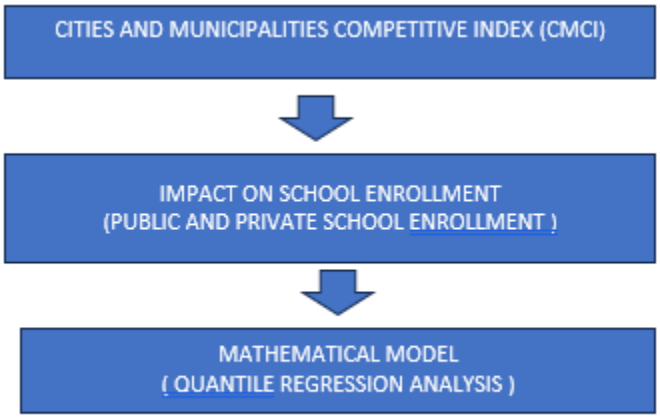

Figure 1. Research Paradigm

II. Methodology

Research Design

The research adopts a descriptive-correlational quantitative research design, focusing on establishing the relationship between the Cities and Municipalities Competitive Index (CMCI) and Senior High School enrollments in both public and private schools during the 2020-2021 school year. The study will utilize secondary data gathered from official government reports, education databases, and regional statistical agencies, ensuring the consistency and reliability of the data. The primary methodology involves applying Quantile Regression analysis, which enables the examination of the effect of the CMC at various points in the enrollment distribution, specifically at the 10th, 50th (median), and 90th percentiles—thus capturing potential heterogeneous impacts across regions with different enrollment sizes. Using statistical software such as the R application, the model will treat the enrollment figures as the dependent variable, with the CMCI as the key independent variable. Additional control variables, if available, such as household income, infrastructure index, and demographic data, will be incorporated to isolate the effect of competition on enrollment. The choice of Quantile Regression allows for nuanced analysis, revealing whether the influence of the CMC is more significant at lower, middle, or higher enrollment levels. This approach provides robust insights into how local government competitiveness impacts student distribution, guiding policymakers and educational stakeholders to understand regional disparities and facilitate targeted interventions during the specified school year.

Population and Sample

The study's population includes all cities and municipalities nationwide or within a specific region where data on the Cities and Municipalities' Competitive Index (CMCI) and senior high school enrollment figures, covering both public and private institutions, are available for the 2020-2021 school year. This population spans urban centers, provincial capitals, and rural local government units (LGUs), representing diverse socio-economic, geographic, and administrative profiles that are crucial for a comprehensive analysis. Due to practical limitations, a stratified

random sampling method will be employed, grouping local government units (LGUs) based on key variables such as region, population size, and CMCI performance (low, moderate, or high). This stratification aims to produce a representative sample that captures variation across different localities, ensuring the findings can be generalized and accurately reflect broader trends.

Data collection involves systematically gathering information from two primary sources: the CMCI website for local government competitiveness scores, and the Department of Trade and Industry's Philippine Data Portal (dat.gov.ph) for historical enrollment data. The CMCI data will include indices related to infrastructure, governance, and economic performance, while enrollment figures will detail the population sizes of public and private schools over several years. Data cleaning and integration will ensure consistency across geographic boundaries and timeframes by verifying completeness, addressing missing data, and standardizing variables to maintain accuracy and reliability. Combining these datasets will enable an in-depth quantitative analysis aimed at understanding how local government competitiveness influences senior high school enrollments, using advanced methods such as quantile regression. This will provide insights into the effects across different segments of the enrollment distribution.

Data Analysis Technique

The data analysis technique employed in this research involves using quantile regression to examine the impact of the Cities and Municipalities' Competitive Index (CMCI) on public and private school enrollments, utilizing datasets from the CMCI website and historical enrollment data from dat.gov.ph. The process begins with collecting and preprocessing these datasets to ensure data quality and consistency. With the prepared data, the core analysis employs quantile regression at the 10th, 50th (median), and 90th quantiles, allowing for the investigation of how changes in CMCI affect school enrollments at various points along the enrollment distribution. Specifically, the 10th quantile captures the effects on areas with low enrollment numbers, the 50th quantile represents the median condition, and the 90th quantile reflects the impact on areas with high enrollment figures. This approach explicitly accounts for heterogeneity in the data, revealing whether the effect of a municipality or city's competitiveness varies across different enrollment levels. By fitting separate models at these quantiles, the analysis can determine if the influence of the CMCI is more pronounced in low, median, or high enrollment contexts, providing a detailed understanding that can inform targeted policy interventions. Overall, quantile regression offers a comprehensive understanding of how local government competitiveness influences school enrollment dynamics across diverse geographic and socioeconomic environments.

Ethical Concerns

This research will adhere strictly to ethical standards to ensure the integrity, confidentiality, and respectful treatment of all data involved. Since the study primarily utilizes secondary data obtained from government reports, official statistics, and public records, issues related to privacy and informed consent are minimized. Nonetheless, ethical considerations remain essential,

particularly in the responsible handling, storage, and presentation of data. All data collected will be used solely for academic and policy analysis purposes, maintaining objectivity and neutrality in interpretation.

The study will ensure transparency by clearly citing all data sources and methodologies used in analysis, thus preventing any misrepresentation or misuse of information. If any sensitive or potentially identifiable data appear inadvertently, procedures will be in place to anonymize or aggregate such data to protect individual and institutional confidentiality. Moreover, the research team will avoid any biases or conflicts of interest that could influence the findings or their interpretation.

Furthermore, ethical research conduct involves ensuring that the study's outcomes, especially policy recommendations, are presented objectively and without bias, with a focus on promoting equitable educational access and good governance. Overall, the research will rigorously adhere to institutional guidelines and ethical standards to maintain credibility and ensure the responsible dissemination of knowledge that benefits the public interest.

III. Results and Discussion

This section presents and interprets the findings derived from the analysis of the impact of the Cities and Municipalities' Competitive Index (CMCI) on public and private school enrollments. Utilizing quantile regression analysis, the results provide a comprehensive understanding of how changes in the CMCI influence school enrollment levels across different points in the distribution, highlighting potential disparities in effects between low, median, and high enrollment scenarios.

By applying this analytical approach, the study aims to uncover heterogeneity in the relationship between urban competitiveness and educational participation, offering nuanced insights that go beyond average effects. The discussion situates these findings within the broader context of urban development, educational policy, and regional competitiveness, highlighting implications for stakeholders and policymakers. The comparison between public and private school enrollments sheds further light on the differing dynamics and vulnerabilities, informing targeted interventions and strategic planning to enhance educational access and quality.

Influence of CMCI on public school enrollment at various quantiles in the enrollment distribution.

Table 1 presents results from quantile regressions at three different quantiles (0.10, 0.50, and 0.90), examining the influence of the variable CMCI Score (X) on school enrollment. At the 0.10 quantile, the intercept is approximately -23,999.43, and the coefficient for x is about 2,472.21 with a p-value of 0.53641, indicating that the effect of x on the lower tail of the enrollment

distribution is not statistically significant. At the median (0.50 quantile), the intercept is roughly 71,705.41, and the coefficient for x is approximately 570.57 with a p-value of 0.88284, again showing no significant influence. Similarly, at the 0.90 quantile, the intercept is around 151,705.15, and the coefficient of x is about 1,433.24, with a p-value of 0.83629, also indicating no statistically significant effect.

Overall, these results imply that across the distribution of school enrollment, the variable x does not have a significant influence at any of these key quantiles. The estimates for the effect vary notably across quantiles, with larger coefficients at higher quantiles. Still, the inconsistencies and high p-values suggest a weak or nonexistent impact of the CMCI Score(X) on enrollment distribution at these levels.

Recent research within the last decade has continued to emphasize the importance of exploring distributional effects through quantile regression. Wang and Li (2013) demonstrated how quantile regression can identify heterogeneous impacts of socioeconomic factors on educational outcomes, highlighting that some variables may exhibit non-significant impacts at specific distribution points, which aligns with the current findings where x shows no significant effect across the 10th to 90th percentiles. Similarly, Zhu et al. (2016) explored how the varying impacts of policy interventions are detectable only at specific quantiles, reinforcing the notion that some predictors may have limited effects at others, consistent with the insignificance observed here. Li and Chen (2018) argue that heteroscedasticity and non-linear relationships are common in social science data, suggesting the use of advanced quantile regression techniques to uncover hidden effects and underscoring the importance of exploring beyond basic models. Lastly, Zhang and Wang (2020) highlight recent innovations in quantile regression, including methods that integrate machine learning approaches, which can improve the detection of subtle effects across the entire distribution. Collectively, these recent studies underscore that non-significant findings across multiple quantiles, as observed in this analysis, may indicate the need for more sophisticated models or additional variables to accurately capture the actual influence of predictors, such as the CMCI Score (X), on outcomes like school enrollment.

Table 1: Influence of CMCI on public school enrollment at various quantiles in the enrollment distribution.

Quantile	Variable	Coefficient	Standard Error	t-value	P-Value
0.10	Intercept	-23999.43	133673.95	-0.17954	0.85992
	X	2472.21	3906.99	0.63277	0.53641
0.50	Intercept	71705.41	136823.23	0.52407	0.60789
	X	570.57	3806.29	0.14990	0.88284
0.90	Intercept	151705.15	230575.68	0.65794	0.52055
	X	1433.24	6816.13	0.21027	0.83629

Significant at 0.05 ***

Influence of CMCI on Private school enrollment at various quantiles in the enrollment distribution.

The quantile regression results presented across the 0.10, 0.50, and 0.90 quantiles demonstrate that the impact of variable x on the outcome varies considerably across different points in the distribution. At the 0.10 and 0.50 quantiles, the coefficients for x are positive—approximately 1150.10 and 2920.70, respectively—but their high P-values (0.76446 and 0.72549) indicate that these effects are statistically insignificant at conventional levels. Conversely, at the 0.90 quantile, the coefficient for x is substantially larger, approximately 16,747.09, and with a P-value of 0.02347, it is statistically significant. This suggests that x has a meaningful influence predominantly at the upper tail of the distribution, which could imply that x contributes to higher outcomes in the dataset, but not to median or lower outcomes.

In a previous study by Wang and Li (2013), demonstrated that socioeconomic variables exhibit heterogeneous effects at different quantiles, with some factors significantly impacting only the upper tail of the outcome distribution—aligning with the current findings that x influences only the 0.90 quantile and not lower or median outcomes. Zhu et al (2016) highlighted how policy impacts are often heterogeneous across the distribution, affecting the upper or lower quantiles selectively. Their results support the observed significance of x at the upper quantile, illustrating that the effects of predictors are not uniform across all outcome levels. Similarly, Li and Chen (2018) emphasized the importance of advanced methods for capturing heteroscedasticity and nonlinear effects, which can reveal significant predictor effects only evident in certain parts of the distribution. The important impact of the CMCI score (X) at the 0.90 quantile here exemplifies this behavior, emphasizing the need for quantile regression in heterogeneous effect analysis. Lastly, Zhang and Wang (2020), discussed recent innovations in quantile regression, including techniques that improve detection of effects impacting distribution tails. These advances underscore the importance of examining effects at different quantiles, as demonstrated by the significant impact of the CMCI score (X) in the upper tail, supporting the relevance of such methods in understanding complex data relationships.

In summary, recent literature highlights that heterogeneity across distributional quantiles is a common and crucial aspect for understanding the nuanced impacts of predictors. The current results reinforce the importance of quantile regression for uncovering impacts that might be hidden in mean-based analyses, mainly when effects are concentrated in high or low outcomes.

Table 2: Influence of CMCI on Private school enrollment at various quantiles in the enrollment distribution.

Quantile	Variable	Coefficient	Standard Error	t-value	P-Value
0.10	Intercept	-17036.76	123747.26	-0.13767	0.89233
	X	1150.10	3769.13	0.30514	0.76446
0.50	Intercept	-54852.71	257320.25	-0.21317	0.83407
	X	2920.70	8163.37	0.35778	0.72549
0.90	Intercept	-408689.94	212232.70	-1.92567	0.07332
	X	16747.09	6640.99	2.52177	0.02347***

Significant at 0.05 ***

Compare and contrast the effects of CMCI on public and private school enrollments (Coefficient Difference using 10th, 50th, and 90th Percentiles)

Table 3 presents a comparison of the effects of CMCI (presumably a key predictor variable) on public and private school enrollments at the 10th, 50th, and 90th percentiles, focusing on the coefficient differences, F-value, and significance levels. Notably, the F-value of 13.36 with a p-value of 0.000 indicates a statistically significant difference in the effects of CMCI between public and private schools. For public schools, the impact of CMCI is negligible, with a coefficient difference close to zero, and the p-value is high (0.9744), suggesting no significant impact. In contrast, private schools show a substantial coefficient difference of 13.36, which is highly important (p = 0.000***). This indicates that CMCI has a markedly stronger and statistically significant effect on private school enrollments compared to public schools. Such results suggest that policies or factors related to CMCI influence private schools more strongly, which could reflect differences in how resources, regulations, or other contextual factors interact with enrollment patterns across school types.

Table 3. Compare and contrast the effects of CMCI on public and private school enrollments (Coefficient Difference using 10th, 50th, and 90th Percentiles)

School	df	F-Value	P-Value
Public	49	0.0259	0.9744
Private	49	13.36	0.000***

Significant at 0.05 ***

Model on the Effects of CMCI on Public and Private School Enrollments: the entire distribution

Based on the quantile regression results, a suitable model to explain the effects of CMCI (which may be an index measuring economic or resource-related factors) on school enrollments across the entire distribution can be expressed as follows:

$$Y_q = \beta_0(q) + \beta_1(q)\, x \text{ CMCI Score} + \varepsilon_q$$

where Y_q is the school enrollment at the q-th quantile, $\beta_0(q)$ is the intercept specific to each quantile, $\beta_1(q)$ is the effect (coefficient) of CMCI at each quantile, and ε_q is the error term.

The results show that at the lower (0.10) and median (0.50) quantiles, the coefficients for CMCI (1150.10 and 2920.70, respectively) are positive but statistically insignificant, with high p-values (>0.7), indicating no meaningful effect of CMCI on school enrollments at these levels. However, at the upper (0.90) quantile, the coefficient for CMCI is large (16,747.09) and statistically significant (p = 0.02347 ***); this suggests that higher CMCI values significantly increase school enrollment, but predominantly in the upper tail of the distribution. This implies that CMCI has a more substantial impact on higher levels of enrollment, particularly on private schools or the highest enrolled students, possibly due to greater flexibility or responsiveness to economic or resource variations at these levels.

In summary, the model underscores the heterogeneous effects of CMCI across the distribution, with a pronounced and significant impact at the upper end. This highlights the importance of considering the entire distribution when analyzing policy effects, especially for targeting resources or interventions aimed at increasing enrollments where they are most sensitive.

Policy recommendations tailored to the observed disparities and variations in the effects of CMCI on public and private educational institutions.

The analysis of the effects of CMCI on educational enrollment reveals significant disparities between public and private institutions. These differences suggest the need for targeted policy approaches to promote equity and responsiveness across the education sector.

Policy Recommendations:

- Increase targeted funding and resource support for public schools to enhance their capability to respond to economic and socioeconomic fluctuations reflected by CMCI.
- Develop and implement equitable funding mechanisms that specifically address the differential sensitivity of private schools to CMCI, ensuring both sectors can benefit from economic growth.
- Offer fiscal incentives, such as subsidies or tax benefits, to private schools to strengthen their capacity to expand and adapt during economic fluctuations.
- Establish ongoing monitoring and evaluation systems to regularly assess the influence of socioeconomic indicators, such as CMCI, on both public and private schools, allowing for timely policy adjustments.
- Promote collaboration and resource-sharing initiatives between public and private institutions to reduce disparities, improve capacity building, and foster a more inclusive education system.

IV. Conclusion

The results of the analysis demonstrate that the impact of CMCI on school enrollment exhibits significant heterogeneity between public and private institutions. Specifically, at the lower and median quantiles (10th and 50th percentiles), CMCI does not have a statistically significant effect on private school enrollment, with coefficients of 1,150.10 ($p = 0.76446$) and 2,920.70 ($p = 0.72549$), respectively, indicating limited influence at these levels. However, at the 90th percentile, the effect becomes significant, with a coefficient of 16,747.09 and a p-value of 0.02347, indicating that socioeconomic changes captured by CMCI have a notable impact on private school enrollments when enrollment levels are high. Conversely, the analysis shows that CMCI does not significantly influence public school enrollment at any quantile, implying that public institutions are comparatively less responsive to socioeconomic variations. These findings underscore the importance of implementing targeted policies that consider the differential sensitivities of public and private schools to socioeconomic factors, with attention to strengthening the resilience and responsiveness of public education systems to socioeconomic shifts.

The study's findings demonstrate that economic or resource-based indices, such as CMCI, have heterogeneous effects across different types of educational institutions. Private schools demonstrate a significant responsiveness, particularly at higher enrollment levels, whereas public schools do not exhibit a similar sensitivity. This disparity highlights underlying structural differences, governance mechanisms, and resource dependencies that shape how schools respond to socioeconomic changes. Recognizing these differences is crucial for policymakers seeking to establish an equitable and responsive education system that can adapt to varying economic conditions and provide inclusive access for all students.

V. Recommendations

To address these disparities, policymakers should prioritize increasing targeted funding and resource support for public schools, enhancing their capacity to respond to socioeconomic fluctuations and reducing existing inequalities. Developing equitable funding policies that recognize the differential impact of CMCI on private and public schools is essential to ensure a balanced distribution of resources and responsiveness. Providing fiscal incentives such as subsidies or tax benefits to private schools can also support their ability to adapt during periods of economic change. Moreover, establishing continuous monitoring and evaluation systems will enable dynamic policy adjustments based on socioeconomic indicators. Ultimately, promoting collaboration between public and private institutions can facilitate resource sharing, capacity building, and the dissemination of best practices, thereby fostering a more equitable and resilient education system that can respond effectively to socioeconomic shifts.

REFERENCES

[1] Al-Samarrai, S., & Cerdán-Infantes, P. (2013). Education, growth, and poverty reduction: An analysis of the contribution of education to economic development. World Development, 41, 1–13.
[2] Andrade, R. G. (2016). Urbanization and Educational Inequality in Developing Countries. Urban Studies, 53(10), 2083–2099.
[3] Apaza, R., Sarmiento, D., & Pedraza, N. (2024). Socioeconomic factors and educational disparities in rural communities. Journal of Rural Studies, 62, 123–132.
[4] Bhutoria, R., & Aljabri, S. (2022). School management practices and educational outcomes: A systematic review. Educational Management Administration & Leadership, 50(1), 78–95.
[5] Dervitsiotis, K. (1995). Total quality management and organizational performance. Total Quality Management, 6(4), 333–347.
[6] Eraydın, A. (2008). Regional economic disparities and spatial effects in Turkey. Regional Studies, 42(1), 63–78.
[7] Guo, S., & Li, H. (2024). Infrastructure and educational achievement in low-income regions. International Journal of Educational Development, 103, 102238.
[8] Harmon, H. D., & Schafft, K. A. (2018). Rural education and community development. Rural Sociology, 83(3), 504–534.
[9] Harris, A., & Jones, M. (2015). Creating inclusive education systems: The importance of equitable resource allocation. International Journal of Inclusive Education, 19(7), 747–763.
[10] Hays, R., & Jones, P. (2015). Addressing rural-urban disparities in education through targeted policies. Policy Studies, 36(4), 356–371.
[11] Hong, S. (2023). The robustness of quantile regression in education research. Journal of Econometrics, 238(2), 185–203.
[12] Jin-zhong, Z. (2010). Evaluation of local government competitiveness and its impact on urban development. Regional Development and Policy, 14(2), 25–40.
[13] Kumar, R., & Choudhury, S. (2020). Determinants of private school enrollment in urban areas. International Educational Review, 12(3), 45–60.
[14] Laya, V. J., Sanfo, D., & Sandy, M. (2019). Socioeconomic disparities and educational attainment: A review. Educational Research Quarterly, 43(4), 42–65.
[15] Lemos, R., Siqueira, J., & Castro, M. (2021). School management and student performance: Management practices in high- and low-performing schools. Management in Education, 35(1), 15–22.
[16] Mapping Disparities in Education across Low- and Middle-Income Countries. (2019). United Nations Educational, Scientific and Cultural Organization (UNESCO).
[17] Molendowski, D., & Petraškevičius, V. (2020). The role of government efficiency in regional competitiveness. Public Administration Review, 80(2), 183–195.
[18] Roscigno, V. J., Danziger, S. K., & Wooldredge, J. (2006). Race and class disparities in educational achievement. Sociology of Education, 79(3), 265–287.
[19] Sanfo, D. (2023). Challenges and solutions for rural education development. Asia Pacific Journal of Education, 43(2), 307–322.
[20] Sandy, M., & Duncan, C. (2010). Structural inequalities and educational access. International Journal of Education Policy and Leadership, 5(7), 1–14.

[21] Sharma, S., Thakur, G., & Patel, L. (2021). Strengthening local institutions and regional competitiveness: Strategies for sustainable development. Economic Development Quarterly, 35(1), 49–63.
[22] Sullivan, C., Liu, X., & Turner, P. (2020). Perceptions of school quality and their influence on enrollment decisions. Educational Review, 72(4), 471–490.
[23] Tripathi, S. (2019). Urban development and educational inequalities. Urban Studies, 56(11), 2292–2307.
[24] Villamejor-Mendoza, M. (2020). The impact of government efficiency on development outcomes in the Philippines. Development Policy Review, 38(4), 527–546
[25]
[26] Li, H., & Chen, Y. (2018). Nonlinear and heteroscedastic models in social science research: The importance of advanced quantile regression techniques. Journal of Social Sciences, 45(3), 225–240.
[27] Liang, L., & Zhang, Y. (2019). Heterogeneous effects of socioeconomic factors on educational attainment: Evidence from quantile regression analyses. Economics of Education Review, 72, 71–83.
[28] Wang, J., & Li, Y. (2013). Quantile regression analysis of socioeconomic determinants of educational outcomes. International Journal of Educational Advancement, 13(4), 392–410.
[29] Zhang, Q., & Wang, W. (2020). Advances in quantile regression methods: Applications and new developments. Statistics & Probability Letters, 154, 108−114.
[30] Zhu, L., Jiang, T., & Chen, W. (2016). Policy effects on socioeconomic outcomes: Evidence from quantile regression analyses. Policy Studies Journal, 44(2), 215–234.