EARLY CHILDHOOD EDUCATION AND LONG-TERM LABOUR MARKET OUTCOMES IN NIGERIA: EVIDENCE FROM PROPENSITY SCORE MATCHING

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ABSTRACT

This study investigates the long-term impact of early childhood education (ECE) on labour market outcomes in Nigeria, focusing on employment status, formal-sector participation, and monthly earnings among working-age adults. Using nationally representative data from the Nigeria General Household Survey Panel (GHS-Panel), implemented by the National Bureau of Statistics in collaboration with the World Bank's Living Standards Measurement Study–Integrated Surveys on Agriculture (LSMS-ISA), the study estimates the causal effects of pre-primary education participation. Given the non-random nature of ECE enrolment, the analysis employs Propensity Score Matching (PSM) using nearest-neighbour, kernel, and radius matching estimators to estimate the Average Treatment Effect on the Treated (ATT), while covariate balance diagnostics, Rosenbaum sensitivity analysis, and placebo tests are conducted to examine the robustness of the results. The findings indicate that participation in early childhood education significantly increases the likelihood of formal-sector employment and enhances monthly earnings in adulthood relative to matched non-participants, with the estimated 22.3 per cent earnings premium translating to an increase of approximately ₦7,800 in monthly earnings relative to the non-participant mean, a sum equivalent to more than a tenth of Nigeria's current national minimum wage. The estimated effects are strongest among individuals from low-income households and rural communities, suggesting that early childhood education contributes to narrowing socioeconomic disparities in labour market outcomes. The treatment effects remain consistent across alternative matching algorithms and are reasonably robust to hidden bias, providing evidence that investment in early childhood education is associated with persistent economic returns through improved labour market performance in Nigeria.

Keywords: *Early Childhood Education, Labour Market Outcomes, Human Capital, Propensity Score Matching, Formal Employment,*
JEL Classification: *I21, I24, J24, J31, O15, C21*

1. Introduction

Investment in the early years of a child's life has increasingly been recognised as one of the most cost-effective instruments available to governments seeking to build human capital and reduce intergenerational poverty.

The period between birth and school entry is characterised by rapid cognitive, socio-emotional, and physiological development, during which the brain is maximally plastic and responsive to environmental stimulation (Cowie, 2019). Early childhood education (ECE) encompassing creche, nursery, and pre-primary programmes is designed to harness this developmental window by providing structured cognitive stimulation, socialisation, and school-readiness skills before the commencement of formal primary schooling (Bendini & Devercelli, 2022). A substantial body of evidence from high-income countries, most notably long-term follow-up studies of the Perry Preschool Project and the Abecedarian Project in the United States, demonstrates that participation in quality ECE programmes yields measurable improvements in educational attainment, employment, earnings, and even health and criminal-justice outcomes several decades later (Nores, 2020).This body of evidence underlies the widely cited proposition that returns to human capital investment are highest when made earliest in the life course the so-called "Heckman curve" and has correspondingly shaped early childhood policy agendas across both high-income and developing countries.

Most of the evidence underlying the Heckman curve, however, derives from high-income, institutionally mature settings in which ECE provision is near-universal, publicly regulated, and delivered against a backdrop of already-high formal-sector employment. Nigeria offers a markedly different and arguably more informative testing ground for this proposition. Unlike contexts where ECE is universal and formal wage employment is the norm, Nigeria is characterised by extreme informalisation of the labour market, pronounced rural–urban and socio-economic divides in ECE access, and a schooling system in which private and informal providers dominate pre-primary delivery. This setting allows the present study to ask a question of independent theoretical interest beyond simple replication: does ECE function in Nigeria primarily as an equalising mechanism that narrows pre-existing disadvantage, or does it instead operate as a multiplier that widens the gap between children who already enjoy advantaged starting conditions and those who do not? The demographic and policy stakes attached to this question are considerable. With a population of over 200 million people and one of the youngest population structures in the world, Nigeria produces several million new labour market entrants annually, yet youth unemployment and underemployment remain persistently high and the economy continues to be dominated by informal, low-productivity activity (Olojede & Oladejo, 2023). The National Policy on Education formally recognises pre-primary education as the first level of the education system and mandates a minimum of one year of pre-primary schooling prior to primary one enrolment (Federal Republic of Nigeria, 2013). In practice, however, access to pre-primary education is highly unequal: enrolment is concentrated in urban areas and among wealthier households, provision is dominated by private and often informal operators, and quality varies enormously across states (UNICEF, 2021; National Bureau of Statistics [NBS], 2021). Whether the children who do participate in ECE subsequently experience better labour market outcomes as adults and whether this relationship is causal rather than a reflection of pre-existing family advantage is an empirical question of direct relevance to Nigeria's human capital and employment policy agenda.

Despite growing policy rhetoric around early childhood development in Nigeria, embodied in instruments such as the National Child Development Policy and the Sustainable Development Goal 4.2

commitment to universal access to quality early childhood care and education by 2030, public investment in pre-primary education remains low relative to other sub-sectors of education, and empirical evidence on its returns is thin. Most existing Nigerian studies on ECE are descriptive or focus on proximate outcomes such as school readiness, primary school enrolment, or cognitive test scores measured shortly after the intervention (e.g., Aboud & Hossain, 2011; NBS/UNICEF Multiple Indicator Cluster Survey reports). Very few studies trace the effects of ECE participation into adulthood to examine labour market performance, and fewer still adopt an identification strategy capable of separating the causal effect of ECE from the confounding influence of household socio-economic status, parental education, and community characteristics that jointly determine both ECE participation and later-life outcomes. Without credible causal evidence, policymakers risk either overstating the returns to ECE investment based on correlational data, or under-investing because the case for pre-primary education is not persuasively made relative to competing claims on scarce public resources. Against this background, the study seeks to: (i) describe patterns of ECE participation and labour market outcomes across socio-economic groups; (ii) estimate the propensity of ECE participation as a function of household, parental, and community characteristics; (iii) estimate the average treatment effect on the treated (ATT) of ECE participation on employment status, formal-sector employment, and monthly earnings using PSM; and (iv) assess the robustness of the estimated effects to alternative matching algorithms and to potential hidden bias from unobserved confounders.

2.3.1 Human Capital Theory

Becker's (1964) human capital theory conceptualises education as an investment that raises an individual's stock of productive skills and knowledge, thereby increasing future productivity and earnings. Under this framework, early childhood education constitutes the earliest formal investment in an individual's human capital trajectory, laying a cognitive and behavioural foundation upon which subsequent schooling investments build. Because later-stage investments are more productive when built on a strong early foundation, the theory implies that returns to ECE should manifest not only directly, through improved school readiness, but indirectly, through enhanced absorption of later educational investments and, ultimately, higher labour market productivity and earnings.

2.3.2 Skill Formation Theory

Skill formation theory, propounded by Heckman and colleagues, extends human capital theory into a dynamic theory of skill formation, formalised in the technology of skill formation model (Cunha & Heckman, 2007; Cunha, Heckman, Lochner, & Masterov, 2006). This framework rests on two key properties: self-productivity, whereby skills acquired at one stage of development raise the productivity of investment at later stages, and dynamic complementarity, whereby early investment increases the return to later investment. A central implication is that investments in the earliest years of life yield higher rates of return than equivalently priced investments made later, because early skills are foundational inputs into the production of later skills, including the non-cognitive and socio-emotional skills that are increasingly recognised as important labour market determinants (Heckman, 2006; Heckman & Masterov, 2007). This theoretical proposition is the basis for the widely cited “Heckman

curve," which depicts declining marginal returns to human capital investment as a function of the age at which the investment is made. Together, these frameworks generate the study's central testable proposition: that individuals who participated in early childhood education will, ceteris paribus, exhibit better adult labour market outcomes than otherwise similar individuals who did not, because ECE participation raises early cognitive and socio-emotional skill stocks that are self-reinforcing and complementary to subsequent human capital investment.

2.3.3 Empirical Literature

Global evidence. The most influential empirical evidence on the long-term returns to ECE derives from small-scale randomised or quasi-randomised experiments in the United States. Long-term follow-up of the Perry Preschool Project found that participants had significantly higher earnings, higher rates of employment, and lower rates of crime and welfare dependency by age 40 than a randomly assigned control group (Heckman et al., 2010; Schweinhart et al., 2005). Similarly, follow-up of the Abecedarian Project found sizeable effects on educational attainment and adult employment and earnings, alongside evidence of favourable effects on health (Campbell et al., 2014; García, Heckman, Leaf, & Prados, 2020). Beyond these landmark studies, cross-country evidence assembled by the World Bank and UNESCO documents a positive association between pre-primary enrolment and subsequent educational attainment and earnings across a range of low- and middle-income countries (World Bank, 2018).

African evidence. Within Sub-Saharan Africa, evidence is comparatively sparse but growing. Studies from Mozambique using a randomised community-based preschool programme found substantial effects on enrolment and cognitive development, with suggestive longer-run schooling effects (Martinez, Naudeau, & Pereira, 2017). Evidence from Ghana's kindergarten policy reform points to positive effects of universal pre-primary provision on primary school performance, while evidence from Kenya and Ethiopia on early stimulation and pre-school interventions similarly documents improvements in school readiness and later grade progression (Bidwell, Watine, & Perry, 2014). Comparatively fewer African studies extend the outcome horizon into the labour market, largely because of the long panel or retrospective data required to observe individuals from early childhood into working age.

Nigerian evidence. Nigerian empirical work on ECE has concentrated on access, quality, and proximate schooling outcomes. Analyses using the Multiple Indicator Cluster Survey and Nigeria Education Data Survey document large socio-economic and rural–urban gaps in pre-primary enrolment and highlight the dominance of private, often unregulated, provision (NBS/UNICEF, 2021; Universal Basic Education Commission, 2020). Studies linking pre-primary attendance to primary school enrolment and completion generally report positive associations, consistent with the notion that ECE improves school readiness and reduces the risk of late entry and dropout (Abubakar, 2012). However, these studies typically rely on cross-sectional correlations without addressing selection bias, and none, to the author's knowledge, traces ECE participation through to adult labour market outcomes using a quasi-experimental identification strategy on nationally representative data the gap this study addresses.

2.4 Mechanisms Linking ECE to Labour Market Outcomes

Much of the existing literature, including the Nigerian studies reviewed above, documents that ECE participation is associated with better later-life outcomes without specifying the channels through which this association operates. At least three, non-mutually exclusive mechanisms are plausible. The first is a cognitive-skills channel: ECE builds early literacy and numeracy foundations that raise the productivity of subsequent schooling and improve performance in the entrance examinations and literacy/numeracy screening that formal-sector employers in Nigeria commonly use to ration scarce wage jobs. The second is a non-cognitive or socio-emotional channel: structured, centre-based programmes cultivate behavioural attributes punctuality, rule-following, sustained attention, cooperation with authority figures that are disproportionately rewarded in formal, supervised wage employment relative to the informal, family-based, or own-account activity that absorbs most Nigerian workers. The third is a signalling or credentialing channel, whereby pre-primary attendance itself, or the subsequent educational trajectory it enables, serves as a marker that formal employers use to screen candidates, independent of any underlying skill gain. The empirical strategy adopted in this study, based on retrospective survey data, is able to identify a reduced-form ATT of ECE participation on labour market outcomes but is not designed to formally decompose these channels; the discussion in Section 4.7 nonetheless draws on the pattern of results particularly the concentration of the estimated effect in formal-sector employment specifically, rather than employment in general to consider which mechanisms are most consistent with the data.

2.5 Quality versus Quantity in ECE Provision

A further debate in the developing-country ECE literature concerns whether any exposure to pre-primary education generates returns, or whether returns are conditional on a minimum threshold of programme quality trained caregivers, adequate child-to-caregiver ratios, structured curricula that is not guaranteed in contexts where private, informal, and often unregulated providers dominate delivery, as is the case in Nigeria (NBS/UNICEF, 2021). Because the GHS-Panel retrospective module records only whether a respondent attended pre-primary/nursery schooling, and not the type, duration, or quality of that provision, the treatment variable used in this study is properly understood as an intention-to-treat-style measure of exposure to ECE as broadly defined, rather than a measure of exposure to quality-assured ECE specifically. The estimated ATT should therefore be interpreted as an average effect across a heterogeneous mix of provider types and quality levels; if returns are in fact concentrated among higher-quality providers, the true effect of quality ECE may be understated by, or differ in composition from, the average effect reported here. This limitation is revisited in Section 5.3 and is a natural focus for future research using provider-level quality indicators.

3. Methodology

3.1 Source of Data

The study uses secondary data from the Nigeria General Household Survey Panel (GHS-Panel), a nationally representative longitudinal survey conducted by the National Bureau of Statistics (NBS) in collaboration with the World Bank's LSMS-ISA programme. The survey covers approximately 5,000 households and 22,000 individuals across waves from 2010/11 to 2023/24 and provides information on education, labour, health and household socio-economic characteristics. The study focuses on working-age individuals aged 25–55 years with available information on pre-primary school attendance, labour market outcomes and household background characteristics. Childhood characteristics, including household wealth, parental education and place of residence, are constructed from retrospective information, which may be subject to recall and measurement errors. Similar concerns apply to self-reported pre-primary school attendance, particularly because of the historical overlap between nursery education and early entry into primary school in Nigeria. Where possible, reported ECE participation was cross-checked against respondents' age at entry into primary school, while unresolved inconsistencies were treated as potential measurement error and acknowledged as a limitation of the study.

Table 1: Data Source and Description of Key Variables

Variable	Description	Type	Source/Module
Treatment: ECE participation	=1 if individual attended pre-primary/nursery education; 0 otherwise	Binary	Retrospective education module
Outcome 1: Employment status	=1 if currently employed; 0 otherwise	Binary	Labour module
Outcome 2: Formal-sector employment	=1 if employed in formal wage/salaried sector; 0 otherwise	Binary	Labour module
Outcome 3: Monthly earnings	Log of monthly labour earnings (₦)	Continuous	Labour module
Household wealth index	Asset-based wealth quintile at childhood (recall-based)	Ordinal	Household asset module
Parental education	Years of schooling of household head/parent	Continuous	Household roster
Household size	Number of household members in childhood	Continuous	Household roster
Rural/urban residence	=1 if rural residence in childhood; 0 urban	Binary	Geographic identifiers
Region	Geopolitical zone of residence	Categorical	Geographic identifiers
Gender	=1 if male; 0 if female	Binary	Individual roster
Birth order	Ordinal position among siblings	Ordinal	Household roster

 @A Publication of the Department of Economics, ADSU, Mubi. ISSN- Print: 2550- 7869; ISSN-Online: 3043-5323. Journal homepage: https://ajaefm.adsu.edu.ng

Variable	Description	Type	Source/Module
Mother's employment status	=1 if mother worked outside home in childhood	Binary	Household roster

Source: *Author's compilation, 2026.*

3.2 Model Specification

The evaluation problem is to estimate the causal effect of ECE participation ($D_i = 1$ for participants, 0 otherwise) on labour market outcome Y_i. The fundamental evaluation problem is that $Y_i(1)$ and $Y_i(0)$ are never simultaneously observed for the same individual; a naive comparison of mean outcomes between participants and non-participants is therefore biased to the extent that ECE participation is correlated with unobserved determinants of the outcome (self-selection bias). Propensity Score Matching (PSM), following Rosenbaum and Rubin (1983), addresses this by first estimating the propensity score the conditional probability of treatment given observed covariates and then matching treated and untreated individuals with similar propensity scores, under the identifying assumption of conditional independence and common support. The propensity score is estimated using a probit model:

$$P(D_i = 1 \mid X_i) = \Phi\ (\alpha_0 + \beta_1 Wealth_i + \beta_2 ParEduc_i + \beta_3 HHsize_i + \beta_4 Rural_i + \beta_5 Region_i + \beta_6 Male_i + \beta_7 BirthOrder_i + \beta_8 MotherWorks_i + \varepsilon_i) \quad \ldots\ldots\ldots\

parental education, household size, residence, region, gender, birth order, and maternal employment are controlled for. This assumption cannot be directly tested, and several plausible unobservable could violate it: innate child cognitive or non-cognitive ability, unmeasured parental motivation or investment beyond what is captured by parental education, and genetic endowments correlated with both later ability and, indirectly, with parents' decisions to enrol a child in ECE. The Rosenbaum bounds analysis reported in Section 4.6 addresses this concern indirectly, by quantifying how strong such an unobserved confounder would need to be, relative to its influence on the odds of treatment, to overturn the estimated effect; it does not, however, verify that no such confounder exists, and the results should accordingly be read as conditionally causal under the CIA rather than as unconditional proof of causality.

A Priori Expectation

Consistent with human capital and skill formation theory, ECE participation is expected to be positively associated with all three labour market outcomes: employment, formal-sector employment, and earnings. Household wealth, parental education, urban residence, and maternal employment are expected to positively predict ECE participation, reflecting demand- and supply-side access constraints, while household size and rural residence are expected to be negatively associated with participation, reflecting resource constraints and limited local provision.

3.3 Robustness Checks

Three robustness checks are implemented. First, the sensitivity of the ATT estimates to the choice of matching algorithm is assessed by comparing nearest-neighbour, kernel, and radius matching results. Second, Rosenbaum bounds are computed to assess how strong an unobserved confounder would need to be to overturn the significance of the estimated effect, expressed as the critical value of Γ (gamma) at which the estimated effect becomes statistically insignificant (Rosenbaum, 2002; DiPrete & Gangl, 2004). Third, a placebo (falsification) test is conducted using a pre-treatment outcome birth-weight category a variable that should not be affected by a treatment (ECE) that occurs several years later, to confirm that the matching procedure does not spuriously generate treatment effects on outcomes it should not affect. It is acknowledged that birth-weight category, like ECE participation itself, is retrospectively self-reported by adult respondents and is therefore potentially subject to the same recall-error mechanism as the treatment variable; this shared exposure means the placebo test is better interpreted as evidence against gross specification error in the matching procedure than as an entirely independent check on recall bias specifically, since a placebo variable wholly immune to recall error such as an objectively recorded, non-self-reported pre-treatment measure was not available in the GHS-Panel retrospective module.

4. Results and Discussion

4.1 Descriptive Statistics

Table 2 presents descriptive statistics for the analytical sample, disaggregated by ECE participation status. ECE participants account for approximately 34% of the working-age analytical sample,

consistent with historically low but rising pre-primary enrolment rates documented in national education statistics. Unconditional comparisons show that ECE participants come from more advantaged backgrounds on nearly every observed dimension higher household wealth, more educated parents, greater likelihood of urban residence underscoring the need for a matching-based rather than a naive comparison of outcomes.

Table 2: Descriptive Statistics by ECE Participation Status

Variable	ECE Participants (n=1,742)	Non-Participants (n=3,381)	Mean Difference	t-stat
Employed (%)	81.4	72.6	8.8***	6.12
Formal-sector employment (%)	38.7	19.2	19.5***	12.84
Monthly earnings (₦, mean)	58,240	35,110	23,130***	10.47
Household wealth index (0–4)	2.81	1.64	1.17***	21.35
Parental education (years)	8.9	4.3	4.6***	26.60
Household size	5.8	6.9	-1.1***	-9.83
Rural residence (%)	31.2	68.5	-37.3***	-24.71
Male (%)	51.3	50.1	1.2	0.72
Mother worked (%)	62.0	48.6	13.4***	8.15

Note: ***p<0.01. Sample restricted to individuals aged 25–55 with complete retrospective schooling and labour market data.
Source: *Author's computation using Stata 17, 2026.*

4.2 Propensity Score Estimation

Table 3 reports the probit estimates of the propensity score model. Household wealth, parental education, urban residence, and maternal employment are positively and significantly associated with the probability of ECE participation, while household size and rural residence are negatively associated, consistent with a priori expectations. The model correctly classifies 78% of observations and the covariates are jointly significant (LR chi-square = 612.4, p<0.001), confirming that the selected variables have meaningful predictive power over treatment assignment, which is a necessary condition for a well-specified propensity score model.

Table 3: Probit Estimates of the Propensity Score Model (Dependent Variable: ECE Participation)

Variable	Coefficient	Std. Error	Marginal Effect
Household wealth index	0.312***	0.028	0.098***
Parental education (years)	0.061***	0.007	0.019***

Variable	Coefficient	Std. Error	Marginal Effect
Household size	-0.045**	0.019	-0.014**
Rural residence	-0.487***	0.061	-0.153***
Male	0.038	0.052	0.012
Birth order	-0.029*	0.016	-0.009*
Mother worked	0.214***	0.055	0.067***
Region fixed effects	Included	—	—
Constant	-1.132***	0.142	—
Pseudo R^2	0.214		
N	5,123		

Note: *p<0.10, **p<0.05, ***p<0.01.

Source: *Author's computation using Stata 17, 2026.*

4.3 Common Support and Matching Diagnostics

Imposition of the common support condition drops 4.6 per cent of treated and 6.1 per cent of untreated observations whose propensity scores fall outside the overlapping region, leaving a matched analytical sample of 4,861 individuals. Table 4 presents covariate balance before and after matching. Prior to matching, standardised bias exceeds 20 % for several covariates, notably household wealth (58.4%) and parental education (63.1%), confirming substantial selection on observables. After nearest-neighbour matching, standardised bias falls below the conventional 5 per cent threshold for all covariates, and the pseudo-R^2 of the propensity score model re-estimated on the matched sample falls from 0.214 to 0.011 and is no longer jointly significant (LR chi-square = 8.92, p=0.348), indicating that matching has successfully balanced the observed covariate distributions between treated and matched comparison groups.

Table 4: Covariate Balance Before and After Matching

Variable	% Bias Before	% Bias After	% Bias Reduction
Household wealth index	58.4	3.1	94.7
Parental education	63.1	2.8	95.6
Household size	24.7	1.9	92.3
Rural residence	71.5	4.2	94.1
Birth order	12.8	1.5	88.3
Mother worked	27.6	2.4	91.3
Pseudo R^2	0.214	0.011	—

Variable	% Bias Before	% Bias After	% Bias Reduction
LR chi² (p-value)	612.4 (0.000)	8.92 (0.348)	—

Source: Author's computation using Stata 17, 2026.

4.4 Average Treatment Effect on the Treated (ATT)

Table 5 presents the ATT estimates of ECE participation on the three labour market outcomes, using nearest-neighbour matching as the primary specification. ECE participation is associated with a statistically significant 6.9 percentage-point increase in the probability of employment, a 14.6 percentage-point increase in the probability of formal-sector employment, and an approximately 22.3 per cent increase in monthly earnings (from the semi-log specification), relative to matched non-participants with observably similar household and childhood characteristics. These effects, while smaller in magnitude than the raw mean differences reported in Table 2 as expected once selection on observables is netted out remain economically and statistically substantial, supporting the hypothesis of a genuine causal effect of ECE participation on adult labour market performance.

Table 5: ATT of ECE Participation on Labour Market Outcomes (Nearest-Neighbour Matching)

Outcome	ATT	S.E.[1]	t-stat	Matched N (Treated/Control) [2]
Employed (p.p.)	6.9***	1.8	3.83	1,662 / 1,662
Formal-sector employment (p.p.)	14.6***	2.1	6.95	1,662 / 1,662
Log monthly earnings	0.223***	0.041	5.44	1,662 / 1,662

Note: ***p<0.01. p.p. = percentage points.

[1] Standard errors are Abadie–Imbens robust SEs for the nearest-neighbour estimator (see Section 3.2).

[2] "Matched N" refers to the number of unique treated units retained on common support and the number of unique control units drawn upon at least once as a match, which coincide here because every treated unit on common support was successfully matched; because matching is with replacement, individual control units may be counted more than once across different treated matches, and the effective control sample used in estimation is therefore weighted rather than a simple one-to-one sample.

Source: Author's computation using Stata 17, 2026.

4.5 Heterogeneity by Household Wealth and Residence

Sub-group analysis (Table 6) suggests that the estimated returns to ECE participation are not uniform across the population. The formal-employment ATT is markedly larger among individuals from poorer households (bottom two wealth quintiles) and among those raised in rural areas, than among wealthier and urban counterparts. This pattern is consistent with a diminishing-returns interpretation in which ECE substitutes for otherwise absent home-based cognitive stimulation among disadvantaged children, whereas children from advantaged households may receive comparable stimulation regardless of formal ECE attendance a pattern also documented in the international literature (Heckman & Masterov, 2007; Attanasio, 2015).

Table 6: Heterogeneous ATT of ECE on Formal-Sector Employment, by Sub-group

Sub-group	ATT (p.p.)	Bootstrap S.E.
Bottom 2 wealth quintiles (childhood)	19.8***	3.2
Top 3 wealth quintiles (childhood)	10.1***	2.6
Rural childhood residence	17.4***	3.0
Urban childhood residence	11.3***	2.7
Female	13.9***	2.9
Male	15.2***	2.8

Note: ***p<0.01.

Source: *Author's computation using Stata 17, 2026.*

4.6 Robustness Analysis

Table 7 compares ATT estimates across the three matching algorithms. The estimated effects are qualitatively and quantitatively similar across nearest-neighbour, kernel, and radius matching, with all estimates remaining statistically significant at the 1% level, indicating that the results are not an artefact of the specific matching algorithm chosen.

Table 7: ATT Estimates Across Matching Algorithms

Outcome	Nearest-Neighbour	Kernel	Radius Caliper
Employed (p.p.)	6.9***	6.5***	7.1***
Formal-sector employment (p.p.)	14.6***	13.9***	15.0***
Log monthly earnings	0.223***	0.208***	0.231***

Note: ***p<0.01.

Source: *Author's computation using Stata 17, 2026.*

Rosenbaum bounds sensitivity analysis for the formal-sector employment ATT indicates that an unobserved confounder would need to increase the odds of ECE participation by a factor of approximately 1.9 ($\Gamma = 1.9$) before the estimated treatment effect would lose statistical significance at conventional levels, suggesting a reasonably robust result, though one that cannot rule out moderately strong hidden bias (Rosenbaum, 2002). The placebo test using birth-weight category as a pre-treatment pseudo-outcome yields a statistically insignificant "effect" of ECE participation (ATT = 0.9 p.p., $p = 0.61$), as expected, which supports the credibility of the matching design and suggests that the main results are not driven by spurious pre-existing differences between the matched groups.

4.7 Discussion of Findings

The results provide quasi-experimental support for the proposition, derived from human capital and skill formation theory, that early childhood education participation is associated with improved adult labour market outcomes in Nigeria. The magnitude of the formal-employment effect roughly 15 percentage points is economically large relative to Nigeria's baseline formal-sector employment rate

and is broadly consistent, in direction if not in exact magnitude, with experimental estimates from high-income settings and quasi-experimental estimates from other developing-country contexts (Heckman et al., 2010; Martinez et al., 2017). The finding that returns are largest among poorer and rural households is particularly important for Nigerian policy: it implies that expanding equitable access to ECE, rather than simply expanding aggregate ECE supply in already well-served urban and wealthier areas, would be expected to generate the largest labour market and poverty-reduction dividends. The results are also consistent with the dynamic-complementarity mechanism proposed by Cunha and Heckman (2007), whereby early skill formation raises the productivity of subsequent educational investment, plausibly explaining why ECE participants are more likely to progress into the kinds of schooling trajectories that lead to formal employment. At the same time, the sensitivity analysis indicates that while the results are reasonably robust, they rely on the conditional independence assumption inherent to PSM and cannot fully rule out bias from unobserved factors such as innate child ability or unmeasured parental motivation that could jointly influence both ECE participation and later labour market success, nor from the recall-based measurement of childhood covariates and treatment status discussed in Section 3.1.

The pattern of results offers some indirect evidence on the mechanisms outlined in Section 2.5. The estimated ATT on formal-sector employment (14.6 percentage points) is roughly double the estimated ATT on employment in general (6.9 percentage points), indicating that ECE participation is disproportionately associated with movement into formal, rather than merely any, employment. This pattern is more consistent with a channel in which ECE builds the basic literacy, numeracy, and behavioural attributes punctuality, rule-following, sustained attention that formal-sector employers screen for at entry, than with a channel operating uniformly across the labour market regardless of sector. It is also consistent with a credentialing or signalling channel, whereby ECE participation is correlated with subsequent educational trajectories that themselves confer formal-sector eligibility; the present data do not allow these two channels to be fully separated, and doing so for example, using detailed schooling-trajectory data or direct measures of cognitive and non-cognitive skills is a natural direction for future research.

The magnitude of the earnings effect is also worth contextualising against Nigeria's current wage structure. The estimated 22.3 per cent increase in monthly earnings corresponds to an increase of roughly ₦7,800 relative to the non-participant mean of ₦35,110 reported in Table 2. For comparison, Nigeria's statutory national minimum wage stood at Rs70,000 per month as of 2026, following the National Minimum Wage (Amendment) Act 2024 (Trading Economics, 2026); the estimated ECE earnings premium is therefore equivalent to roughly one-ninth of the minimum wage, a non-trivial addition to monthly income for workers clustered near the bottom of the earnings distribution, even though it would not by itself move a non-participant's mean earnings above the minimum wage threshold. This suggests that while the ECE earnings premium is economically meaningful, it should be interpreted as one contributor among several alongside minimum-wage policy, informal-sector productivity growth, and social protection to closing the gap between typical earnings and a living income in Nigeria, rather than as sufficient on its own.

5. Conclusion and Policy Recommendations

5.1 Conclusion

This study examined the long-term association between early childhood education participation and adult labour market outcomes in Nigeria using nationally representative GHS-Panel data and a Propensity Score Matching design. After addressing selection bias arising from the strong association between household socio-economic status and both ECE participation and adult outcomes, the results show that ECE participation significantly raises the probability of employment, significantly raises the probability of formal-sector employment, and significantly raises monthly earnings. These effects are consistent across matching algorithms, pass covariate balance and placebo diagnostics, and are moderately robust to potential unobserved confounding. The returns to ECE participation are found to be largest among individuals from poorer households and rural areas, suggesting that ECE plays a particularly important compensatory role for children who would otherwise lack access to comparable early cognitive stimulation.

5.2 Policy Recommendations

Based on these findings, four policy recommendations are advanced. First, given the sizeable and pro-poor returns identified, government should prioritise expansion of public investment in equitable, quality-assured pre-primary education, particularly in rural and underserved areas where current provision is thinnest and where the estimated returns are largest. Second, because private, community-run, and faith-based providers currently dominate ECE delivery in Nigeria, strengthening regulatory oversight should take the form of a tiered, phased minimum-standards framework rather than a single uniform licensing bar: a basic tier covering child-safety, caregiver-to-child ratio, and caregiver literacy/numeracy requirements that low-cost community and faith-based providers can plausibly meet without being priced out of the market, alongside a subsidised caregiver-training and curriculum-support programme (potentially delivered through Universal Basic Education Commission or State Universal Basic Education Board structures) so that the cost of meeting higher-tier quality standards does not fall entirely on providers or, in turn, on the poor households the policy aims to serve. This graduated approach would help ensure that expanded access translates into the kind of quality provision associated with the returns documented here, rather than nominal enrolment alone, while avoiding a regulatory shock that shutters the informal and community-based supply that currently serves most Nigerian children. Third, targeted subsidies or conditional support (e.g., fee waivers, school-feeding integration, transport support) for ECE enrolment among poor and rural households could be an efficient mechanism for maximising the pro-poor labour market returns identified in the heterogeneity analysis. Fourth, given the dynamic-complementarity mechanism underlying the results, ECE investment should be coordinated with, rather than treated as a substitute for, continued investment in primary and secondary schooling quality, so that early gains are sustained rather than eroded at later stages of the education pipeline.

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