Dynamics Of Quality In Public High Schools In Pernambuco: Assessment Using Convergence Models And Wavelet Analysis

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Abstract:

Background*: Regional disparities in educational quality pose substantial challenges to Brazil's development trajectory. Pernambuco, nationally recognized for its advances in secondary education, has adopted results-based management and expanded full-time schooling as core policy instruments. This study examines whether these interventions have accelerated convergence in educational performance across municipalities, using the Basic Education Development Index (IDEB) as the primary metric.*

Materials and Methods*: The empirical strategy combines a balanced panel of municipal data from 2013 to 2021 with IDEB time series spanning 2005 to 2023. Absolute and conditional β-convergence models are estimated using fixed effects and robust clustered standard errors to assess whether initially underperforming municipalities exhibit faster improvement. Convergence speed and half-life metrics complement the econometric analysis. Continuous Wavelet Transform is applied to decompose IDEB growth rates, identifying cyclical patterns and volatility linked to policy implementation and external shocks. Control variables include average class size, proportion of students enrolled in full-time programs, teacher qualifications, per-student expenditure, and dummy variables for regulatory reforms and the COVID-19 pandemic.*

Results*: The findings reveal statistically significant absolute and conditional β-convergence, with a negative coefficient on initial IDEB scores. The estimated half-life of disparities is 3.57 years, indicating relatively rapid equalization compared to other regions. Wavelet analysis uncovers dominant cycles of 4 to 4.5 years, particularly pronounced in municipalities exhibiting high volatility, consistent with the timing of policy interventions. Structural school factors especially higher full-time enrollment and smaller class sizes significantly enhance IDEB growth, whereas per-student expenditure and recent regulatory reforms show no measurable effect over the period. The COVID-19 shock did not produce significant average disruption but did amplify volatility in critical nodes.*

Conclusion: *Pernambuco's education model, anchored in performance-based governance and the expansion of full-time schooling, has proven effective in promoting equity and accelerating convergence in educational quality. The results suggest that organizational and pedagogical reforms yield more robust long-term outcomes than incremental financial inputs or isolated regulatory changes. Other states may draw lessons from Pernambuco's integrated governance and sustained policy execution, particularly its strategic targeting of equity through advanced monitoring tools. Policy implications underscore the need for continuity, evidence-based resource allocation, and territorially differentiated adaptation.*

Key Word: *Educational convergence; IDEB; Pernambuco; Wavelet analysis; Full-time education; Public policy; Panel data; β-convergence; Regional inequality.*

I. Introduction

Education is widely recognized as one of the primary engines of economic development and national productivity growth, occupying a central role in public policy debates since the twentieth century. Seminal contributions by Baumol (1986) and Lucas (1988) underscored the importance of human capital in driving economic expansion, emphasizing that countries with higher educational endowments tend to exhibit superior growth trajectories. More recent empirical evidence—such as Barro (2001), Woessmann (2006, 2014), and Hanushek (2007, 2021)—further reinforces that beyond quantity, the quality of education, as measured by cognitive achievement indicators, exerts a decisive influence on long-term growth and social equity.

In Brazil, persistent regional and structural inequalities continue to undermine educational quality, particularly in socioeconomically vulnerable areas. The Basic Education Development Index (IDEB) was

introduced as a composite indicator capable of synthesizing school performance outcomes and guiding the design and evaluation of public policies. Over the past decade, the state of Pernambuco has emerged as a national benchmark for improvements in public secondary education, driven by initiatives such as the expansion of full-time schooling and the adoption of a goal-oriented management model.

Nonetheless, questions remain regarding the sustainability of these gains and the extent to which innovative policies have succeeded not only in raising average IDEB scores but also in narrowing inter-municipal disparities. Both international and domestic literature suggest that successful trajectories require structural reforms, targeted interventions in underperforming schools, and rigorous evaluation of educational programs.

Against this backdrop, the present study investigates the convergence dynamics of public secondary school quality in Pernambuco between 2013 and 2021 and examines the temporal cycles of IDEB scores through wavelet analysis from 2005 to 2023. These methodological approaches allow for the identification of long-term trends as well as short- and medium-term fluctuations in educational performance, offering empirical insights to inform the refinement of equity-oriented and efficiency-driven public education policies.

II. Material And Methods
This quantitative study, based on panel data, investigates convergence dynamics and temporal cycles in the quality of public secondary education in Pernambuco (Brazil) from 2013 to 2021, with an extended time series for wavelet analysis covering 2005 to 2023.

Study Design and Data Structure
The analysis employs a balanced panel dataset comprising all municipalities in Pernambuco, with biennial observations corresponding to IDEB release years. Data sources include the Brazilian Ministry of Education (IDEB), Pernambuco's School Census, and the State Transparency Portal.
- Average IDEB score (media_ideb)
- Number of secondary school teachers (quantidade_docente_medio)
- Average number of students per classroom (aluno_por_sala)
- Proportion of students with special needs (proporcao_especial)
- Proportion of students enrolled in full-time secondary schools (proporcao_medio_integral)
- Per-student expenditure (despesa_por_aluno)
- Dummy variables for BNCC reform (d_bncc) and COVID-19 pandemic (d_covid)
All variables were converted to numeric format and log-transformed when appropriate to reduce skewness and facilitate coefficient interpretation.

Empirical Strategy
Absolute β-Convergence
To assess absolute β-convergence, the following model is estimated using both fixed effects (FE) and random effects (RE), relating IDEB growth rates to initial scores:

Where:

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A negative and statistically significant supports convergence.

Conditional β-Convergence
To test conditional β-convergence, the model incorporates school- and municipality-specific covariates:

Expected signs:
- < 0: Evidence of convergence
- > 0: More teachers associated with better outcomes
- < 0: Larger class sizes associated with lower performance

Convergence Speed and Half-Life Main and Control Variables:
Based on the estimated , convergence speed (λ) and half-life ($_{1/2}$) are computed as:

Where t is the time interval between observations (biennial).

Wavelet Analysis
To explore cyclical patterns in IDEB growth, the study applies the Continuous Wavelet Transform (CWT):

Where:
- W(a, b): Wavelet coefficient at scale a and location b
- y(t): IDEB growth time series
- : Mother wavelet
- : Complex conjugate

Statistical Tests
Spatial autocorrelation (Moran's I), heteroskedasticity (Breusch-Pagan), autocorrelation (Wooldridge), and multicollinearity (VIF) tests were conducted to validate model assumptions. Robust standard errors clustered at the municipality level address serial correlation and heteroskedasticity.

Software and Reproducibility
Statistical analyses were performed using R (panel data and wavelet packages) and SPSS for basic descriptive statistics.

III. Result
This section presents a statistical analysis of the dynamics of public secondary school quality in Pernambuco between 2013 and 2021, integrating psychometric data from the Basic Education Development Index (IDEB) with the results of econometric convergence models and wavelet analysis.

Descriptive Statistics of Model Variables
Table 1 reports descriptive statistics for the variables used in the econometric analysis of Pernambuco's municipalities over the biennial period from 2013 to 2021. The average IDEB growth rate was 4.4% (SD = 11.2%), ranging from −43.4% to 43.9%. The mean log of initial IDEB scores was 1.42 (SD = 0.146). The log of the average number of teachers was 4.38 (SD = 1.053), and the log of students per classroom was 3.59 (SD = 0.146). The proportion of students with special needs was 12.2%, while full-time secondary education reached 48% of enrollment. Per-student expenditure exhibited high dispersion, averaging R\$ 871.28 (SD = R\$ 1,468.62). Regarding recent policy variables, 40% of municipalities adopted the BNCC reform and 20% were directly affected by the COVID-19 pandemic during at least one observed year.

Table 1. Descriptive Statistics of Model Variables

Variable	Mean	St. Dev.	Min	Max	Median
Growth_rate	0.044	0.112	-0.434	0.439	0.041
Log of Initial IDEB Score	1.420	0.146	0.875	1.792	1.435
Log of Average Number of Teachers	4.379	1.053	2.079	8.455	4.248
Log of Students per Classroom	3.592	0.146	3.093 4	4.061	3.591
Proportion of Students in Special Education	0.122	0.070	0.004	0.614	0.112
Proportion of Students in Full-Time Secondary	0.480	0.220	0.000	1.000	0.431
Expenditure per Student	871.286	1,468.620	6.371	14,607.060	358.837

BNCC Dummy Variable	0.400	0.490	0	1	0
d_covidCOVID Dummy Variable	0.200	0.400	0	1	0

Source: IDEB, Pernambuco School Census, and State Transparency Portal.

IDEB Distribution Across Municipalities

A generalized upward trend in IDEB scores was observed across Pernambuco's municipalities. The state average increased from 3.93 in 2013 to 4.64 in 2021, representing a cumulative gain of approximately 18%. The standard deviation declined from 0.55 to 0.40, and the coefficient of variation fell from 13.98% to 8.67%, indicating reduced intermunicipal disparities and preliminary evidence of convergence. Nonetheless, disparities persist: in 2021, IDEB scores ranged from 3.5 (minimum) to 5.8 (maximum).

Table 2. IDEB Descriptive Statistics by Year

Year	Mean	Sd	Min	Max	Cv (%)
2013	3.930	0.550	2.500	5.600	13.980
2015	4.350	0.530	3.100	6.000	12.290
2017	4.260	0.450	3.100	5.600	10.670
2019	4.610	0.400	3.700	6.000	8.660
2021	4.640	0.400	3.500	5.800	8.670
Total	4.360	0.540	2.500	6.000	12.320

Source: Author's calculations based on model results.

Convergence Models
Spatial Autocorrelation and Diagnostic Tests

Spatial autocorrelation tests (Moran's I) on model residuals indicated no systematic propagation across municipalities: all years yielded Moran's I values near zero with non-significant p-values. The use of robust fixed effects was supported by the Hausman test and evidence of heteroskedasticity and serial autocorrelation in residuals. Detailed results of these diagnostic tests, including Moran's I statistics, Hausman test outputs, and residual diagnostics, are presented in Table 1 and 2 of the Appendix.

Absolute Convergence Model

The fixed effects model yielded a negative and statistically significant coefficient for the log of initial IDEB scores (−0.606, $p < 0.01$), indicating that municipalities with lower initial performance experienced faster subsequent growth—consistent with absolute convergence in Pernambuco. The Hausman test confirmed the appropriateness of the fixed effects specification.

Table 3. IDEB Absolute Convergence Model

	Dependent variable:	
	Growth Rate of the IDEB	
	FE	**RE**
	(1)	**(2)**
Log IDEB Inicial	-0.606***	0.412***
	(0.038)	(0.028)
Constant	0.629***	
	(0.041)	
Observations	515	515
R^2	0.384	0.290
Adjusted R^2	0.229	0.288
F Statistic	255.867*** (df = 1; 411)	209.205***

Note: *p<0.1; **p<0.05; ***p<0.01
Robust FE: errors clustered by municipality

Source: Author's calculations based on model results

Conditional Convergence Model

In the robust fixed effects model, the coefficient for initial IDEB was even more negative (−0.788, p < 0.01), reinforcing the convergence pattern: half of the disparities were eliminated in 3.57 years (half-life). Additionally, smaller class sizes (β = −0.206, p < 0.01) and higher full-time enrollment (β = 0.128, p < 0.01) were positively associated with IDEB growth, while per-student expenditure, BNCC reform, and COVID-19 showed no statistically significant effects.

Table 4. Models FE, RE e FE (Robust)

	Dependent variable:		
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	growth_rate		
	panel linear	**coeficiente test**	
	(FE)	**(RE)**	FE (Robust))
Log Initial IDEB)	-0.788***	-0.431***	-0.788***
	(0.048)	(0.034)	(0.064)
Log Average Number of Teachers	0.020	0.014**	0.020
	(0.014)	(0.007)	(0.016)
LogStudents per Classroom	-0.206***	-0.071**	-0.206***
	(0.061)	(0.034)	(0.069)
Proportion of Students with Special Needs	0.347***	0.074	0.347***
	(0.119)	(0.068)	(0.100)
Proportion of Full-Time High School Students	0.128***	0.070***	0.128***
	(0.031)	(0.024)	(0.035)
LogExpenditure per Student	0.008	-0.001	0.008
	(0.013)	(0.007)	(0.012)
d_bncc	0.030	-0.008	0.030
	(0.030)	(0.019)	(0.029)
d_covid	0.036	-0.011	0.036
	(0.031)	(0.020)	(0.028)
Constant	0.818***		
	(0.152)		
Observations	515	515	
R2	0.489	0.313	
Adjusted R2	0.350	0.302	
F Statistic	48.304*** (df = 8; 404)	230.058***	

Note: *p<0.1; **p<0.05; ***p<0.01

Half-life: 3.57 years.

Source: Author's calculations based on model results.

Wavelet Analysis of Municipalities
Wavelet analysis revealed that IDEB growth cycles across municipalities predominantly occur in intervals of 4 to 4.5 years, especially in high-volatility contexts. Municipalities classified in the high-power band (e.g., São Caitano, Camutanga, Toritama) exhibited intense oscillations and rapid policy response cycles. In contrast, low-power municipalities demonstrated reduced sensitivity and disengagement from long-term strategies. A summary of the wavelet results by Development Region is presented in Table A3 of the Appendix, providing detailed coefficients and frequency bands that support these findings.

Table 5. Top 10 Wavelet - High Range

Region Band Period	Municipality	Years	Mean Power	Median Power Power	Power	Max Power	Avg. Power Period (yrs)
Agreste Central High	São Caitano	9	0.1270	0.0175		1.0361	4.2379
Mata Norte High	Camutanga	9	0.1247	0.0110		1.0355	4.4898
Agreste Setentrional High	Toritama	9	0.1162	0.0339		0.9129	4.2379
Metropolitana High	Ipojuca	9	0.1153	0.0288		0.8689	4.4898
Sertão do Pajeú High	Solidão	9	0.1153	0.0265		0.8766	4.4898
Metropolitana High	Igarassu	9	0.1098	0.0689		0.6586	4.2379
Mata Sul High	Xexéu	5	0.1097	0.021		0.6695	4.2379
Agreste Meridional High	Canhotinho	9	0.1096	0.0169		0.902	4.2379
Sertão Central High	Cedro	5	0.1034	0.0215		0.6281	4.2379
Mata Norte High	Condado	9	0.1024	0.0241		0.7997	4.4898

Source: Author's calculations based on global wavelet spectrum.

Summary of Findings
- Accelerated convergence: Half of disparities eliminated in 3.57 years
- Positive impact of full-time education and smaller class sizes on IDEB growth
- Temporal cycles of 4–4.5 years in high-volatility municipalities
- No significant effects from per-student expenditure or recent policies (BNCC/COVID-19)
- Municipal disparities persist but are rapidly mitigated under Pernambuco's governance model.

IV. Discussion

The empirical findings of this study provide compelling evidence on the dynamics of educational quality in Pernambuco's public high schools, as measured by the IDEB. The confirmation of both absolute and conditional β-convergence, with an estimated half-life of 0.45 years, underscores a rapid equalization process, where schools with initially lower performance exhibit higher growth rates. This result aligns with Silva et al. (2021), who documented similar convergence in Ceará's public schools from 2005 to 2017, attributing it to sustained policies like PAIC. In Pernambuco, the shorter half-life suggests even faster dynamics, likely driven by the Integral Education Program's expansion since 2008, which has reached 69.6% of high school enrollments by 2024—far exceeding Brazil's 24.2% average. However, the implausibly brief half-life warrants caution; educational changes typically unfold over years, and this figure may reflect data periodicity (biennial IDEB) or model specification, rather than instantaneous real-world adjustments.

The positive impact of full-time education (coefficient 0.128, p<0.001) and smaller class sizes (-0.206, p<0.001) on IDEB growth corroborates Palmiere (2018), who used propensity score matching to show superior ENEM performance in Pernambuco's integral schools from 2009 to 2016. These factors enhance learning through extended instructional time and reduced student-teacher ratios, fostering individualized attention and interdisciplinary practices, as noted by Lima (2014). Conversely, the non-significant effects of per-student expenditure and teacher quantity echo Araújo Júnior et al. (2016), whose DEA analysis of Northeast schools revealed that resource volume alone does not drive efficiency; rather, allocation and management are key. This challenges resource-heavy approaches, emphasizing organizational reforms over fiscal increments.

The wavelet analysis complements these insights by revealing predominant cycles of 4 to 4.5 years in IDEB growth, with higher intensity in volatile municipalities like São Caitano and Camutanga. This periodicity may correspond to policy implementation cycles, such as EREM expansions or FUNDEB adjustments, aligning with Monteiro (2023) on wavelet's utility for non-stationary series. High-power regions (e.g., Mata Sul, Agreste Central) exhibit greater fluctuations, potentially linked to socioeconomic vulnerabilities, as per Leite et al. (2016)'s multidimensional poverty analysis in Bahia. The absence of significant BNCC and COVID-19 effects in convergence models, despite pandemic disruptions, suggests these influences manifest in localized cycles rather than aggregate trends, possibly due to biennial data masking lags.

These results affirm the efficacy of Pernambuco's results-based management model (Benittes, 2014), promoting equity and serving as a benchmark for other states. Yet, managerialism's focus on metrics risks overlooking socioemotional dimensions, as critiqued by Teixeira (2017). Limitations include aggregated municipal data obscuring intra-school heterogeneity, unaddressed σ-convergence, and potential endogeneity in integral education adoption. Future research should disaggregate to school-level data, incorporate socioemotional indicators, and explore causal mechanisms via instrumental variables. Ultimately, Pernambuco's model demonstrates that targeted, sustained reforms can accelerate educational convergence, but long-term sustainability demands balancing quantitative gains with holistic formation.

V. Conclusion

This study provides a comprehensive investigation into the dynamics of public secondary education quality in Pernambuco, using the Basic Education Development Index (IDEB) as the principal metric. The results reveal accelerated convergence across municipalities, evidenced by the negative and statistically significant coefficient on initial IDEB scores in β-convergence models. The estimated half-life of 3.57 years indicates that educational disparities are being reduced in a consistent and relatively rapid manner.

Wavelet analysis complements this understanding by identifying medium-term temporal cycles ranging from 4 to 4.5 years that shape IDEB trajectories and reflect the timing and maturation of public policy interventions across municipalities. These cycles suggest that while progress is evident, educational quality remains a dynamic process, subject to fluctuations that require ongoing monitoring and strategic recalibration.

The findings further underscore the critical role of structural policies particularly the expansion of full-time education and reductions in class size in enhancing school performance. In contrast, increases in per-student expenditure and the implementation of recent policies such as the BNCC and COVID-19 response measures did not yield statistically significant short-term effects. This reinforces the importance of pedagogical and administrative efficiency over purely financial inputs.

In conclusion, Pernambuco's model anchored in results-based management, and the strengthening of full-time education emerges as an effective reference for promoting educational equity in Brazil. However, its replication in other states demands stable governance, sustained political commitment, and careful attention to local school conditions and educational agents to ensure that gains are both scalable and sustainable, given the inherent challenges of the national educational context.

References

[1]. Aguiar-Conraria, L.; Soares, M. Business Cycle Synchronization And The Euro: A Wavelet Analysis. Journal Of Macroeconomics, Vol. 33, Pp. 477–489, 2011.

[2]. Araújo Júnior, J. N.; Justo, W. R.; Rocha, R. M.; Gomes, S. M. F. P. O. Technical Efficiency Of Public Schools In The Northeast States: A Two-Stage Approach. Revista De Economia Do Nordeste, Fortaleza, Vol. 3, Pp. 61–73, Jul./Sep. 2016.

[3]. Barro, R. J.; Sala-I-Martin, X. Convergence. Revista De Economia Política, Vol. 100, No. 2, Pp. 223–251, 1992.

[4]. Baumol, W. J. Productivity Growth, Convergence, And Welfare: What The Long-Run Data Show. American Economic Review, Vol. 76, No. 5, Pp. 1072–1085, 1986.

[5]. Becker, G. S. Human Capital: A Theoretical And Empirical Analysis, With Special Reference To Education. 2nd Ed. New York: Columbia University Press, 1964.

[6]. Benhabib, J.; Spiegel, M. M. The Role Of Human Capital In Economic Development: Evidence From Aggregate Cross-Country Data. Journal Of Monetary Economics, Vol. 34, No. 2, Pp. 143–173, 1994.

[7]. Benittes, V. L. A. Secondary Education Policy In The State Of Pernambuco: A Prototype Of Full-Time Education Management. 2014. Master's Thesis – Universidade Federal De Pernambuco, Caruaru, 2014. Program (Ncep) Expert Panel On Detection, Evaluation, And Treatment Of Highblood Cholesterol In Adults (Adult Treatment Panel Iii) Finalreport. Circulation. 2002;106(25, Article 3143).

[8]. Brasíl. Ministério Da Educação. Public Policy Evaluation: Methodological Guide. Brasília: Mec, 2017.
[9]. Carvalho, C. M.; Melo, T. R. Full-Time Education And Its Effects: A Critical Review Of Recent Literature. Revista Brasileira De Educação, Vol. 25, E250080, 2020. Doi: 10.1590/S1413-24782020250080.
[10]. Chaves, R. G.; Justo, W. R.; Severino, J. J.; Cunha, A. A. P. Dynamics Of Public School Quality In Ceará: A Convergence Model Approach. Xix National Meeting Of The Brazilian Association Of Regional And Urban Studies – Enaber, 2021.
[11]. Fernandes, D. P. Performance Differential Of Students In The Enem: An Evaluation Of The Full-Time School Program In Pernambuco's Public Network From 2009 To 2016. 2018. Master's Thesis – Universidade Federal De Pernambuco, Caruaru, 2018.
[12]. Ferreira, A. R.; Santos, M. M. The Importance Of Evaluation For Improving Educational Policies. Cadernos De Pesquisa, São Paulo, Vol. 173, Pp. 570–590, 2019. Doi: 10.1590/198053143090.
[13]. Freitas, M. P.; Melo, A. L. S. Impact Evaluation In Public Policies: Concepts, Methods, And Challenges. Revista De Administração Pública, Rio De Janeiro, Vol. 2, Pp. 290–310, 2018. Doi: 10.1590/0034-761220180207.
[14]. Glewwe, P.; Muralidharan, K. Improving Education Outcomes In Developing Countries: Evidence, Knowledge Gaps, And Policy Implications. In: Hanushek, E. A.; Machin, S.; Woessmann, L. (Eds.). Handbook Of The Economics Of Education. [S.L.]: Elsevier, 2016. Vol. 5, Pp. 653–743.
[15]. Hanushek, E. A.; Woessmann, L. The Role Of Cognitive Skills In Economic Development. Journal Of Economic Literature, Vol. 46, No. 3, Pp. 607–668, 2008.
[16]. Inep – Instituto Nacional De Estudos E Pesquisas Educacionais Anísio Teixeira. Understanding Ideb. Brasília: Inep, 2025.
[17]. Justo, W. R. Does Human Capital Reduce Inequality? Evidence For Brazil From Quantile Regressions. Economia E Desenvolvimento, Recife, Vol. 2, Pp. 189–220, 2006.
[18]. Leite, Á. R.; Silva, A. F.; Araújo, J. A.; Santana, G. U. Is Multidimensional Poverty In Bahia Complete? Evidence From The Bourguignon And Chakravarty Approach. Revista De Economia Contemporânea, Rio De Janeiro, Vol. 1, Pp. 177–200, 2016.
[19]. Lima, E. M. M. The Mais Educação Program In State Schools Of Recife's Metropolitan Region: Training And Integration Of Actors For Full-Time Education. 2014. Master's Thesis – Universidade Federal De Juiz De Fora, Juiz De Fora, 2014.
[20]. Lima, U. C. W. Reference High Schools In Pernambuco: Interdisciplinary Practices And Youth Protagonism. Revista Gestão Pública, Recife, Vol. 2, Pp. 45–60, 2014. Bener A, Dafeeah E, Ghuloum S, Al-Hamaqaoaa.Association Between Psychological Distress And Gastrointestinal Symptoms In Type 2 Diabetes Mellitus. World Journal Of Diabetes. 2012;3(6):123–129
[21]. Lo Cascio, I. A Wavelet Analysis Of U.S. Fiscal Sustainability. Economic Modelling, Vol. 51, Pp. 33–37, 2015.
[22]. Monteiro, V. S. Empirical Essays On Fiscal Policy In Brazil. 2023. Doctoral Dissertation – Universidade Federal Do Ceará, Graduate Program In Economics (Caen), Fortaleza, 2023.
[23]. Palmiere, D. P. F. Performance Differential Of Students In The Enem: An Evaluation Of The Full-Time School Program In Pernambuco's Public Network From 2009 To 2016. 2018. Master's Thesis – Universidade Federal De Pernambuco, Caruaru, 2018.
[24]. Pereira, L. F. Et Al. Evaluative Culture In Educational Public Policies: Challenges And Perspectives. Revista Avaliação, Belo Horizonte, Vol. 3, Pp. 683–705, 2019. Doi: 10.1590/S1414-40772019000300005.
[25]. Romer, P. M. Endogenous Technological Change. Revista De Economia Política, Vol. 98, No. 5, Pp. 71–102, 1990.
[26]. Schultz, T. W. Investment In Human Capital. American Economic Review, Vol. 51, No. 1, Pp. 1–17, 1961.
[27]. Silva, O. Full-Time Education In Pernambuco: Historical Trajectory And Current Challenges. Revista Realize, Vol. 2, Pp. 90–105, 2016. Foundation.Diabetes Care. 2008;31(4):811–822
[28]. Silveira, L. M. L. C. Participatory Management And Quality In The Full-Time Education Program: A Study At The Ginásio Pernambucano Reference High School. 2020. Doctoral Dissertation – Universidade Federal De Pernambuco, Recife, 2020.
[29]. Teixeira, P. H. M. Working Conditions In Pernambuco's Reference High Schools (Erems): Between Public Policies And Educational Practices. 2017. Master's Thesis – Universidade Federal De Pernambuco, Recife, 2017.
[30]. Torrence, C.; Compo, G. A Practical Guide To Wavelet Analysis. Bulletin Of The American Meteorological Society, Vol. 79, No. 1, Pp. 61–78, 1998.
[31]. Woessmann, L. The Economic Case For Education. European Economic Review, Vol. 50, No. 3, Pp. 677–691, 2006.

Appendix
Table A.1 Moran's I statistics

Ano	Moran_I	p_value
2013	-0.009	0.495
2015	0.074	0.149
2017	-0.021	0.555
2019	-0.065	0.754
2021	0.019	0.360

Source: Author's calculations based on model results

Table A2. Diagnostic Tests for Fixed Effects Models

Test	Statistics df	p_value
Hausman (FE vs RE)	157.190	8 < 2.2e-16
Heterocedasticidade (Breusch-Pagan) 3	9.916	8 3.322e-06
Autocorrelação serial (Wooldridge)	94.912	5 < 2.2e-16
VIF: Log Initial IDEB)	1.428	
VIF: Log Average Number of Teachers	2.814	
VIF: LogStudents per Classroom	1.486	
VIF: Proportion of Students with Special Needs	1.344	
VIF: Proportion of Full-Time		

High School Students	1.628
VIF: LogExpenditure per Student	5.304
VIF: d_bncc	4.945
VIF: d_covid	3.875

Source: Author's calculations based on model results.

Table A3. Summary of the wavelet results by Development Region

Region	Municipality	Years	Mean Power	Median Power	Maz Power	Avg. Power (yrs)	Band Period
Mata Sul	23	9	0.0839	0.0285	0.7833	5.0397	High
Agreste Central	27	9	0.0760	0.0352	1.0361	4.2379	High
Sertão do São Francisco	7	9	0.0756	0.0315	0.7401	4.7568	High
Metropolitana	15	9	0.0856	0.0363	0.8689	4.4898	Upper-Middle
Agreste Meridional	26	9	0.0752	0.0394	0.9020	4.2379	Upper-Middle
Sertão Central	8	9	0.0647	0.0310	0.6281	4.2379	Upper-Middle
Mata Norte	19	9	0.0828	0.0354	1.0355	4.4898	Lower-Middle
Sertão do Moxotó	7	9	0.0771	0.0353	0.6931	4.7568	Lower-Middle
Agreste Setentrional	19	9	0.0754	0.0344	0.9129	4.2379	Lower-Middle
Sertão de Itaparica	7	9	0.0787	0.0480	0.5647	5.0397	Lower
Sertão do Pajeú	17	9	0.0757	0.0323	0.8766	4.4898	Lower
Sertão do Araripe	10	9	0.0712	0.0307	0.7935	4.7568	Lower

Source: Author's calculations based on model results.