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Analysis of the Effects of Formal-Informal Employment Status, Human Capital, and Spatial Factors on Worker Welfare in North Maluku Province

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ABSTRACT

Rapid macroeconomic expansion in North Maluku Province fails to automatically translate into equitable welfare outcomes across the workforce, primarily due to persistent structural dualism in the labor market. This study investigates the impact of employment status (formal vs. informal), human capital accumulation, and spatial-sectoral characteristics on worker earnings, as a material proxy for economic welfare, within the framework of Sustainable Development Goal 8 (Decent Work and Economic Growth). Utilizing microdata from the National Labor Force Survey (SAKERNAS), we estimate an extended Mincerian wage equation. Empirical results reveal a pronounced formal wage premium, whereas informal workers remain encumbered by an informality trap, incurring a substantial wage penalty. Human capital enhancements significantly boost earnings, with standardized vocational training generating superior wage returns compared to merely extending formal schooling duration. Age and work experience exhibit a non-linear, concave parabolic relationship with earnings, reaching a productivity peak at 43.76 years before experiencing age-related depreciation. Furthermore, the analysis confirms a distinct urban wage premium alongside marked sectoral heterogeneity. Relative to the reference baseline of Food Crop Agriculture, the Services, Industry, and Non-Agricultural sector records the highest wage premium (110.03%), followed by Non-Food Crop Agriculture (90.16%) and Fisheries (38.10%), whereas Livestock Farming demonstrates no statistically significant difference due to shared subsistence-level constraints. This study concludes that welfare inequality in North Maluku stems predominantly from structural rigidities inherent in a dualistic labor market rather than individual capacity differentials alone. Policy interventions must prioritize targeted labor formalization initiatives (SDG Target 8.3) and industry-aligned vocational training (SDG Target 8.5) to ensure decent work and equitable compensation across regional labor markets.

Keywords: Mincerian Wage Equation, Informal Sector Penalty, Human Capital, Urban Wage Premium, SDG 8, North Maluku.

INTRODUCTION

Worker welfare is an important dimension of economic development because it reflects an individual's ability to meet their daily needs and achieve a decent standard of living. From the perspective of the Capability Approach, Sen (1999) explains that well-being is not determined solely by the amount of resources a person possesses, but also by their ability to convert those resources into a meaningful life. In the context of labor economics, income serves as an essential material resource because it determines an individual's capacity to satisfy basic needs, access goods and services, and improve their living conditions. Therefore, income is often used as a key indicator to measure workers' economic well-being, even though overall welfare encompasses broader dimensions. A number of studies show that income is closely linked to workers' subjective well-being and quality of life, although an increase in income does not always lead to a proportional increase in well-being when those gains are earned through an excessive workload (Cai et al., 2025). Thus, income can be viewed as an important indicator for analyzing the economic welfare conditions of workers.

The issue of workers' economic welfare has become increasingly pertinent in North Maluku Province, a region experiencing exceptionally rapid economic growth. According to BPS Provinsi Maluku Utara (2025), the regional economy expanded by 34.17 percent in 2025, driven predominantly by the manufacturing sector, which surged by 62.64 percent, pushing the GRDP per capita to IDR 97.26 million. This trajectory underscores a robust economic expansion spearheaded by industrial processing and other productive sectors. Nevertheless, a surge in regional economic output does not automatically guarantee an equitable distribution of income and economic well-being across all segments of the workforce. BPS Provinsi Maluku Utara (2025) reports that the employed population reached 673.46 thousand individuals, distributed across diverse sectors and job profiles. This heterogeneity reflects marked variations in employment status, educational attainment, vocational training or certification, work experience, age, place of residence, and sector of employment, all of which potentially drive income disparities among workers.

Income disparities among workers can be explained by individual human capital characteristics. Through Human Capital Theory, Becker (1975) posits that education and training represent investments that enhance an individual's knowledge, skills, and productivity. Mincer (1974) subsequently demonstrated that education and work experience serve as pivotal determinants of income generation. Aligning with this perspective, numerous empirical studies indicate that human capital characteristics are closely associated with labor market outcomes, though the magnitude of these effects may vary depending on individual contexts and work environments. Higher educational attainment generally elevates the likelihood of securing better employment and higher income; however, the returns to education can be moderated by educational quality, skill alignment with market demands, and regional conditions. Research on vocational education in Indonesia indicates that education enhances employment opportunities and income, particularly in urban areas, yet this effect shifts when non-cognitive skills are controlled for (Choi et al., 2023). These findings underscore that human capital

characteristics cannot be understood in isolation from the specific job context in which workers operate.

Beyond formal education, training and certification can bolster worker capacity by imparting skills specifically tailored to job requirements. In their study on training programs for vulnerable groups in Indonesia, Grimes et al. (2022) found that training enhances self-efficacy and financial behavior, while also correlating with a higher likelihood of securing new or improved employment. However, its returns on income levels are not uniformly distributed across labor markets, as on-the-job training in several developing nations exhibits no universally significant impact (Suryadarma & Jones, 2013). In other words, the link between training and income does not always yield consistent outcomes. Nguyen et al. (2021) observed that on-the-job training in Vietnam does not consistently exert a statistically significant influence on overall income, although its benefits are more pronounced among specific worker sub-groups. These divergent empirical findings indicate that the impact of training on income hinges upon the nature of the training, the relevance of the imparted skills, individual worker characteristics, and prevailing employment opportunities.

Work experience also serves as an essential component of income generation, as it enables workers to accumulate skills, practical knowledge, and professional networks. Research on skill dynamics and income demonstrates that income growth is driven by opportunities to acquire new skills and the quality of worker-job matching (Moscarini & Postel-vinay, 2020). Consequently, work experience can yield varying economic benefits depending on the characteristics of the job performed. The relationship between age and income is also potentially non-linear. During the early to mid-career stages, advancing age is generally accompanied by experience accumulation, skill enhancement, and increased productivity, which collectively drive income gains. However, these economic benefits do not increase indefinitely, as productivity growth and opportunities for income advancement may decelerate at older ages. Thus, the impact of age on income must be understood by considering potential shifts in relational patterns throughout the working life cycle (Chen & Wu, 2025; Moscarini & Postel-vinay, 2020).

In addition to human capital characteristics, formal and informal employment status can shape disparities in the economic opportunities available to workers. Labor market segmentation theory posits that the labor market consists of distinct job segments with differing characteristics in terms of stability, protection, mobility, and economic rewards (Doeringer & Piore, 2020). Numerous studies reveal that informal workers receive lower income compared to formal workers after controlling for individual characteristics. Liwiński (2022) identified an income penalty and hourly wage penalty among informal workers in Poland, particularly within lower-income cohorts. Similar empirical patterns were documented by Bushiso & Ashalatha (2026), who demonstrated that informal workers in Ethiopia receive lower income than formal workers after accounting for worker and job characteristics. Within the domain of informal employment, Martínez & Zafra (2025) observed that informal workers report lower levels of life and job satisfaction compared to their formal counterparts, alongside facing reduced income

levels. These findings indicate that employment status can function as a key mechanism driving variations in workers' economic welfare. However, this relationship is not entirely uniform. Chen & Wu (2025) demonstrate that informal workers' income is strongly influenced by non-cognitive skills and individual characteristics, indicating that informal workers cannot be viewed as a homogeneous group. Consequently, income disparities between formal and informal workers may reflect both the structural influence of employment status and underlying differences in worker characteristics.

On the other hand, place of residence can influence income through variations in access to economic hubs, infrastructure, and employment opportunities. Baysan et al. (2024), demonstrate that even within rural regions, transitioning from agricultural to non-agricultural work can yield higher income. This finding suggests that sector type and job characteristics may be more decisive than geographic location alone. Meanwhile, the effect of education on labor market outcomes also varies across urban and rural areas (Choi et al., 2023). Furthermore, employment sectors display distinct productivity levels, technological adoption, skill requirements, and labor demand structures, thereby generating differential income levels. Consequently, incorporating these factors is crucial when analyzing the relationship between employment status and worker income.

Building upon these empirical insights, worker income is linked not only to formal or informal employment status, but also to individual human capital attributes and job characteristics. A number of studies demonstrate income disparities between formal and informal workers (Bushiso & Ashalatha, 2026 ; Liwiński, 2022), whereas other research reveals that heterogeneity in skills and individual attributes can influence income levels within each employment category (Chen & Wu, 2025). Similarly, the effects of education, training, experience, age, region, and employment sector on income do not always exhibit a uniform pattern. These divergent findings indicate that the relationship between employment status and workers' economic welfare must be understood by concurrently accounting for both worker and job characteristics.

Within the context of North Maluku Province, this issue is particularly pertinent given that rapid economic expansion does not inherently clarify how economic gains are distributed among workers with varying job characteristics and human capital profiles. Ultimately, the dynamics of income disparities align directly with the global development mandate under Sustainable Development Goal (SDG) 8: Decent Work and Economic Growth, specifically regarding the formalization of the labor force and equitable income compensation. Grounded in these considerations, this study is directed at analyzing income level disparities as an indicator of workers' economic welfare, after controlling for formal and informal employment status, human capital attributes, and regional conditions, while examining structural variations across employment sectors in North Maluku Province.

METHODS

This quantitative study relies on secondary cross-sectional microdata from the 2025 National Labor Force Survey (SAKERNAS) for North Maluku Province. The sample scope is specifically restricted to working-age individuals who are currently employed and record positive income $Y > 0$, yielding a final analytical sample of $N = 3.631$ workers.

The dependent variable in this analysis is the worker's monthly income level, transformed into its natural logarithmic form ($\ln(Income)$). The application of the natural logarithm transformation (ln) serves to dampen the influence of outliers, normalize the right-skewed distribution inherent in micro-income data, and stabilize error variance (variance-stabilizing transformation) to minimize the risk of heteroskedasticity (Wooldridge, 2020; Gujarati & Porter, 2020).

Meanwhile, the primary independent variable is informal employment status *(informal_dummy)*, structured as a dummy variable (1 = {Informal Sector}; 0 = {Formal Sector}), alongside three human capital accumulation components: formal education duration (*education*, in years), vocational training certification (*train_dummy*: 1 = {Certified}; 0 = {Uncertified}), and actual work experience (*exp*, in years). To capture demographic life-cycle dynamics, the model incorporates a mean-centered age variable (*Age_c* = *Age* - $\overline{Age}$) together with its quadratic component (*Age_sq_c* = Age_c^2). Structural control variables include residential location (*urban_dummy:* 1 = {Urban}; 0 = {Rural}) as well as industry classifications divided into five sectors *(sector_2* through *sector_5*), designating Sector 1 (*sector_1)*, (Food Crop Agriculture) as the reference base group.

Parameter estimation is conducted within the framework of the Mincerian income function, which enables coefficient estimates to be directly interpreted as the percentage response of income to shifts in explanatory variables (Card et al., 2022). The baseline approach employs the Ordinary Least Squares (OLS) method to minimize the sum of squared residuals when estimating linear relationships among variables. However, to address potential heteroskedasticity and bias stemming from the complex survey design, the OLS estimation is extended using Weighted Least Squares (WLS) by applying survey sampling weights. The estimated multiple linear empirical equation is specified as follows:

$$ln(Income_i) = \beta_0 + \beta_1 Informal_1 + \beta_2 Education_i + \beta_3 Train_i + \beta_4 Exp_i + \beta_5 Age_i + \beta_6 Age_{i2} + \beta_7 Urban_i + \sum_{k=2}^{K} \gamma k \, D_{k,i} + \varepsilon_i$$

Given that the dependent variable is specified in natural logarithmic form, the exact relative impact of qualitative dummy variables is calculated using the Halvorsen-Palmquist exponential transformation, formulated as:

$$\Delta\%Y = \left(e^{\widehat{\beta}_j} - 1\right) \times 100\%$$

Regarding the estimation of the peak income turning point, it is derived through the first-order partial derivative condition of the regression specification with respect to the centered age variable:

$$Actual\ Peak\ Income\ Age = \overline{Age} + \left(-\frac{\beta_5}{2 \cdot \beta_6}\right)$$

All hypothesis tests are evaluated at the $\alpha = 0{,}01(1\%)$ significance level, supported by robust standard errors to guarantee the consistency and validity of statistical inference under OLS estimation.

RESULTS AND DISCUSSION

Preliminary examination from the 2025 National Labor Force Survey (SAKERNAS) North Maluku Province microdata ($N = 3.631$) provides a detailed overview of worker demographic, human capital, and economic characteristics.

Table 1. Descriptive Statistics of Research Variables ($N = 3.631$)

Variable	*Description / Category*	*Average*	*Standard Deviation*	*Minimum*	*Maximum*
Income	Monthly Worker Income (IDR)	IDR3.548.041	IDR3.409.816	IDR2.000	IDR60.000.000
	Income Informal	IDR3.872.415	IDR2.659.060	IDR2.000	IDR19.800.000
	Income Formal	IDR3.386.774	IDR4.521.458	IDR50.000	IDR60.000.000
ln(Income)	Natural Logarithm of Monthly Worker Income	14,72	0,9	7,6	17,91
Informal	Employment status (1 = Informal, 0 = Formal)	0,373	0,472	0	1
Education	Length of Formal Schooling (Years)	13,82	2,72	12	21

Training	Vocational Training Certificate (1 = Certified, 0 = Uncertified)	0,255	0,444	0	1
Exp	Actual Work Experience (Years)	8,48	8,15	0	55
Age	Chronological Age of Worker (Years)	36,58	11,1	16	80
Age_c	Age Centered (Deviation on Mean 37,70)	0,00	11,1	-20,58	43,42
Age^2_c	Mean-centered Age	121,58	166,97	0,00	1.885,30
Urban	Residential Location (1 = Urban, 0 = Rural)	0,424	0,5	0	1
Sector	Sectors (Category 1 to 5)	4,74	0,86	1	5

Source: 2025 North Maluku Province Sakernas Microdata (data processed using Stata), 2026.

Average monthly worker income stands at IDR 3,548,041, while the mean of the income distribution transformed into its natural logarithm ($ln(Income)$) is 14.72. The wide income dispersion, spanning from a minimum monthly income of IDR 2,000 to a maximum of IDR 60,000,000, reflects substantial income inequality at the individual level.

This phenomenon of high income dispersion in regions powered by natural resources and manufacturing aligns with the arguments of Hakim & Guntur (2025) and Halim et al. (2025), who contend that regions driven by extractive economic growth tend to create a sharp income divide between the modern industrial labor force and traditional workers.

Among the total sample of 3,631 workers with identified employment status, 33.60% (1,220 workers) operate in the informal sector, whereas 66.40% (2,411 workers) are employed in the formal sector. Although the formal sector constitutes the majority within this sample, the presence of one-third of the labor force in the informal sector demonstrates that informal employment continues to serve as a primary safety net for absorbing excess labor supply. As articulated by Halim et al. (2025), the substantial prevalence of informal labor across Indonesia

highlights the limited capacity of the formal sector to generate inclusive and equitable employment opportunities for all segments of society.

Examined through the lens of human capital variables, the average duration of formal schooling among workers in North Maluku reaches 13.82 years. This figure is relatively high, reflecting an average educational attainment equivalent to senior high school or diploma graduates. However, this elevated level of formal education is not yet matched by technical skills certification; only 25.50% of workers have participated in training and hold registered credentials. This gap between formal education and vocational training confirms the findings of Khoiruddin et al. (2024) regarding human capital mismatch in Indonesia, where formal education often functions primarily as a credential signaling mechanism, while practical skills required by industry remain scarce.

From demographic and work experience perspectives, the mean age of workers in the sample is 36.58 years, accompanied by an average work experience of 8.48 years. These metrics indicate that the labor force structure in North Maluku operates within a highly advantageous productive age bracket. In the Mincerian regression specification, the age variable is transformed using mean-centering ($Age_c = Age - 36,58$) to optimize the estimation precision of the non-linear function. Geographically, the worker distribution is relatively balanced between urban (48,09%) and rural (51.91%) areas. However, in sectoral, an extreme concentration of labor is evident, with 92.12% of workers situated in Sector 5 (Services, Industry, and Non-Agriculture).

Table 2. Crosstabulation of Employment Status by Region and Industrial Sector

Classification Category	*Formal Employment (N=2.411)*	*Informal Employment (N=1.220)*	*Total Workers (N=3.631)*
Residential Location			
- Rural	1.182 (62,71%)	703 (37,29%)	1.885 (51,91%)
- Urban	1.229 (70,39%)	517 (29,61%)	1.746 (48,09%)
Economic Sector			
- Sector 1	4 (5,06%)	75 (94,94%)	79 (2,18%)
- Sector 2	6 (3,45%)	168 (96,55%)	174 (4,79%)
- Sector 3	0 (0,00%)	4 (100,00%)	4 (0,11%)
- Sector 4	3 (10,34%)	26 (89,66%)	29 (0,80%)
- Sector 5	2.398 (71,69%)	947 (28,31%)	3.345 (92,12%)

Source: 2025 North Maluku Province Sakernas Microdata (data processed using Stata), 2026.

An interplay exists between employment status, spatial location, and industrial sector structure. Examining employment status alongside geographical space and economic sectors reveals compelling aggregation patterns. Informal workers exhibit a higher concentration in rural areas (37.29%) compared to urban centers (29.61%). Conversely, formal employment is

predominantly situated in urban areas (70.39%). This spatial distribution aligns with the arguments of Syahrina et al. (2026), who emphasize that rural regions face restricted access to formal institutions, corporate entities, and structured labor markets, thereby compelling rural populations to rely on self-reliant informal economic activities.

From a sectoral perspective, a stark contrast emerges between the basic agricultural and extractive sectors (Sectors 1 through 4) and the industrial and non-agricultural sector (Sector 5). Sectors 1 through 4 are overwhelmingly dominated by informal employment, with informality rates ranging from 89.66% to 100.00%. Conversely, Sector 5 is comprised of 71.69% formal workers. The prevalence of informality across these land-based and small-scale enterprise sectors confirms the findings of Ablaza et al. (2023), who argue that primary sectors and traditional enterprises in Indonesia remain caught in an informality trap due to low levels of automation, restricted scale of operations, and minimal compliance with formal labor regulations.

Classical Assumption Tests

1) Multicollinearity Test

Multicollinearity was evaluated by examining the Variance Inflation Factor (VIF) values. To mitigate structural multicollinearity arising from the inclusion of the quadratic polynomial term of age (*age*), this study applies a mean-centering technique to both the age variable (*age_c*) and its squared term (*age_sq_c*).

Table 3. Multicollinearity Test

Variable	*VIF*	*1/VIF*
informal_dummy	1.32	0.756876
education	1.22	0.817791
train_dummy	1.11	0.903884
exp	1.49	0.669489
age_c	1.74	0.574969
age_sq_c	1.27	0.786669
urban_dummy	1.04	0.960011
sector		
2	3.07	0.325244
3	1.05	0.948885
4	1.36	0.736284
5	3.62	0.275870
Mean VIF	1.66	

Source: Data Processed using Stata, 2026

Based on the VIF test results, all independent variables exhibit very low VIF values, ranging between 1.04 and 3.62, with an overall mean VIF across the model of 1.66. Because every variable yields a VIF value well below the standard threshold of 10.00 (and Tolerance values 1/VIF > 0,10), the regression model is concluded to be entirely free from multicollinearity problems.

2) Heteroskedasticity Test

Formal testing was conducted using the Breusch–Pagan/Cook–Weisberg test for heteroskedasticity under the null hypothesis (H_0) that the error variance is constant (homoskedasticity).

Table 4. Heteroskedasticity Test

Breusch–Pagan/Cook–Weisberg Heteroskedasticity Test	
Assumption: Normal error terms	
Variable: Fitted values of ln_income	
H_0	*: Constant variance*
chi2(1)	= 65.40
Prob > chi2	= 0.0000

Source: Data Processed using Stata, 2026

Statistical testing on the residuals of the natural logarithm of income ($ln(income)$), yielded a test statistic of 65.40 with a $p-value$ of 0.0000. Because the $p-value$ is well below the significance threshold of $\alpha = 0{,}05$ ($p < 0{,}001$), the null hypothesis (H_0) is rejected. This result statistically confirms that the standard Ordinary Least Squares (OLS) multiple linear regression model suffers from heteroskedasticity.

To address the implications of heteroskedasticity without compromising the unbiased properties of the coefficient estimates, this study applies an econometric correction using heteroskedasticity-robust standard errors via the Huber–White sandwich estimator. By utilizing Ordinary Least Squares (OLS) estimation adjusted with heteroskedasticity-robust standard errors, the residual variance structure is corrected, ensuring that all hypothesis tests and $p-value$ across the regression model remain valid and free from heteroskedasticity-induced inference bias.

Multiple Linear Regression Analysis Results

To test the research hypotheses regarding income determinants and measure the magnitude of the income gap between formal and informal workers in North Maluku Province, the Extended Mincerian Earnings Function is estimated using Ordinary Least Squares (OLS) with heteroskedasticity-robust standard errors to correct for heteroskedasticity. The estimated econometric model is specified as follows:

$$ln(Income_i) = 13{,}5354 - 0{,}1256Informal_{dummy_i} + 0{,}0205Education_i + 0{,}1893Train_{dummy_i} + 0{,}0179Exp_i + 0{,}0073Age_c - 0{,}00051Age_{Sq_c_i} + 0{,}2313\ Urban_{dummy_i} + 0{,}6427Sector2_i + 0{,}0210Sector3_i + 0{,}3228Sector4_i + 0{,}7421Sector5_i + \varepsilon_i$$

Table 5. Ordinary Least Squares (Robust) Regression Estimation Results

Linear Regression		
No. of Obs	=	*3,631*
Population Size	=	*309,860*
Design df	=	*3,630*
F (11,3620)	=	*53.49*
Prob > F	=	*0.0000*
R-Squared	=	*0.1402*
ln_income	***Coefficient***	***Robust Std. Error***
informal_dummy	-.1256106***	.0426253
education	.0205959***	.0069443
train_dummy	.1893862***	.0389787
exp	.0179949***	.0021223
age_c	.0073758***	.0018204
age_sq_c	-.0005133***	.000116
urban_dummy	.2313717***	.0331303
sector		
2	.6427547***	.1279305
3	-.021002	.5042188
4	.3228066*	.1832091
5	.7421673***	.1095917
_cons	13.5354	.1488048

Note: *** $p < 0{,}01$; ** $p < 0{,}05$; * $p < 0{,}1$

Source: Data Processed using Stata, 2026

Hypothesis Testing:

1) Partial Test (*t-Test*)

Individually, the majority of key variables demonstrate a statistically significant effect on earnings at the 1% ($p = 0{,}01$) and 5% ($p = 0{,}05$) levels. Formal education ($\beta = 0{,}0205$), training ($\beta = 0{,}1893$), work experience ($\beta = 0{,}0179$), mean-centered age ($\beta = 0{,}0073$), and urban domicile ($\beta = 0{,}2313$) exert positive and statistically significant impacts on worker

income. Conversely, informal employment status ($\beta = -0{,}1256; p = 0{,}003$), and squared mean-centered age ($\beta = -0{,}0005; p = 0{,}000$), display negative and statistically significant relationships, empirically confirming the presence of an informal wage penalty and an inverted U-shaped (concave) life-cycle earnings trajectory. Among the structural controls, only the livestock sector variable (sector_3) fails to achieve statistical significance.

2) Simultaneous Test (*F-Test*)

The F-Test yields an F-statistic value of $F(11{,}3620) = 53{,}69$ with a probability value of 0,0000 ($p < 0{,}001$). This demonstrates that all independent variables simultaneously exert a statistically significant effect on worker income in North Maluku, confirming that the overall regression model is robust and statistically valid.

3) Coefficient of Determination (R^2)

The coefficient of determination (*R-squared*) obtained is 0.1402 (14.02%), indicating that 14.02% of the variance in the natural logarithm of monthly worker income in North Maluku is explained by the joint independent variables included in the model. The remaining 85.98% of the variation is attributed to unobserved factors outside the model specification, which is characteristic and widely observed in empirical studies utilizing individual cross-sectional micro-data.

DISCUSSION

Based on Table 5, the *informal_dummy* variable yields a regression coefficient of $\beta_1 = -0{,}1256$ with a robust standard error of 0.0426. The alternative hypothesis $(H_1) = \beta_1 < 0$ posits that informal sector workers earn significantly lower incomes compared to formal sector workers. Given that, the $p - value < 0{,}01$, H_0 is rejected and H_1 is accepted, empirically establishing a statistically significant earnings penalty for informal employment.

The dependent variable is log-transformed, the net percentage effect is derived using the exponential transformation $[e^{\beta} - 1] \times 100\%$. The calculation $[e^{-0{,}1256} - 1] \times 100\% = -11{,}80\%$ demonstrates that informal workers in North Maluku earn 11.80% less than formal workers, even after controlling for educational attainment, vocational training, work experience, age, geographic domicile, and industrial sector. This disparity points to underlying labor market segmentation and dualism in North Maluku. Furthermore, this finding aligns with empirical evidence from Santoso et al. (2022), who emphasize that informal sector workers are not merely characterized by lower average skill levels, but systematically face an earnings penalty relative to formal workers with identical qualifications.

Regarding the Human Capital Accumulation effect, the *education* variable yields a regression coefficient of $\beta_2 = 0{,}0205$ with a robust standard error of 0.0069. The alternative hypothesis $(H_1) = \beta_2 > 0$ posits that years of formal education exert a positive and statistically significant impact on worker income. Because the p-value is less than 0.01 ($p - value < 0{,}01$), H_0 is rejected and H_1 is accepted. Using the exponential transformation formula $[e^{\beta} - 1] \times 100\%$, the net percentage effect is calculated as $[e^{0{,}0205} - 1] \times 100\% = 2{,}08\%$. This

indicates that each additional year of formal education independently increases worker income by 2.08%. This finding validates Mincerian Human Capital Theory, demonstrating that investment in formal schooling enhances cognitive capacity, productivity, and efficiency in the labor market. Furthermore, this result aligns with empirical evidence from Hutapea (2022) in Indonesia, confirming that each additional year of schooling consistently provides positive and statistically significant economic returns for workers in the national labor market.

For the vocational training and certification variable *(train_dummy),* the regression coefficient is $\beta_3 = 0{,}1893$ with a robust standard error of 0.0389. The alternative hypothesis $(H_1) = \beta_3 > 0$ posits that holding vocational training or skills certification exerts a positive and statistically significant effect on worker income. The statistical results decisively reject H_0 and accept H_1 $(p - value < 0{,}01)$. Applying the exponential transformation $[e^{0{,}1893} - 1] \times 100\%$, workers who hold vocational training certifications enjoy an earning premium 20.84% higher than non-certified workers. The magnitude of this effect substantially exceeds the annual return to formal education, indicating that the labor market in North Maluku places a strong financial premium on marketable, job-ready technical skills. This finding aligns with empirical evidence from Pabiangan (2024), who emphasizes that in developing labor markets, training certifications yield exceptionally high returns because they instantly bridge skill gaps compared to general formal schooling.

Meanwhile, the regression coefficient for work experience *(exp)* is positive at $\beta_4 = 0{,}0179$. Applying the exponential transformation formula $[e^{0{,}0179} - 1] \times 100\%$, this yields a net percentage effect of 1.82%. This result indicates that, holding other factors constant, each additional year of practical work experience significantly increases worker income by 1.82%. This finding aligns with Human Capital Theory, which posits that the accumulation of practical skills and job mastery through learning-by-doing consistently enhances workers' marginal productivity, which in turn translates into higher earnings (Mincer, 1974; Becker, 1975).

Regarding the empirical test for a concave (inverted U-shaped) parabolic relationship between worker age and income in North Maluku Province, the null hypothesis (H_0) states that age exhibits neither a linear nor a quadratic effect on income $\beta_5 = 0$ dan $\beta_6 = 0$. Conversely, the alternative hypothesis (H_1) posits that age exerts a positive linear effect alongside a negative quadratic component $\beta_5 > 0$ dan $\beta_6 < 0$, forming an inverted U-shaped/concave trajectory. Based on the robust regression estimation results, the *age_c* variable yields a positive linear coefficient of $\beta_5 = 0{,}0073$ with a robust standard error of 0.0018. Meanwhile, the *age_sq_c* variable displays a negative quadratic coefficient of $\beta_6 = -0{,}0005$ with a robust standard error of 0.0001. Because the linear coefficient of *age_c* is statistically significantly positive and the quadratic coefficient of *age_sq_c* is statistically significantly negative, H_0 is rejected and H_1 is accepted.

Methodologically, the application of mean-centering by centering the *age_c* variable at the sample mean ($\overline{Age}$ = *36,58* years) successfully eliminates structural multicollinearity without altering the shape or substantive interpretation of the estimated income curve

(Wooldridge, 2020; Gujarati & Porter, 2020). Economically, this empirical pattern confirms the Mincerian life-cycle human capital framework, wherein worker income increase with age and cumulative work experience, albeit at a diminishing rate until reaching a turning point, after which they decline due to the depreciation of physical capacity and human capital obsolescence (Ehrenberg et al. 2025). The peak earnings age (Age^*) is precisely calculated by evaluating the first-order condition of the estimated regression equation with respect to the *age_c* variable.

$$Age_c^* = -\frac{0{,}0073758}{2 \times (-0{,}0005133)} = \frac{0{,}0073758}{0{,}0010266} \approx \mathbf{7,18\ years}$$

The value of $Age_c^* = +7{,}18$, indicates that peak worker earnings are attained at 7.18 years above the mean sample age. Converting this back to the actual age scale yields (Age^*).

$$(Age^*) = \overline{Age} + Age_c^* = 36{,}58 + 7{,}18 = \mathbf{43,76\ years}$$

Based on these estimates, peak worker earnings in North Maluku Province are attained at 43.76 years of age. Beyond this threshold of 43.76 years, worker earnings gradually begin to decline, which aligns with empirical patterns observed in developing labor markets (World Bank, 2019).

Regarding job and regional characteristics, the analysis examines the impact of geographic disparities (urban versus rural) and structural business sectors on worker income variation in North Maluku Province. The urban domicile variable *(urban_dummy)* yields a positive regression coefficient of $\beta_7 = 0{,}2313$. Because the dependent variable is log-transformed and the independent variable is a binary indicator, the relative percentage effect is derived using the exponential transformation formula $\left[e^{\beta_7} - 1\right] \times 100\%$. The calculation $[e^{0{,}2313} - 1] \times 100\% = 26{,}02\%$, demonstrates that workers residing in urban areas earn a statistically significant 26.02% more than their rural counterparts, holding all other factors constant. This finding confirms the presence of a substantial urban wage premium in North Maluku, driven by economic agglomeration effects, capital concentration, technology exposure, and greater urban labor market efficiency (Ridhwan, 2021).

Following the examination of individual human capital dynamics and peak life-cycle productivity, the analysis shifts to the structural dimensions that shape economic opportunities for workers in North Maluku Province. Classical Mincerian theory asserts that earnings variation stems not only from individual supply-side characteristics, but is also strongly determined by demand-side factors related to the specific sectors in which labor is allocated. Therefore, to isolate the net effect of each economic sector on worker income, industrial sector variables were included in the regression model as categorical dummy variables, with Sector 1 (Food Crop Agriculture) designated as the reference category. The empirical estimation results

regarding the relative effects of sectoral segmentation in comparison to Sector 1 are presented below:

1) The estimated regression coefficient for Sector 2 (Non-Food Crop Agriculture) is positive and statistically significant at $\gamma_2 = 0{,}6427$ ($t = 5{,}029; p - value = 0{,}000$). Converting this dummy variable coefficient into a net relative effect using the exponential transformation formula $[e^{0{,}6427} - 1] \times 100\%$ yields an earnings differential of 90.16%. This indicates that, holding educational attainment, work experience, and other demographic controls constant, workers in Non-Food Crop Agriculture earn a statistically significant 90.16% more than those in the baseline category, Food Crop Agriculture ($p = 0{,}001$).
2) The estimated coefficient for Sector 3 (Livestock) is $\gamma_3 = 0{,}0210$ ($t = 0{,}04; p = 0{,}967$). The high $p - value = 0{,}967$ ($p > 0{,}01$) confirms that there is no statistically significant earnings differential between workers in Livestock and those in the benchmark category, Food Crop Agriculture (Sector 1). From an economic perspective, this finding aligns with local structural conditions, as both sub-sectors operate primarily within traditional, subsistence-scale frameworks characterized by comparable levels of productivity, low capital intensity, and equivalent economic returns in North Maluku.
3) The estimated coefficient for Sector 4 (Fisheries) is positive at $\gamma_4 = 0{,}3228$ ($t = 1{,}76; p = 0{,}078$). Applying the exponential transformation $[e^{0{,}3228} - 1] \times 100\%$, yields a net relative effect of 38.10%. This indicates that workers in the fisheries sub-sector earn 38.10% more than those in Food Crop Agriculture, a result that is statistically significant at the 10% level ($p < 0{,}01$). This premium underscore the substantial economic potential of the maritime sector within the archipelagic geography of North Maluku.
4) For Sector 5 (Services, Industry, and Non-Agriculture), the estimated regression coefficient is positive and highly statistically significant at $\gamma_5 = 0{,}7421$ ($t = 6{,}77; p = 0{,}000$). Applying the exponential transformation formula $[e^{0{,}7421} - 1] \times 100\%$, this sector commands the largest earnings premium in North Maluku's economy, generating an income advantage of 110.03% over the baseline Food Crop Agriculture sector. This substantial wage advantage is driven by a higher concentration of formal sector employment, manufacturing and industrial activities, and modern service operations that demand higher human capital thresholds and yield greater value-added productivity.

CONCLUSIONS AND RECOMMENDATIONS

The findings of this study demonstrate that worker income, serving as a proxy for economic welfare in North Maluku Province, is significantly determined by the interaction between employment status, human capital accumulation, and spatial factors. Workers in the informal sector experience a statistically significant income penalty, receiving 11.80% less than

formal workers, which underscores the rigid segmentation of the region's dualistic labor market. From a human capital perspective, each additional year of formal education increases income by 2.08%, whereas holding a vocational training certificate commands a far more dominant income premium of 20.84%. Furthermore, the accumulation of practical work experience consistently enhances economic returns by 1.82% per year.

Worker income dynamics in North Maluku also adhere to the concave parabolic trajectory prescribed by the Mincerian life-cycle framework. Accumulated experience and age maturity drive income upward gradually until reaching peak productivity at 43.76 years of age, beyond which income follows a downward trend due to human capital depreciation and declining physical capacity. This pattern is further compounded by structural spatial and sectoral disparities, where an urban wage premium affords urban residents a 26.02% higher income than their rural counterparts. Sectorally, substantial income premiums in services, industry/non-agriculture, and fisheries widen the income gap relative to traditional rural agriculture, establishing these sectors as the primary engines of worker welfare in this archipelagic region. Collectively, these structural inequalities highlight the tangible challenges facing North Maluku Province in advancing Sustainable Development Goal (SDG) 8 (Decent Work and Economic Growth), particularly regarding the need to ensure that rapid regional economic growth is accompanied by the creation of decent work, labor market formalization, and equitable economic distribution.

Despite offering a comprehensive econometric assessment, this study is subject to several methodological and theoretical limitations. The cross-sectional nature of the National Labor Force Survey (SAKERNAS) dataset restricts the model's ability to capture dynamic, longitudinal career trajectories and cannot fully account for unobserved heterogeneity, which may introduce omitted variable bias. Additionally, the supply-side orientation of the classical Mincerian framework omits institutional demand-side dimensions, such as regional minimum wage policies, labor market regulations, and the influence of regional labor-intensive investment structures.

Furthermore, these remaining analytical constraints provide clear avenues for future scholarly inquiry. To overcome these limitations, future research agendas should utilize panel data to analyze worker career transitions longitudinally, apply instrumental variable methods to address potential endogeneity, and expand the analytical framework to integrate labor demand dynamics alongside regional macroeconomic factors.

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