Science & Technology Development Journal – Economics - Law and Management 2025, ():1-8

Open Access Full Text Article

Research article

Information technology and wage disparities between labor groups: An empirical study in Vietnam

Dong Nguyen Thi[1,2,*], Tu Le Thi Ngoc[3], Van Tran Quang[4]

ABSTRACT

The world is undergoing rapid transformation, propelled by groundbreaking advancements in science and technology. Within this dynamic and ever-evolving landscape, the advent of the Fourth Industrial Revolution, often referred to as Industry 4.0, has significantly extended the boundaries of human existence. This era is marked by the seamless integration of physical and digital realms, which are primarily driven by two pivotal elements: data and connectivity. As industries increasingly rely on digital technologies, the workplace is being redefined, and workers are required to adapt to these changes. Embracing artificial intelligence and related technologies in the workplace can empower the workforce of the 4.0 era, enabling them to drive heightened productivity, achieve their desired income levels, and and reduce economic economic disparities. This study aims of this study is to investigate wage differentials between two distinct labor groups: those utilizing information technology (IT) in their work and those who do not. Specifically, it seeks to understand whether adopting IT-related skills can bring workers tangible financial benefits for workers. Using data from the Labor Force Survey (LFS), the study employs both the Oaxaca-Blinder decomposition and quantile regression methods to understand wage disparities across different income levels comprehensively. The study's findings of the study highlight that, beyond traditional wage determinants such as education, qualifications, and gender, the use of IT significantly impacts workers' earnings. Employees who leverage IT in their job roles tend to command higher wages. Furthermore, the study reveals that income inequality is notably reduced among workers who utilize IT, indicating that IT is crucial in promoting both individual wage growth and a more equitable income distribution.

Key words: Quantile regression, Oaxaca-Blinder composition, information technology (IT), wage disparities

[1]*University of Economics and Law, Ho Chi Minh City, Viet Nam*

[2]*Vietnam National University, Ho Chi Minh City, Vietnam*

[3]*University of Management and Technology, Ho Chi Minh City*

[4]*Ho Chi Minh University of Banking, Viet Nam*

Correspondence

Dong Nguyen Thi, University of Economics and Law, Ho Chi Minh City, Viet Nam

Vietnam National University, Ho Chi Minh City, Vietnam

Email: dongnt@uel.edu.vn

History

- Received: 9-5-2024
- Revised: 29-9-2024
- Accepted: 8-10-2024
- Published Online:

DOI :

INTRODUCTION

The world is undergoing a profound transformation driven by the 4.0 industrial revolution. This era marks a convergence of digital technologies like automation, artificial intelligence, and computer communications, shaping a smarter and more adaptable manufacturing landscape. The development of information technology (IT) has made the world feel smaller, breaking down geographical barriers and enabling global connectivity in both work and communication. In this landscape, mastering IT skills opens doors to expanding job scopes and accessing modern, flexible work environments. It paves the way for individuals to enter a more equitable society, where earnings align with skills and are unaffected by gender, race, or location. However, the widespread adoption of IT-driven automation can also bring challenges such as job losses, job transitions, or reduced wages in specific sectors, posing risks to workers. While some traditional skill sets may still offer stability in select cases, the overall relationship between IT adoption and wages is multifaceted, reflecting the intricate interplay of technological progress, labor market dynamics, and organizational strategies. Hence, exploring the correlation between IT and income is vital for fostering sustainable and equitable employment in the future.

With its rapidly growing economy and increasingly international working environment, Vietnam is being strongly impacted by the Fourth Industrial Revolution. The boom in information technology is opening up many new job opportunities, especially in fields related to automation and artificial intelligence. However, along with these opportunities come many challenges, such as the need to retrain the workforce, wage disparities between industries and geographical areas, as well as the risk of job losses in traditional occupations. Therefore, studying the correlation between IT applications and wages in Vietnam not only helps clarify technology's impact on the domestic labor market and provides a scientific basis for developing appropriate labor and wage policies. This is crucial

Cite this article : Thi D N, Ngoc T L T, Quang V T. **Information technology and wage disparities between labor groups: An empirical study in Vietnam**. *Sci. Tech. Dev. J. - Eco. Law Manag.* 2025; ():1-8.

for Vietnam to maximize the benefits of the Fourth Industrial Revolution while minimizing its negative impacts on the workforce.

LITERATURE REVIEW

The wage gap is a significant concern for both the government and workers alike. From the government's perspective, it reflects the economic health and the efficacy of socio-economic management. When wages are fairly distributed across society regardless of gender, location, or ethnicity, it boosts productivity and fosters a fair and equitable society[1–3]. For workers, their salary isn't just a paycheck; it's the value of their labor and the foundation upon which they build their lives. It's a unique commodity shaped by personal attributes like education, experience, age, gender, and occupation[4–8].

The wage gap has been discussed since Edgeworth's time, over a century ago, shedding light on why men and women earn different salaries despite performing the same tasks[9]. Later, economists like Becker[10], Mincer[11], Schultz[12] delved into wage disparities through an economic lens. They not only identified causes of the wage gap but also developed econometric models to analyze how factors like human capital affect wages. Mincer and Jovanovic[13] explored wage disparities across occupations and industries, suggesting that workers are motivated to seek higher-paying positions to maximize their earnings. Card[14] took a broader perspective, suggesting that wage dynamics vary among workers, economies, and over time. Therefore, factors such as age, education, gender, and industry influence wage functions. Similarly, Moock, Patrinos[15] expanded the wage function to assess the impact of education level on wages, finding that it varies by region and gender. Specifically, educational level has a stronger impact on wages in the public sector than in the private sector. Similarly, this impact is stronger in women than in men.

Alsulami[5] surveyed 2,470 individuals in Saudi Arabia, identifying factors like field of study, education level, experience, and industry as influential in determining salaries. Among them, education level and occupation are the two factors that have the strongest impact on salary differences. Sakellariou and Fang[16] concluded that education level significantly affects wages, especially in urban areas. Conversely, Trung, Tien-Trung[17] found that only college degrees or higher impact wages in Vietnam.

Akdogan-Gedik and Gunel[18] focus on the demographic, social and economic factors influencing the gender wage gap at the multinational level, revealing that higher rates of female employment in the industry can reduce wage disparities. In addition, studies are showing the opposite aspect, they believe that education is not the most important factor for workers' wages. Sorel and Shinners[19] analyzed data from Georgia in 2017, suggesting that while education is often considered the primary wage determinant, gender exerts the most substantial influence in their study.

In the context of the fourth industrial revolution, the factors influencing wages have evolved, with the advent of various new concepts, notably the pivotal role of Information Technology (IT). When Genz, Janser[20] studied the relationship between technology adoption and wages, they devised a novel technology index. This index offers detailed insights into the digitalization levels of workplace tools, enabling researchers to probe the impact of IT on wage disparities. Their findings revealed that German workers using IT command higher salaries than their non-IT counterparts. Similarly, Shair, Zahra[21] conducted a study on wage disparities among workers in Pakistan, affirming that socioeconomic factors and IT proficiency play significant roles. Individuals adept at utilizing digital skills tend to earn more than those lacking such capabilities.

Moreover, the capacity for IT application is intertwined with labor proportion in the industrial sector. Integrating IT into industries bolsters labor productivity, leading to a reduction in labor proportion[22]. However, Yang, Si[23] presented contrasting findings. Their study unveiled a negative correlation between technology and workers' wage rates. They suggest that the influence of IT diminishes wages for workers engaged in both physical and online business operations.

In summary, wage disparities have long been a significant concern and a focal point of economic research. Previous studies not only identify the causes of wage gaps but also develop economic models to explore the impact of various factors on earnings. While most research traditionally examines factors like education, location, and demographics, recent investigations emphasize the role of contemporary factors, particularly workers' proficiency in applying IT. However, most studies have primarily focused on analyzing the direct impact of IT on wages, overlooking salary inequalities between IT users and non-users. Therefore, this study aims to explore wage disparities, highlighting how earnings vary across different groups of workers.

METHODOLOGY

This study approaches Mincer earnings function[7] and the expanded wage function[14] using the quantile re-

gression method for estimation. This method, initially introduced by Koenker and Bassett Jr[24], was later utilized by Buchinsky[25] to analyze wage disparities. What sets this method apart is its capability to estimate regression parameters across various quantiles of the dependent variable. This enables a more detailed description of the relationship between the dependent variable and explanatory variables at each quantile.

Let group A represent workers who do not utilize IT, and group denote those who integrate IT into their paid work. LnW denotes the natural logarithm of workers' wages, and X represents the explanatory variables. Therefore, the regression model for the quantiles of the two labor groups can be expressed as follows:

$\mathrm{LnW}_a = \mathrm{X}_a\beta_{\tau a} + \varepsilon_{\tau a}$ with the residual assumption $\varepsilon_{\tau a} = 0$

$\mathrm{LnW}_b = \mathrm{X}_b\,\beta_{\tau b} + \varepsilon_{\tau b}$ with the residual assumption $\varepsilon_{\tau b} = 0$

In these equations, β_τ represents the regression coefficient to be estimated at the τ percentile, where τ belongs to the range (0, 1). This coefficient has the smallest total error difference at the τ percentile. Quantile regression can be conducted for any quantile within the range (0, 1). This article focuses on computing regressions at standard quantiles, including 0.1, 0.25, 0.5, 0.75, and 0.9.

After quantile regression, the wage gap will be assessed using the Machado and Mata approach[26]. While the Oaxaca-Blinder method primarily examines mean disparities[27], Machado and Mata[26] analyzed the differences between distribution quantiles, offering enhanced flexibility and deeper insights into the wage disparities.

Let $\mathrm{LnW}_{ab} = \mathrm{X}_a\beta_{\tau b}$ represent the hypothetical wage function constructed under the assumption that both groups of workers possess similar characteristics. In this scenario, the wage gap between these two groups of workers is decomposed by Machado and Mata (2005) as follows:

$\mathrm{LnW}_a - \mathrm{LnW}_b = (\mathrm{X}_a\beta_{\tau a} - \mathrm{X}_a\beta_{\tau b}) + (\mathrm{X}_a\beta_{\tau b} - \mathrm{X}_b\beta_{\tau b})$

By grouping the common factors, we derive the following wage disparity decomposition function:

$$\mathrm{LnW}_a - \mathrm{LnW}_b = (\beta_{\tau a} - \beta_{\tau b})\,\mathrm{X}_a + (\mathrm{X}_a - \mathrm{X}_b)\beta_{\tau a} \quad (3)$$

The first term on the right-hand side signifies the wage gap resulting from disparities in regression coefficients. Meanwhile, the second term represents the wage gap attributed to distinctions in the characteristics of the two worker groups.

Based on the extended Mincer wage function and the availability of existing data, this study uses the log of monthly wages as the dependent variable. The wage is measured in thousand VND per month, and this value is transformed using the natural logarithm for regression analysis. The explanatory variables in the regression model include professional qualifications, age, housework time, region, and gender. Specifically:

- The professional qualification variable is divided into four categories: no professional qualification, primary or secondary vocational qualification, college or university qualification, and postgraduate qualification. Three dummy variables are created to analyze these qualifications, with the group of workers who do not possess any professional qualifications serving as the reference group. This allows for comparative analysis between the baseline group and those with vocational, college, or postgraduate qualifications. In addition, the age variable, which serves as a proxy for work experience, includes workers between the ages of 19 and 64, thus ensuring the analysis focuses on those within this working age range.
- Additionally, the authors suggest that unpaid housework time often has an inverse relationship with income from formal employment; as housework time increases, income from work tends to decrease. However, for workers proficient in information technology (IT), flexible time management and remote working capabilities may help mitigate the negative impact of housework time on income. Conversely, workers who lack IT skills may find it harder to balance housework with paid work, leading to a more significant negative impact on their income. To assess this differential impact, the study includes a "housework time" variable to compare its effects on two cohorts: those who know how to use IT and those who do not. This allows for a clearer analysis of the interaction between housework time and the ability to utilize technology at work, leading to more convincing research results.
- Finally, dummy variables for region and gender are included in the model as control variables.

RESEARCH DATA

The study utilizes data from the Labor Force Survey 2022 (LFS 2022), an annual survey conducted by Vietnam's General Statistics Office. Its primary objective is to monitor fundamental information concerning

Table 1: Summary of variable definition

Variables	Explain variable name	Mean		
		Total	Group using IT	Group not using IT
lnwage/ilnwage	Natural logarithm of the monthly wage received by a worker	8.718	9.063	8.635
age/iage	Age of workers (year)	41.111	37.694	41.934
urban/iurban	Dummy variable indicating area of workers (True = 1; False = 0)	0.449	0.723	0.383
male/imale	Dummy variable indicating the gender of workers (Male = 1, Female = 0)	0.552	0.503	0.564
beinter/ibeinter	A dummy variable indicating whether the worker's highest level of education is primary or intermediate (True = 1; False = 0)	0.161	0.305	0.127
col_uni/icol_uni	A dummy variable indicating whether the worker's highest level of education is college or university (True = 1; False = 0)	0.190	0.679	0.072
postgra/ipostgra	A dummy variable indicating whether the worker's highest level of education is postgraduate (True = 1; False = 0)	0.010	0.044	0.001
fa_time/ifa_time	Unpaid housework time during the week (hour)	14.763	15.952	14.476
Observations (Obs)		342,973	66,575	276,398

Source: Authors' compilation

the Vietnamese labor market systematically. This nationwide survey covers households and their members. The investigation methodology of the LFS is guided and technically supported by the International Labor Organization (ILO). In 2022, the survey collected data from over 800,000 observations. After filtering for individuals aged 19 to 64 and ensuring all necessary information for the research model, the remaining dataset comprises 342,793 observations. The variables lnwage, age, male, beinter, col_uni, postgra, fa_time pertain to the wage function of workers who do not use IT in their work. Meanwhile, ilnwage, iage, imale, ibeinter, icol_uni, ipostgra, ifa_time are variables belonging to the wage function of the group of workers who use IT in their work. The descriptive data are presented Table 1.

RESULTS AND DISCUSSIONS

The results of OLS regression and quantile regression for the wage function in two labor groups are presented in Tables 2 and 3. Based on these tables, the authors will reevaluate the regression coefficients in graphical format for easier comparison.

In all the figures below, the horizontal axis represents the percentiles of the regression, corresponding to workers across different income levels, from low to high. The vertical axis displays the regression coefficient values at various percentiles, simultaneously indicating wage disparities between the two cohorts based on the explanatory variables.

Figure 1 shows the regression coefficients for dummy variables representing educational levels for two cohorts: those using IT in their paid work and those not using IT. In the non-IT group, the regression coefficients for primary or intermediate qualifications are consistently higher across all quantiles than other qualifications. This indicates that lower qualifications have a pronounced impact on wages within this workforce, outweighing the effect of advanced degrees and highlighting an imbalance in the labor market. Tùng Nguyên [28] explains that the current Vietnamese labor market requires many low-skilled workers for manual tasks, prioritizing physical strength over specialized skills. In contrast, educational degrees are significant for workers using IT in their jobs, with salaries increasing with higher qualifications. Comparing the

Table 2: Quantile regression for the group of workers not using IT

	Quantile regression					
Variables	OLS	10%	25%	50%	75%	90%
Age	-0.0049***	-0.0126***	-0.0085***	-0.0040***	-0.0001	0.0048***
urban	0.1753***	0.3166***	0.1917***	0.1175***	0.1075***	0.1326***
male	0.1616***	0.1743***	0.1590***	0.1488***	0.1393***	0.1851***
beinter	0.3012***	0.3315***	0.2717***	0.2134***	0.2157***	0.2638***
col_uni	0.1158***	0.3039***	0.2391***	0.2059***	0.1994***	0.2161***
postgra	0.1693***	0.3180***	0.2115***	0.1628***	0.1866***	0.1416***
fa_time	0.2745***	-0.0138***	-0.0092***	-0.0051***	-0.0033***	-0.0040***
const	0.1298***	8.3292***	8.6185***	8.7832***	8.8826***	8.9320***
Obs	276,398	276,398	276,398	276,398	276,398	276,398
Note	The stars indicate the level of significance for the t-statistics: ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.					

Table 3: Quantile regression for the group of workers using IT

	Quantile regression					
Variables	OLS	10%	25%	50%	75%	90%
Iage	0.0090***	0.0092***	0.0099***	0.0096***	0.0105***	0.0114***
iurban	0.0790***	0.0799***	0.0691***	0.0623***	0.0944***	0.1226***
imale	0.1426***	0.1049***	0.1325***	0.1550***	0.2134***	0.2252***
ibeinter	0.1529***	0.0794***	0.0611***	0.0793***	0.0903***	0.0864***
icol_uni	-0.0435***	0.2395***	0.1672***	0.1398***	0.1228***	0.0587***
ipostgra	0.0306***	0.1602***	0.1484***	0.1437***	0.1432***	0.1620***
ifa_time	0.1450***	-0.0016***	-0.0013***	-0.0011***	-0.0010***	-0.0003
const	0.1047***	7.9567***	8.2040***	8.4524***	8.6325***	8.8840***
Obs	66,575	66,575	66,575	66,575	66,575	66,575
Note	The stars indicate the level of significance for the t-statistics: ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.					

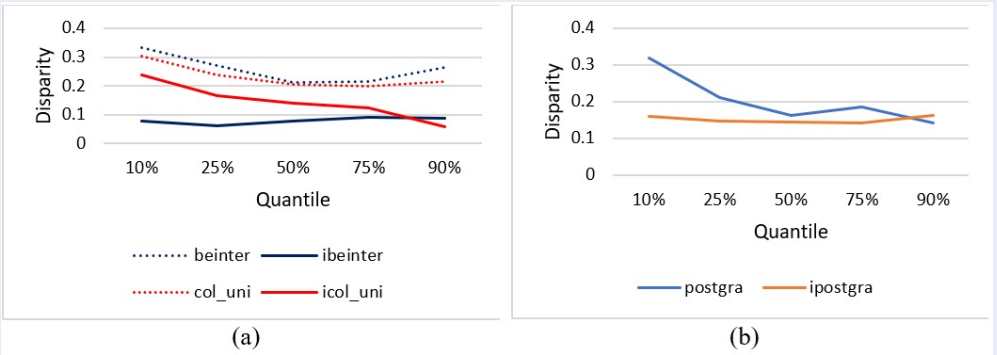

Figure 1: Regression coefficient by educational attainment in two labor groups

two groups, the regression coefficients by educational attainment are notably higher in the non-IT group, especially at lower income levels.

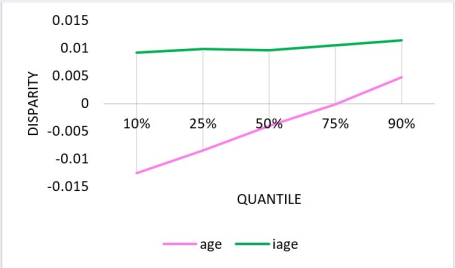

Figure 2: Regression coefficient by age in two labor groups

Figure 2 illustrates the disparity in the regression coefficient of the age variable between the two groups of workers. In the group of workers utilizing IT, it age's effect of age on wages appears consistent across all quantiles. Conversely, for the group of workers not utilizing IT, the impact of age on wages fluctuates significantly. At lower quantiles, advancing age correlates with decreasing wages, whereas wages receive a positive boost from the worker's age at higher quantiles.

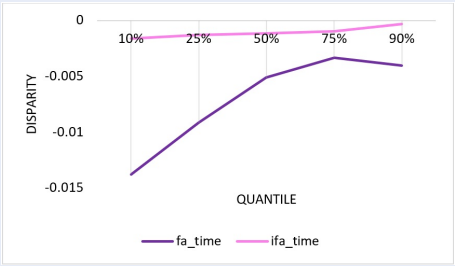

Figure 3: Regression coefficient by housework time in two labor groups

For the variable fa_time in Figure 3, representing time spent on housework, the gap in the regression coefficient between the two labor groups is notable at lower income levels, gradually diminishing as income levels rise. Across all quantiles, the regression coefficient for the group of workers utilizing IT exceeds that of the group not utilizing IT. This suggests that housework time significantly impacts the wages of non-IT workers.

Figure 4 offers insights into economic equality between the two labor groups. It demonstrates that the

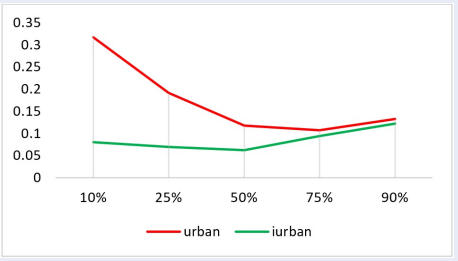

Figure 4: Regression coefficient by area in two labor groups

wage disparity between rural and urban areas is significantly more pronounced for the group of workers not utilizing IT than those who do, across all quantiles. This implies that for IT-using workers, whether they work in rural or urban areas, they have equal opportunities. Conversely, non-IT workers' wages are heavily contingent upon the working area. Particularly for low-wage workers, urban areas yield considerably higher wages.

In today's Vietnam, IT application extends beyond the IT industry and permeates all sectors of the economy. While specific roles demand specialized skills like software engineering and web development, others rely on IT proficiency, such as those within Grab or e-commerce platforms. Hence, the IT application serves as a pivotal tool for enabling workers to access digital business platforms. It fosters a seamless connection between labor supply and demand, facilitating practical training and bridging labor resources with the job market.

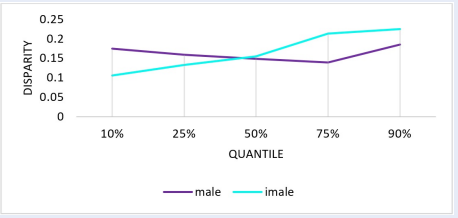

Figure 5: Regression coefficient by gender in two labor groups

Figure 5 offers an intriguing depiction of the gender wage gap across two labor groups. Overall, men consistently earn higher wages than women, underscoring the presence of gender inequality. However, the gender gap trends diverge within the two labor groups. While the curve illustrating the wage disparity for men in the non-IT worker group tends to decrease as wage levels rise, conversely, this curve in the

IT worker group exhibits a gradual increase.

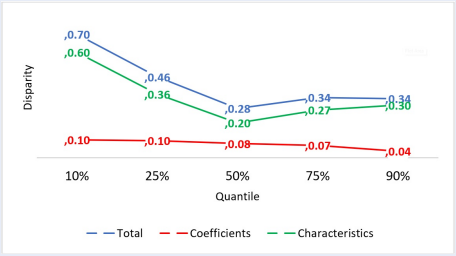

Figure 6: Decomposition of wage disparities by labor group in Vietnam

Lastly, Figure 6 showcases the findings regarding the wage gap between the two labor groups. Generally, workers who utilize IT tend to earn higher salaries than those who do not, across all quantiles. Notably, this discrepancy widens in the lower percentiles, diminishes in the middle percentiles, and experiences a slight resurgence in the higher percentiles. This disparity predominantly stems from differences in labor characteristics, mirroring the overall difference line trend, whereas the variation attributed to regression coefficients across quantiles exhibits a more subtle fluctuation.

CONCLUSION AND RECOMMENDATIONS

Based on data from the LFS Vietnam 2022, this study employs a quantile regression model in conjunction with the Oaxaca-Blinder difference decomposition method to investigate the influence of IT application on wage disparities among labor groups. From the regression outcomes, several conclusions can be drawn as follows:

For workers who don't utilize IT in their paid work, a higher level of education doesn't significantly impact their earnings. This outcome reflects the prevailing situation in Vietnam, with an oversupply of middle managers and a shortage of skilled workers. It underscores deficiencies in training policies that fail to align with practical needs. Additionally, age and time spent on household chores negatively affect the wages of this group. The combination of age and education level suggests that these workers typically engage in straightforward tasks, relying more on physical health than cognitive prowess.

Conversely, a notable feature for workers who incorporate IT into their paid endeavors is the minimal wage gap across regions. This implies that these workers can access to diverse information sources related to employment, business, finance, and personal development. This advantage empowers individuals in this group to enhance their skills and knowledge, thus improving their living standards. The findings suggest that IT could catalyze the narrowing of the wage disparity between urban and rural areas.

Based on the analysis results above, the article suggests several ideas to improve the wage disparities towards a more positive trajectory:

Firstly, workers should recognize that education and professional skills are lifelong assets that significantly impact their earning potential, not just in a short period of time in their careers. Therefore, they should devise suitable strategies and plans to enhance their qualifications. It's crucial to foster both critical thinking and practical skills not only within educational settings but also in the workplace. Moreover, the national education system should evolve to foster close collaboration between schools and businesses, ensuring a harmonious balance between labor market demand and supply.

Secondly, the research findings underscore the potential for narrowing the wage gap through IT proficiency. This highlights the importance of IT knowledge alongside education and professional skills. Workers should equip themselves with essential IT skills and knowledge to navigate the modern work environment effectively. Additionally, governmental efforts to enhance workers' IT capabilities are paramount. The state should enact policies supporting technology access for marginalized workers. Strengthening communication campaigns about the advantages of IT will further empower individuals to leverage IT safely and effectively.

Lastly, gender wage inequality persists, stemming from a complex interplay of socio-economic and cultural factors. In Vietnamese society, women often shoulder primary responsibilities for family and childcare. Naturally, increased time spent on household duties correlates with reduced income. To address gender inequality in the workforce, government collaboration is essential. Policies supporting maternity leave and childcare should be introduced to ensure postpartum women don't miss out on career opportunities. Simultaneously, women should enhance their professional skills and capabilities to overcome barriers in the workplace. In particular, acquiring soft skills like foreign languages and IT proficiency will significantly contribute to narrowing the gender wage disparity.

ACKNOWLEGMENT

This research is funded by Vietnam National University Ho Chi Minh City (VNU-HCM) under grant number B2023-34-03.

ABBREVIATIONS

IT: information technology

LFS: Labor force Survey

ILO: International Labor Organization

CONFLICT OF INTEREST

The authors declare that they have no competing interests

AUTHORS' CONTRIBUTION

Nguyen Thi Dong: writing – original draft, data curation and formal analysis

Le Thi Ngoc Tu: writing, review and editing

Tran Quang Van: data curation

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Tạp chí Phát triển Khoa học và Công nghệ – Economics-Law and Management 2025, ():1-1

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Bài nghiên cứu

Công nghệ thông tin và chênh lệch tiền lương giữa các nhóm lao động: Nghiên cứu trường hợp Việt Nam

Nguyễn Thị Đông[1,2,*], Lê Thị Ngọc Tú[3], Trần Quang Văn[4]

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TÓM TẮT

Thế giới đang thay đổi rất nhanh nhờ những tiến bộ đột phá của khoa học và công nghệ. Trong bối cảnh đó, cuộc cách mạng công nghiệp 4.0 đã mở rộng không gian sống của con người, tạo nên một sự hoà quyện tinh tế giữa môi trường thực và môi trường số với hai đặc điểm nổi bật là dữ liệu và kết nối. Nếu người lao động trong thời đại 4.0 biết tận dụng trí tuệ nhân tạo cho mục đích công việc, họ có thể sẽ tạo ra năng suất cao và nhận được mức lương kỳ vọng cũng như đạt được bình đẳng về kinh tế. Mục đích của nghiên cứu này là điều tra sự chênh lệch tiền lương giữa hai nhóm lao động riêng biệt: những người sử dụng công nghệ thông tin (CNTT) trong công việc và những người không sử dụng. Sử dụng dữ liệu từ Khảo sát lao động – việc làm (LFS), nghiên cứu sử dụng cả phương pháp phân tích Oaxaca-Blinder và phương pháp hồi quy phân vị để cung cấp hiểu biết toàn diện về sự chênh lệch tiền lương giữa các mức thu nhập khác nhau. Những phát hiện nhấn mạnh rằng, ngoài các yếu tố quyết định tiền lương thông thường như trình độ chuyên môn và giới tính, việc sử dụng CNTT tác động tích cực đến thu nhập của người lao động. Những nhân viên tận dụng CNTT trong công việc của họ có xu hướng được trả lương cao hơn. Hơn nữa, nghiên cứu cho thấy bất bình đẳng thu nhập giảm đáng kể trong số những người lao động sử dụng CNTT. Những kết quả này nhấn mạnh vai trò quan trọng của CNTT trong việc thúc đẩy cả tăng trưởng tiền lương cá nhân và phân phối thu nhập công bằng hơn.

Từ khoá: Hồi quy phân vị, phân rã Oaxaca-Blinder, công nghệ thông tin (CNTT), chênh lệch tiền lương

[1]*Trường Đại học Kinh tế - Luật, Việt Nam*

[2]*Đại học Quốc gia Thành phố Hồ Chí Minh, Việt Nam*

[3]*Trường Đại học Quản lý và Công nghệ TP.HCM, Việt Nam*

[4]*Trường Đại học Ngân hàng, TP. HCM, Việt Nam*

Liên hệ

Nguyễn Thị Đông, Trường Đại học Kinh tế - Luật, Việt Nam

Đại học Quốc gia Thành phố Hồ Chí Minh, Việt Nam

Email: dongnt@uel.edu.vn

Lịch sử

- Ngày nhận: 9-5-2024
- Ngày sửa đổi: 29-9-2024
- Ngày chấp nhận: 8-10-2024
- Ngày đăng:

DOI :

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Trích dẫn bài báo này: Đông N T, Tú L T N, Văn T Q. **Công nghệ thông tin và chênh lệch tiền lương giữa các nhóm lao động: Nghiên cứu trường hợp Việt Nam**. *Sci. Tech. Dev. J. - Eco. Law Manag.* 2025; ():1-1.