سلسلة أوراق عمل
معهد التخطيط القومي

The Effect of Using Technology on Gender Wage Gap in the Egyptian Labor Market

Ms. Marina Adel Riad

Assistant Lecturer

ورقة عمل رقم (14) 2025

مايو 2025

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مارينا عادل رياض
مدرس مساعد - مركز السياسات الاقتصادية الكلية - معهد التخطيط القومي

Email: marina.riad@inp.edu.eg

ورقة عمل رقم (14) -2025

تم النشر لأول مرة في عام 2025 بواسطة معهد التخطيط القومي

سلسلة أوراق عمل معهد التخطيط القومي: تستهدف هذه السلسلة عرض بعض النتائج الأولية للبحوث التي يجريها معهد التخطيط القومي بقصد مناقشتها من جانب المعنيين من داخل المعهد وخارجه تمهيد لتطوير هذه النتائج والارتقاء بمستوى البحث العلمي بالمعهد، وإعادة نشر الورقة في وعاء نشر محكم محليا أو إقليميا أو دوليا

سلسلة أوراق عمل- معهد التخطيط القومي

أثر استخدام التكنولوجيا على فجوة الأجر وفقاً للنوع الاجتماعي في سوق العمل في مصر

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مارينا عادل رياض
مدرس مساعد - مركز السياسات الاقتصادية الكلية -
معهد التخطيط القومي

Email: marina.riad@inp.edu.eg

Executive Summary

This study presents a novel approach to analyzing gender wage disparities in the Egyptian labor market, focusing on the role of technological advancements amid the country's ongoing economic reforms and digital transformation. Despite gains in female education and labor force participation, the gender wage gap persists. Unlike previous research, this paper investigates the impact of skill-biased technological change on wage dynamics, offering new insights for policymakers.

Drawing on data from the 2023 Egypt Labor Market Panel Survey, the study employs robust econometric methods—including Ordinary Least Squares (OLS), Instrumental Variable Two-Stage Least Squares (IV-2SLS), and the Neuman-Oaxaca decomposition—to estimate gender wage differentials across varying levels of technological exposure. Workers are categorized into three groups: technology professionals, technology users, and non-users.

Key findings reveal that while technology professionals experience the narrowest gender wage gap, significant disparities remain, with 91.4% of the gap unexplained. In contrast, technology users and non-users face larger and more persistent wage gaps, reflecting structural barriers and occupational segregation. Notably, higher technological proficiency is associated with reduced wage disparities, underscoring the importance of digital skills in promoting gender equity in the labor market. However, women's rising education levels also correspond with lower tolerance for substandard working conditions. Based on these results, the study recommends targeted policy interventions, including:

- Expanding scholarships and incentives for women in STEM fields and high-tech occupations.
- Enforcing mandatory wage transparency and regular pay audits in major firms.
- Addressing occupational segregation through leadership training, mentorship, and government-backed entrepreneurship programs for women.
- Implementing targeted policy interventions to enhance women's skills in the formal sector and empower their effective integration into the labor market.
- Adopting an integrated strategy to address the root causes of labor market informality, expand decent work opportunities, and strengthen the role of technical education in supporting productive employment, social mobility, economic inclusion, and poverty reduction.
- Promoting a more balanced public sector recruitment policy by reversing recent hiring freezes and leveraging skilled personnel, particularly to meet the growing

demands for digital transformation and advanced technologies in government institutions.

The findings highlight that without proactive, research-informed policies, digital transformation risks deepening gender inequalities. Ensuring equitable access to technological skills and opportunities is critical to building a more inclusive and fair labor market in Egypt.

الملخص التنفيذي

تقدم هذه الدراسة منهجية جديدة لتحليل فجوات الأجور بين الجنسين في سوق العمل المصري، مع التركيز على دور التقدم التكنولوجي في ظل الإصلاحات الاقتصادية الجارية والتحول الرقمي في البلاد. فعلى الرغم من التحسن في مستويات تعليم النساء وزيادة مشاركتهن في القوى العاملة، لا تزال فجوة الأجور بين الجنسين تمثل تحدياً قائماً. وعلى عكس الدراسات السابقة، تستكشف هذه الورقة تأثير التغيرات التكنولوجية المنحازة للمهارات على ديناميكيات الأجور، مما يقدم رؤى جديدة لصانعي السياسات.

واستناداً إلى بيانات مسح سوق العمل المصري لعام 2023، تعتمد الدراسة على منهجيات اقتصادية متقدمة، تشمل المربعات الصغرى العادية (OLS)، وطريقة المربعات الصغرى ذات المرحلتين باستخدام المتغيرات الآلية (IV–2SLS)، وتقنية تفكيك فجوات الأجور (Neuman–Oaxaca) لتقدير الفروق في الأجور بين الرجال والنساء عبر مستويات مختلفة من التعرض للتكنولوجيا. وقد تم تصنيف العمال إلى ثلاث مجموعات: المتخصصون في التكنولوجيا، ومستخدمو التكنولوجيا، وغير المستخدمين لها.

وتُظهر النتائج الرئيسة أن المتخصصين في التكنولوجيا يواجهون أضيق فجوة في الأجور بين الجنسين، ومع ذلك تظل الفجوة كبيرة، حيث أن 91.4% منها غير مفسر بالعوامل التقليدية. وعلى النقيض، يواجه مستخدمو التكنولوجيا وغير المستخدمين فجوات أوسع وأكثر ثباتاً، مما يعكس الحواجز الهيكلية والتقسيم المهني القائم على النوع الاجتماعي. ومن الجدير بالذكر أن ارتفاع الكفاءة التكنولوجية يرتبط بانخفاض فجوات الأجور، مما يبرز أهمية اكتساب المهارات الرقمية في تعزيز المساواة بين الجنسين في سوق العمل. ومع ذلك، يترافق ارتفاع مستويات التعليم لدى النساء مع انخفاض استعدادهن لقبول ظروف العمل المتدنية.

واستناداً إلى هذه النتائج، توصي الدراسة بجملة من السياسات المستهدفة لمعالجة فجوات الأجور بين الجنسين، من أبرزها:

- توسيع نطاق المنح الدراسية والحوافز المقدمة للنساء في مجالات العلوم والتكنولوجيا والهندسة والرياضيات (STEM) والمهن التقنية المتقدمة.
- فرض شفافية الأجور وإجراء مراجعات دورية للأجور في الشركات الكبرى للحد من التحيزات القائمة على النوع في تحديد الأجور وتقييم الأداء.

- معالجة التقسيم المهني من خلال برامج تدريب القيادات، والإرشاد المهني، وبرامج ريادة الأعمال المدعومة من الحكومة لتعزيز تقدم النساء في القطاعات التقنية.
- تنفيذ تدخلات سياساتية مستهدفة لتعزيز مهارات النساء في القطاع الرسمي وتمكينهن من الاندماج الفعّال في سوق العمل.
- اعتماد استراتيجية متكاملة لمعالجة الجذور الأساسية لظاهرة العمل غير الرسمي، وتوسيع فرص العمل اللائق، وتعزيز دور التعليم الفني في دعم التوظيف المنتج، والحراك الاجتماعي، والإدماج الاقتصادي، والحد من الفقر.
- تعزيز سياسة توظيف أكثر توازنًا في القطاع العام من خلال إنهاء تجميد التعيينات الأخير والاستفادة من الكوادر الماهرة، لا سيما في ضوء تنامي الحاجة إلى التحول الرقمي واعتماد التقنيات المتقدمة داخل المؤسسات الحكومية.

وتُبرز نتائج الدراسة أنه دون تدخلات سياسية نشطة ومبنية على البحث، قد يؤدي التحول الرقمي إلى تعميق الفجوات الجندرية القائمة بدلاً من تقليصها. وعليه، فإن ضمان وصول النساء على قدم المساواة إلى المهارات والفرص التكنولوجية يُعد أمراً حاسماً لبناء سوق عمل أكثر شمولاً وعدالة في مصر.

1. Introduction

The relationship between technology and wage inequality has been a subject of debate, especially with the rise of the Fourth Industrial Revolution. A key concern is whether technological advancements will generate positive outcomes for workers or reduce overall employment opportunities. This issue is particularly relevant for women, who have historically faced discrimination in both hiring and wages, especially in developing countries. A considerable amount of literature analyzes the effect of using technology at work on wage inequalities between highly skilled (Technology professionals), skilled (Technology-users) and unskilled (Technology-non-users) workers (Galbis & Wolff, 2008; Beaudry and Green, 2005; Lee and Kim, 2004; Krusell et al., 2000; Krueger, 1993). While many studies have explored the potential of technology usage to benefit women by increasing their participation in the labor market and empowering them through education and flexible working conditions (Maier and Nair-Reichert, 2008), the empirical evidence—particularly in the context of developing nations—remains limited.

This research introduces a different methodology for analyzing gender disparities in wage dynamics, specifically within the Egyptian labor market. Egypt's labor market is undergoing significant transformations, influenced by economic reforms and technological advancements. Despite progress in education and increased labor force participation, the gender wage gap remains a persistent issue. Simultaneously, various sectors are integrating new technologies, reshaping employment patterns and skill requirements. To the best of the researcher's knowledge, this approach has not been previously applied in this context. While there is an extensive body of work in labor economics that seeks to explain gender wage differences, much of it has not addressed the role of skill-biased technological changes in addressing this issue. As a result, the effect of new technologies on the gender wage gap remains underexplored. This paper aims to bridge that gap by examining how technological advancements have contributed to the recent narrowing of the gender wage gap, thereby adding to the broader labor economics literature. The findings will provide policymakers with a comprehensive understanding of how the significance of job and individual characteristics shifts based on technology adoption. The emergence of technological revolutions in labor markets places significant pressure on employment dynamics by driving the creation of new jobs that demand different skill sets while simultaneously rendering others obsolete. This shift necessitates a deeper analysis of labor markets from this perspective, particularly in developing countries, where such transformations may exacerbate existing challenges, most notably the gender wage gap.

Understanding how technological advancements affect wage structures for both women and men based on their technological skill level is a key and effective way to develop policy implications for the Egyptian labor market that effectively absorb technological pressures.

This study focuses on Egypt and aims to address the underexplored question of how technology might affect wage disparities between men and women. It is part of the broader "Egypt after 2025" series, which examines the future challenges facing the labor market, wages, and productivity in the face of regional and global competition. The study's objective is to answer the main question, which is: **What is the effect of adopting different levels of technological skills in the workplace on gender wage gap?**

To answer this research question, the study first presents a literature review on the relationship between technology use and gender wage dynamics. Second, the study provides an analysis of the Egyptian labor market in terms of gender wage gaps and the sectors that recently adopted technological applications. Then, it introduces the data source, methodology and the results of the econometric models. Lastly, the study provides general conclusions and policy implications.

2. Literature Review

Recent studies in labor economics have increasingly focused on incorporating technology as a key factor in their analyses. The growing influence of technological advancements on employment structures, wage determination, and skill requirements has made it essential to examine labor market dynamics through this lens. This shift in research emphasis reflects the recognition that technological change is not only reshaping job opportunities but also influencing long-standing labor market challenges, such as the gender wage gap, particularly in developing economies. Some studies highlight the complex relationship between different levels of technology usage and the gender wage gap, indicating that technological advancements can have both mitigating and exacerbating effects on wage disparities between men and women. For instance, a study by Galbis & Wolff (2008) examines the influence of information and communication technologies (ICT) on the gender wage gap across different points of the wage distribution. The analysis is based on two extensive French employee surveys conducted in 1998 and 2005, utilizing quantile regression models and a difference-in-differences approach to evaluate the effects of technological adoption on wage disparities. The findings indicate that in both 1998 and 2005, the gender wage gap among ICT users was not significantly different from that of non-users. However, within the group of ICT users, the observed wage disparities between

men and women were primarily driven by differences in the returns to similar characteristics, rather than differences in qualifications or experience. This suggests that while technology adoption does not necessarily reduce gender-based wage inequalities, variations in how male and female employees are rewarded for equivalent characteristics contribute to sustaining the wage gap.

In an attempt to engage the effect of technology on job arrangements among genders, a study by Brussevich et al. (2019) used individual-level data on task composition at work for 30 advanced and emerging economies to assess the risk of job displacement due to automation. The study found that women, on average, perform more routine tasks than men, making them more prone to automation. Approximately 11% of the female workforce is at high risk of being automated, with significant cross-country heterogeneity. The probability of automation is lower for younger cohorts of women and for those in managerial positions. This drives the analysis to further dig into studies that investigate wage differentials among women and men across different job structures with different technological skill requirements. A study by Cortes et al. (2020) investigated how men and women are differentially exposed to structural employment and wage changes associated with advancing technology in Portugal and the United States. The findings suggest that while women have generally been less exposed to the automation of work, this has not always led to declining gender wage gaps. At times, women have transitioned to jobs where wage levels or wage growth were lower. Non-technological changes appear at least as important in understanding the evolution of the gender wage gap.

Referring to generalized results of more developed countries, a study by Taniguchi & Yamada (2020) examines how technological advancements affect wage disparities across genders and skill levels in OECD countries. The findings indicate that information, communication, and computation technologies have significantly contributed to narrowing the gender wage gap while widening the skill wage gap. Conversely, a study by Ma (2022) utilized national longitudinal survey data to explore how internet usage influences the gender wage gap in China. Employing fixed effects and instrumental variable methods to address individual heterogeneity and endogeneity issues, the research found that the return on internet use is higher for men than for women. Both the gender disparity in internet access and the difference in returns from internet use contribute to widening the gender wage gap, with the latter having a more significant impact. The study also noted that these effects vary across educational attainment and age cohorts. Supporting the results of Ma

(2022), a study by Masso & Vahter (2023) investigated the relationship between both technological (product and process) and non-technological (organizational and marketing) innovation and the gender wage gap at firms in Estonia. Using employer–employee level data from, the study found that both types of innovation are associated with a larger gender wage gap at firms. The relationship reflects, to a significant extent, the different selection of men and women with different time-invariant characteristics to innovative firms. The study also observed that the relationship between innovation and the gender wage gap is stronger in the case of women with children.

Focusing on using tools of technology and dealing with them easily, a study by Guo et al. (2024) examined the role of digital finance in influencing the gender wage gap in China. Utilizing data from the Chinese General Social Survey and the Digital Financial Inclusion Index, the study found that digital finance reduces the gender wage gap. In other words, women who deal with digital finance, which implicitly indicate their direct use of technological tools (computers, tablets, laptops,..etc.) are more likely to benefit. Digital finance facilitates female entrepreneurship by lowering financing barriers, thereby promoting employment opportunities for women and empowering them to negotiate higher wages. The study also highlighted that digital finance enhances women's bargaining power within domestic settings, positively influencing their wages.

The above-mentioned studies highlight the complex relationship between technology usage and the gender wage gap. Research examining the impact of technology usage on the gender wage gap has produced mixed findings, with some studies indicating that technology can exacerbate disparities, while others suggest it may help reduce them. However, this indicates that technology can both mitigate and exacerbate wage disparities between men and women, depending on various factors such as access, skill levels, and the nature of technological advancements, the degree of technological exposure and the income level of a country (considering the distinction between developed and developing countries). Thus, this drives the analysis to focus on the case study of our country Egypt and investigate the results of previous research in this field.

Studies conducted on Egypt provide valuable insights into the gender wage gap in Egypt, though research specifically linking technology usage to this disparity remains limited. A study by Mandour (2009) is a prominent one that established the linkage between technology usage and gender gap in Egypt. This research assesses the impact of Information and Communication Technology (ICT) on gender equality, focusing on

differences in wage rates and employment opportunities. The study focuses its analysis on the ICT sector in Egypt, suggesting that while the ICT sector holds promise for enhancing women's participation in the labor market, more efforts are needed to increase their engagement. It emphasizes the importance of equipping women with the necessary skills to prepare them for various roles, not only as ICT users but also as creators and designers. Further analysis of the Egyptian context is more directed toward the gender wage gap among high and low paying jobs. For instance, a study by Biltagy (2014) focuses on wage differentials between males and females. This paper utilizes the Oaxaca-Blinder decomposition technique to understand the determinants of the gender wage gap. The findings indicate that part of the wage gap can be explained by the underrepresentation of females in high-level and high-paying jobs.

In addition, a study by Nazier (2017) examines gender wage disparities across the wage distribution in Egypt. Utilizing data from the Egypt Labor Market Panel Surveys (ELMPS) for the years 1998, 2006, and 2012, the study employs a quantile regression approach to analyze these disparities. The results of this research show that on average, women's hourly wages are significantly lower than men's. Moreover, the negative effect of being female on hourly wages is more pronounced at both the lower and upper ends of the wage distribution, indicating the presence of both "glass ceiling" and "sticky floor" effects. Furthermore, the findings suggest that factors such as household characteristics and geographic location significantly impact the wage gap, particularly at higher wage levels, contributing to the "glass ceiling" phenomenon.

Following the same wage structure distinction, a study by Zaghloul (2018) investigates the gender wage gap across the wage distribution in Egypt. Employing quantile regression and decomposition analysis, it finds that the wage gap is more pronounced in the lower quantiles, indicating a significant "sticky floors" effect, while a minor "glass ceiling" effect is observed at the higher end of the wage distribution. Recently, a study conducted by the ILO in cooperation with the Ministry of Planning, Economic Development and International Cooperation in Egypt (2024) provides a comprehensive analysis of the size, evolution, and determinants of the gender wage gap in Egypt. Utilizing data from the Egyptian Labour Market Panel Survey (ELMPS) for the years 1998, 2006, 2012, and 2018, it offers insights into the persistent disparities in earnings between men and women.

In a recent attempt to investigate the effect of technology usage in the workplace on different Egyptian labor market outcomes, a study by Yasser et al. (2024) indicates that

public sector employees, both men and women, report the highest levels of computer proficiency. However, a notable gender disparity emerges, as working-age women (15-64) exhibit lower self-reported computer skills compared to men, whereas women in the labor force (employed or unemployed) report higher proficiency levels. Interestingly, unemployed women demonstrate the highest levels of computer skills, surpassing both unemployed men and employed women, suggesting that high-skilled women are disproportionately affected by job shortages, particularly in technology-intensive sectors. The retrenchment of formal employment—both in public and private sectors—has further contributed to the decline in women's labor force participation. Moreover, digital task analysis reveals that men dominate ICT-intensive roles, such as software development, electrotechnology engineering, and financial services, while women are primarily concentrated in technology-related fields within healthcare (e.g., pharmacists) and client information services. These findings underscore the persistent gendered occupational segregation in Egypt's digital economy and highlight the need for policies that enhance women's integration into high-paying, technology-intensive professions.

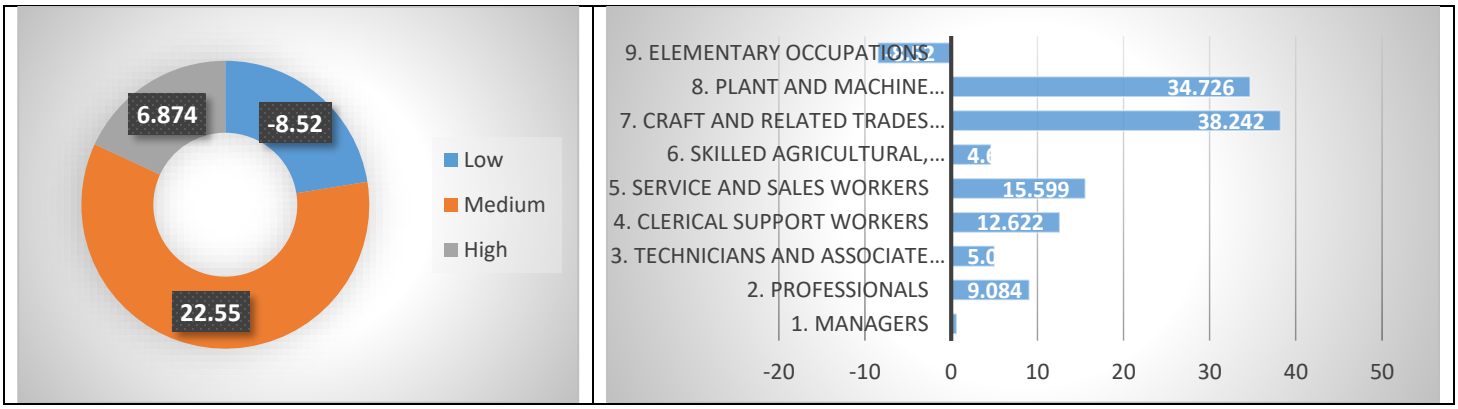
Obviously, studies that cover the relationship between technology used in the workplace and gender wage gap directly are little, especially in the case of Egypt. The studies that examine this relationship in the Egyptian context are directed to analyzing the ICT sector only and other papers that offer this analysis do not provide deep investigations employing econometric tools. Even the international studies in this context provide counterintuitive results suggesting more investigations with different methodologies and on different countries' case studies.

3. The Egyptian Labor Market: Gender Wage Gap and Technological Adoption

This section presents an analysis for the main reasons for the gender wage gap in Egypt, identifies sectors embracing technological adoption, and explores the implications of these developments on labor market dynamics. The gender wage gap in Egypt is a multifaceted issue, with women consistently earning less than men across various sectors. Despite the fact that women in Egypt become highly educated and well-qualified to be engaged in the labor market, the existence of gender wage gap and occupational segregation are key factors that drive women to be discouraged from participating in the labor force (Alazzawi & Hlasny, 2024). **Figure 1** shows the gender wage gap according to skill level and occupations. The gender wage gap is expressed as an unadjusted difference between

average earnings of men and average earnings of women as a percentage of average earnings of men. This indicator provides a measure of the relative difference between the earnings of men and those of women.

Figure 1: Gender wage Gap by skill level and Occupations, 2023



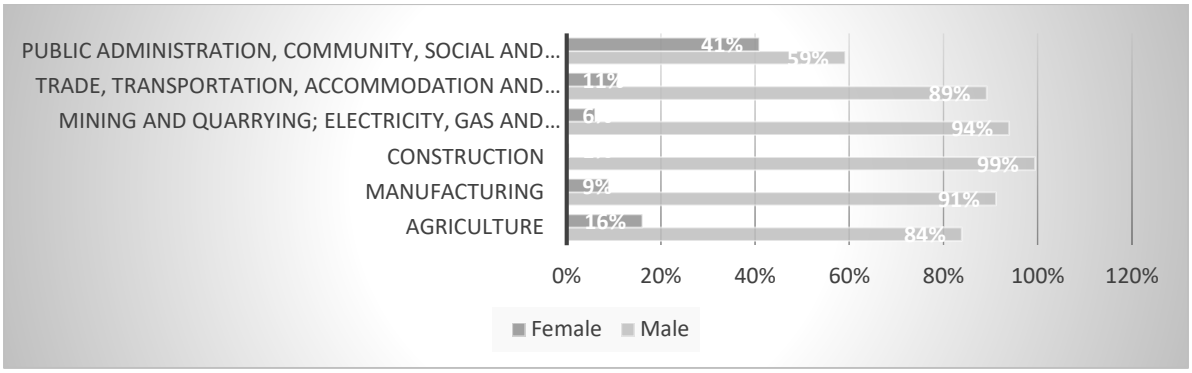
Source: ILOSTATS

The widest gender wage gap in favor of men is found among medium-skilled workers, followed by high-skilled categories. Conversely, among low-skilled workers, the wage gap tends to favor women. This trend indicates that women are overrepresented in lower-paying roles, which are often associated with inadequate working conditions and a lack of decent job quality. Further disaggregation by occupation supports these findings, revealing that jobs requiring medium skill levels—such as service and sales positions, as well as clerical support roles—exhibit a pronounced gender wage gap benefiting men. This disparity is largely attributed to the "glass ceiling" phenomenon, where employers systematically discriminate against women in matters of promotion and career advancement within these occupations. Notably, elementary occupations show a wage gap in favor of women; however, these roles are predominantly low-paid and informal in nature, exposing female workers to heightened vulnerability.

In fact, according to several empirical studies, some key contributing factors to the existence of the gender wage gap in Egypt include:

- Occupational Segregation: Women are predominantly employed in lower-paying services sectors such as education and healthcare, while men are more prevalent in higher-paying fields like industrial engineering and information technology (Figure 2).

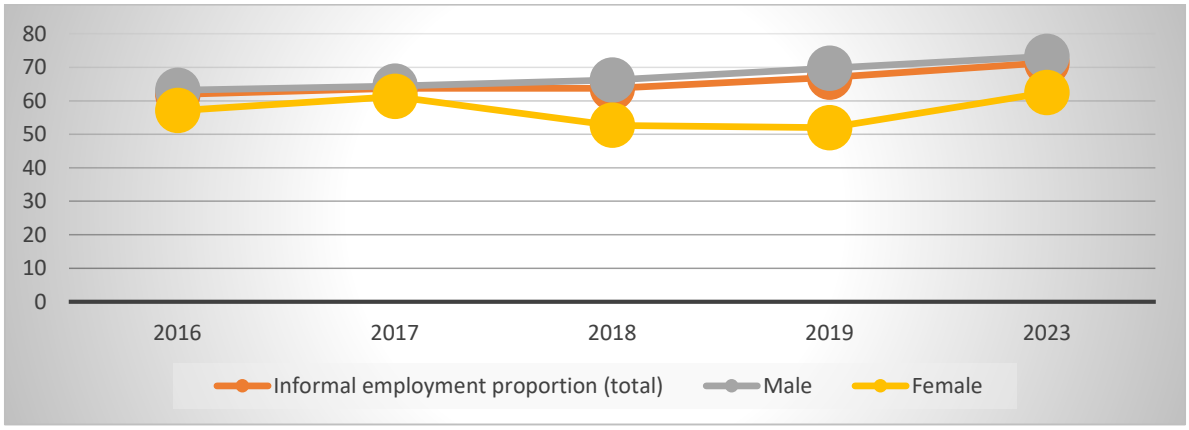
Figure 2: Employment share by Economic Activity and gender (2023)



Source: ILOSTATS

Informal Employment: A significant proportion of women work in the informal sector, characterized by lower wages and limited job security. As mentioned in **Figure 3**, despite the low participation of females (approximately 18.1%) compared to males, their representation in informal employment is approximately equal to men. It is important to note that one of the defining features of the Egyptian labor market is the dominance of the informal sector, which results in the prevalence of non-decent job opportunities. This sector often attracts marginalized and disadvantaged groups and is generally characterized by precarious and unprotected working conditions. The available evidence points to the expansion of informal employment as a major feature of the Egyptian labor market, particularly among graduates of technical education. This trend is reflected in the high rate of informal employment among wage workers, indicating that informal work constitutes the main channel of labor market integration for technical education graduates.

Figure 3: Proportion of Informal employment, by gender



Source: ILOSTATS

- **Cultural norms, childcare responsibilities, limited mobility, and frequent interruptions in women's employment tenure** further restrict women's access to well-paying jobs.
- **Technological Skill Gaps:** The increasing demand for digital skills has highlighted disparities in access to relevant education and training for women, limiting their opportunities in tech-driven sectors. Not only educated women but also educated men are discouraged. Whereas, unemployment rates tend to be higher among educated individuals compared to their less-educated counterparts, reflecting a structural imbalance between educational attainment and labor market absorption. However, women in STEM education have higher potential to benefit from being engaged in high-skill jobs (Yasser, 2024).

Notably, several sectors in Egypt have accelerated their adoption of technology, influenced by digital transformation initiatives and investments. Notable developments in the **Information and Communications Technology (ICT)** sector have demonstrated robust growth, with a rate of 15.2% in the fiscal year 2022/2023, surpassing the overall GDP growth rate. Its contribution to GDP increased to 5.1% during the same period (ITA, 2024). Despite this growth, women remain underrepresented in high-tech roles within the sector. In addition, a prominent sector regarding technological advances in Egypt is the **Financial Services and Fintech** sector that is undergoing rapid digitalization, with the expansion of mobile banking, electronic payments, and fintech solutions. This evolution has created new opportunities requiring advanced technological skills; however, women often face barriers to entry and advancement in these areas. The representation of women in the **Education sector** can be a potential for increasing women participation in the labor force and lessen gender gap as the adoption of educational technologies and the shift towards remote work have introduced more flexible employment options. This would contribute to potential opportunities for women who exhibit high technological skills. Notwithstanding, the representation of low-skilled women in sectors like the **Manufacturing sector**, would lead to their displacement due to the integration of automation and AI, thus highly skilled women would have more opportunities to be represented in such sectors that have been male-oriented for a long time.

Overall, while technological adoption has generated new employment opportunities, the benefits have not been equally distributed. Women often lack access to high-paying, tech-oriented positions, perpetuating existing wage disparities. Analyzing the gender wage gap across different technological uses is critical for shaping policies that ensure equitable

digital transformation. Without proactive interventions, technological progress may reinforce existing wage inequalities rather than bridge them. A research-based policy approach can ensure that women benefit equally from technological advancements in the workplace.

4. Methodology

First, the data is split into three groups:

1- **Technology professionals**: this group includes workers who exhibit at least one of the professional computer skill: Setting up and protecting computer systems, Solving Computer problems, Computer Systems Programming, Carry out maintenance and management of information and communication technology, using digital tools to control machines, Use of computer aided design and drawing tools, Using digital tools to process sound and images, using digital tools to create content, and/or Digital video/photo editing skills.

2- **Technology users:** workers who exhibit at least one of the following (has computer skills and/or uses computer at work connected or not connected to the internet and/or own a laptop or tablet and/or uses internet for work or studying)

3- **Technology non-users:** who are not exposed to any of the above-mentioned technology forms.

Second, for each group, the study implements either an Ordinary Least Squares Regression model (OLS) or a Instrumental Variable Two Stage Least Squares (IV-2SLS) model to estimate wage equations for males and females separately. When IV-2SLS is applied to correct for endogeneity problems, the study depends on using instrumental variables of parents' education, parents' employment status and occupations instead of the worker's years of schooling (Beblo et al. 2003b). The wage equations are expressed as follows:

$$ln\ ln\ \underline{W_m} = \alpha_0 + \alpha_1 S_{mi} + \alpha_2 E_{mi} + \alpha_3 E_{mi}^2 + \alpha_4 Numhour_{mi} + \alpha_5 R_{mi} + \alpha_6 Fsize_{mi} + \mu_{mi} \ldots (1)$$

$$ln\ ln\ \underline{W_f} = \beta_0 + \beta_1 S_{fi} + \beta_2 E_{fi} + \beta_3 E_{fi}^2 + \beta_4 Numhour_{fi} + \beta_5 R_{fi} + \beta_6 Fsize_{fi} + \mu_{fi} \ldots . (2)$$

Third, The Neuman-Oaxaca decomposition equation is represented for each group after correcting for the sample selection bias (Neuman & Oaxaca, 2004) using the two-step Heckman decomposition technique (Heckman, 1979) as follows:

$$ln\ ln\ \underline{W_m} - ln\ ln\ \underline{W_f} = \left(\underline{X_m} - \underline{X_f}\right)\beta_m + \left(\beta_m - \beta_f\right)\underline{X_f} + \left(\theta_m\lambda_m - \theta_f\lambda_f\right) \ldots (3)$$

Where $\left(\underline{X_m} - \underline{X_f}\right)\beta_m$ represents the differences in observed endowments between males and females. $\left(\beta_m - \beta_f\right)\underline{X_f}$ captures the part of the gender discrimination represented in group differences in unobserved endowments. $(\theta_m\lambda_m - \theta_f\lambda_f)$ refers to the sample selection bias. In this approach, a two-stage Heckman selection model is employed to estimate the probability of employment separately for males and females. The selection equation incorporates variables that affect the decision to work directly. These variables include marital status, and urban or rural residence (dummy variable). Following this, the Inverse Mills Ratio (IMR) is computed and incorporated into the earnings equations, which are then re-estimated separately for males and females. The gender earnings gap is subsequently decomposed, incorporating a third component that accounts for selectivity bias.

5. Data and Data Source

The study makes use of the Egypt Labor Market Panel survey in its cross-sectional form (round 2023) as it contains the questionnaire of the detailed knowledge on technology using. This data is a production of cooperation between the Economic Research Forum (ERF) with Egypt's Central Agency for Public Mobilization and Statistics (CAPMAS). The ELMPS 2023 wave follows four previous survey waves conducted in 1998, 2006, 2012, and 2018 (OAMDI, 2019, 2020, 2024). The ELMPS (2023) includes a total sample size of 70,636 individuals across 17,784 households. (Assaad & Krafft, 2024). The size of the sample of males is 35,030 individuals and the size of females' sample is 35,606 individuals. Only 10,589 of the sample size are wageworkers, 8,940 are males and 1,649 are females. The mean age ranges from 20-59 years. **Table 1** shows the variables used in the models of this study accompanied by the descriptive statistics of each one.

Table 1: List of the Variables used in the Econometric models (wageworkers)

Variable	Definition	No. of Observations	Mean	St. Dev.	Min.	Max.
Hourly wages	The Hourly wage of all jobs	10,589	150.7569	12155.28	.0343407	1249999
Years of schooling	Number of years of schooling (expresses years of education)	10,589	10.38285	4.814032	0	23
Years of experience	Number of years of work experience from life history	8,946	15.8349	11.93341	0	64
Number of working hours per day	Number of market working hours per day	10,303	8.835776	2.682264	1	24
Region	Divided into 6 groups: Gr. Cairo, Alex & Suez canal, urban lower, urban upper, rural lower, rural upper	10,589	4.510341	1.530144	1	6
Urban/Rural	Urban/rural areas	10,589	1.624044	.4843917	1	2
Sector of the firm	Economic sector of primary job Divided into 6 groups: Government, Public, private, Investment, international, other	10,553	2.525159	.9137134	1	6
Size of the firm	Size of the firm of the current job based on the number of total workers: 1-4, 5-9, 10-24, 25-49, 50-99, 100+	10,381	3.15432	1.987698	1	6
Marital status	less than minimum age, never married, contractually married, married, divorced, widowed(er)	10,589	3.570214	.9394718	1	6

Father Education	Father's level of education attained: Illiterate, Reads & Writes, Less than Intermediate, Intermediate, Above Intermediate, University, Post-Graduate	10,527	2.165099	1.551664	1	7
Father occupation	Father's occupation (coding system)	8,267	5660.925	1919.989	110	9623
Father employment status	Father's employment status: Wageworker, employed, self-employed, unpaid family worker, no job	10,430	2.006807	1.512771	1	5
Mother Education	Mother's level of education attained: Illiterate, Reads & Writes, Less than Intermediate, Intermediate, Above Intermediate, University, Post-Graduate	10,521	1.689573	1.292055	1	7
Mother Occupation	Mother's occupation (coding system)	1,348	5032.216	1771.149	310	9621

Source: Author's calculations based on ELMPS 2023.

6. Results

The study begins by estimating the gender-disaggregated wage equations separately for each group. To ensure the validity of the estimates, tests for endogeneity using Durbin-Wu-Hausman Test applying parent's education and employment status as instruments (see Table 8 in the Appendix), in addition to tests of selection bias applying two stage Heckman selection bias estimate (Inverse-Mills ratio) are conducted (refer to Tables 9-14 in the Appendix). For groups where no endogeneity issues are detected, the wage equations are estimated using Ordinary Least Squares (OLS). Conversely, for groups where endogeneity is identified, the equations are estimated using Instrumental Variables Two-Stage Least Squares (IV-2SLS). All results are subjected to robustness checks to ensure their unbiasedness and reliability. The findings of the wage equations for both genders, along

with estimates of the gender wage gap, are presented separately for each group. Finally, the study compares results of the three groups according to gender wage disparities.

In the ELMPS 2023 dataset, female wage workers constitute 15.6% of the total wage-employed population, with 1,649 women out of 10,589 wage workers. Disaggregated by technology use, female representation varies notably across groups. Among technology professionals, women account for 457 out of 1,841 individuals, representing 25% of this group. In the category of technology users, females comprise 3,831 out of 8,443 individuals, corresponding to 45.4%. In contrast, among technology non-users, women represent a majority, with 31,775 out of 62,193 individuals, amounting to 51.1%.

6.1 Technology Professionals

For the Technology professionals group, the wage equations are tested for endogeneity of years of schooling variable. The result of the endogeneity test implies no endogeneity for both genders hence OLS estimation is applied. The disaggregated results of wage equations **(Table 2)** show that years of schooling, work experience, and number of working hours per day exhibit significant effects on log hourly wages of both males and females. For females, each additional year of schooling and experience increases the hourly wage by about 8% and 2.7% respectively. Also, results show that females working in large firms receive hourly wages higher compared to females who work in small firms by around 40%. Similar trends of explanatory variables apply to males regarding years of schooling and experience, they increase the hourly wage by 24.3% and 2.4% respectively. This result shows that additional investment in education for males contribute to their hourly wage rate, while the return on an additional year of education for females is lower, which refers to a clear discrimination that will be further examined in the Neuman-Oaxaca decomposition results. Unlike women, the wage equation of men shows no significant effect of the firm size on the rate of hourly wage. However, results show that men working in Alexandria and urban Lower governorates receive lower hourly wage rate by 19.2% and 25% respectively compared to those who are working in Greater Cairo.

The Number of working hours per day shows a negative effect on the log hourly wage of both males and females. This is explained by the nature of high-tech professionals, as most of them are salaried employees rather than hourly workers, so excessive work hours dilute total earnings per hour, making hourly wages appear lower. Also, In **tech professions**, especially in mid-level positions, longer hours may not lead to **higher earnings**, as firms focus on output rather than time worked (Cortes & Pan, 2019; Collewet, & Sauermann,

2017). Although both males and females face declining wages per extra hour worked, women face a slightly higher penalty (-10.6%) than men (-8.1%). This aligns with Goldin's (2014) research, which shows that women in high-skill professions face larger earnings penalties for long work hours due to work-life balance constraints.

Table 2: OLS results of wage equations, gender disaggregated for the Technology Professionals group

	OLS Estimation	**IV-2SLS Estimation**
VARIABLES	**Ln (Hourly wages of Females)**	**Ln (Hourly wages of males)**
Years of Schooling	0.0800***	0.243***
	(0.0174)	(0.0731)
Work Experience	0.0268**	0.0241***
	(0.0113)	(0.00778)
(Work Experience)^2	-0.000441	-0.000343*
	(0.000298)	(0.000189)
Number of working hours per day	-0.106***	-0.0813***
	(0.0238)	(0.0182)
Region: (ref. Great Cairo)		
Alex.& Suez Canal	-0.158	-0.192*
	(0.214)	(0.102)
Urban Lower	-0.162	-0.249*
	(0.214)	(0.147)
Urban Upper	-0.150	-0.135
	(0.228)	(0.0969)
Rural Lower	-0.107	-0.0566
	(0.205)	(0.0886)
Rural Upper	-0.245	-0.0781
	(0.218)	(0.104)
Firm Size: (ref. 1-4 Workers)		
5-9 workers	-0.0782	0.0420
	(0.209)	(0.165)
10-24 workers	0.364*	0.260
	(0.212)	(0.165)
25-49 workers	0.492***	0.0328
	(0.173)	(0.140)

50-99 workers	0.544***	0.0401
	(0.160)	(0.167)
100+ workers	0.417**	-0.00361
	(0.165)	(0.151)
Constant	2.276***	0.153
	(0.366)	(1.116)

Robust standard errors in parentheses

***** p<0.01, ** p<0.05, * p<0.1**

Source: Author's calculations based on ELMPS 2023.

To capture the gender wage gap among technology professionals, Neuman-Oaxaca wage decomposition is employed **(Table 3).** This model extends the standard Oaxaca-Blinder decomposition by incorporating selection bias correction and instrumental variable (IV) adjustments to address endogeneity. The analysis decomposes the gender wage gap into explained and unexplained components, allowing for a detailed assessment of the sources of wage disparities between men and women in Egypt.

The total wage differential, as reported in Column (1) of **Table 3**, indicates that on average, males earn approximately 1.97% more than females. Given that the mean hourly wage for females technology professionals is EGP 35.7, this implies an estimated male technology professional mean hourly wage of approximately EGP 36.4, translating to an absolute gender wage gap of EGP 0.70 per hour in favor of males. However, this difference is found to be insignificant, assuring that the gender wage gap is relatively negligible among technology professionals.

The total explained part of the gender wage gap shows to be insignificant, indicating that estimated differences in human capital and job characteristics may not fully account for gender wage disparities among technology professionals in Egypt. This means that differences in observable characteristics (e.g., education, experience, number of working hours, region, firm size) do not significantly contribute to the wage gap between men and women.

The total coefficient of the unexplained component is shown to be insignificant too; this assures the negligible existence of labor market discrimination, occupational segregation, or unmeasured productivity differences among the technology professionals group. The negative and significant coefficient of years of schooling indicates that, despite women attaining higher levels of education, their educational credentials do not translate into higher wages at the same rate as men. In absolute terms, this means that a female worker

with the same years of schooling as a male earns approximately EGP 0.56 less per hour than she would if education were valued equally across genders. Moreover, the significant coefficient of work experience suggests that men benefit more from additional years of experience than women do, contributing to an estimated EGP 0.33 per hour wage premium for males.

The inclusion of the Inverse Mills Ratio and Instrumental Variables Residuals for males is attributed to the examination of having self-selection bias and endogeneity problems tests that show significance in terms of male wages only. The negative and significant Inverse Mills Ratio (IMR) for males indicate that men who choose to participate in the labor market tend to have unobserved characteristics (e.g., higher motivation, better networking opportunities, or access to better jobs) that increase their wages. On the contrary, the insignificant IMR for females suggests that women who are employed do not systematically differ from those who are not in a way that affects wages, reinforcing the idea that structural labor market barriers may limit female wage progression, namely, glass ceiling effect.

Table 3: Neuman-Oaxaca Wage Decomposition model for technology professionals

VARIABLES	(1) Differential	(2) Explained	(3) Unexplained
Years of Schooling		-0.0285	-0.0156*
		(0.0176)	(0.00950)
Work Experience		0.0128	0.00925**
		(0.0155)	(0.00455)
(Work Experience)^2		-0.00508	-0.00550**
		(0.00643)	(0.00242)
Number of working hours per day		-0.1000***	0.00190
		(0.00968)	(0.00487)
Region		0.000351	-0.00347
		(0.000799)	(0.00292)
Firm Size		-0.000447	0.00376
		(0.00135)	(0.00358)
Inverse-mills-ratio_male		-0.0132***	-0.0385**
		(0.00434)	(0.0191)
Instrumental variables residuals		0.152***	5.81e-05

		(0.0513)	(0.000160)
Total		0.0178	0.00189
		(0.0554)	(0.00137)
Prediction_Male	3.185***		
	(0.0290)		
Prediction_Female	3.165***		
	(0.0473)		
Difference	0.0197		
	(0.0554)		
Constant			0.0500**
			(0.0227)
Observations	**1,073**	**1,073**	**1,073**
	Robust standard errors in parentheses		
	***** p<0.01, ** p<0.05, * p<0.1**		

Source: Author's calculations based on ELMPS 2023.

6.2 Technology Users

Among the technology users group, the endogeneity problem is captured for years of schooling variables. After testing for over-identification of parents' education, occupation and employment status variables, an instrument of father occupation is used to account for endogeneity in years of schooling. Two-stage least squares (2SLS) model is applied to indicate the determinants of log hourly wages of both men and women among this group (results in **Table 4**). Years of schooling is found to be significant for men but not for women. A one year increase in education enhances the hourly wage rate of men by about 10%. This indicates that among technology users, the hourly wage rate of females is not directly affected by their education but other determinants are more likely to affect their wage rate per hour. Work experience is significant for both men and women; however, women who are endowed in computer skills gain a higher hourly wage rate by 7.3% for each year increase in experience. Similarly, men gain higher hourly wage in return for an incremental increase in years of experience but with a lesser rate compared to women (3.2%). The negative effect of **experience squared** implies that **returns to experience decrease over time for women more than for men**. Like the technology professionals group, the number of working hours negatively affects the hourly wage rate of both women and men by 9% and 8%, respectively.

Table 4: IV-2SLS results of wage equations, gender disaggregated for the Technology Users group

	IV-2SLS Estimation	IV-2SLS Estimation
VARIABLES	**Ln (Hourly wages of Females)**	**Ln (Hourly wages of males)**
Years of Schooling	0.0183	0.101***
	(0.0189)	(0.0198)
Work Experience	0.0734***	0.0321***
	(0.0166)	(0.00882)
(Work Experience)^2	-0.00129***	-0.000465**
	(0.000408)	(0.000207)
Number of working hours per day	-0.0903***	-0.0795***
	(0.0330)	(0.0156)
Region: (ref. Great Cairo)		
Alex.& Suez Canal	-0.110	0.0130
	(0.209)	(0.187)
Urban Lower	0.177	0.0390
	(0.219)	(0.173)
Urban Upper	0.0411	-0.188
	(0.174)	(0.168)
Rural Lower	-0.199	0.123
	(0.166)	(0.165)
Rural Upper	-0.110	0.163
	(0.203)	(0.173)
Firm Size: (ref. 1-4 Workers)		
5-9 workers	-0.429	-0.0716
	(0.295)	(0.152)
10-24 workers	0.0534	-0.0851
	(0.208)	(0.131)
25-49 workers	0.178	0.0367
	(0.174)	(0.137)
50-99 workers	0.169	0.0102
	(0.197)	(0.146)
100+ workers	0.287*	0.0473
	(0.165)	(0.135)
Constant	2.786***	2.079***
	(0.428)	(0.353)

Robust standard errors in parentheses
***** p<0.01, ** p<0.05, * p<0.1**

Source: Author's calculations based on ELMPS 2023.

The Neuman-Oaxaca decomposition results of the technology users group, as shown in **table 5**, indicate that males earn, on average, 39.5% more than females. Given that, the mean hourly wage for females among the technology users is EGP 32, this translates into an estimated male mean hourly wage of approximately EGP 44.6. Thus, the absolute gender wage gap amounts to approximately **EGP 12.6 per hour in favor of males**.

The explained component **(-25.7%, p < 0.01 equivalent to EGP 8.22 per hour)** refers to the existence of an overall negative effect of the observable endowments (education, experience and other characteristics) on the hourly wages gap between males and females. This suggests that observable characteristics are undervalued for women compared to men. Among technology users, who have some computer and internet skills, employers may systematically undervalue women's skills or productivity, leading to wage suppression despite higher qualifications. Also, this effect may indicate the concentration of highly-qualified women (within this group) in low-wage occupations due to career interruptions that women face due to family obligations.

The intuition of the unexplained component **(65.2%, p < 0.01 equivalent to EGP 21 per hour)** supports the argument of the explained part. The results show that the portion of the wage gap that cannot be explained by education, experience, or other observed characteristics is likely to insist on the existence of occupational segregation, gender-based wage discrimination, or unmeasured factors such as negotiation skills and informal networks that favors men despite attained the same level of education and experience as their women counterparts.

Table 5: Neuman-Oaxaca Wage Decomposition model for technology users

VARIABLES	(1) Differential	(2) Explained	(3) Unexplained
Years of Schooling		0.0635	-0.861
		(0.0485)	(0.844)
Work Experience		-0.00661	-1.156**
		(0.0223)	(0.468)
(Work Experience)^2		0.00353	0.451**
		(0.0151)	(0.197)
Number of working hours per day		-0.0353	0.408
		(0.0545)	(0.470)
Region		-0.000800	0.187
		(0.00191)	(0.148)
Firm Size		-0.00482	-0.130
		(0.00604)	(0.146)
Instrumental Variables residuals		-0.277***	1.429
		(0.0928)	(2.153)
Total		-0.257***	0.652***
		(0.0374)	(0.198)
Prediction_Male	3.557***		
	(0.191)		
Prediction_Female	3.162***		
	(0.0542)		
Difference	0.395**		
	(0.198)		
Constant			0.324
			(1.552)
Observations	**859**	**859**	**859**

Robust standard errors in parentheses
***** p<0.01, ** p<0.05, * p<0.1**

Source: Author's calculations based on ELMPS 2023.

6.3 Technology Non-Users

Among the workers who do not exhibit any technological skills, the ordinary least squares results of the log hourly wages disaggregated by gender show that education, experience and number of working hours are significant for both men and women (as shown in **Table 6**). However, the hourly wages of men is significantly affected by region and firm size, unlike that of women workers in this group. Among females, an additional year of education and experience contributes positively to the hourly wage rate by 1.5% and 5.5%, respectively. However, the number of working hours per day is negatively related to the log hourly wage, indicating that an extra working hour per day decreases the hourly wage rate among females by around 10%. This indicates that most probably, workers among this group receive low salaries (payment per month) with a large number of working hours. Working in upper rural areas shows a significant yet negative effect on the hourly wage rate of females by 30.6%. In addition, results show that women who work in large firms earn a higher hourly wage rate by approximately 38% compared to women who work in small firms.

The OLS estimation for the wage equation of men reveals that an incremental increase in education and experience contributes positively to men's hourly wage rate among this group by 12.4% and 13.9%, respectively. Similar to women's results' intuition, the number of working hours negatively affects the hourly wage rate of men by 10.3%. Moreover, results show that men earn a higher hourly wage rate in Greater Cairo and their location in any other areas lessens their hourly wage rate by approximately 15%. Similarly, working in large firms contribute positively to the hourly wages of males in this group compared to working in small firms.

Table 6: IV-2SLS results of wage equations, gender disaggregated for the Technology Non-Users group

	OLS Estimation	OLS Estimation
VARIABLES	**Ln (Hourly wages of Females)**	**Ln (Hourly wages of males)**
Years of Schooling	0.0150**	0.0124***
	(0.00632)	(0.00186)
Work Experience	0.0555***	0.0139***
	(0.00781)	(0.00217)
(Work Experience)^2	-0.000951***	-0.000203***
	(0.000218)	(4.83e-05)
Number of working hours per day	-0.0971***	-0.103***
	(0.0162)	(0.00396)
Region: (ref. Great Cairo)		
Alex.& Suez Canal	-0.179	-0.176***
	(0.143)	(0.0521)
Urban Lower	-0.124	-0.137***
	(0.128)	(0.0527)
Urban Upper	-0.0277	-0.150***
	(0.137)	(0.0512)
Rural Lower	-0.177	-0.116**
	(0.129)	(0.0479)
Rural Upper	-0.306**	-0.130***
	(0.142)	(0.0469)
Firm Size: (ref. 1-4 Workers)		
5-9 workers	-0.0227	0.0321
	(0.106)	(0.0210)
10-24 workers	0.117	0.0712***
	(0.0995)	(0.0262)
25-49 workers	0.385***	0.169***
	(0.0928)	(0.0350)
50-99 workers	0.331***	0.246***
	(0.0914)	(0.0437)
100+ workers	0.382***	0.115***
	(0.0927)	(0.0279)
Constant	2.896***	3.553***
	(0.235)	(0.0671)

Robust standard errors in parentheses
***** p<0.01, ** p<0.05, * p<0.1**

Source: Author's calculations based on ELMPS 2023.

The results of the Neuman-Oaxaca wage decomposition for technology non-users in Egypt, incorporating selection bias correction using the Heckman two-step model for both males and females are expressed in **Table 7**. No evidence of endogeneity detected in the estimation process, confirming the robustness of the results. The total gender wage differential, reported in Column (1) of **Table 7**, is 0.205 log points ($p < 0.01$), indicating that on average, males earn approximately 20.5% more than females. Given that the mean hourly wage for female technology non-users is EGP 26, this translates into an estimated male mean hourly wage of approximately EGP 31.3. Thus, the absolute gender wage gap amounts to approximately **EGP 5.3 per hour in favor of males**.

The explained component (**- 20.3%, p < 0.01 equivalent to EGP 5.3 per hour**) accounts for the portion of the wage gap attributed to differences in observable characteristics, suggesting that females who exhibit the same observable characteristics, such as education, experience, and firm size, as males should have earn a 20.3% higher wage rate. The negative coefficient of education suggests that women's higher educational attainment among technology non-users does not translate into higher wages. This points to occupational segregation—women may be concentrated in lower-paying roles (e.g., administrative work, retail, and manual labor) while men dominate high-wage roles (e.g., technical trades, managerial positions). The strong positive coefficient for work experience suggests that women's wages increase with experience much faster than men's wages. The negative coefficient for experience squared implies that returns to experience accelerate over time for women, while men's wages flatten earlier. This result may indicate that women in this group have the potential for skill attainment and work progression despite they are facing promotion barriers, informal hiring practices, or lack of access to skill-based training. The negative coefficient of firm size implies that women are more likely to work in smaller firms, which generally pay lower wages. The strong negative coefficient of working hours suggests that longer working hours reduce women's effective hourly wage. This is likely because women are overrepresented in jobs that require high work intensity but offer lower pay (e.g., manual labor, service industry, retail work), whereas men are more likely to be in higher-paying leadership or managerial positions.

The unexplained component **(40.8%, p < 0.01 equivalent to EGP 10.6 per hour)** represents the portion of the wage gap that cannot be explained by education, experience, or other observed characteristics. Instead, it may reflect gender-based discrimination, differences in negotiation power, bias in promotion practices, or informal hiring networks

that favor men. The strong negative coefficient for work experience suggests that women of higher years of experience still face a lesser wage rate compared to their male counterparts. Also, the negative unexplained effect of firm size suggests that even when women work in large firms, they are still paid less than men in similar-sized organizations.

Table 7: Neuman-Oaxaca Wage Decomposition model for technology non-users

VARIABLES	(1) Differential	(2) Explained	(3) Unexplained
Years of Schooling		-0.0359***	-0.0746
		(0.00495)	(0.0736)
Work Experience		0.0872***	-0.660***
		(0.0124)	(0.103)
(Work Experience)^2		-0.0415***	0.271***
		(0.00792)	(0.0640)
Number of working hours per day		-0.183***	-0.0307
		(0.0111)	(0.124)
Region		-0.00396	0.140
		(0.00263)	(0.0871)
Firm Size		-0.0254***	-0.184***
		(0.00440)	(0.0622)
Total		-0.203***	0.408***
		(0.0155)	(0.0478)
Prediction_Male	3.007***		
	(0.0391)		
Prediction_Female	2.802***		
	(0.0310)		
Difference	0.205***		
	(0.0499)		
Constant			0.946***
			(0.223)
Observations	**6,751**	**6,751**	**6,751**

Robust standard errors in parentheses
***** p<0.01, ** p<0.05, * p<0.1**

Source: Author's calculations based on ELMPS 2023.

6.4 Results of the Two-Stage Heckman Selection Model

The two-stage Heckman Selection bias models applied for both males and females separately indicate some key messages for each classified group based on technology usage (see tables 9-14 in the Appendix). Among technology professionals, lamda λ that reveals the Inverse-Mills ratio is positive for both males and females. This indicates that highly skilled women and men are more likely to be engaged in the labor market for the suitable job options. Job market conditions in this group reward the highly skilled and productive workers either men or women.

Conversely, among normal technology users, the inverse mills ratios for both males and females are negative and significant. This indicates that, for men, those who are employed tend to have lower unobserved earning potential compared to those who are out of the workforce. The possible explanation for this result is that less skilled men may be more likely to take available jobs, even at lower wages; however, highly skilled men may opt out of employment due to better opportunities elsewhere (e.g., informal work, entrepreneurship). In addition, among this group, many highly skilled women are out of the workforce, most probably due to social norms, family responsibilities, or lack of flexible job options. Notwithstanding women who enter the workforce may accept lower-paying jobs due to fewer available opportunities. Generally, the available jobs for this group opt to be limited and not well-paid. This indicates that higher skills are much more demanded in the labor market. The same argument goes with the group of technology non-users.

7. Conclusion and Policy Implications

The results of a technology professionals group indicate that the majority of the gender wage gap remains unexplained, with selection bias playing a significant role in male wages but not female wages. Even after controlling for education, experience, and job-related factors, women earn approximately EGP 0.70 per hour less than men on average, with the unexplained component accounting for 91.4% of the gap (EGP 0.64 per hour). However, among this group, wages for both genders are higher compared to the other two groups and the difference between genders is the least.

Due to data availability, a key limitation of the study lies in its reliance on academic qualifications as the primary indicator of educational attainment, measured by the number

of completed schooling years, without accounting for the quality and type of educational institution attended. This approach overlooks important dimensions such as institutional reputation, curriculum relevance, and the transition to higher education or technical and vocational pathways. Additionally, the study does not consider the role of international and private educational institutions, whose graduates may exhibit different labor market outcomes compared to those from public institutions. Moreover, when decomposing wage gaps, the unexplained component remains substantial, exceeding 50% in some cases, suggesting that other unobserved factors—beyond the measured educational variables—are at play. This highlights the need for future research to incorporate broader measures of education quality and other hidden determinants to more accurately capture labor market disparities.

The decomposition results of the technology users group show that women exhibiting some technological skills should theoretically earn more than men based on their education and experience. However, in practice, they earn EGP 12.6 per hour less than men, with over 65% of this gap remaining unexplained. This suggests that gender-based wage disparities are driven more by structural barriers and discrimination than by differences in qualifications or productivity.

Among technology non-users, the results show that women still earn EGP 5.3 per hour less than men do, with over 50% of this gap remaining unexplained. This suggests that gender-based wage disparities result from structural barriers and discrimination rather than by differences in productivity or qualifications.

Notably, the group of technology professionals exhibits the smallest gender wage gap. However, when comparing technology users to non-users, the gender wage gap is actually smaller among non-users, accounting for 20.5% compared to 39.5% among technology users. This can be explained by the fact that women with intermediate computer skills are less willing to accept low-paid, precarious jobs and are more likely to reject occupational segregation. As a result, their participation as wage workers in this group is lower (45.4%) compared to non-users (51.1%). Econometric model results further reveal that the unexplained component of the gender wage gap is significant for both groups, but is notably larger among technology users (65.2%) than among non-users (40.8%). Additionally, while the explained portion of the wage gap is negative for both groups, its magnitude is more pronounced among technology users (-25.7%) than among non-users (-20.3%). This suggests that women with technological skills are more likely to opt out of

the labor market when confronted with occupational segregation or substandard job opportunities, whereas women in the non-user group appear more willing to accept such unfavorable conditions. Overall, higher technological proficiency tends to be associated with a narrower gender wage gap, yet higher educational attainment among women also corresponds with a lower tolerance for indecent working conditions.

While technological adoption has created new employment opportunities, its benefits have not been equitably distributed across genders. Women remain underrepresented in high-tech roles and continue to face significant wage disparities. Without proactive policy interventions, digital transformation may reinforce existing gender inequalities rather than mitigate them. A research-based policy approach is essential to ensure that women benefit equally from technological advancements in the workplace, fostering a more inclusive and equitable labor market in Egypt. The study suggests some policy recommendations in light of the study's results:

- The lower gender wage gap among technology professionals compared to the other two groups (technology users and non-users) suggests that the positions of high technological skills in the labor market have the potential to overcome the impeded disparity among genders. Thus, providing scholarships and incentives for women to gain education and training programs in STEM fields would help closing the gender wage gap in the Egyptian Labor Market.
- More than half of the gender wage gap remains unexplained across the three groups of technology usage. This suggests that females' observed endowments like education and experience remain undervalued in wage-setting processes. Policies that enforce mandatory salary transparency and pay audits in major firms should take place to avoid subjective pay-setting mechanisms and gender penalty that discourage women from participating in the labor force.
- The significant gender wage gap and unexplained component suggest that occupational segregation exists and women are concentrated in low-paying jobs across the three classifications. For instance, technology professional women may be concentrated in lower-paying roles (e.g., IT support, administrative tech jobs) rather than software development, cybersecurity, or AI. Also, among technology users and non-users, women are away from the high-paying specializations like management, skilled trades, and entrepreneurship. This can be addressed through implementing clear promotion criteria, leadership training and mentorship programs

to overcome structural barriers and glass ceiling effect. In addition, government-backed training programs for women in management and business ownership could help close the earnings gap.

- The presence of non-cognitive attributes among men, such as motivation, perseverance, access to informal social networks, negotiation abilities, and interpersonal competencies, often gives them an advantage in the labor market in terms of employability and career progression. This underscores the need for policy interventions aimed at enhancing these skills among women in the formal segments and empowering them to integrate more effectively into the labor market.
- It is critical to reconsider the policies and frameworks governing technical and vocational education in Egypt to better align with the demands of the formal labor market. This requires adopting an integrated strategy that addresses the root causes of labor market informality and offers effective solutions to create decent work opportunities. Such a strategy should also aim to enhance the role of technical education in supporting productive employment and contributing to broader goals of social mobility, economic inclusion, and poverty reduction.
- Adopting a more balanced policy regarding recruitment in the public sector—which has largely been frozen in recent years—is essential. This approach should focus on leveraging skilled personnel, particularly in light of the growing need for digital transformation and the adoption of advanced technologies within government institutions.

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Appendix

Table 8: Endogeneity problem tests (Durbin-Wu-Hausman Test) for the Three Classifications

H0: Variables are exogenous

	Technology Professionals		Technology Users		Technology Non-users	
	Males	Females	Males	Females	Males	Females
Robust score chi2(1)	13.3059 (p = 0.0003)	1.03857 (p = 0.3082)	12.02 (p = 0.0005)	5.40201 (p = 0.0201)	.084022 (p = 0.7719)	2.55309 (p = 0.1101)
Robust regression F	13.3541 (p = 0.0003)	.982208 (p = 0.3227)	11.182 (p = 0.0009)	5.77771 (p = 0.0173)	.083817 (p = 0.7722)	2.52965 (p = 0.1122)

Source: Author's calculations based on ELMPS 2023.

Table 9: Two-Stage Heckman Selection Model, for Males Technology professionals

VARIABLES	(1) lnhrwages_M	(2) select	(3) /mills
yrschl	0.0201		
	(0.0137)		
wexp	0.0104		
	(0.00795)		
exp2	-0.000129		
	(0.000176)		
marital	0.0551	-0.0992***	
	(0.0937)	(0.0326)	
ussectrp	-0.00687		
	(0.0310)		
ushrsday	-0.0984***		
	(0.0123)		
region	-0.0236		
	(0.0308)		
crfirm_size	0.0468***		
	(0.0157)		
urban		0.123**	
		(0.0620)	
lambda			0.0910
			(1.284)

Constant	3.282***	0.0666	
	(0.943)	(0.142)	
Observations	1,674	1,674	1,674

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Author's calculations based on ELMPS 2023.

Table 10: Two-Stage Heckman Selection Model, for Females Technology professionals

VARIABLES	(1) lnhrwages_F	(2) select	(3) /mills
yrschl	0.0736***		
	(0.0209)		
wexp	0.0182		
	(0.0122)		
exp2	-0.000342		
	(0.000309)		
marital	0.151	0.0836**	
	(0.275)	(0.0372)	
ussectrp	-0.132**		
	(0.0524)		
ushrsday	-0.106***		
	(0.0215)		
region	-0.0625		
	(0.0488)		
crfirm_size	0.0666**		
	(0.0287)		
urban		-0.0528	
		(0.0705)	
lambda			1.372
			(4.057)
Constant	0.281	-1.179***	
	(6.869)	(0.165)	
Observations	1,804	1,804	1,804

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Author's calculations based on ELMPS 2023.

Table 11: Two-Stage Heckman Selection Model, for Males Technology users

VARIABLES	(1) lnhrwages_M	(2) select	(3) /mills
yrschl	0.0445***		
	(0.00998)		
wexp	0.0132		
	(0.0103)		
exp2	-0.000205		
	(0.000237)		
marital	-0.366	0.303***	
	(0.487)	(0.0166)	
ussectrp	-0.0423		
	(0.0386)		
ushrsday	-0.0866***		
	(0.0122)		
region	-0.0224		
	(0.0369)		
crfirm_size	0.0210		
	(0.0188)		
urban		0.0912**	
		(0.0453)	
lambda			-1.960
			(1.907)
Constant	7.740	-2.348***	
	(4.971)	(0.0926)	
Observations	6,489	6,489	6,489

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Author's calculations based on ELMPS 2023.

Table 12: Two-Stage Heckman Selection Model, for Females Technology users

VARIABLES	(1) lnhrwages_F	(2) select	(3) /mills
yrschl	0.0621***		
	(0.0222)		
wexp	0.0414**		
	(0.0174)		
exp2	-0.000605		
	(0.000444)		
marital	-0.449	0.298***	
	(0.633)	(0.0235)	
ussectrp	-0.114*		
	(0.0600)		
ushrsday	-0.0931***		
	(0.0279)		
region	-0.0204		
	(0.0613)		
crfirm_size	0.0268		
	(0.0330)		
urban		-0.0994	
		(0.0627)	
lambda			-2.067
			(2.460)
Constant	8.580	-2.603***	
	(7.289)	(0.129)	
Observations	6,572	6,572	6,572

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Author's calculations based on ELMPS 2023.

Table 13: Two-Stage Heckman Selection Model, for Males Technology non-users

VARIABLES	(1) lnhrwages_M	(2) select	(3) /mills
yrschl	0.0115***		
	(0.00400)		
wexp	0.00591		
	(0.00474)		
exp2	-8.66e-05		
	(0.000104)		
marital	-0.510	0.230***	
	(0.456)	(0.00494)	
ussectrp	-0.0653***		
	(0.0247)		
ushrsday	-0.102***		
	(0.00662)		
region	-0.0369		
	(0.0226)		
crfirm_size	0.0128		
	(0.00939)		
urban		0.0398***	
		(0.0153)	
lambda			-3.059
			(2.382)
Constant	10.81*	-2.065***	
	(5.690)	(0.0317)	
Observations	60,831	60,831	60,831

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Author's calculations based on ELMPS 2023.

Table 14: Two-Stage Heckman Selection Model, for Females Technology non-users

VARIABLES	(1) lnhrwages_F	(2) select	(3) /mills
yrschl	0.0127**		
	(0.00605)		
wexp	0.0430***		
	(0.00788)		
exp2	-0.000747***		
	(0.000212)		
marital	0.000581	0.218***	
	(0.0988)	(0.0100)	
ussectrp	-0.150***		
	(0.0305)		
ushrsday	-0.0917***		
	(0.0122)		
region	-0.0385		
	(0.0344)		
crfirm_size	0.0519***		
	(0.0149)		
urban		-0.225***	
		(0.0286)	
lambda			-0.321
			(0.495)
Constant	4.075***	-2.573***	
	(1.454)	(0.0599)	
Observations	61,959	61,959	61,959

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Author's calculations based on ELMPS 2023.