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Is there an augmented Kuznets curve among the provinces of the Philippines? A panel data analysis

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Abstract

Purpose – This study explores the relationship between regional economic development and income inequality in the Philippines using a provincial panel dataset.

Design/methodology/approach – This study performs static, spatial and dynamic panel data analyses to assess whether income inequality follows an N-shaped augmented Kuznets curve in the context of regional economic development.

Findings – Our findings reveal that income inequality follows a semi-N-shaped curve, indicating that in the early stages of regional economic development, income inequality increases but at a decelerating rate. Unlike the inverted-U curve, it does not transition into a decline. After reaching an inflection point, income inequality rises. The Philippines has undergone a rapid shift in its industrial structure from relatively uniform manufacturing to skill-diverse services. This appears to have been particularly pronounced in the wealthier provinces, with their gross domestic product (GDP) shifting from manufacturing to high-productivity services. These provinces seem to have experienced the rising portion of the second Kuznets wave.

Originality/value – A panel dataset covering 87 provinces was constructed based on five rounds of the Family Income and Expenditure Survey from 1997 to 2018. This panel dataset resolves many of the issues encountered in cross-country studies on economic development and income inequality. Our study is the first attempt to investigate the evolution of income inequality in relation to regional economic development in the Philippines.

Keywords Income inequality, Regional economic development, Augmented Kuznets curve, Spatial and dynamic panel data models, the Philippines

Paper type Research article

1. Introduction

In his pioneering article on economic development and income inequality, Kuznets (1955) proposed a hypothesis stating that income inequality initially rises, but, after reaching a peak, it declines as economic development progresses. When income inequality is plotted against the level of economic development, this overall process forms an inverted-U pattern; thus, the hypothesis has been termed the Kuznets inverted-U hypothesis. Using the variance of log income as a measure of inequality, Robinson (1976) introduced a simple model that can generate the inverted-U pattern of income inequality during a population shift from low-income to high-income groups. Anand and Kanbur (1993) described this inverted U-shaped pattern as the Kuznets process.

JEL Classification — C23, D31, O15, R12

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Kuznets (1955) has triggered a substantial body of empirical studies on the Kuznets inverted-U hypothesis [1]. Due to the scarcity of long-term time series data for individual countries, most studies have relied on cross-sectional or panel datasets. However, the findings of these studies have been mixed. Early studies utilizing cross-country or pooled cross-country datasets, such as Ahluwalia (1976a, b), Campano and Salvatore (1988), Jha (1996), Papanek and Kyn (1986), Ram (1988) and Tsakloglou (1988), have found evidence supporting the Kuznets inverted-U relationship. On the other hand, recent studies employing large, comprehensive datasets that enable panel data and/or country-by-country regressions, such as Angeles (2010), Deininger and Squire (1998), Fraser (2006), Hsing and Smyth (1994) and Matyas *et al.* (1998), have provided little support for the hypothesis.

In recent years, the Kuznets hypothesis seems to have lost popularity. Since the 1980s, income inequality has resurged in many developed countries, driven primarily by technological advancements and globalization, which have shifted labor from relatively uniform manufacturing to skill-diverse service sectors (List and Gallet, 1999; Milanovic, 2016). Milanovic (2016) characterized this as the onset of the second Kuznets wave. By merging the first Kuznets wave with the rising portion of the second wave, the relationship between economic development and income inequality forms an N-shaped curve, which is referred to as the augmented Kuznets curve (Figure A1 [2]).

As indicated in the previous paragraphs, most empirical studies on the relationship between economic development and income inequality have relied on cross-country datasets. However, these studies have often faced comparability issues. First, sample sizes in household surveys, relative to the target population, vary across countries, affecting the accuracy of estimated income inequality. Second, household surveys are subject to measurement errors, which can also vary across countries. Third, while net-income or consumption expenditure data are commonly used in most countries to estimate inequality in the distribution of economic well-being, such data are unavailable in some countries. Fourth, institutional systems vary significantly across countries. Fifth, there are vast differences in population size between countries.

Against this background, this study examines the relationship between regional economic development and income inequality in the Philippines using a unique panel dataset of 87 provinces constructed from five rounds of the Family Income and Expenditure Survey (FIES) from 1997 to 2018. Specifically, the study assesses whether income inequality follows the N-shaped augmented Kuznets curve in relation to regional economic development using static, spatial, and dynamic panel data models. The FIES has been conducted by the Philippine Statistics Authority (PSA) using consistent data collection methods, ensuring that our provincial panel dataset is both internally consistent and comprehensive. This resolves many of the issues commonly encountered in cross-country datasets.

The Philippines is renowned for its diversity in geography, natural resources, religions, ethnicities and cultures. As the world's second-largest archipelagic nation, it consists of over 7,500 islands classified into three island groups: Luzon, Visayas and Mindanao (Figure A2 [2]). The country is home to over 180 ethnic groups and has a population of 115 m, with 52.5% residing in Luzon, where the capital city, Manila, is located. The Philippines is a member of the Association of Southeast Asian Nations (ASEAN). While the country is classified by the World Bank as a lower middle-income country, with a per capita gross domestic product (GDP) of 4,100 US dollars, it has experienced significant growth over the past two decades, with its GDP increasing at an annual average rate of 4.8% in constant 2015 US dollars. However, regional economic development is very uneven, with Manila having more than 11 times the per capita GDP of the poorest region, Muslim Mindanao. This substantial interregional economic disparity makes the Philippines an intriguing case for studies on regional economic development and income inequality.

2. Literature review

In addition to cross-country studies on the Kuznets inverted-U hypothesis and the augmented Kuznets hypothesis, several studies have examined regional variations in income inequality within individual countries or across a set of countries to assess these hypotheses [3]. Notable examples include Blanco and Ram (2019), Breau and Lee (2023), Castells-Quintana *et al.* (2015), Kim *et al.* (2011), Partridge *et al.* (1996) and Ram (1991).

Previous studies, including cross-country analyses, have suggested that several factors may contribute to a reversal in inequality trends, with rising inequality observed in the latter stages of economic development. Many of these studies have attributed this reversal to structural changes driven by globalization and technological advancements. For example, List and Gallet (1999), using an unbalanced panel dataset of 71 countries from 1961 to 1992, argued that one possible driver of rising income inequality among developed economies was the shift in industrial structure from manufacturing to skill-diverse service sectors. Milanovic (2016), based on cross-country analyses, found that the recent inequality upturn in developed economies was closely associated with advances in information technology, globalization and the transfer of labor from more homogeneous manufacturing to heterogeneous service sectors.

Meanwhile, Castells-Quintana *et al.* (2015), using a panel dataset of 67 European regions from 1993 to 2011, examined the relationship between regional development and income inequality. Their fixed-effect estimates revealed a U-shaped relationship between these two variables when inequality was measured using the Gini coefficient. Although they did not explicitly analyze the augmented Kuznets hypothesis, their findings indicated that shifts in the sectoral structure of regional economies are significant determinants of income inequality, with a higher share of employment in tradable services, alongside technological innovations, being positively associated with greater levels of income inequality.

Some regional studies have argued that population size and density may contribute to the rising phase of the second Kuznets wave. For example, Castells-Quintana *et al.* (2015) identified population density as another potential factor contributing to income inequality, with higher population density being positively associated with greater levels of inequality. Using a panel dataset covering 284 Canadian regions over the period 1981–2016, Breau and Lee (2023) found evidence supporting an N-shaped augmented Kuznets curve between regional economic development and interpersonal income inequality and suggested that a region's population size and its evolving industrial structure contributed to the rise in income inequality during the latter stages of regional development [4].

It is worth noting that, using state-level panel data for the US, Blanco and Ram (2019), Kim *et al.* (2011) and Ram (1991) observed a U-shaped rather than an inverted U-shaped relationship between regional economic development and income inequality. However, these studies did not offer an explanation for the factors driving the rise in income inequality.

Our study shares a similar research objective with that of Breau and Lee (2023); however, it focuses on the Philippines, a lower middle-income country, rather than a high-income country. To the best of our knowledge, this is the first attempt to investigate the evolution of income inequality in relation to regional development at the provincial level in the Philippines. It should be noted that, unlike Breau and Lee (2023), our dynamic panel data model is estimated not only using the Arellano–Bond difference generalized method of moments (GMM) estimator but also the Arellano–Bover/Blundell–Bond system GMM estimator (Arellano and Bond, 1991; Arellano and Bover, 1995; Blundell and Bond, 1998).

Breau and Lee (2023) introduced a spatially lagged dependent variable to address potential misspecifications in their cross-sectional regression models and account for spatial spillover effects on income inequality. Their spatial regression analyses revealed that interpersonal income inequality was strongly correlated across Canadian regions, and the inclusion of the spatially lagged dependent variable did not alter the main conclusions obtained from both cross-sectional and panel data analyses. However, their spatial analyses were based on yearly cross-sectional data. On the other hand, our spatial models were estimated using provincial panel data. Blanco and Ram (2019) also examined spatial spillover effects on income inequality using state-level panel data for the US from 2006 to 2016. While their pooled ordinary least squares (OLS) and two-way fixed effects panel estimates supported a significant U-shaped relationship between regional economic development and income inequality, the spatial lag model estimates, which accounted for spatial spillover effects across US states, did not reveal a significant relationship.

In the Philippines, spatial econometric analyses examining the relationship between economic development and income inequality are limited. One notable study was by Pede *et al*. (2018), who employed a conditional convergence growth model to assess the effects of income inequality on economic growth across provinces from 1991 to 2000. By estimating a geographically weighted regression (GWR), they found evidence that the contribution of income inequality to per capita income growth was overestimated when spatial effects were excluded. They emphasized the importance of incorporating spatial interdependence in the analysis of the inequality-growth relationship; however, the construction of their spatial weight matrix in the GWR analysis remains unclear. In constructing spatial weight matrices for our spatial econometric analyses, we account for the fact that the Philippines comprises more than 7,500 islands, separated by water and grouped into three main island regions.

3. Methods and the data

3.1 Methods

3.1.1 Static panel data model. To examine the relationship between regional economic development and income inequality, we conducted several panel data regression analyses. We first estimate the following static panel data model.

$$I_{it} = \beta_0 + \beta_1 y_{it} + \beta_2 y_{it}^2 + \beta_3 y_{it}^3 + X_{it}\gamma + \alpha_i + \delta_t + u_{it} \quad (1)$$

I_{it} represents inequality in per capita income as measured by the Gini coefficient or the Theil indices for province i at time t, while y_{it} denotes mean per capita income for province i at time t. α_i and δ_t are the province- and time-specific fixed effects, while u_{it} is the usual error term. X_{it} is a vector of control variables accounting for provincial socioeconomic characteristics, including mean years of education, the proportion of households mainly engaged in the non-agriculture sector and the proportion of female-headed households.

We should note that the Gini coefficient of income inequality is estimated for each province by

$$G_{inc} = \frac{1}{2n^2\mu}\sum\nolimits_{i=1}^{n}\sum\nolimits_{j=1}^{n}\lceil y_i - y_j \rceil, \quad (2)$$

where n, y_i and $\mu = \frac{1}{n}\sum_{i=1}^{n} y_i > 0$ are the number of households, per capita income of ith household and the mean per capita income, respectively. On the other hand, the Theil L and T indices are estimated, respectively, by

$$\text{Theil}\, L = \frac{1}{n}\sum\nolimits_{i=1}^{n}\ln\left(\frac{\mu}{y_i}\right),$$

$$\text{Theil}\, T = \frac{1}{n}\sum\nolimits_{i=1}^{n}\frac{y_i}{\mu}\ln\left(\frac{y_i}{\mu}\right). \quad (3)$$

The Gini coefficient and the Theil indices satisfy the principles of anonymity, income homogeneity, population homogeneity and the Pigou–Dalton transfer principle. The Gini coefficient, the Theil L and Theil T indices are sensitive to changes in middle-, lower- and upper-income groups, respectively.

To test the N-shaped augmented Kuznets relationship, model 1 includes y_{it}^3. If $\beta_1 > 0$, $\beta_2 < 0$ and $\beta_3 = 0$, model 1 is a quadratic function with respect to y_{it}, exhibiting an inverted-U pattern. On the other hand, if $\beta_1 > 0$, $\beta_2 < 0$ and $\beta_3 > 0$, model 1 is a cubic function with a single inflection point where $y_{it} = -\frac{\beta_2}{3\beta_3} > 0$. If $\beta_2^2 > 3\beta_1\beta_3$, then the model exhibits an N-shaped pattern, as depicted in Figure A1 [11]. If $\beta_2^2 \leq 3\beta_1\beta_3$, it presents the pattern shown in Figure A3 [11], which we refer to as the semi-N-shaped augmented Kuznets curve.

As shown in Figure A4 [11], the Gini coefficient of educational inequality is negatively associated with mean years of education. Here, the Gini coefficient of educational inequality is estimated using the following formula (Thomas *et al.*, 2001).

$$G_{edu} = \frac{1}{2n^2\varepsilon}\sum_{i=1}^{n}\sum_{j=1}^{n}\left|e_i - e_j\right|, \tag{4}$$

where e_i and $\varepsilon = \frac{1}{n}\sum_{j=1}^{n} e_i$ are the number of years of education of the ith household and the mean years of education, respectively. In addition, it is widely believed that a decrease in educational inequality has an equalizing effect on income distribution (De Gregorio and Lee, 2002; Lee and Lee, 2018; Park, 1996, 2017; Rodríguez-Pose and Tselios, 2009). Therefore, we expect that the coefficient for mean years of education will be negative; that is, the expansion of education has an inequality-reducing effect.

As suggested by Anand and Kanbur (1993) and Robinson (1976), a shift in population from the more equal, lower-income agricultural sector to the less equal, higher-income non-agricultural sector would result in an inverted-U curve for income inequality. If provinces have reached the later stages of this structural transformation, their income inequality would decrease as the proportion of households in non-agriculture increases. In the Philippines, the proportion of households in the non-agriculture sector has exceeded 50 in 80% of provinces, indicating that many provinces have already entered the declining phase of the inverted-U curve for income inequality. Therefore, we expect the coefficient for the proportion of households in the non-agriculture sector to be negative.

According to the FIES, there are no significant differences between male-headed and female-headed households in terms of within-gender income inequality. Therefore, it is unclear whether the coefficient for the proportion of female-headed households will be positive or negative.

3.1.2 Spatial panel data model. As discussed in the introduction, the Philippines is diverse in terms of geography, natural resources, religions, ethnicities and cultures. However, provinces within each island group (Luzon, Visayas and Mindanao) tend to share similar characteristics and their economies are, to some extent, interconnected through transportation networks. To account for spatial interdependence among provinces, we estimate the following spatial Durbin panel data model (LeSage and Pace, 2009) [5].

$$I_t = \rho W I_t + Y_t\beta + WY_t\theta + WX_t\pi + \alpha + u_t, \tag{5}$$

where $\boldsymbol{I}_t$ is a $(n\times1)$ vector of income inequality, Y_t is a $(n\times3)$ matrix of variables for mean per capita household income $(y_{it}, y_{it}^2, y_{it}^3)$, X_t is a $(n\times k)$ matrix of other independent variables and W is a $(n\times n)$ spatial weight matrix. α is a $(n\times1)$ vector of province-specific fixed effects, while u_t is a $(n\times1)$ vector of the error term. ρ, β, θ and π are the coefficients to be estimated by the quasi-maximum likelihood estimator (Belotti *et al.*, 2017).

3.1.3 Dynamic panel data model. Given the persistent nature of income inequality over time, we finally consider the following dynamic panel data model. This approach is expected to address potential misspecifications that may arise when using the static and spatial panel data models.

$$I_{it} = \delta I_{it-1} + \beta_0 + \beta_1 y_{it} + \beta_2 y_{it}^2 + \beta_3 y_{it}^3 + X_{it}\gamma + \alpha_i + u_{it} \quad (6)$$

where I_{it-1} is the first-order lag of the dependent variable and $|\delta| < 1$.

We estimate the model according to the Arellano–Bond difference GMM and Arellano–Bover/Blundell–Bond system GMM estimators [6]. These estimators fit a linear dynamic panel data model where unobserved individual-fixed effects are correlated with the lags of the dependent variable. They are designed for datasets with many individual units and few time periods. The difference GMM estimator proceeds by first-diffencing the data to eliminate the individual-fixed effects, while the system GMM estimator enhances the difference GMM estimator by estimating simultaneously difference and level equations, which are distinctly instrumented (Roodman, 2009).

3.2 The data

Using data from five rounds of the FIES compiled by the PSA, this study constructs a unique balanced panel dataset covering 87 provinces over the period 1997–2018, with all household incomes adjusted to 2010 constant prices. We should note that due to the unavailability of data for some variables in the 2003, 2009 and 2015 rounds, this study uses the 1997, 2000, 2006, 2012 and 2018 rounds of the FIES (PSA, 1998, 2001, 2007, 2013, 2019).

Table A1 [2] provides summary statistics for our dataset. Income inequality varies significantly across provinces; in 2018, the Gini coefficient of income inequality ranged between 0.219 and 0.539 (Figure A5 [2]). Mean per capita income also shows significant variation. In 2018, the fourth district of the National Capital Region (NCR) recorded the highest mean per capita income, which was 5.4 times greater than that of the southernmost island province of Sulu, located in the Bangsamoro Autonomous Region in Muslim Mindanao. As economic development has progressed, the proportion of households primarily engaged in the non-agriculture sector, the mean years of education and the proportion of female-headed households have increased. These variables also exhibit significant variation across provinces.

4. Empirical results

4.1 Relationship between income Gini coefficient and mean per capita income

Previous empirical studies have suggested that there are structural differences in the development-inequality relationship between developing and developed regions. Therefore, before conducting panel data analyses, we examine these differences by classifying all provinces into the top 20% and bottom 80% based on their mean per capita income (in 2010 constant prices). Figure A6 [2] shows provinces in the top 20% (dark pink) and bottom 80% (light pink). Provinces in the top 20% (developed provinces) are mostly located in the Luzon island group, while provinces in the bottom 80% (developing provinces) are mostly located in the Visayas and Mindanao island groups.

How do the top 20% and bottom 80% income groups differ in their development-inequality relationship? Figure A7 [2] presents scatter plots showing the relationship between the Gini coefficient of income inequality (vertical axis) and mean per capita income (horizontal axis). Figure A7A [2] displays a scatter plot for the bottom 80% (developing provinces). It clearly demonstrates an inverted U-shaped pattern, indicating that income inequality initially increases, peaks and then decreases as regional development advances. Meanwhile, Figure A7B [2] presents a scatter plot for the top 20% (developed provinces). Unlike the bottom 80%, it shows a U-shaped pattern, suggesting that income inequality initially decreases, bottoms out and then rises as regional economic development progresses.

By merging the scatter plots in Figures A7A [2] and A7B [2] horizontally, we anticipate an N-shaped augmented Kuznets curve for the relationship between income inequality and mean per capita income. This hypothesis is explored in the following panel data regression analyses.

4.2 Fixed effects panel data models

Table A2 [2] presents the estimates of fixed effects panel data models with income inequality measured by the Gini [7]. In model (2), where time-specific effects are absent, all coefficients associated with per capita income (β_1, β_2 and β_3) are significant at the 1% level and $\beta_1 > 0$, $\beta_2 < 0$ and $\beta_3 > 0$, indicating that income inequality has a unique inflection point. However, it exhibits the semi-N-shaped pattern shown in Figure A2 [2] because $\beta_2^2 < 3\beta_1\beta_3$. In model (3), where time-specific effects are included, β_3 loses significance.

Except for the proportion of female-headed households, the coefficients for the other independent variables are significant and have the expected signs.

4.3 Spatial panel data models

According to the Global Moran's *I* based on a row-normalized contiguity spatial weight matrix, all variables seem to be spatially auto-correlated with their Global Moran's *I* values ranging from 0.375 to 0.563 (LeSage and Pace, 2009). Therefore, we estimate the spatial Durbin panel data model (SDM model). It is important to note that, since the Philippines is an archipelagic country comprising more than 7,500 islands, island provinces do not have spatial links with other provinces in the spatial weight matrix [8]. Additionally, provinces within each island group (Luzon, Visayas and Mindanao) do not have spatial links with provinces in other island groups. In other words, the spatial weight matrix has a block-diagonal structure consisting of three regional blocks (Anselin *et al.*, 2014) [9]. The spatial weight matrix is an 87×87 square matrix.

Table A3 [2] presents the estimates of the SDM model with income inequality measured by the Gini. As indicated by the estimated coefficients of the spatial lag variables, spatial interdependence appears to be weak. However, the results essentially replicate the fixed effects results reported in Table A2 [2]. Even with the inclusion of time-specific effects (model (5)), β_3 remains significant at the 10% level, contrasting with the result from the static fixed-effects model with time-specific effects (model (3)). However, the spatial autoregressive coefficient (ρ) becomes insignificant.

We also estimate the SDM model using a distance-based spatial weight matrix as well as the spatial autoregressive panel data model (SAR model) using both row-normalized contiguity and distance-based spatial weight matrices (LeSage and Pace, 2009). Although the coefficient for β_3 is less significant, the results are essentially consistent with those presented in Table A3 [2][10]. It is important to note that in the case of the SAR model with time-specific effects, the spatial autoregressive coefficient ρ is significant at the 10% level when the distance-based spatial weight matrix is used, in contrast to the result from the SDM model with time-specific effects.

4.4 Dynamic panel data models

Table A4 [2] presents the estimates of dynamic panel data models with income inequality measured by the Gini. In the difference GMM estimation, the lags of the dependent variable and the first differences of the per capita income variables are used as instruments for the first-difference equation. In the system GMM estimation, these instruments are supplemented by the lagged first differences in the dependent variable, which serve as instruments for the level equation. While the Sargan test results suggest that the models may be over-identified, the Arellano–Bond test results are satisfactory, so we can reject the null hypothesis of no first-order serial correlation but cannot reject the null hypothesis of no second-order serial correlation [11].

The results demonstrate the importance of controlling for the persistence of income inequality, as the coefficient for the lagged dependent variable (δ) is statistically significant at the 5% level and $\delta < 1$. Whether the model is estimated by the difference GMM estimator or the system GMM estimator, all coefficients for per capita income (β_1, β_2 and β_3) are significant at either the 1 or 5% level and $\beta_1 > 0, \beta_2 < 0$ and $\beta_3 > 0$. This suggests that income inequality has a unique inflection point. However, we have $\beta_2^2 \approx 3\beta_1\beta_3$; thus, it exhibits a semi-N-shaped curve.

Unlike static and spatial panel data models, the coefficients for all other independent variables are significant at the 1, 5 or 10% levels and exhibit the expected signs. Provinces with higher mean years of education tend to exhibit lower income inequality, suggesting that educational expansion may help reduce income inequality by narrowing educational inequality, as shown in Figure A4 [2], *ceteris paribus*. Provinces with a larger proportion of households in the non-agricultural sector tend to have less income inequality. As suggested by the inverted-U relationship between the proportion of households in the non-agricultural sector and income inequality, this result indicates that many provinces have already entered the declining phase of the inverted-U curve with respect to the proportion of non-agricultural sector households. Therefore, a further increase in the proportion of households in the non-agricultural sector would decrease income inequality, *ceteris paribus*. Finally, provinces with a higher proportion of female-headed households tend to exhibit lower income inequality. However, the underlying reason for this finding remains unclear in the context of the dynamic panel data models.

4.5 Robustness check

To assess the robustness of our findings, we estimate the dynamic and spatial panel data models using the Theil *L* and *T* indices as alternative measures of income inequality. The results are presented in Tables A5 [2] and A6 [2]. They are qualitatively consistent with those obtained using the Gini. In the case of the dynamic panel data models, all coefficients are significant, while in the case of spatial panel data models, all coefficients except for the proportion of female-headed households are significant.

4.6 Possible factor for rising income inequality in the later stages of development

What factors contribute to rising income inequality in the later stages of regional development? One possible factor is the structural transformation from relatively uniform manufacturing to skill-diverse services (Castells-Quintana *et al.*, 2015; List and Gallet, 1999; Milanovic, 2016). To assess whether this factor contributes to rising income inequality, data on industrial structure at the provincial level is required. However, such data is unavailable; thus, we rely on GDP data at the regional level. In the Philippines, there are 17 administrative regions, each comprising four to seven provinces. The PSA has compiled regional GDP data by industry. Using regional GDP at constant 2018 prices over the period 2000–2020, we analyze changes in the industrial structure at the regional level (PSA, 2024).

We focus on agriculture, manufacturing and high-productivity services, where high-productivity services include ICT, finance/insurance, real estate and professional and business services. Figure A8 [2] depicts changes in the GDP shares of these sectors. With the exception of the Mimaropa region, the regions in the Luzon island group have experienced a shift in GDP from manufacturing to high-productivity services. As discussed before, most developed provinces are located in Luzon (see Figure A6 [2]). This suggests that a possible factor for rising income inequality in the later stages of regional development is the structural transformation from manufacturing to high-productivity services. While the GDP share of the service sector has increased, the proportion of high-productivity services within the service sector has risen significantly in most regions of Luzon.

On the other hand, most developing provinces are located in the Mindanao island group (see Figure A6 [2]). Unlike the Luzon region, the administrative regions of Mindanao have increased their GDP shares of both manufacturing and high-productivity services. In contrast, the GDP share of agriculture has declined significantly. As suggested by Baymul and Sen (2020), a possible explanation for the inverted-U curve observed among developing provinces is the structural transformation from agriculture to non-agricultural sectors.

To explain in more detail how different stages of structural transformation affect income inequality, we consider a two-sector model comprising a low-income, low-inequality sector and a high-income, high-inequality sector. In this model, overall income inequality is driven by three key factors: within-sector income inequalities, income inequality between the two sectors and the population share of the high-income, high-inequality sector. When a population shift from the former to the latter sector occurs, overall income inequality is found to follow an inverted-U curve, i.e. overall inequality initially rises but after reaching a peak, it starts to decline (Akita and Kataoka, 2022; Anand and Kanbur, 1993; Robinson, 1976).

In developing provinces where agriculture accounts for a relatively large share of GDP, the population is shifting from low-income and low-inequality agriculture to non-agricultural sectors. As a result, these provinces are likely to follow an inverted-U curve in income inequality (see Figure A7A [2]). On the other hand, among developed provinces, where the GDP share of agriculture is small, the population is shifting from relatively uniform manufacturing to skill-diverse services. As most of these provinces are in the early stages of this structural transformation, the shift is likely to increase overall income inequality (see Figure A7B [2]).

5. Discussion and conclusion

This study examined the relationship between regional economic development and income inequality in the Philippines using a unique panel dataset. Our results show that income inequality exhibits a semi-N-shaped cubic curve. The results are robust in terms of different measures of inequality and panel data models, including static, spatial and dynamic panel data models. It is suggested that in the early stages of regional development, income inequality increases, but at a decelerating rate. Unlike an inverted-U curve, however, it does not transition into a decline with regional development. Instead, after reaching an inflection point, it continues to rise. The results from the dynamic panel data analyses highlight the importance of accounting for the persistence of income inequality over time. In contrast, the results from the spatial panel data analysis suggest that spatial interdependence is relatively weak, despite the use of spatial weight matrices designed to reflect the country's archipelagic characteristics.

Over the last three decades, the Philippines has undergone a shift in its industrial structure from relatively uniform manufacturing to skill-diverse services. Between 2000 and 2020, the GDP share of the services sector increased from 50 to 61%, while the GDP share of manufacturing declined from 25 to 17%. This structural transformation appears to have been particularly pronounced in the wealthier provinces of Luzon, with their GDP shifting from manufacturing to high-productivity services. These provinces seem to have experienced the rising phase of the second Kuznets wave.

During globalization and technological advancements, the demand for higher education is growing in wealthier provinces. However, according to the World Development Indicators, the Philippines' gross enrollment ratio for tertiary education remained low at 33% in 2020. To close the gap between the supply and demand for higher education, the government should continue to promote and strengthen senior secondary education institutions. At the same time, efforts should be made to promote vocational education to address the mismatch between the demand for and supply of required skills and knowledge. The service sector includes a broad spectrum of subsectors, ranging from informal, low-productivity services to high-productivity services such as ICT, financial services and business services. Strengthening both senior secondary and vocational education could help reduce income inequality within the services sector, thereby mitigating the rise in overall income inequality, particularly in wealthier provinces.

Our results also suggest that overall educational expansion contributes to the reduction of income inequality. Over the last three decades, the Philippines has experienced a rapid increase in the level of education. According to the Barro and Lee dataset on educational attainment among the population aged 25–64 (Barro and Lee, 2013), mean years of education increased from 7.8 to 10.1 between 1990 and 2015. This rise in educational attainment has been accompanied by a decrease in educational inequality. It is widely believed that a decrease in educational inequality has an equalizing effect on income distribution. In many provinces, the mean years of education remain low at less than nine years. Therefore, the further expansion of education could play a crucial role in mitigating the rise in income inequality. With greater fiscal autonomy in resource allocation under decentralization since the 1990s (UN-HABITAT, 2011), regional governments may need to prioritize expanding educational opportunities to reduce educational inequality. They should also try to reduce dropout rates at the primary education level, as a significant portion of the population has not completed primary education.

The results indicate that an increasing proportion of non-agricultural households contributes to the reduction of income inequality. In 2018, about 80% of households were engaged in the non-agricultural sector, and the proportion is likely to increase with regional development. This would help to mitigate the rise in income inequality. The results also suggest that a rising proportion of female-headed households has an equalizing effect on income distribution. In 2018, 23% of households were headed by females, and the proportion is likely to increase. Regional governments should support initiatives that promote earning opportunities for female-headed households to further reduce income inequality.

Over the period 1997–2018, income inequality in the Philippines declined substantially, with the Theil L index decreasing from 0.46 to 0.28. We should note that overall income inequality depends not only on within-province but also on between-province inequalities. According to Theil L, income inequality between provinces declined from 0.13 to 0.05, indicating that more than half of the decrease in overall inequality can be attributed to the reduction in income inequality between provinces. It is important to note that our study examined the evolution of income inequality within provinces in relation to provincial development. The semi-N-shaped augmented Kuznets curve that we observed describes the long-run relationship between income inequality and regional development and thus does not contradict the declining income inequality in the Philippines as a whole.

This study is not without limitations. First, due to the unavailability of data for certain variables, this study excluded the 2003, 2009 and 2015 rounds of the FIES. Future research should aim to include data from these rounds. Second, our panel data models included three control variables: the mean years of education, the proportion of households primarily engaged in the non-agricultural sector and the proportion of female-headed households. However, other factors, such as unemployment rate, population density, degree of decentralization and urbanization rate, may also influence intra-provincial income inequality. Future research should consider incorporating these variables.

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Notes

1. They include Ahluwalia (1976a, 1976b), Anand and Kanbur (1993), Angeles (2010), Baymul and Sen (2020) Breau and Lee (2023), Campano and Salvatore (1988), Castells-Quintana *et al*. (2015), Deininger and Squire (1998), Fraser (2006), Hsing and Smyth (1994), Jha (1996), Kim *et al*. (2011), Matyas *et al*. (1998), Papanek and Kyn (1986), Partridge *et al*. (1996), Ram (1988, 1991) and Tsakloglou (1988).

2. Please see it in the Online Appendix

3. Most previous cross-country and/or panel data studies on the relationship between economic development and income inequality have focused on testing the Kuznets inverted-U hypothesis. Notable examples include Ahluwalia (1976a, 1976b), Angeles (2010), Campano and Salvatore (1988), Deininger and Squire (1998), Fraser (2006), Hsing and Smyth (1994), Jha (1996), Matyas *et al*. (1998), Papanek and Kyn (1986), Ram (1988) and Tsakloglou (1988). On the other hand, Castells-Quintana (2018), List and Gallet (1999) and Milanovic (2016) explored the augmented Kuznets hypothesis, but their analyses were based on cross-country panel datasets. Breau and Lee (2023) and Castells-Quintana *et al*. (2015) are among the few regional panel data studies that have analyzed the augmented Kuznets hypothesis.
4. Breau and Lee (2023) used the term ‘sideway S-shaped curve’ to refer to an N-shaped curve.
5. We estimate the spatial panel data model using the Stata command, *xsmle*.
6. We estimate the dynamic panel data model using the Stata commands, *xtabond* and *xtdpdsys*.
7. The Hausman test indicates that the fixed-effects model is preferred over the random-effects model, as we can reject the null hypothesis that the errors are uncorrelated with the independent variables with a *p*-value of 0.00.
8. These island provinces include Batanes, Catanduanes, Marinduque, Masbate, Palawan and Romblon in the Luzon; Biliran, Bohol, Cebu, Guimaras and Siquijor in the Visayas and Camiguin, Sulu and Tawi-Tawi in the Mindanao island group.
9. We are grateful to a reviewer for raising this point. The spatial weight matrices are available upon request.
10. The results are available upon request.
11. The Sargan test results suggest that some of the selected instruments may be invalid. The issues raised by these results will be addressed in future research.

Supplementary material
The supplementary material for this article can be found online.

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