Does Crop Diversification Improve Rural Household Income in Bangladesh?

Evidence from the Household Income and Expenditure Survey 2022

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Abstract

This paper examines whether crop diversification improves household income among rural farming households in Bangladesh, using data from the Household Income and Expenditure Survey (HIES) 2022. Using ordinary least squares (OLS) regression with division fixed effects and robust standard errors, the study finds that diversification has a strong and stable positive effect on crop sales income, but not on total household income once household characteristics are controlled. This suggests that diversification operates primarily through the agricultural income channel. The findings carry practical implications for agricultural extension policy in Bangladesh.

Keywords: crop diversification, household income, rural Bangladesh, OLS regression, HIES 2022

JEL Codes: O12, Q12, Q18, R20

1 Introduction

Agriculture employs roughly 40 per cent of Bangladesh's labour force and remains central to rural livelihoods (Bangladesh Bureau of Statistics, 2023; World Bank, 2008). Despite significant gains in poverty reduction over the past two decades, many rural farming households continue to face income instability, price shocks, and the risks that come with depending on a single crop. Crop diversification has attracted attention as both a risk management strategy and a potential driver of income growth (Pellegrini and Tasciotti, 2014; Hossain, 1988).

The case for diversification rests on a portfolio logic: growing multiple crop types reduces exposure to any single price or yield failure (Dercon, 1996). A competing view holds that specialising in one high-value crop may generate higher returns through economies of scale and deeper market integration (Rahman, 2009). Whether diversification or specialisation is the better strategy for Bangladeshi farmers remains an empirical question that has not been adequately tested with recent, nationally representative data.

This paper fills that gap using the HIES 2022, which covers 14,395 households across all eight administrative divisions of Bangladesh. It estimates the effect of crop diversity on two income measures: total household income and crop sales income. The choice of two outcomes is deliberate and analytically motivated. Total income aggregates farm and off-farm sources, so a significant effect there would suggest diversification has broad welfare effects. Crop sales income isolates the within-farm channel, which is the mechanism directly activated by the diversification decision. Comparing effects across both measures therefore reveals not just whether diversification raises income, but through which pathway it does so. Four OLS models are estimated, from bivariate specifications to fully controlled models with division fixed effects, to assess how much of the raw income gap between single-crop and multi-crop households reflects a genuine diversification effect versus household sorting.

The paper makes three contributions. First, it uses the most recent nationally representative survey of Bangladesh. Second, it separates the effect on total income from the effect on agricultural income to identify the channel through which diversification operates. Third, the division-level analysis reveals geographic heterogeneity relevant for targeted agricultural policy. The paper is structured as follows: Section 2 reviews the literature; Section 3 describes the data and methodology; Section 4 presents results; Section 5 discusses limitations; Section 6 concludes.

2 Literature Review

The evidence on crop diversification and household welfare is broadly supportive, though the strength of the effect depends on context.

Pellegrini and Tasciotti (2014) use data from eight developing countries and find that diversification generates net income gains rather than merely shifting income across crops. Barrett et al. (2001) identify three channels through which diversification improves welfare: risk reduction, better use of household labour, and crop complementarities. They also caution that wealthier, better-educated households are more capable of diversifying, which complicates causal interpretation in cross-sectional studies. Dercon (1996) reinforces the risk dimension, showing that diversified smallholders in Tanzania experience lower income variability over time even if mean income gains are modest.

For Bangladesh specifically, Rahman (2009) finds that diversified farms achieve higher gross margins than monocropped counterparts, with profitability depending on market access and extension services. Hossain (1988) documents that the Green Revolution concentrated production around a small number of high-yielding rice varieties, reducing crop diversity and increasing exposure to covariate shocks. This historical legacy explains the current dominance of rice monoculture in several Bangladeshi divisions and underscores the relevance of promoting diversification.

Birthal et al. (2013) find in the Indian context that diversification toward high-value crops drives farm income growth, with larger gains for smallholders, suggesting both efficiency and equity benefits. Minot et al. (2006) report similar findings in rural Vietnam, where diversified households earn higher and more stable incomes through risk spreading and better seasonal labour utilisation. Timmer (2005) argues that diversification is a necessary condition for sustained pro-poor growth, as rising household incomes generate demand for non-staple crops that creates opportunities for early diversifiers.

Bryceson (2002) adds an important caveat: the ability to diversify depends on household endowments. Land-poor and credit-constrained households often cannot afford to experiment with new crop types. This motivates the inclusion of land ownership and credit access as controls in the present analysis. The foundational theoretical framing comes from Schultz (1964), who treats smallholder farmers as rational optimisers. Under this view, observed diversification patterns are equilibrium outcomes, and any income premium reflects genuine productive gains rather than passive risk spreading.

3 Data, Variables, and Methodology

Data and Sample

The HIES 2022 is conducted by the Bangladesh Bureau of Statistics (BBS) and covers 14,395 nationally representative households using a stratified two-stage cluster sampling design, with the *mauza* (rural) and *mahalla* (urban) as the primary sampling units. The analysis restricts the sample to rural households that cultivated at least one crop type during the reference year, since

crop diversification is not a meaningful choice variable for non-farming or urban households. Observations missing on any regression variable are dropped, yielding a final analytical sample of 2,145 households.

Variables

Dependent variables. Log total household income (`ln_income`) is the natural logarithm of the sum of wage income, enterprise income, crop sales, and domestic remittances, winsorised at the 99th percentile to limit outlier influence. Log crop sales income (`ln_crop_income`) isolates the agricultural income channel and serves as a robustness outcome. A $\log(x+1)$ transformation is applied throughout to accommodate zero-income observations.

Main independent variable. Crop count (`crop_count`) is the number of distinct crop types cultivated during the reference year, constructed from HIES Section 7B by summing a binary cultivated indicator across crop types for each household.

Controls. Six characteristics are included: cultivable land owned in acres (`land_owned`); head's highest class completed (`head_educ`); head's age (`head_age`); a binary female headship indicator (`head_female`); household size (`hh_size`); and bank or MFI account ownership (`credit_access`). Division fixed effects absorb unobserved regional variation in agro-ecological conditions and market access.

Empirical Specification

Bivariate models (1a and 2a) regress each outcome on crop count alone:

$$\ln Y_i = \alpha + \beta \cdot \text{CropCount}_i + \varepsilon_i \tag{1}$$

Full models (1b and 2b) add household controls and division fixed effects:

$$\ln Y_i = \alpha + \beta \cdot \text{CropCount}_i + \gamma' \mathbf{X}_i + \delta_d + \varepsilon_i \tag{2}$$

where $\mathbf{X}_i$ is the vector of six household controls listed above, δ_d denotes division fixed effects, and all models use Huber-White robust standard errors. The bivariate models serve a diagnostic purpose: comparing $\hat{\beta}$ between the bivariate and full specifications reveals how much of the raw income gap reflects household sorting. A large reduction in $\hat{\beta}$ signals confounding by endowments; a stable $\hat{\beta}$ indicates a more independent diversification effect.

4 Results and Discussion

Descriptive Statistics and Hypothesis Tests

The final analytical sample consists of 2,145 rural farming households. The mean number of crop types cultivated is approximately four, with considerable variation across households and divisions. Mean log total household income is around 10.1, while mean log crop sales income is around 4.6, reflecting that crop revenue represents only part of total household earnings and that many households earn relatively little from crop sales alone.

Figure 1 shows the distribution of crop count in the sample. It is right-skewed, with most households cultivating between two and four crop types, extending to approximately 25 for a small number of highly diversified farms. This pattern is consistent with South Asian smallholder agriculture more broadly (Birthal et al., 2013; Minot et al., 2006).

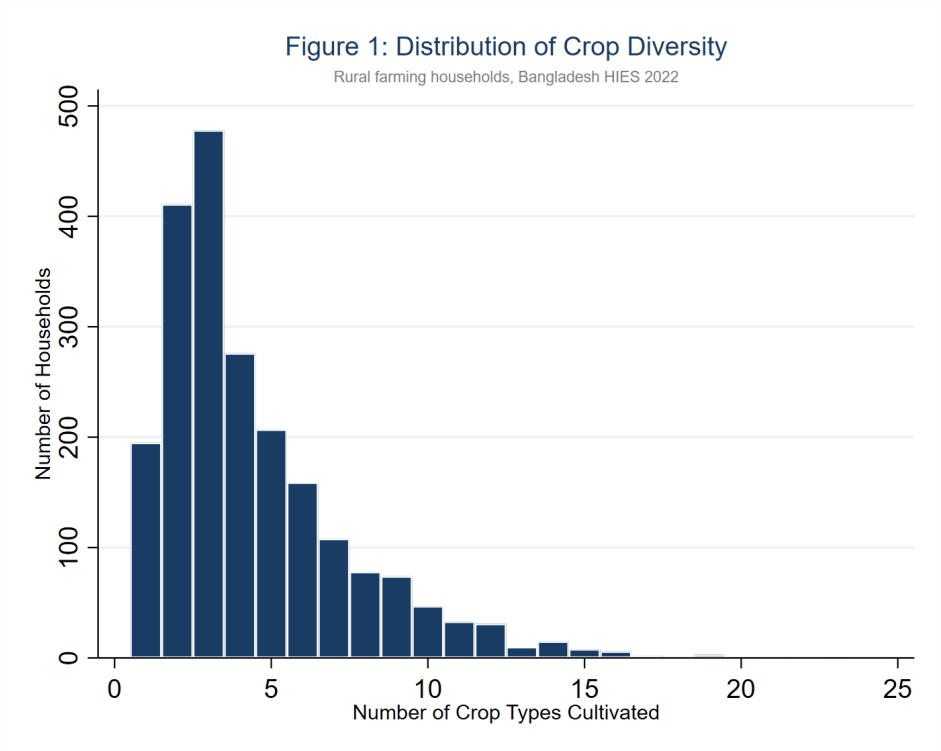


Figure 1: Distribution of crop diversity among rural farming households. *Source*: Author's calculations, HIES 2022.

Figure 2 shows a positive gradient in mean log total income across crop groups, rising from approximately 9.75 for single-crop households to 10.3 for those cultivating four or more types. This pattern is consistent with the portfolio diversification hypothesis. However, this unconditional gradient should not be over-interpreted. As the regression results below show, it largely reflects household sorting: better-endowed households tend to both diversify more and earn more, and the gap loses statistical significance once these characteristics are controlled.

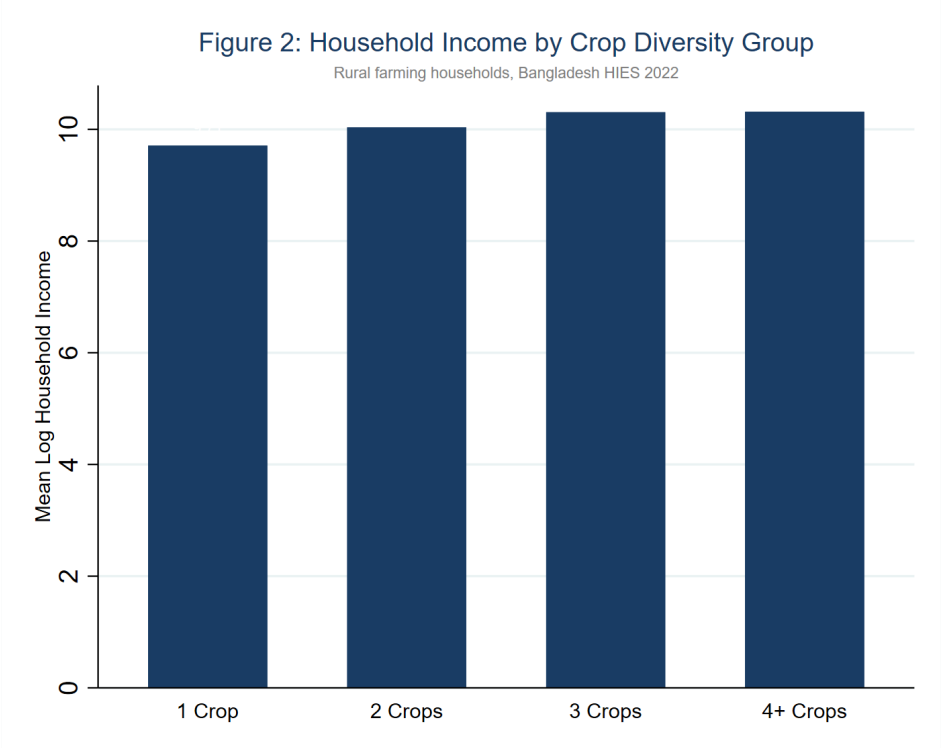


Figure 2: Mean log total household income by crop diversity group. *Source*: Author's calculations, HIES 2022.

Figure 3 presents a substantially steeper gradient for crop sales income, rising from approximately 2.75 for single-crop households to 7.1 for those cultivating nine or more types. Non-overlapping confidence intervals across most adjacent groups confirm that these differences are statistically meaningful. This steeper gradient, compared to Figure 2, already points toward the regression finding that diversification has a stronger and more robust effect on agricultural income specifically.

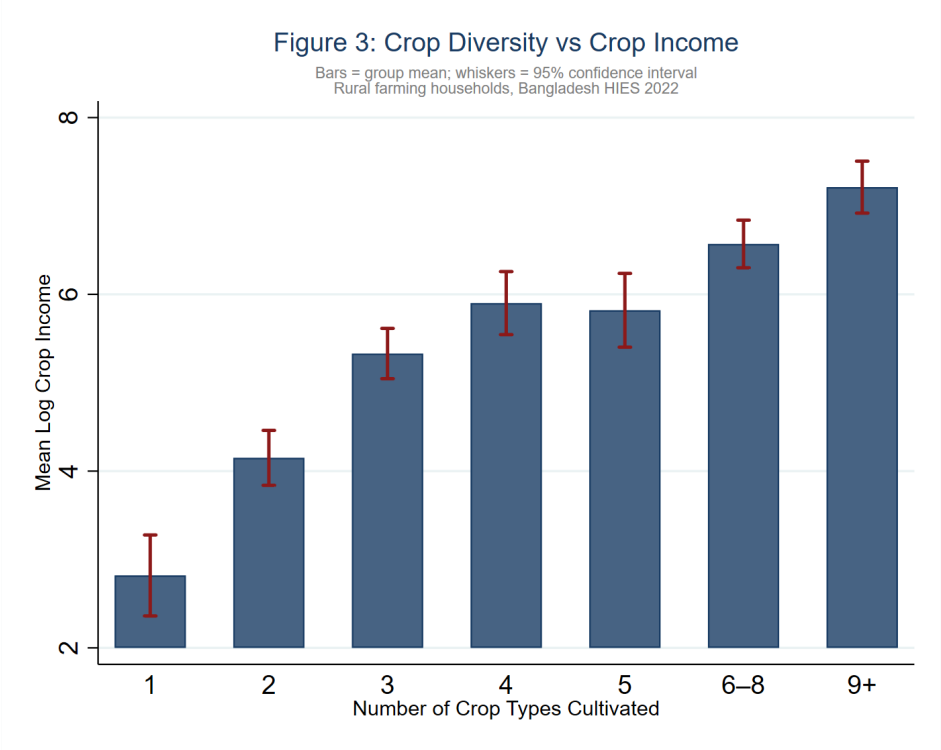


Figure 3: Mean log crop sales income by crop diversity group with 95 per cent confidence interval whiskers. *Source*: Author's calculations, HIES 2022.

A two-sample t-test and a Wilcoxon rank-sum test both confirm a statistically significant unconditional income gap between single-crop and multi-crop households. Since neither test controls for household characteristics, these results should be treated as descriptive rather than causal. The regression analysis below shows that the total income gap is largely explained by observable differences between households.

Figure 4 shows mean log crop sales income for single-crop and multi-crop households across all eight administrative divisions. Multi-crop households earn more than single-crop households in every division without exception, which reinforces the regression finding that diversification has a consistent and robust effect on agricultural income. The income gap is particularly large in Mymensingh and Rangpur, where single-crop households report very low crop earnings, suggesting that farmers in those divisions stand to gain the most from diversifying their crop portfolio. This geographic uniformity of the crop income premium contrasts with the more mixed pattern observed when total household income is used as the outcome, and further supports the view that diversification's primary contribution is to on-farm earnings rather than to overall household welfare.

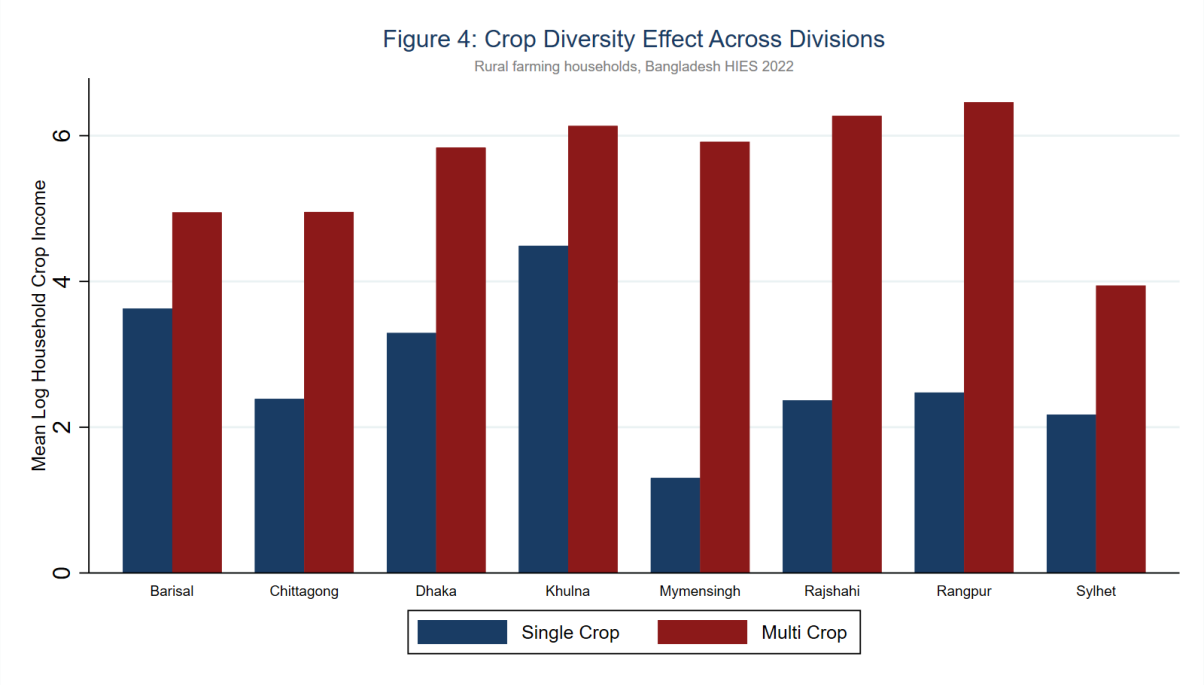


Figure 4: Mean log crop income by crop diversity status and administrative division. *Source*: Author's calculations, HIES 2022.

Regression Results

The results tell a clearly differentiated story across the two outcomes. For total household income, crop count is marginally significant in the bivariate model (0.0374, $p < 0.10$, Model 1a) but loses significance in the full model (0.0168, Model 1b). The attenuation of approximately 55 per cent indicates that much of the raw association reflects household sorting: wealthier, better-educated, and larger households both diversify more and earn more. Once these factors are accounted for, diversification has no statistically significant independent effect on total income. The near-zero R^2 of 0.001 in Model 1a confirms that crop count alone explains almost none of the variation in total household income.

Table 1 presents the four OLS estimates across 2,145 rural farming households.

For crop sales income, the picture is markedly different. The coefficient on crop count is 0.351 ($p < 0.01$) in the bivariate model (Model 2a) and barely changes to 0.332 ($p < 0.01$) in the full model (Model 2b). This stability is the central finding of the paper. Each additional crop type is associated with a 33 per cent increase in crop sales income, and this effect is not explained by observable household characteristics or regional differences. The R^2 of 0.111 in Model 2a also shows that crop count alone accounts for a meaningful share of variation in agricultural income, even before controls are added.

Table 1: OLS Regression: Crop Diversification and Household Income

	Log Total Income		**Log Crop Income**	
Variable	**Model 1a**	**Model 1b**	**Model 2a**	**Model 2b**
Crop count	0.0374*	0.0168	0.351***	0.332***
	(0.0196)	(0.0192)	(0.0192)	(0.0193)
Land owned (acres)		−0.00730		0.0742***
		(0.0163)		(0.0262)
Head's education		0.0177***		0.00819
		(0.00605)		(0.0107)
Head's age		−0.0196***		0.00384
		(0.00497)		(0.00481)
Head female (=1)		−2.609***		−1.290***
		(0.428)		(0.290)
Household size		0.378***		0.00582
		(0.0369)		(0.0382)
Credit access (=1)		0.441***		−0.0784
		(0.136)		(0.143)
Constant	10.04***	9.355***	3.840***	2.999***
	(0.122)	(0.323)	(0.119)	(0.363)
Observations	2,145	2,145	2,145	2,145
R^2	0.001	0.123	0.111	0.199
Controls	No	Yes	No	Yes
Division FE	No	Yes	No	Yes
Sample	Rural farming households			

Robust standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Division fixed effects suppressed.

Among the controls in Model 1b, head's education (0.0177, $p < 0.01$), household size (0.378, $p < 0.01$), and credit access (0.441, $p < 0.01$) are all positive and significant, consistent with the broader literature on returns to human capital and financial inclusion (Barrett et al., 2001; Schultz, 1964). Head's age is negative and significant (-0.0196, $p < 0.01$), possibly reflecting more traditional farming practices among older heads. The largest coefficient in Model 1b belongs to female headship (-2.609, $p < 0.01$), pointing to a substantial income penalty for female-headed households. This is consistent with well-documented gender disadvantages in land access, credit, and mobility in rural Bangladesh (Bangladesh Bureau of Statistics, 2023).

In Model 2b, land ownership is positive and significant (0.0742, $p < 0.01$), which reflects the

capacity of larger holdings to support diverse cropping. Female headship remains large and negative (-1.290, $p < 0.01$) for crop income, reinforcing the gender inequality finding across both outcomes. Notably, the controls that are significant in Model 1b, namely education, credit access, and household size, lose significance in Model 2b. This divergence makes economic sense. Education and financial access are important determinants of total income because they open doors to off-farm employment and enterprise activities. For crop income specifically, however, what a household can grow on its land is more directly governed by the physical extent of that land and the number of crops it chooses to cultivate, which is precisely what the coefficient on crop count captures.

5 Limitations

Three limitations should be noted. First, the HIES 2022 is a cross-sectional survey, so establishing causal relationships is much harder, as a credible identification strategy is required. The association between diversification and crop income may partly reflect reverse causality or unobservable factors such as farming ability and risk preferences (Barrett et al., 2001). Panel data or a credible instrumental variable would be needed for causal identification.

Second, crop count treats all crop types equally regardless of commercial value. A household cultivating five minor subsistence crops is counted the same as one growing five high-value commercial crops. A revenue-weighted index, such as a Herfindahl-based measure, would better distinguish these cases and could be explored in future work.

Third, the HIES covers a twelve-month reference period and does not capture seasonal variation. Bangladesh's distinct *Boro*, *Aus*, and *Aman* seasons may involve very different diversification strategies that an annual snapshot cannot reveal.

6 Conclusion

This paper asked whether crop diversification improves income among rural farming households in Bangladesh. The findings from HIES 2022 offer a nuanced answer. Diversification has a robust, large, and stable positive effect on crop sales income: each additional crop type is associated with a 33 per cent increase in agricultural earnings, and this finding holds across bivariate and fully controlled specifications. However, there is no statistically significant effect on total household income once household characteristics are controlled, suggesting that the raw income gap between single-crop and multi-crop households largely reflects differences in household endowments rather than a direct return to diversification.

These findings have clear policy implications. Bangladesh's National Agricultural Policy and successive Five-Year Plans have emphasised crop diversification as a pathway to food security

and income growth, yet implementation has been uneven across divisions (Rahman, 2009). The results of this paper suggest that these efforts are well-directed: diversification does raise agricultural earnings in a meaningful and robust way. Interventions that lower the barriers to crop diversification, such as agricultural extension services that introduce higher-value crop types and investments in local markets and storage infrastructure, could generate meaningful gains in farm income for currently single-crop households. The large and persistent income penalty for female-headed households across both outcomes also points to the need for targeted programmes that address gender disparities in land access and financial inclusion.

Future research should seek causal identification through panel data or natural experiments, and should examine the effect of diversification on income variability in addition to income levels, since reducing seasonal income volatility may be as important as raising average earnings for the poorest farming households.

AI Use Disclosure

Claude AI was used as a tool to assist in writing and formatting the Stata do-file code for data cleaning and analysis, and to support the linguistic refinement of written sections. The author, however, reviewed every line of code, verified all outputs against the raw data, and made all analytical decisions independently. The author assumes full academic responsibility for the content of this paper.

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