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Determinants of Female Worker Productivity in Indonesia: Panel Data Analysis

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Abstract

This study examines the determinants of female labor productivity in Central Java Province during 2019–2023 by analyzing the effects of the number of female workers, female education level, female Human Development Index (HDI), Gender Empowerment Index (GEI), and female wage level. Using a quantitative approach, panel data from districts/cities were analyzed through the Fixed Effects Model (FEM), with variables measured annually and controlled for regional heterogeneity. The results show that the number of female workers negatively affects female labor productivity, indicating that increases in labor quantity without proportional improvements in quality may reduce efficiency. Conversely, female education level, HDI, GEI, and wage level positively influence productivity, suggesting that human capital quality and empowerment play a central role in enhancing output performance. These findings imply that policies should prioritize education, health, skill development, fair wages, and gender empowerment rather than focusing solely on labor absorption. Strengthening productivity-oriented employment strategies is essential so workforce expansion is accompanied by efficiency gains. Future research may incorporate sectoral composition, technological adoption, and labor participation dynamics to better capture structural productivity differences across regions.

Keywords: *female labor productivity; number of female workers; female education level; female human development index; gender empowerment index; female wage level; fixed effects model*

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INTRODUCTION

Labor is a powerhouse in propelling economic advancement, particularly when armed with the right skills and capabilities (Asrinda et al., 2022). A proficient workforce has the potential to boost productivity, ignite innovation, and enhance efficiency across various economic sectors. Therefore, elevating the caliber of human resources through training, education, and skill enhancement is crucial for fostering sustainable economic growth.

Amplifying labor productivity is vital for the economy at large, as it directly influences the competitiveness of a nation or region (Puspasari & Handayani, 2020). An efficient workforce can yield greater outputs with the same resources, thereby slashing production costs and heightening efficiency. Elevated productivity also leads to increased wages and improved labor welfare.

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Table 1. Number (Persons) and Productivity of Male and Female Workers (Million Rupiah Per Person) in Central Java Province 2019-2023

Years	Number of Workers		Productivity	
	Men	Women	Men	Women
2019	10239961	7201192	97	138
2020	10088536	7448399	96	130
2021	10282028	7553742	97	132
2022	10691448	7699011	98	136
2023	11739366	8249509	94	134

Source: Central Statistics Agency (BPS)
Note: *) Productivity is calculated by dividing GRDP by the number of workers.

According to Table 1, it is evident that the workforce in Central Java province is poised for growth from 2019 to 2023, encompassing both male and female employees. Conversely, the productivity of male workers has shown a tendency to plateau over the last five years, even witnessing a marginal drop in 2023, marking it as the lowest productivity during that timeframe. On the flip side, female workers consistently outperformed their male counterparts in productivity, with minor fluctuations occurring occasionally. The rise in women's human capital, including knowledge and skills (refer to Table 2), underscores the reasons behind the surge in female productivity (Said et al., 2016).

The enhancement in labor force quality, signified by an elevating average educational attainment, positively influences the growth of labor productivity (Zahari et al., 2022). Advanced education typically yields a workforce endowed with superior knowledge and skills, enabling them to execute tasks more effectively and adapt to technological advancements and labor market shifts. Hence, investment in education emerges as a pivotal long-term strategy for fostering economic growth via heightened productivity in the labor sector.

Table 2. Percentage of Higher Education Population in Central Java Province

Years	Men	Women
2019	30,94	23,94
2020	32,85	26,97
2021	32,26	26,82
2022	34,14	28,79
2023	34,82	29,20

Source: BPS

Table 2 reveals that from 2019 to 2023, the proportion of individuals possessing higher education in Central Java Province saw an upward trend among both men and women. Nonetheless, a significant gender disparity exists in higher education engagement, with the percentage of educated males surpassing that of females. In situations where family finances are tight, the priority for educational opportunities

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tends to favor boys, despite girls having equal potential and capabilities to pursue higher education. This indicates that gender biases in educational choices are still prevalent, potentially widening the gender gap (Achmad, 2019).

Achieving gender equality means leveling the playing field for both men and women across all sectors, particularly in education (Fitriani & Neviyarni, 2022). Granting women the same educational opportunities as men will empower them with knowledge and insights, ultimately enhancing productivity and employment outcomes.

Table 3. Male Human Development Index, Female Human Development Index, and Gender Empowerment Index (GEM) in Central Java Province

Years	HDI		IDG
	Men	Women	
2019	75,79	69,64	72,18
2020	75,87	69,94	71,73
2021	76,08	70,36	71,64
2022	76,54	71,05	73,78
2023	77,13	71,63	74,18

Source: BPS

Table 3 illustrates the upward trajectory of the Human Development Index (IPM) and Gender Empowerment Index (IDG) in Central Java Province, consistently rising year after year. However, a glaring disparity persists between the male and female IPM figures. This discrepancy can be attributed to ongoing gender inequalities within society, including the dual burdens faced by women and violence against them (Jumiati, 2020). Conversely, the IDG in Central Java province is also on the rise, likely due to enhanced opportunities for women to engage more actively in public spheres, including the workforce (Abdurrahman & Tusianti, 2021).

Beyond the count of workers, education, IPM, and IDG, labor productivity is significantly influenced by wage increases. Elevated wages boost employees' motivation, propelling them to exert greater effort. Furthermore, wage hikes positively affect worker health, as higher earnings enable workers to afford nutritious food, ultimately enhancing their energy and endurance, which in turn elevates productivity levels (Rahmi & Riyanto, 2022). Companies that offer competitive wages create a financial incentive that drives workers to enhance their productivity, as they feel recognized for their contributions to the organization.

Table 4. Wages of Male and Female Workers (Rupiah) in Central Java Province

Years	Worker's Wages	
	Men	Women
2019	2438257	1816805
2020	2344375	1725461
2021	2296349	1765799
2022	2427528	1869967
2023	2544719	1973400

Source: BPS

According to Table 4, it is evident that male workers earn higher wages compared to their female counterparts. This disparity arises from the variance in working hours, as men often seize opportunities for extended work hours due to a

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lack of domestic obligations. In contrast, women frequently juggle dual responsibilities as employees and caretakers, leading many to opt for jobs with flexible schedules, which inadvertently restricts their engagement and presence in the workforce (Gautama et al., 2021).

From this information, it is clear that Central Java Province continues to experience a divide between men and women across various employment dimensions, including productivity, educational attainment, Human Development Index (IPM), and wages earned. Despite a rise in female workforce participation and access to advanced education, their productivity and earnings still trail behind those of men. With this context and the problem outlined, the purpose of this study was to evaluate the impact of the number of female workers, women's educational levels, the Human Development Index (IPM) for women, the Gender Empowerment Index (IDG), and women's wage levels on the productivity of female labor in Central Java Province from 2019 to 2023.

LITERATURE REVIEW

Chairunnisa & Juliannisa (2022) boldly employed the Ordinary Least Squares (OLS) model to scrutinize the impact of education, health, age, and wages on labor productivity in DKI Jakarta spanning 1991-2020. The study boldly revealed that age and wage levels exerted a positive influence on labor productivity, whereas education and health surprisingly had a negative impact on it. This outcome starkly contrasts with the findings from Mahendra & Pasrizal (2025), who asserted that education and health positively influence labor productivity, along with income in Padang Panjang City from 2017-2023. In parallel, Nor et al. (2023) boldly demonstrated that capital positively influences labor productivity, while local and foreign workers negatively affect it in Malaysia between 1986 and 2020.

Putri & Kusreni (2017) utilized panel data regression with a Fixed Effects Model (FEM) approach to assertively estimate the impact of health, education level, and wages on labor productivity in Indonesia during 2008-2013. The findings emphatically indicated that health, education, and wages positively influenced labor productivity in Indonesia for that period. This aligns resolutely with the discoveries of Puspasari & Handayani (2020), who confirmed that education, health, and wages positively affect labor productivity in Central Java Province from 2010-2015. Furthermore, Arham & Junus (2020) found a similar positive impact of wages on productivity in their Indonesian research from 2014-2019. They also discovered that working hours, the number of SMK graduates, and PDRB positively affected labor productivity, while unemployment, foreign investment, per capita spending, and electricity capacity negatively impacted it in Indonesia. Subsequently, Sari & Oktora (2021) conducted a study in Indonesia from 2010-2015, also affirming that wages positively influenced labor productivity, alongside IPM and investment.

Ariani & Sari (2022), employing the FEM approach, found that women's life expectancy and average schooling duration positively influenced labor productivity, while TPAK and per capita spending negatively affected it in West Java Province from 2015-2020. Later, Maharani & Woyanti (2023) boldly revealed that health and wages positively influenced labor productivity, whereas education and foreign investment had no effect in Indonesia during 2010-2019. The positive effects of wages and health

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on labor productivity were also highlighted by Alviona & Faridatussalam (2023) in their study in West Nusa Tenggara from 2018-2021. They also noted that education negatively impacted labor productivity. This conclusion aligns powerfully with the findings of Andriani & Wijaya (2024), who stated that wages positively affect labor productivity, while education had a negative effect, and the dependency ratio bore no influence in East Java from 2017-2022.

Zakaria (2022) employed panel data regression with the Random Effects Model (REM) technique and revealed that the minimum wage and average education length positively influenced labor productivity, while the human development index negatively impacted labor productivity in various districts and cities of East Java Province from 2015 to 2019. Conversely, this wage effect contradicts the findings of Yuliana (2023) in her Indonesian research from 2009 to 2011, which indicated that wages adversely affected labor productivity. Additionally, it was discovered that education did not impact labor productivity.

Baharin et al. (2020) carried out a study in Indonesia covering 1981 to 2014 through the Autogressive Distributed Lag (ARDL) analytical method and found that, in the short term, education and health positively affected labor productivity. However, in the long run, education negatively impacted, while health continued to positively influence labor productivity. These findings partially conflict with the results of Restiatun et al. (2024), who utilized the Dynamic Autogressive Distributed Lag (DARDL) methodology, revealing that wage and education levels positively influenced productivity in both short and long terms, whereas health negatively affected worker productivity over the same periods in Indonesia from 1991 to 2023.

This study diverges from prior research by focusing on worker productivity specifically concerning female workers. By centering on female productivity as the dependent variable, this research effectively illustrates the impact of various factors on women in the labor market. This distinct variable also highlights women's role in employment, showcasing their contributions to economic advancement. Furthermore, the study incorporated the gender empowerment index as one of the independent variables, a facet that has not been extensively explored previously.

RESEARCH DESIGN AND METHODOLOGY

This research is a bold quantitative analysis utilizing secondary data sourced from the Central Statistical Agency (BPS) covering the years 2019-2023. The data employed in this research is an integration of cross-sectional and time series data. In this investigation, the cross-sectional data encompasses 35 districts/cities within the Central Java province, while the time series data spans from 2019 to 2023. The econometric equation devised for evaluating the impact of the number of female workers, women's education levels, the Human Development Index (IPM) for women, the Gender Empowerment Index (IDG), and the wage levels of women on the productivity of the female labor force is outlined as follows:

$$LogPRODP = \beta_0 + \beta_1 LogJPP_{it} + \beta_2 PPTP_{it} + \beta_3 IPMP_{it} + \beta_4 IDG_{it} + \beta_5 LogUPP + \varepsilon_{it}$$

where:

PRODP : Women's productivity (million rupiah per person)

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β_0	:	Constant
$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$	:	Coefficient
JPP	:	Number of female workers (people)
PPTP	:	Percentage of highly educated women (%)
IPMP	:	Female HDI
IDG	:	Gender empowerment index
UPP	:	Female workers' wages (rupiah)
I	:	*Cross section (35 districts/cities in Central Java Province)*
T	:	*Time series (2019-2023)*
E	:	Residual

The panel data regression methodology employs three distinct estimates: the Common Effects Model (CEM), the Fixed Effects Model (FEM), and the Random Effects Model (REM). The identification of the most effective models is carried out via the Chow Test and the Hausman Test. The optimal model selected will be utilized to gauge the impact of independent variables on the dependent ones.

The model existence test, or F test, is conducted to ascertain whether the independent variables collectively influence the dependent variable. The null hypothesis (H0) for the F test asserts that $\beta1 = \beta2 = \beta3 = \beta4 = \beta5 = 0$, indicating that the number of female workers, women's education level, the Human Development Index (IPM) for women, the Gender Empowerment Index (IDG), and the wage level of women do not affect the productivity of female labor in Central Java Province. The null hypothesis (H0) is dismissed when the probability of the F-statistic is less than a certain threshold (Indrasto et al., 2025).

Subsequently, a t-test is essential to determine if the individual independent variables impact the dependent variable. The null hypothesis (H0) claims that $\beta i = 0$ (i = 1-5), suggesting that the number of female workers, women's education level, the Human Development Index (IPM) for women, the Gender Empowerment Index (IDG), and the women's wage level do not collectively influence female labor productivity. Furthermore, Hamen$\beta1 < 0$ indicates that the number of female workers has a negative impact on female labor productivity, while $\beta i > 0$ (i = 2-5) signifies that women's education level, the Human Development Index (IPM) for women, the Gender Empowerment Index (IDG), and women's wage rate each positively influence female labor productivity.

RESULT AND DISCUSSION

Bold evaluations of the panel data regression model were executed through three distinct methodologies: the Common Effects Model (CEM), the Fixed Effects Model (FEM), and the Random Effects Model (REM). The findings from the panel data estimation are presented in Table 5.

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Variable	Regression Coefficient		
	CEM	**FEM**	**REM**
C	-7,693035	3,484943	2,681572
LOG(JPP)	0,036902	-0,733014	-0,653409
PPTP	0,025620	0,004254	0,003894
IPMP	-0,006395	0,002877	0,002375
IDG	-0,002938	0,012823	0,011776
LOG(UPP)	0,350952	0,146003	0,142881
R^2	0,505932	0,995998	0,614015
Prob.F	0,000000	0,000000	0,000000
1) Chow *Cross-section F* **(32, 127) = 485,9982; Prob.** *F* **= 0,0000**			
2) Hausman *Cross-section random* χ^2 **(5) = 39,7553; Prob** χ^2 **= 0,0000**			

Table 5. CEM, FEM, and REM Regression Results

The results from the CEM, FEM, and REM regression analyses necessitate the execution of two critical tests to ascertain the optimal model for estimating the panel data. Initially, the Chow Test was conducted to identify whether CEM or FEM is superior. Subsequently, the Hausman Test was employed to ascertain whether FEM outperforms REM.

The condition for the Chow Test stipulates that if the F-statistic probability is < α, H0 is dismissed, indicating that FEM is the more advantageous model over CEM. In contrast, the Hausman Test requires that if the probability is < α, H0 is rejected, indicating that FEM is the more fitting model compared to REM. The findings from both the Chow Test and the Hausman Test present in Table 5 reveal that the Cross-section F probability is 0.0000 < α (0.01) and the probability is 0.0000 < α (0.01), leading to the rejection of H0 as both probabilities fall below α. Consequently, FEM stands out as the most suitable model for estimating panel data.

Table 6. FEM Regression Results

$$logPRODP_{it} = \underset{}{3{,}484943} - \underset{(0{,}0000)^*}{0{,}733014}\ logJPP_{it} + \underset{(0{,}0000)^*}{0{,}004254} PPTP_{it} + \underset{(0{,}0001)^*}{0{,}002877} IPMP_{it} + \underset{(0{,}0147)^{**}}{0{,}012823} IDG_{it} + \underset{(0{,}0001)^*}{0{,}146003} logUPP_{it}$$

R^2 = 0,995998; *F-stat* = 854,2539; Prob *F-stat* = 0,0000

Note: *significant coefficient at α 0.01; **significant coefficient at α 0.05

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Table 6 boldly reveals that the F-statistic probability value of 0.0000 is less than α (0.01), leading to the rejection of H0. This decisively indicates that the quantity of female workers, women's education level, the Human Development Index (IPM) for women, the Gender Empowerment Index (IDG), and the female wage rate collectively exert a significant positive impact on female labor productivity in Central Java Province between 2019 and 2023. The coefficient of determination (R2) standing at 0.995998 boldly asserts that a staggering 99.59% of the variance in women's labor productivity is attributable to variations in the number of female workers, women's educational attainment, the women's Human Development Index (IPM), the Gender Empowerment Index (IDG), and the female wage rate, while a mere 0.41% is influenced by other external factors beyond this model.

The t-test is rigorously employed to evaluate whether each independent variable has a partial or individual impact on the dependent variable. According to Table 7, it is emphatically concluded that the number of female workers negatively impacts female labor productivity. Conversely, women's education level, the women's Human Development Index (IPM), the Gender Empowerment Index (IDG), and the female wage rate positively contribute to women's labor productivity in Central Java Province from 2019 to 2023. The summary of t-test findings is boldly encapsulated in Table 7.

Table 7. Results of the t-test

Variable	Cofficient	Prob. *t*	
LogJPP	-0,733014	0,0000	β_1 significant at *a* 0,01
PPTP	0,004254	0,0001	β_2 significant at *a* 0,01
IPMP	0,002877	0,0147	β_3 significant at *a* 0,05
IDG	0,012823	0,0000	β_4 significant at *a* 0,01
LogUPP	0,146003	0,0001	β_5 significant at *a* 0,01

A JPP coefficient of -0.733 indicates that a one percent rise in the number of female employees would result in a 0.733 percent decline in female labor productivity. The PPTP coefficient stands at 0.0042 following a log-linear relationship pattern, signifying that an additional one percent of highly educated women would boost female labor productivity by 0.425 percent. Furthermore, an IPMP coefficient of 0.0028 with a log-linear relationship pattern implies that an increase in the female human development index by one would enhance female labor productivity by 0.287 percent. Additionally, an IDG coefficient of 0.0128 with a log-linear relationship pattern shows that a one-point rise in the gender empowerment index will escalate the productivity of the female workforce by 1.282 percent. A one percent hike in female worker wages would uplift female workforce productivity by 0.146 percent.

The regression results reveal that the quantity of female workers negatively impacts the productivity of women's labor. These findings align with Nor et al. (2023), who assert that if the surge in workforce numbers is primarily comprised of workers with lesser skills, their output capacity remains constrained. This limitation results in lower output per worker, leading to a decline in labor productivity.

Table 8. Number of Female Workers based on Highest Education Completed (Person) in Central Java Province

Years	SD	SMP	SMA	PT
2019	112908347.7	43859489.01	50562910.44	15251638.58

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2020	115493173.8	44976417.68	50927232.03	15532821.89
2021	109345101.5	44413705.48	53783609.14	15641223.82
2022	119474837.6	46659382.03	52421003.86	14385664.28
2023	125996221.6	56045423.46	64417997.78	17955336.99

Source: BPS

According to Table 8, the count of female workers in Central Java Province based on their highest level of education from 2019 to 2023 exhibits a notable upward trajectory, although there are fluctuations across different education tiers. The number of women with primary and secondary education has shown a steady annual increase, marked by a minor dip in 2021, followed by a resurgence in subsequent years. In contrast, female workers with high school and college education have shown a more stable rise, particularly in 2023, which reports significant growth. This rise in the percentage of women attaining secondary and higher education signifies an enhancement in the quality of women's human resources, theoretically translating to improved skills, work efficiency, and female labor productivity in the region.

As for the impact of the percentage of women with higher education on female labor productivity, this study's results align with the research by Mahendra & Pasrizal (2025), which indicated that education positively influences labor productivity in Padang Panjang City from 2017 to 2023. Educated women typically possess superior skills and knowledge, enabling them to work more effectively and adapt to technological advancements that boost female workforce productivity. This conclusion also echoes the findings of Putri & Kusreni (2017), which asserted that education levels positively affect labor productivity in Indonesia from 2008 to 2013. Conversely, Chairunnisa & Juliannisa (2022) reported differing results, indicating that higher education without strong capabilities or competitiveness fails to produce a qualified workforce, leading to diminished productivity.

The impact of the women's Human Development Index in this study aligns with the discoveries of Sari & Oktora (2021), where the quality of human capital, reflected in education and health, is crucial for enhancing women's labor productivity. Highly educated individuals are likely to possess the necessary knowledge and cognitive skills to work efficiently. Furthermore, good health enables individuals to operate at their best with reduced risk of work-related issues. However, these findings contradict Zakaria (2022) observations, which noted that as the Human Development Index rises, education and workforce health improve. Yet, if job types available do not demand high skills, such labor capabilities remain underutilized. Consequently, a high-quality workforce may find itself in roles that do not align with their abilities, resulting in decreased productivity for these workers.

On the flip side, the findings from the Gender Empowerment Index in this research resonate with the conclusions drawn by Ariani & Sari (2022), where empowering women by granting equal access to the labor market significantly amplifies both the quantity and quality of the female workforce. This surge in equality propels women away from low-yield informal jobs and into high-yield formal employment. Conversely, Arham & Junus (2020) uncovered contrasting results, asserting that merely providing women with opportunities in the industrial sector doesn't inherently boost labor productivity, particularly when women's empowerment lacks the accompanying enhancement of skills and adaptability to

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technological advancements. As technology enhances production efficiency, the role of labor in the production cycle diminishes, ultimately leading to a decline in productivity.

The impact of wages on women's labor productivity in this analysis aligns with the observations of Alviona & Faridatussalam (2023), indicating that wages serve as compensation for labor performance within companies. Elevated wages will inspire workers to elevate their performance and generate higher output. Furthermore, the increase in wages received by employees will amplify their productivity. These findings echo the research by Andriani & Wijaya (2024), which determined that wages positively influenced labor productivity in East Java during 2017-202. However, these results diverge from Yuliana (2023) observations. When wages are raised, companies often respond by hiring more workers. Yet, this influx of labor does not correlate with a sufficient increase in output or production capacity, leading to a diminished contribution of workers to overall output and causing labor productivity to actually plummet.

Labor productivity stands as a crucial measure for evaluating the efficiency and caliber of the workforce in generating output, alongside their overall contribution to the economy. This study aims to unveil the extent and direction of the impact that the count of female workers, their educational attainment, the women's human development index, the gender empowerment index, and the level of women's wages exert on the productivity of female labor in Central Java Province from 2019 to 2023. To fulfill the study's objective, a panel data regression was conducted utilizing the Fixed Effects Model (FEM) as the chosen methodology. The findings revealed that the number of female workers negatively influenced their productivity, whereas higher education levels, improved human development indices, gender empowerment metrics, and increased wage rates positively affected women's labor productivity.

In light of these findings, it is imperative for the government to intensify efforts in prioritizing strategies that enhance the quality of the female workforce by broadening access to tertiary education, vocational training, and advancing health standards for women, ensuring that an increase in the workforce does not detrimentally impact labor productivity. Moreover, the advancement of women's empowerment must persist through policies that foster gender equality within the job market, mitigate wage disparities, and bolster women's entry into sectors with greater productivity potentials.

CONCLUSION

Labor productivity stands as a crucial measure for evaluating the efficiency and caliber of the workforce in generating output, alongside their overall contribution to the economy. This study aims to unveil the extent and direction of the impact that the count of female workers, their educational attainment, the women's human development index, the gender empowerment index, and the level of women's wages exert on the productivity of female labor in Central Java Province from 2019 to 2023. To fulfill the study's objective, a panel data regression was conducted utilizing the Fixed Effects Model (FEM) as the chosen methodology. The findings revealed that the number of female workers negatively influenced their productivity, whereas higher

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