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## Abstract

This study examines gender dynamics in digital employment in Egypt, Jordan, Tunisia, and the United Arab Emirates using harmonized national labor force survey data. Using descriptive statistics, Oaxaca-Blinder decompositions, and regularized regressions (LASSO and ridge), we analyze how women's access to and outcomes in digital jobs compare to those in the broader economy. Our results reveal that women are underrepresented in digital sectors, and those employed in these sectors tend to be highly educated and concentrated in high-skill occupations. They are also more likely to work in medium-sized and large formal establishments. Informality rates are systematically lower in digital employment than in the overall economy for both women and men. However, gender wage gaps in digital sectors differ across countries. They are relatively small in Egypt, yet substantial in Jordan and Tunisia. Decomposition results indicate that, in Jordan, differences in job characteristics and returns contribute to the observed gaps. In Egypt, positive selection into digital jobs largely offsets male-advantaging characteristics. These findings suggest that digitalization can create higher-quality employment opportunities for women, though it does not automatically reduce gender inequalities.

**Keywords:** Digital economy, gender inequality, informal employment, wage gaps, digital employment, Arab region, artificial intelligence, labor market policy, econometric analysis

**JEL Classifications:** J1, O3

## ملخص

تتناول هذه الدراسة ديناميكيات النوع الاجتماعي في التوظيف الرقمي في مصر والأردن وتونس والإمارات العربية المتحدة باستخدام بيانات مسح القوى العاملة الوطنية المنسقة. باستخدام الإحصاءات الوصفية، وتحليلات أوكاساكا-بليندر، والانحدارات المنتظمة (LASSO و ridge)، نقوم بتحليل كيفية مقارنة وصول المرأة إلى الوظائف الرقمية ونتائجها بتلك الموجودة في الاقتصاد الأوسع. وتكشف نتائجنا أن تمثيل المرأة ناقص في القطاعات الرقمية، وأن العاملين في هذه القطاعات يميلون إلى الحصول على تعليم عالٍ ويتركزون في المهن التي تتطلب مهارات عالية. ومن المرجح أيضًا أن يعملوا في المؤسسات الرسمية المتوسطة والكبيرة. ومعدلات العمل غير الرسمي أقل بشكل منهجي في العمالة الرقمية منها في الاقتصاد العام لكل من النساء والرجال. ومع ذلك، تختلف فجوات الأجور بين الجنسين في القطاعات الرقمية عبر البلدان. وهي صغيرة نسبيًا في مصر، ولكنها كبيرة في الأردن وتونس. وتشير نتائج التحليل إلى أن الاختلافات في خصائص الوظائف والعوائد في الأردن تساهم في الفجوات الملحوظة. وفي مصر، يعوض الاختيار الإيجابي في الوظائف الرقمية إلى حد كبير الخصائص التي تحابي الذكور. وتشير هذه النتائج إلى أن التحول الرقمي يمكن أن يخلق فرص عمل ذات جودة أعلى للنساء، على الرغم من أنه لا يقلل تلقائيًا من عدم المساواة بين الجنسين.

## 1. Introduction

Digital transformation has reshaped economic landscapes, labor markets, and social structures worldwide, creating new opportunities for economic participation and social empowerment. In the Middle East and North Africa (MENA) region, the expansion of digital technologies offers significant potential for economic diversification and inclusive growth. However, existing research shows that women in this region still face significant disadvantages when accessing these opportunities. These disadvantages stem from entrenched societal norms, structural inequalities, and lower access to digital resources (Ferdous, 2017; Kwan, 2023). The persistence of these gender disparities underscores the need to examine the impact of digitalization on women's economic participation, particularly in emerging digital labor markets.

For the purposes of this study, digitalization is defined as the use of digital technologies and data, as well as interconnection, that results in new activities or changes to existing activities, in accordance with the OECD framework. This is distinct from digitization, which is the conversion of analog information into digital form. Digital transformation refers to the broader economic and societal effects of both processes (OECD, 2019; OECD, 2024).

Digital technologies have the potential to empower women economically and socially. They facilitate labor market entry, entrepreneurship, and greater economic autonomy, particularly in contexts with limited traditional employment opportunities. Suzor et al. (2019) demonstrate how digital platforms can create safer spaces for women to participate and amplify their voices in social and economic spheres. Similarly, Olaitan (2024) emphasizes that digital tools enhance reporting and awareness of gender-based violence, especially in marginalized communities. However, technological advancements alone cannot resolve systemic inequalities. Ferdous (2017) and Kwan (2023) emphasize that without targeted policy interventions and supportive institutional frameworks, digitalization can exacerbate existing socioeconomic disparities.

The digital gender divide remains a significant challenge in Egypt, Jordan, Tunisia, and the United Arab Emirates (UAE). Despite advances in digital infrastructure, there are still notable gaps in internet usage between women and men. This represents only one dimension of digitalization. The International Telecommunication Union (ITU) defines internet usage as the proportion of individuals who have used the internet within the last three months. In Egypt, for example, 65.2 percent of women use the internet, compared with 79.3 percent of men. Jordan exhibits similar, albeit less pronounced, patterns: 90.9 percent of women use the internet, compared to 94.0 percent of men (ITU, 2025). These usage disparities are indicative of the broader disadvantages that women face in digital economies. These disadvantages include lower representation in digital sector employment, a tendency to be concentrated in lower-paid or informal digital work, and persistent gender gaps in earnings (see Section 4; GSMA, 2023; World Bank, 2023). In contrast, the UAE reports 100 percent internet usage for both women and men (ITU, 2025); however, sociocultural norms and labor-market structures still limit women's full and equitable participation in the digital economy (GSMA, 2023; World Bank, 2023).

Labor market structures in these four countries further exacerbate gender inequalities. According to the 2025 Global Gender Gap Report, Egypt ranks 139th out of 148 economies, indicating substantial

disparities across economic and political dimensions with a gender gap score of 62.5 percent. Jordan reports a closure score of 65.5 percent, while Tunisia ranks 123rd with 65.4 percent. The UAE holds a notably better position, ranking 69th globally and first in the MENA region with a gender gap score of 72.4 percent (World Economic Forum, 2025).

These labor market dynamics are driven by broader structural barriers. For instance, Ait Ali Slimane et al. (2019) demonstrate that inadequate transportation infrastructure restricts women's employment prospects in Jordan, particularly their involvement in urban economies. Similarly, Zeitoun (2018) illustrates how traditional household power structures and restrictive gender norms in Egypt restrict women's economic decision-making abilities and labor market mobility. Recent legal reforms in Saudi Arabia illustrate an attempt to remove formal barriers to women's participation in the economy. However, in addition to economic-related structural issues, deeply ingrained societal norms across the broader MENA region remain significant obstacles to women's active participation in the labor market (Alotaibi, 2023).

The emergence of digital employment opportunities linked to the Fourth Industrial Revolution, particularly those involving artificial intelligence (AI), introduces new possibilities as well as specific challenges. Despite its potential economic benefits, Adams et al. (2024) argue that AI may exacerbate existing gender biases through data collection methods, algorithmic decision-making processes, and downstream economic outcomes.

Platform-based digital employment presents additional complexities. While these platforms offer flexible employment, they also exacerbate precarity, informality, and inadequate labor protections, which disproportionately affect women. Research by the Fairwork Foundation in Egypt, Jordan, Tunisia, and other regional contexts has documented vulnerabilities such as insufficient social protections, wage instability, and limited legal protections for women working on digital platforms (Rizk et al., 2022a; Fairwork, 2023a, 2023b). For instance, Rizk et al. (2018) revealed significant gender-based vulnerabilities in Egypt's ridesharing industry, demonstrating how sociocultural norms intersect with digital employment to intensify economic insecurity among women. Similarly, Anwar and Graham (2020) note that the informality inherent in platform-mediated employment significantly disadvantages female digital workers in the MENA region.

This study examines the relationship between digital transformation and gender equality in labor market, which is defined as the absence of systematic disparities between women and men regarding employment, job quality, wages, and access to digital occupations. The study focuses on Egypt, Jordan, Tunisia, and the UAE. The study aims to identify and analyze gendered patterns that influence women's participation in digital employment. Additionally, it evaluates how acquiring digital skills influences women's employment outcomes, providing nuanced insights into labor market participation dynamics. By investigating these factors, the study seeks to inform policy interventions that dismantle barriers and promote inclusive digital economies that leverage women's full economic potential.

The following sections of this paper are organized accordingly. Section 2 reviews the relevant literature and identifies key research gaps related to gender dynamics in digital employment. Section 3 details the data sources and methodological approach used in this study. Section 4 presents findings on gendered

digital employment patterns, educational influences, informality, institutional factors, occupational segregation, and wage disparities. Section 5 discusses structural barriers based on these findings, offering interpretation and context. Section 6 proposes targeted policy recommendations based on the results. Finally, Section 7 concludes by acknowledging the study's limitations and outlining potential directions for future research.

## 2. Literature review

The potential of digitalization to improve employment prospects for women, especially in regions with limited traditional opportunities, has received more attention recently. Digital technologies, such as mobile broadband and digital financial services, can generate employment and entrepreneurial opportunities in environments characterized by gender-based labor market constraints. Viollaz and Winkler (2022), for example, demonstrate that mobile broadband can generate employment opportunities by relaxing traditional gender restrictions and sociocultural barriers, particularly for women in rural areas. At the regional level, a joint UNDP-ERF policy research report by Fardoust and Nabli (2022) summarizes evidence on growth, employment, poverty, inequality, and digital transformation in Arab countries. The report emphasizes that the potential benefits of digitalization are significant but uneven and contingent on institutional and policy settings. Similarly, Yusuf (2021) highlights that digital technologies can reduce or amplify inequality in Arab countries, depending on access, skills, and labor market structures.

Targeted investments in information and communication technologies (ICT) across the MENA region have modernized several sectors, including finance, education, healthcare, commerce, and labor markets. Public-private partnership initiatives aim to improve digital literacy and expand equitable access to digital resources (Ben Youssef et al., 2012; Ben Youssef et al., 2014; Kerras et al., 2020; Hadhri et al., 2017; Dahmani and Ben Youssef, 2023). For instance, Tunisia's STEM-focused education programs and Jordan's digital literacy initiatives are deliberate attempts to provide women with the necessary skills for evolving labor markets. Selwaness et al. (2023) document the potential and limitations of ICT jobs in Egypt. They show that digital jobs can provide higher-quality employment, yet they remain concentrated among highly educated urban youth Mahroum (2021).

Despite improvements in women's educational attainment, their labor market outcomes often fail to reflect these achievements. Structural and institutional barriers persist, limiting women's economic engagement. These barriers are reinforced by restrictive social norms, limited access to productive resources, and entrenched gender biases. Badran (2019) illustrates how patriarchal norms restrict women's aspirations and access to opportunities in high-growth sectors, such as STEM. Building on this analysis, Alhajri and Aloud (2023) demonstrate that despite significant progress in STEM education, women are still significantly underrepresented in related professional fields. This indicates the ongoing underutilization of female talent. These findings echo the broader evidence of the "MENA paradox", which is the simultaneous increase in female educational attainment and low, stagnant female employment (Assaad et al., 2020).

Digital entrepreneurship has emerged as a complementary pathway for women's economic resilience. Althohali and Al-Dajani (2022) examined women-owned microbusinesses in Saudi Arabia during

the pandemic and found that digital platforms enabled entrepreneurs to maintain income by adapting quickly. This was made possible by emotional resilience, informal support networks, and passion-driven initiatives. Their study demonstrates that, while platform-based microenterprises can mitigate gender-specific vulnerabilities during crises, such coping strategies depend on access to digital tools, finance, and family support.

However, informality remains a significant concern in digital employment contexts, even where digitalization has increased women's participation in labor markets. Taheri et al. (2023) analyze how informal employment affects men and women differently in Middle Eastern countries. The evidence they and others present (e.g., Assaad and Krafft, 2018; Adair et al., 2024; AlAzzawi and Hlasny, 2019) suggests that men are more likely than women to transition to informal employment when formal public and private opportunities diminish. Many women, in contrast, respond by either leaving the labor force or engaging in unpaid family work. This pattern reflects a segmented labor market in which informality mainly benefits men, while women's options are more constrained by norms and care responsibilities. Therefore, Taheri et al. (2023) emphasize the importance of transitioning informal digital employment towards formal structures to ensure more stable employment conditions and equitable outcomes for women.

Related work by Adair et al. (2024) on informal employment, gender patterns, and policies in MENA countries highlights how structural segmentation between the formal public and private sectors and the informal sector interacts with gender norms to shape opportunities for women and men throughout their lives. These contributions underscore that informality is a structural feature of MENA labor markets that contributes to unequal risk exposure, wage penalties, and stalled mobility, especially for women.

Anwar and Graham (2020) expand upon this line of analysis by focusing on platform-mediated work. They emphasize the necessity of robust labor protections to address the vulnerabilities that arise from informal platform employment in the Middle East, North Africa (MENA), and Africa. The Fairwork Foundation's empirical assessments (Fairwork, 2023a, 2023b, 2023c; Rizk et al., 2022b) reveal significant deficiencies in social protection, wages, and employment stability for women in the digital workforce, especially in Egypt, Jordan, Lebanon, and Morocco. These studies demonstrate that weak regulatory frameworks and structural vulnerabilities disproportionately expose female digital workers to economic insecurity and labor exploitation despite the potential advantages of digital platforms. Concurrently, ERF-supported research on ICT and employment (Kılıçaslan and Töngür, 2018) and ICT jobs in Egypt (Selwaness et al., 2023) confirms that digital job quality and distribution are highly stratified by sector, firm type, and worker characteristics.

Rizk et al. (2018) present detailed findings from ridesharing platforms in Cairo that demonstrate how entrenched cultural and socioeconomic norms exacerbate the risks faced by female digital workers, thereby increasing their vulnerability to economic insecurity, harassment, and violence. Additional studies by Rizk et al. (2022a) report comparable vulnerabilities in platform-mediated domestic service sectors in Tunisia and Turkey. While digital platforms can, in principle, provide safer work environments, these studies suggest that traditional risks persist where regulatory oversight is weak and socioeconomic marginalization is pronounced.

Digital technologies associated with the Fourth Industrial Revolution (4IR), such as artificial intelligence (AI), robotics, and data analytics, are expected to reshape labor market structures and create new job opportunities for women. Assi and Marcati (2020) predict that integrating cognitive and digital technologies could increase women's representation in technical and highly skilled positions by 2030. Similarly, Ben Youssef et al. (2022) identify emerging employment opportunities in rapidly growing technology sectors, including AI and robotics, that could reduce gender disparities. However, realizing these opportunities depends on inclusive policies that foster digital literacy, workplace flexibility, and family-friendly working conditions. Without such interventions, existing gender inequalities could intensify, continuing to disadvantage women in rural and marginalized communities (Kerras et al., 2020; Fardoust and Nabli, 2022).

At the same time, integrating AI into labor markets introduces challenges related to embedded gender biases. Adams et al. (2024) demonstrate that AI systems can replicate and exacerbate existing gender biases throughout the AI development cycle, including in data collection and algorithmic decision-making processes. These biases can generate unequal outcomes in hiring, promotion, pay, and access to financial services. Morocco's National Council for Human Rights (CNDH) has started to monitor gender equality in AI systems, providing an example of institutional oversight that can mitigate AI-driven discrimination. Adams et al. (2024) emphasize that effective policy interventions must combine technological safeguards with broader sociocultural and structural reforms.

Social norms persistently influence women's economic participation, especially in digital employment. Studies by Gauri et al. (2019) and Barnett et al. (2021) demonstrate that patriarchal norms significantly constrain women's employment choices, hindering their participation in high-growth digital sectors. Additionally, cybersecurity concerns and online harassment discourage women, especially younger ones, from using digital platforms. These findings suggest that effective digitalization strategies must include comprehensive digital safety measures and cybersecurity education to enable women to participate actively and safely in the digital sphere.

Despite this substantial body of work, important gaps remain. Much of the existing literature on digitalization and gender in the Middle East and North Africa (MENA) region focuses on either broad macroeconomic impacts (growth, inequality, and digital trade) or specific case studies of platform work and entrepreneurship. Relatively little evidence jointly examines how digital sectors, skills, informality, and wage gaps interact within national labor markets to shape women's employment outcomes. Additionally, although a substantial body of literature applies Oaxaca–Blinder decompositions, occupational segregation indices, and related empirical tools to gender wage gaps and labor market segmentation in the region (e.g., AlAzzawi and Hlasny, 2019; Hanchane and Mounir, 2023; Adair et al., 2024), this body of work has rarely been explicitly linked to the dynamics of digital employment. Building on these interconnected research strands, the present paper makes two contributions. First, it synthesizes the literature on digitalization and gender in the labor market by focusing specifically on women's employment in digital sectors in Egypt, Jordan, Tunisia, and the UAE. It also compares these outcomes with those in other sectors of the economy. Second, the paper applies decomposition and segmentation tools to quantify the contributions of sector, skills, informality, and occupational structure to gender gaps in employment and earnings. This extends the existing evidence on digital transformation and gender inequality in MENA labor markets.

### 3. Data and methodology

#### 3.1. Data sources and country selection

This study draws on aggregated indicators derived from national labor force surveys (LFS) in Egypt, Jordan, Tunisia, and the UAE. Produced by national statistical offices, these surveys align with International Labour Organization (ILO, 2013) standards. They provide nationally representative, sex-disaggregated information on employment, sector of activity, occupation, informality, and wages. All results are based on harmonized LFS aggregates rather than individual-level microdata or stand-alone ILO summary statistics.

The analytical scope spans from 2009 to 2023; however, the data coverage for digital employment and wage indicators varies across the four countries. For Egypt, consistent digital employment indicators are available from 2013 to 2023, and the wage gap series extends back to 2009. This allows for the longest time series analysis in our sample. For Jordan, digital employment indicators and wage gaps are available from the mid-2010s onward, with most series spanning from 2016 or 2017 to 2023. Tunisia enters the analysis somewhat later; digital employment indicators are available from 2014, and wage gap information is reported for 2019. This still permits useful comparisons of digital and non-digital employment structures. For the UAE, the LFS provides digital employment indicators from 2017 to 2023 but not a comparable wage-gap series, so Emirati evidence is primarily used in a descriptive manner. These country-specific coverage patterns correspond to the years shown in our figures on digital employment and digital wage gaps, reflecting the structure of the underlying LFS series.

The selection of these four countries balances data availability and regional relevance. Egypt and Jordan have relatively long, internally consistent sequences of LFS aggregates that support econometric exercises relying on time-series variation. Tunisia offers shorter yet informative series that capture key policy and economic shifts affecting women's digital employment. The UAE provides the perspective of a rapidly digitalizing, high-income Gulf economy. The four cases, collectively, cover a wide spectrum of institutional and economic contexts, enabling us to compare gendered patterns of employment in digital sectors and in the broader economy under diverse structural conditions.

Several variables are essential for systematically evaluating gender-based employment patterns and the factors influencing women's labor market outcomes. For analytical comparison, employment is classified into two domains: the digital sector and all other sectors. The digital sector encompasses both ICT industries and digitally intensive service activities. This definition follows the OECD (2018) digital-intensity taxonomy and recent evidence on ICT jobs in Egypt and other Arab economies (e.g., Mahroum, 2021; Selwaness et al., 2023). This includes information and communication activities, as well as select service industries such as finance, wholesale and retail trade, transport and storage, and professional and administrative services, where digital technology use is high. This definition aligns our classification with regional literature on ICT and digitalization, ensuring that the digital sector encompasses both core ICT production and services heavily dependent on digital tools.

To facilitate cross-country comparability, educational attainment is grouped into three categories. We harmonize country-specific education levels as follows: basic, intermediate, and advanced. Basic

education includes primary and lower secondary schooling. Intermediate education broadly corresponds to upper secondary or high school completion. Advanced education includes postsecondary and tertiary education, such as university and postgraduate degrees. This three-level grouping enables us to compare education gradients across countries with different national education systems while maintaining the distinction between low, medium, and high levels of human capital.

Firm size is another important structural determinant. In line with how enterprise size is reported in the labor force surveys used here, establishments are classified as small, medium-sized, or large according to their number of employees. Small establishments have one to four employees; medium-sized establishments have five to forty-nine employees; and large establishments have fifty or more employees. Many national classifications refer to units with one to four workers as micro or very small enterprises. In our analysis, these units are included in the “small” category to maintain a consistent three-level size classification across all four countries and throughout the period covered by the LFS aggregates. Studies indicate that firm size significantly influences employment stability, working conditions, and gender disparities in employment opportunities (ILO, 2019). Thus, incorporating firm size into the analysis provides important insight into the structural determinants of gendered employment outcomes across sectors.

We distinguish institutional employment sectors as either public or private and pay particular attention to how this interacts with formal and informal arrangements within the private sector. This distinction enables a thorough analysis of how institutional contexts and employment arrangements collectively influence gender disparities in employment security, working conditions, informality rates, and wage outcomes, particularly in digital activities predominantly driven by the private sector.

We define occupational skill levels using the International Standard Classification of Occupations (ISCO-08), as specified by the ILO (2012). We classify occupations as low-, medium-, or high-skilled by grouping ISCO-08 major groups consistently: high-skilled occupations include managers and professionals (major groups 1 and 2); medium-skilled occupations include technicians, associate professionals, clerical support workers, and service and sales workers (major groups 3 to 5); and low-skilled occupations include agricultural workers, craft and related trade workers, plant and machine operators, and elementary occupations (major groups 6 to 9). This classification provides a consistent basis for analyzing gender-based occupational segregation in digital and non-digital contexts.

Informal employment is defined based on labor force survey information available in each country and regional literature on informality. Conceptually, informality is associated with an absence of formal employment relationships and social protection. Practically speaking, we classify a job as informal if the worker reports having no social security coverage. Where information on written contracts is available, we verify that this classification aligns with an absence of a formal contract. This definition captures the employment dimension most directly linked to vulnerability, lack of protection, and exposure to risk in our data.

Finally, we analyze gender wage disparities using average monthly earnings expressed in U.S. dollars as the main monetary variable. We use monthly earnings because they are consistently reported in LFS aggregates across all four countries. However, information on hours worked is not available in a

sufficiently comparable way to construct reliable hourly wages. To make earnings comparable over time and across countries, we convert the nominal wages reported in local currency into constant purchasing power parity (PPP) US dollars using World Bank PPP conversion factors. This measure is suitable for Oaxaca-Blinder decompositions and related empirical tools applied in subsequent sections.

### *3.2. Analytical framework and econometric methods*

The empirical strategy uses descriptive and econometric tools to study the relationship between digital transformation and gender equality in labor markets. First, descriptive statistics document differences in employment, informality, occupational structure, and wages between women and men in digital and non-digital sectors. These patterns then inform the econometric analysis, which focuses on two key dimensions of gender inequality among employed workers: earnings and informality.

To analyze the determinants of women's earnings, we estimate wage equations using regularized regression. We use the least absolute shrinkage and selection operator (LASSO) regression method as an exploratory tool to handle a large set of correlated covariates and identify the characteristics most strongly associated with women's average monthly wages in digital and non-digital employment. We do not interpret LASSO coefficients causally. Instead, we use them to summarize the relative importance of education, firm size, institutional sector, occupational skill level, informality status, and digital versus non-digital employment. We evaluate model performance using standard diagnostics such as  $R^2$ , root mean squared error (RMSE) and mean absolute error (MAE).

Because informality is a significant channel through which digitalization interacts with vulnerability, we also estimate models of informal employment among women. To this end, we employ logistic regression with ridge (L2) regularization, which stabilizes estimates in the presence of correlated predictors. The dependent variable indicates whether a woman's job is informal, and the explanatory variables are the same as those used in the wage equations. As with wage models, we interpret these estimates as descriptive associations rather than causal effects. We use pseudo- $R^2$  and information criteria to assess their adequacy.

Finally, to quantify gender wage gaps in digital employment and separate characteristics from returns, we apply the Oaxaca-Blinder decomposition (Blinder, 1973; Oaxaca, 1973). In our study, the explained component reflects differences between women and men in observable characteristics, such as education, firm size, sector, occupational skill level, and informality. The unexplained component reflects differences in returns to these characteristics consistent with discrimination or unobserved structural barriers. Focusing this decomposition on digital jobs links the digital transformation of employment directly to the structure of gender wage gaps in the part of the economy most relevant to our research question.

### *3.3. Methodological limitations*

Several methodological constraints should be considered when interpreting the findings. First, the Labor Force Surveys used in this study are repeated cross-sections rather than true panel data. Even when individual-level records are available, the same workers are not tracked over time. This limits our

ability to trace employment trajectories or make strong causal claims about the impact of digitalization on women's labor market outcomes. Second, although the LFS follow ILO guidelines, cross-country comparisons may still be affected by differences in sampling procedures, survey periodicity, questionnaire design, and how national statistical offices code key variables.

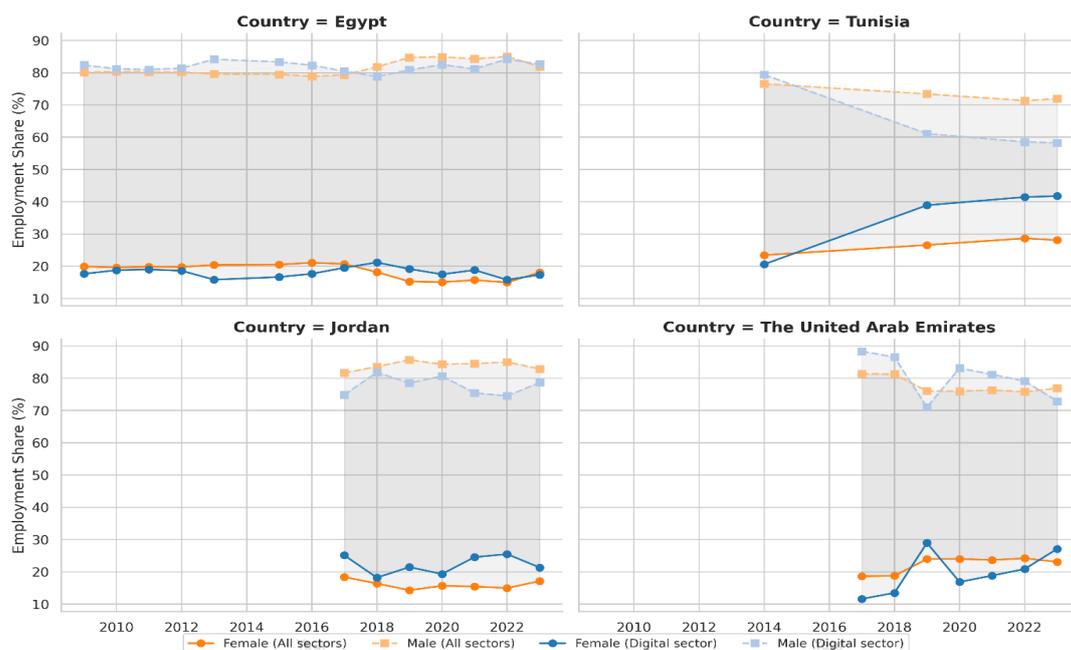
These constraints explain why the econometric analysis is restricted to Egypt and Jordan, where the microdata are rich and consistent enough to estimate earnings and informality models. In contrast, the evidence for Tunisia and the UAE remains descriptive. In all cases, the results are to be interpreted as associations that complement the descriptive patterns and decomposition analysis rather than as causal estimates. Acknowledging these limitations highlights the necessity of ongoing efforts to enhance the granularity, consistency, and longitudinal depth of labor market data in the region, particularly with regard to digital employment.

## 4. Empirical results

### 4.1. Gender dynamics in employment: Digital versus Total Economy

Figure 1 compares the employment shares of women and men in digital sectors and in the total economy in Egypt, Jordan, the UAE, and Tunisia over the period covered by the available LFS data. Across all four countries, digital sectors account for a smaller, yet growing, share of total employment. Within this evolving structure, women's employment share in digital activities often differs from their employment share in the wider economy. Hereafter, "female (male) employment share in a sector" refers to women's (men's) share of all workers in that sector, not the share of working women (men) employed in that sector.

*Figure 1. Evolution of female and male employment shares: comparing digital and all sectors*



In Egypt, women's employment share in digital sectors fluctuated from 15.8 percent in 2013 to 21.2 percent in 2018. Over the same period, their share of employment in the total economy ranged from 15.0 to 21.1 percent. On average, women held a slightly smaller share of employment in digital sectors (roughly 18 percent) than in the broader economy (around 19 percent). However, from the late 2010s onward, the trend in digital sectors indicates an upward movement in women's employment shares, consistent with the growth of ICT activities and policy initiatives explicitly encouraging women to enter digital occupations.

In Jordan, women have consistently held a larger proportion of jobs in the digital sector than in the overall economy. From 2017 to 2023, women accounted for between 18.2 percent and 25.5 percent of employment in digital sectors, compared to between 14.3 percent and 18.4 percent in the total economy. This suggests that digital sectors offer better entry opportunities for women than the rest of the labor market, although women remain significantly underrepresented.

In the UAE, the percentage of women employed in digital roles increased from 11.6 percent in 2017 to 27.1 percent in 2023. Over the same period, the women's share of employment in the overall economy rose from 18.6 percent to 23.1 percent. The faster increase in women's representation in digital sectors aligns with the UAE's initiatives to encourage gender diversity in high-skilled, technology-intensive roles, despite overall female employment levels remaining below those of men.

In Tunisia, women's share of employment in the digital sector increased from 20.6 percent in 2014 to 41.8 percent in 2023, nearly doubling within a decade. By comparison, women's share of employment in the total economy increased more moderately, rising from 23.5 percent to 28.1 percent during that time. This widening gap between digital and non-digital employment is consistent with targeted initiatives to support women's digital employment, as well as broader shifts in market demand and social norms. However, the growing disparity between women's and men's employment rates suggests that structural barriers persist within digital sectors and the broader labor market.

#### *4.2. Educational achievement and gender-based employment opportunities*

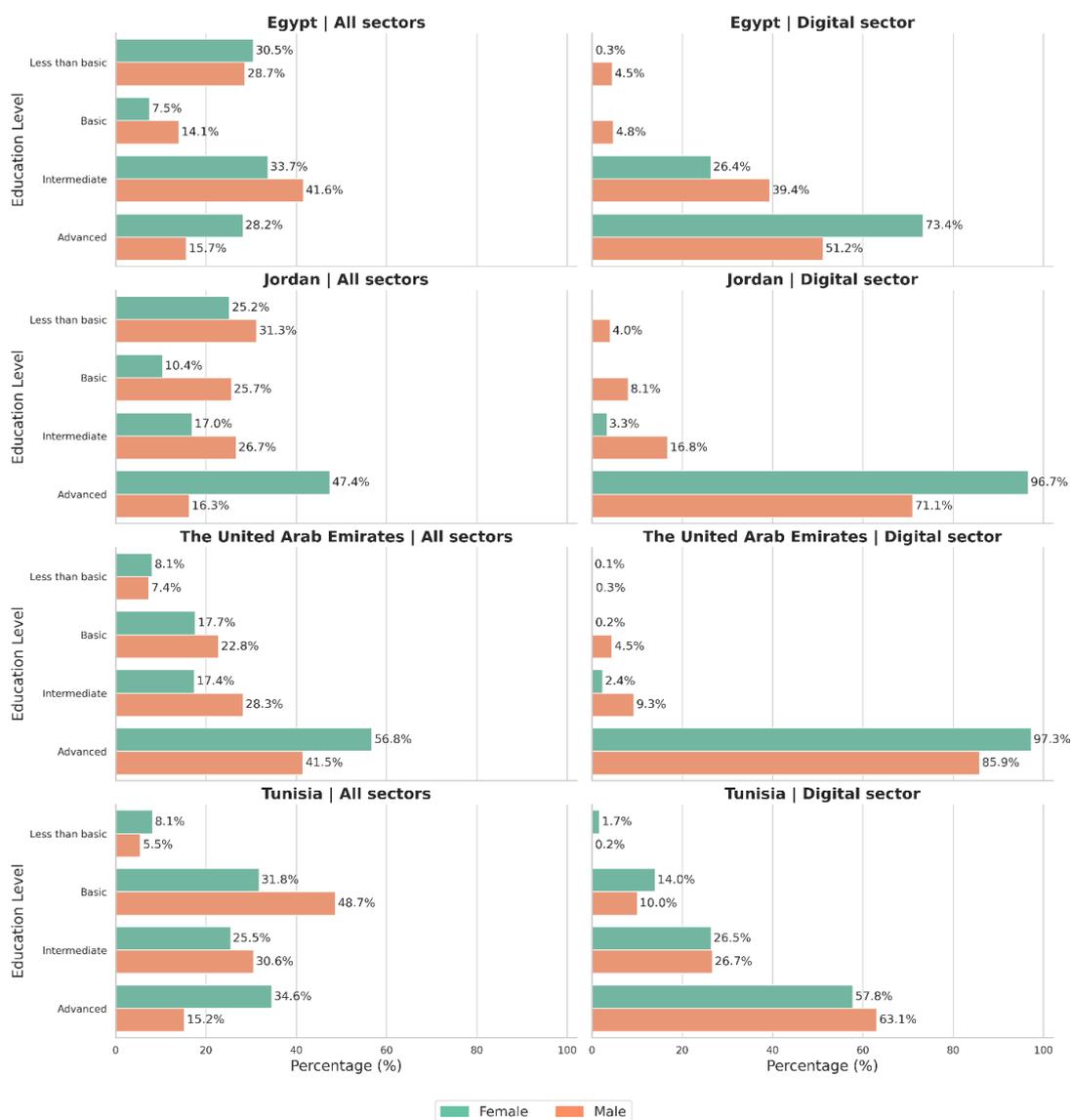
Educational attainment significantly impacts women's employment opportunities in digital sectors. Figure 2 shows the distribution of employment by gender and education level (less than basic, basic, intermediate, and advanced) in digital sectors compared to the total economy. The percentages are weighted averages across all available Labor Force Survey (LFS) waves in each country, using survey employment weights.

In Egypt, women employed in digital sectors are concentrated primarily at the top of the educational distribution. Among all digital workers, 73.4 percent of women and 51.2 percent of men have an advanced education compared to 28.2 percent of women and 15.7 percent of men in the broader economy. Women with intermediate education represent 26.4 percent of the digital workforce, which is slightly below their representation in the broader economy. Workers with less-than-basic education are nearly absent from digital sectors, both among women and men, even though they account for a significant proportion of total employment. These patterns suggest that digital jobs disproportionately attract highly educated women compared to men and the overall workforce.

Jordan exhibits an even stronger education gradient in digital employment. In digital sectors, 96.7 percent of women and 71.1 percent of men have advanced degrees. In contrast, in the total economy, the corresponding percentages are 47.4 and 26.7. Women with intermediate or lower education levels are underrepresented in digital jobs despite accounting for a much larger share of overall female employment. Therefore, the digital segment selects highly educated women to a greater extent than highly educated men.

In the UAE, advanced education also dominates female digital employment. Within digital sectors, 97.3 percent of women and 85.9 percent of men have advanced degrees, compared to 41.5 and 56.8 percent, respectively, in the total economy. Women with intermediate or basic education are scarcely represented in digital jobs, while men with intermediate education are more present in other sectors.

Figure 2. Employment distribution by gender and educational attainment in digital versus all sectors



Note: Percentages represent weighted averages over multiple years. Egypt (2009–2023), Jordan (2017–2023), UAE (2021–2023), Tunisia (2019, 2022, 2023). Data Source: National Labor Force Surveys (LFS), processed by authors.

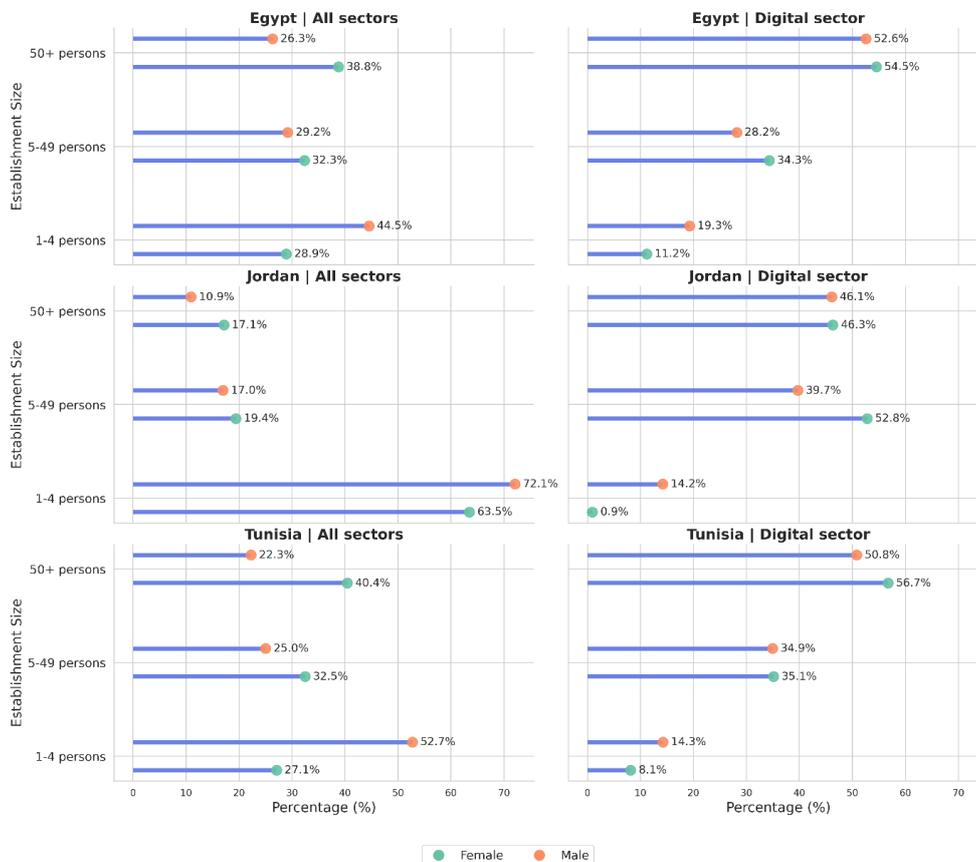
Tunisia shows a somewhat more balanced pattern, but the selection effect remains visible. In digital sectors, 57.8 percent of women and 63.1 percent of men have advanced degrees, while around one-quarter of both groups have intermediate degrees. However, women with only a basic education comprise 14.0 percent of digital employment, compared to 31.8 percent in the total economy. These results suggest that women in digital jobs are, on average, more highly educated than women in other sectors and that men with lower education levels are more likely to be employed outside the digital sector.

These cross-country results highlight that digital employment tends to recruit from the upper end of the educational distribution, and that women in digital jobs are typically more educated than men in digital jobs and women in the wider economy. This information is crucial for interpreting gender gaps in digital labor markets.

### 4.3. Firm size as a determinant of gendered employment patterns

Figure 3 shows the distribution of male and female employment by firm size in digital sectors and in the total economy in Egypt, Jordan, and Tunisia. The UAE is not included because the country’s Labour Force Survey does not provide a consistent breakdown of digital employment by establishment size. The percentages are weighted averages over all available LFS waves for each country.

Figure 3. Employment distribution by gender across firm size categories in digital and all sectors



Note: Percentages represent weighted averages over multiple years. Egypt (2009–2023), Jordan (2017–2023), Tunisia (2019). Data Source: National Labor Force Surveys (LFS), processed by authors.

In Egypt, both women and men in the digital sector are concentrated in medium-sized and large firms, though this pattern differs from that of the total economy. In all sectors, women are employed across small (28.9 percent), medium-sized (32.3 percent), and large firms (38.8 percent), while men are concentrated in small establishments. In digital sectors, women's employment is much more concentrated in large firms (54.5 percent) and, to a lesser extent, in medium-sized firms. Small establishments account for only 11.2 percent of women's digital jobs. Men in digital employment are also more present in medium and large firms than in the total economy. However, the shift is stronger for women, indicating that women's digital jobs are particularly concentrated in larger enterprises. In Jordan, the contrast between digital and non-digital employment is sharper. In the total economy, most women and men work in small establishments, and only a minority are employed in medium-sized or large firms. In digital employment, however, very few women work in small firms, while similar percentages of women and men are employed in medium-sized and large digital enterprises. This suggests that medium-sized and large firms are the main source of digital jobs for both sexes and that women in digital employment are almost exclusively employed in these larger organizational settings.

In Tunisia, the distribution of digital employment shifts towards medium-sized and large establishments for both women and men. In the total economy, however, women are more evenly spread across small, medium, and large firms, while men predominantly work in small firms. In the digital sector, women are concentrated in large firms (56.7 percent) and medium-sized firms (35.1 percent) and have a limited presence in small firms. Similarly, men in digital jobs are concentrated in medium and large establishments; however, the shift away from small firms is more pronounced for women. This pattern aligns with the notion that ICT and digitally intensive activities are prevalent in medium-sized and large enterprises in the region. It also reinforces the idea that firm size is an important dimension of gender inequality in digital employment.

#### *4.4. Institutional sector and gender disparities in employment*

As Figure 4 illustrates, differences between the public and private sectors significantly impact gender disparities in digital employment compared to the broader economy.

In Egypt, for instance, women comprise a larger proportion of digital employees in the public sector (43.9 percent) than in the broader economy (38.3 percent). However, the percentage of men employed in digital roles in the public sector is notably lower (39.4 percent digital versus 19.5 percent overall). These observations suggest that the public sector is relatively favorable for women in digital roles, possibly due to stable career paths and supportive employment policies.

Meanwhile, in Jordan, women are predominantly employed in digital roles in private enterprises (94.5 percent), as opposed to minimal representation in the public sector (5.5 percent). Nevertheless, women have a greater presence in the public sector overall (37.4 percent). This distribution underscores the private sector's central role in promoting digital employment opportunities for women in Jordan.

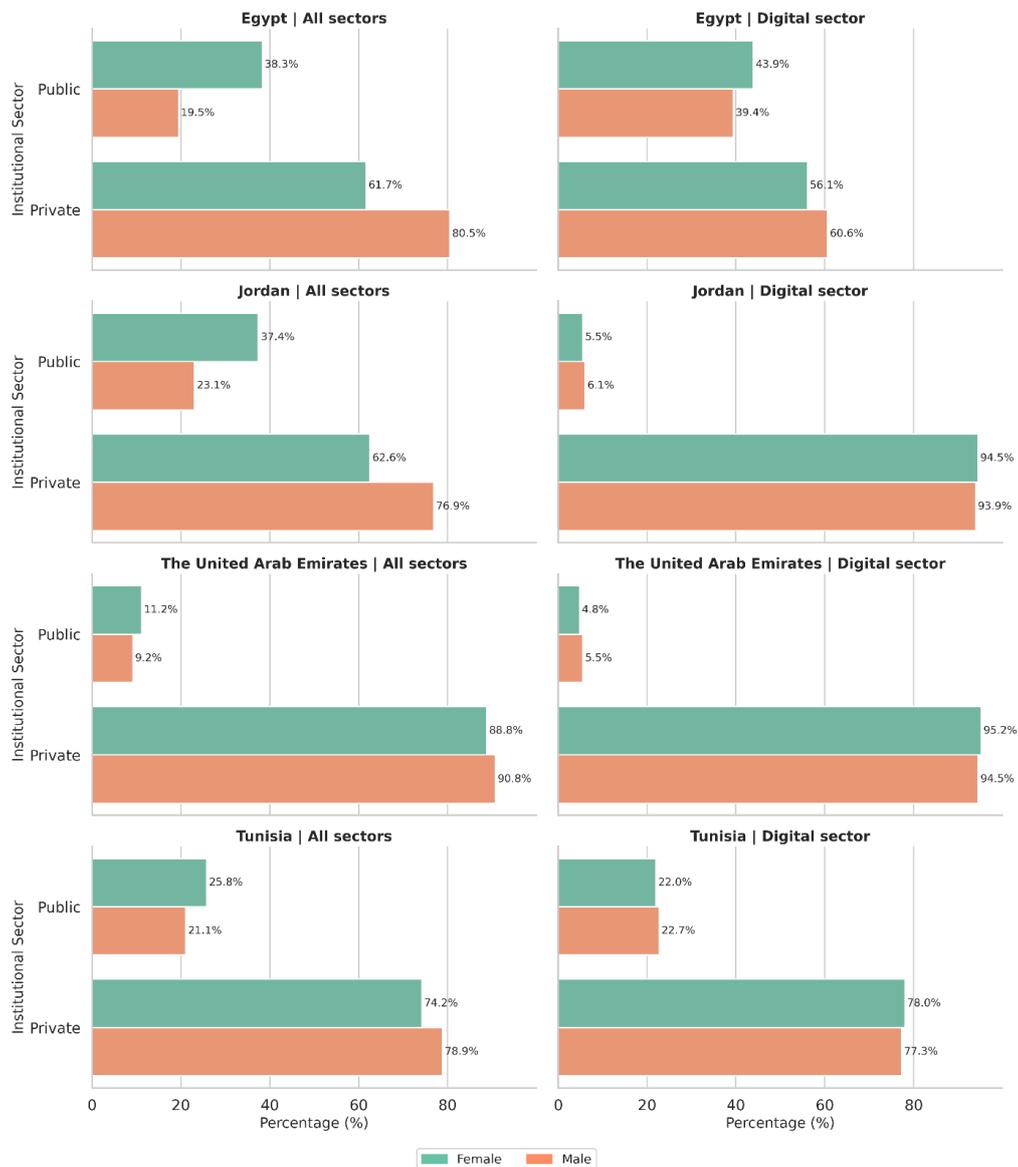
In the UAE, the private sector dominates digital employment. More than 95 percent of digitally employed women work in private enterprises, surpassing their 88.8 percent representation in the

broader economy. This aligns with the UAE’s economic diversification strategy driven by private-sector initiatives.

Tunisia has a balanced institutional sector distribution, with women’s digital employment split more evenly between the public (22.0 percent) and private sectors compared to Jordan and UAE, reflecting their broader economic representation, with similar patterns in digital employment and the broader economy. This balance likely reflects effective government-driven public-private partnerships that support women’s employment in digital sectors.

These empirical insights suggest that leveraging the strengths of public or private institutions could significantly increase women’s participation in digital employment in each national context.

**Figure 4. Employment shares by gender in the public and private sectors, comparing digital versus all sectors**



Note: Percentages represent weighted averages over multiple years. Egypt (2009–2023), Jordan (2017–2023), UAE (2017–2023), Tunisia (2014, 2019). Data Source: National Labor Force Surveys (LFS), processed by authors.

#### 4.5. Occupational skill levels and gender segregation in employment

Occupational skill requirements significantly impact gender segregation in the workforce, especially when comparing digital sectors with the broader economy.. Section 4.2 focuses on educational attainment as a measure of formal qualification. This section, however, examines how women and men are allocated across jobs of different skill levels. This provides complementary information on gendered occupational sorting within digital and non-digital employment.

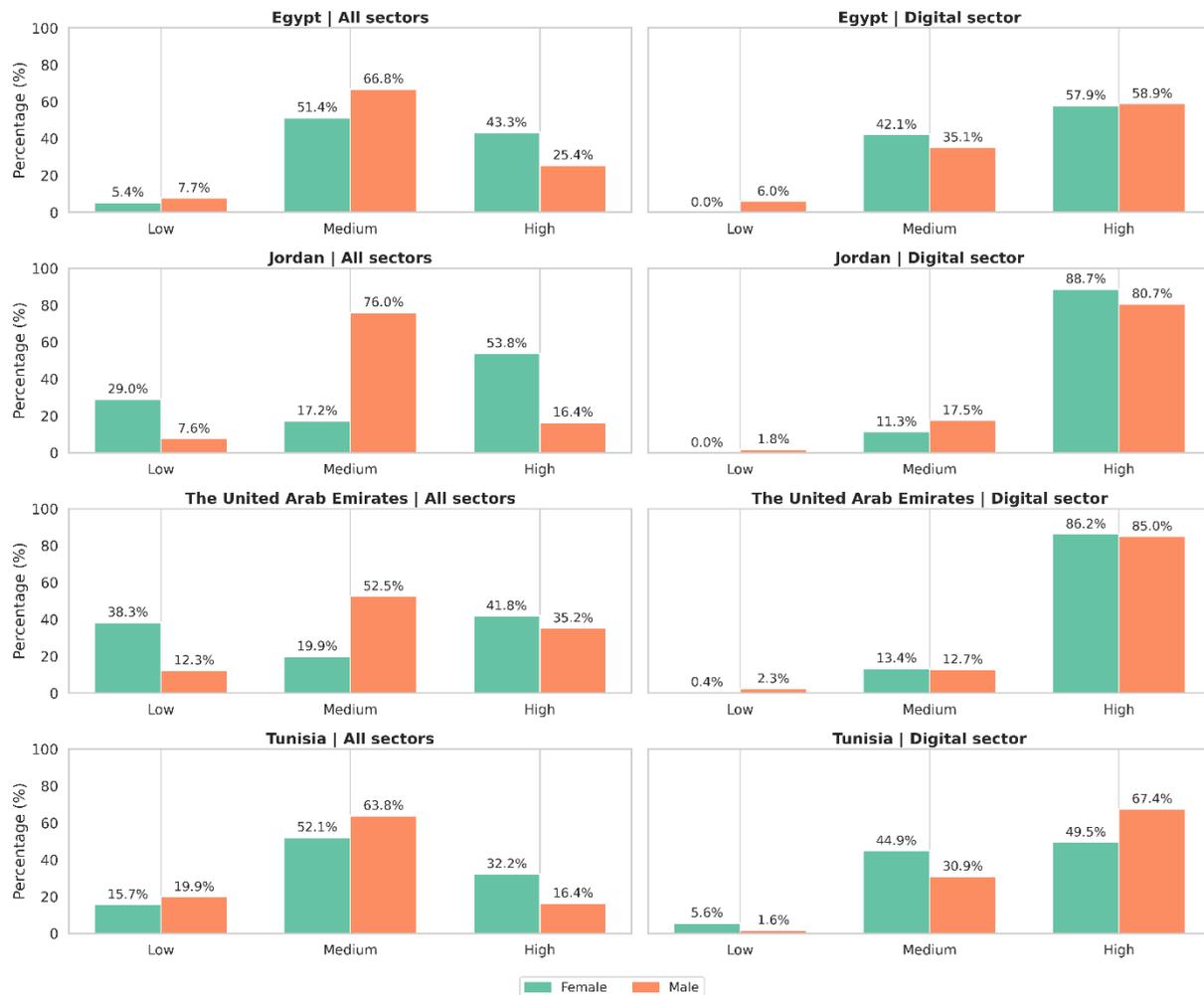
Figure 5 illustrates these occupational differences in Egypt, Jordan, the UAE, and Tunisia. In Egypt, most women employed in digital sectors hold high-skilled positions (57.9 percent), while the remainder work in medium-skilled jobs (42.1 percent). There is virtually no female representation in low-skilled occupations. In the general economy, however, women are somewhat more evenly distributed across high-skilled (43.3%), medium-skilled (51.4%), and low-skilled (5.4%) occupations. Among men, digital employment also favors high-skilled positions (58.9 percent), though medium-skilled (35.1 percent) and low-skilled (6.0 percent) roles are present as well. In the broader economy, men are predominantly employed in medium-skilled roles (66.8 percent), while high- (25.5 percent) and low-skilled (7.7 percent) roles are less common.

Jordan exhibits an even more pronounced form of skill-based segregation in digital employment. Nearly all women employed in the digital sector (88.7 percent) hold high-skilled positions, with minimal representation in medium-skilled roles (11.3 percent), and no representation in low-skilled positions. In contrast, women's employment in the broader economy is more evenly distributed across high-skilled (53.8 percent), medium-skilled (17.2 percent), and low-skilled (29.0 percent) jobs. Similarly, digitally employed men concentrate in high-skilled occupations (80.7 percent), followed by medium-skilled roles (17.5 percent), with very limited representation in low-skilled positions (1.8 percent). In the total economy, however, men are primarily in medium-skilled jobs (76 percent).

In the UAE, the pattern of occupational skill segregation in digital sectors is similar. Women in digital employment are predominantly in high-skilled positions (86.2 percent), with smaller shares in medium-skilled positions (13.4 percent) and nearly none in low-skilled positions (0.4 percent). Overall, women's employment is more dispersed: 41.9 percent are in high-skilled jobs, 19.9 percent are in medium-skilled jobs, and 38.3 percent are in low-skilled jobs. Digitally employed men also favor high-skilled positions (85.0 percent), while medium-skilled (12.7 percent) and low-skilled (2.3 percent) roles are less common. Overall, men's employment is largely situated in medium-skilled roles (52.5 percent).

Compared to other countries, Tunisia has comparatively moderate occupational segregation in digital employment. Women in the digital sector are nearly equally represented in high-skilled (49.5 percent) and medium-skilled (44.9 percent) positions, with limited participation in low-skilled roles (5.6 percent). In the broader economy, women are predominantly employed in medium-skilled positions (52.1 percent), followed by high-skilled (32.2 percent) and low-skilled (15.7 percent) jobs. Digitally employed men in Tunisia primarily occupy high-skilled positions (67.4 percent), followed by medium-skilled (30.9 percent) and low-skilled (1.6 percent) roles. Overall, men are mostly employed in medium-skilled jobs (63.8 percent), followed by low-skilled (19.9 percent) and high-skilled (16.4 percent) roles.

**Figure 5. Employment distribution by occupational skill level and gender in digital versus all sectors**



Note: Percentages represent weighted averages over multiple years. Egypt (2009–2023), Jordan (2017–2023), UAE (2017–2023), Tunisia (2019). Data Source: National Labor Force Surveys (LFS), processed by authors.

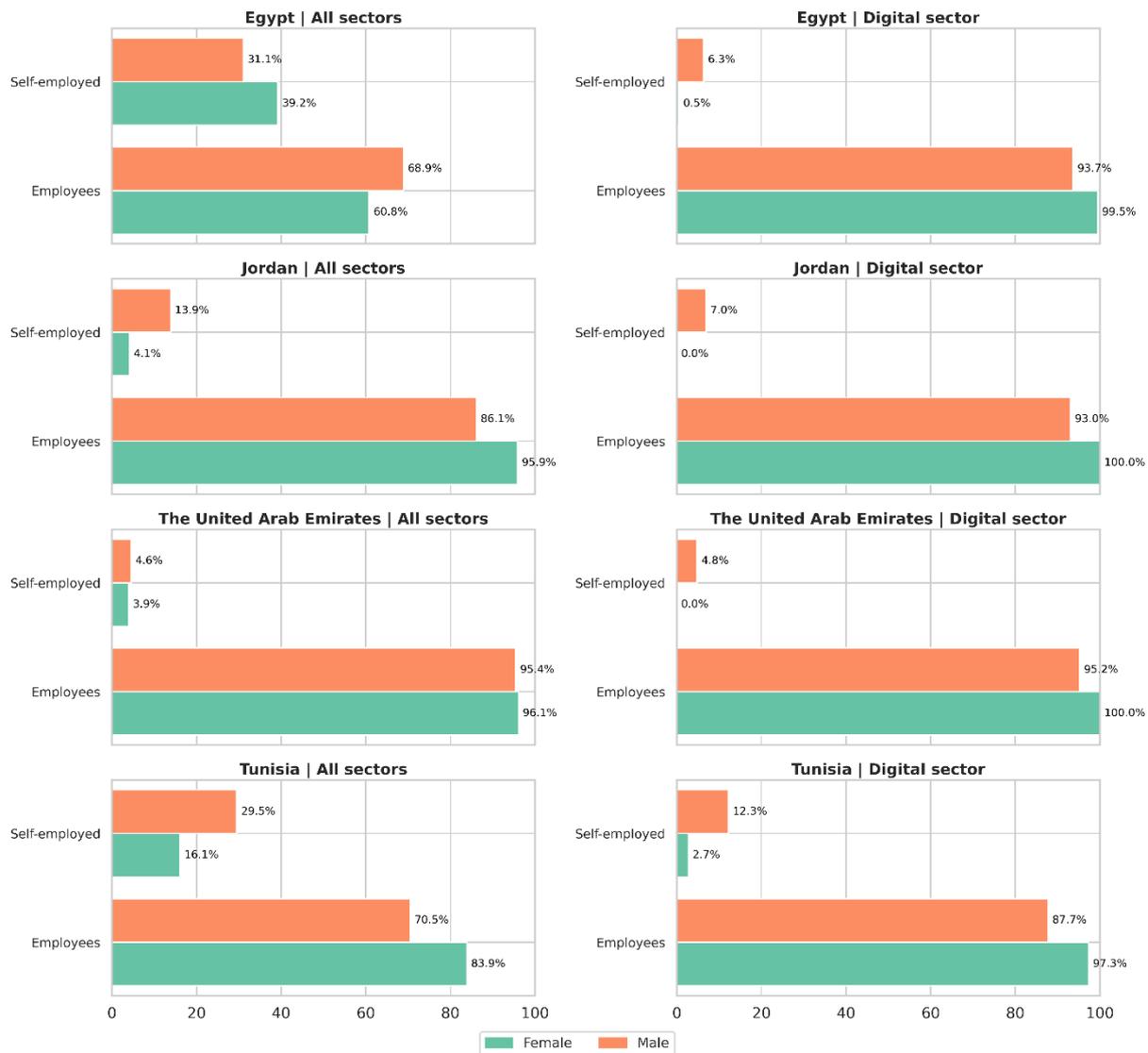
Along with the results on education, these patterns demonstrate that women in digital jobs tend to have higher qualifications and are concentrated in high-skill occupations. This information is crucial for understanding gender segregation in digital labor markets and for designing education and training policies that support women's advancement into these roles.

#### 4.6. Status in employment: a gender perspective on employees and self-employment

Figure 6 illustrates the differences in employment status (defined as employee versus self-employed) by gender in digital sectors and in the total economy. Employment status is distinct from formality; a worker may be an employee or self-employed in either a formal or informal arrangement. In this section, we focus only on employment status, while informality is analyzed separately using the social security-based definition introduced earlier.

In Egypt, women in digital employment are predominantly employees, with self-employment playing a negligible role. In the broader economy, however, self-employment accounts for a significant proportion of women's jobs, while men are somewhat more evenly split between being employees and

Figure 6. Gender distribution of job status (employees vs. self-employed; digital vs. all sectors)



Note: Percentages represent weighted averages over multiple years. Egypt (2009–2023), Jordan (2017–2023), UAE (2017–2023), Tunisia (2019). Data Source: National Labor Force Surveys (LFS), processed by authors.

being self-employed. This indicates that digital employment channels women far more into employee roles than the rest of the labor market, while men still have a some overall presence in self-employment.

In Jordan, women’s digital employment is entirely concentrated in employee status. Self-employment appears only in the broader economy, where it is limited but higher than in digital sectors. Digitally employed men are also predominantly employees, though self-employment represents a slightly larger proportion of their jobs than it does for women. These patterns suggest that digital employment in Jordan is primarily organized through employee relationships, with relatively few self-employment opportunities for either gender.

In the UAE, the majority of employees in digital sectors and the broader economy are men and women with traditional employment status. Self-employment is relatively uncommon, particularly among

women, reflecting the country's general work organization rather than a pattern specific to the digital sector.

Tunisia shows more variation by gender and sector. Women in digital employment are primarily employees, with only a small percentage self-employed. In contrast, men in digital sectors have somewhat higher self-employment rates. In the broader economy, both women and men have higher self-employment rates than in digital sectors, with the difference being more pronounced for men. These findings suggest that, as in Egypt and Jordan, digital employment in Tunisia is more closely associated with employee status than self-employment, particularly among women.

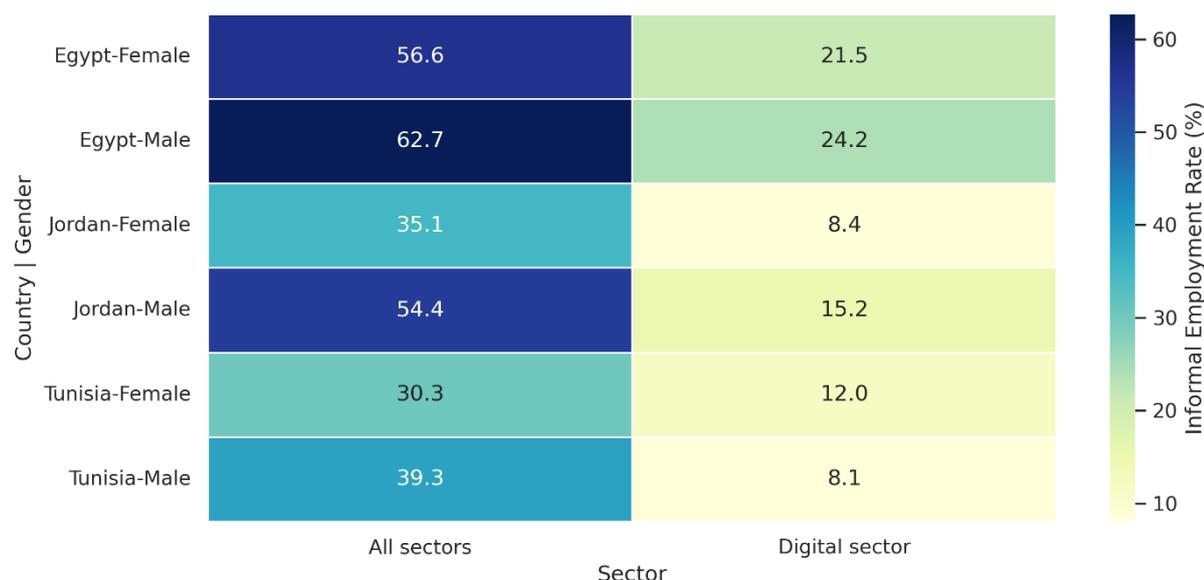
#### 4.7. Informal employment: gender disparities in digital and overall sectors

Informal employment plays an important role in shaping gendered labor market outcomes. Informality is defined as employment without social security coverage, as defined in Section 3.2.

As Figure 7 shows, in Egypt, the informal employment rate for women in digital sectors (21.5 percent) is substantially lower than the rate across all sectors (56.6 percent). A similar pattern emerges among men, with informality standing at 24.2 percent in digital jobs versus 62.7 percent across the entire economy. Therefore, digital employment appears to be associated with a lower incidence of informality for both women and men relative to the broader labor market.

Jordan's digital sectors show particularly low levels of informal employment. The informality rate for women is 8.4 percent in digital jobs, compared to 35.1 percent across all sectors. For men, the informality rate is 15.2 percent in digital employment, compared to 54.4 percent overall. These differences suggest a more formal employment structure in digital activities than in the rest of the economy.

**Figure 7. Gender comparison of informal employment rates (digital vs. all sectors)**



Note: Informal employment rates are weighted averages calculated over multiple years. Egypt (2009–2023 except 2014), Jordan (2017–2023), Tunisia (2014, 2019). Data Source: National Labor Force Surveys (LFS), processed by authors.

In Tunisia, the informality rate for women in digital employment is 11.9 percent, which is considerably lower than the rate in the total economy (30.3 percent). Men's informality rate in digital employment (8.1 percent) is also lower than the informality rate in general economic employment (39.3 percent). In all three countries, digital jobs are less likely to be informal for both women and men, suggesting that expanding digital sectors has the potential to reduce exposure to informality, particularly for women, who are often more vulnerable in informal work.

#### *4.8. Gender wage gap dynamics in digital versus overall economy*

Analyses of gender wage gaps reveal significant differences between the digital sector and other economic sectors in Egypt, Jordan, and Tunisia, as shown in Figures 8 and 9. The wage gap is calculated as the difference between men's and women's average monthly earnings in each sector, combining public and private sector employment.

From 2009 to 2023, the average gender wage gap in Egypt's digital sector was modest at approximately 3.29 USD per month. This contrasts with the substantially wider average wage gap observed across all economic sectors (20.79 USD). The relatively small wage gap in digital employment is consistent with the higher concentration of women in formal, regulated labor market segments described earlier. It suggests comparatively more compressed wage structures for women who can access digital jobs.

In contrast, Jordan exhibits considerably larger gender wage disparities within digital employment contexts, with an average gap of \$103.87 per month from 2016 to 2023. This is much larger than the average gap of \$5.59 across all sectors. These differences suggest that women working in Jordan's digital sector face structural and institutional factors that result in significantly lower pay than men, which could be a factor of higher employment in private sector than the rest of the economy.

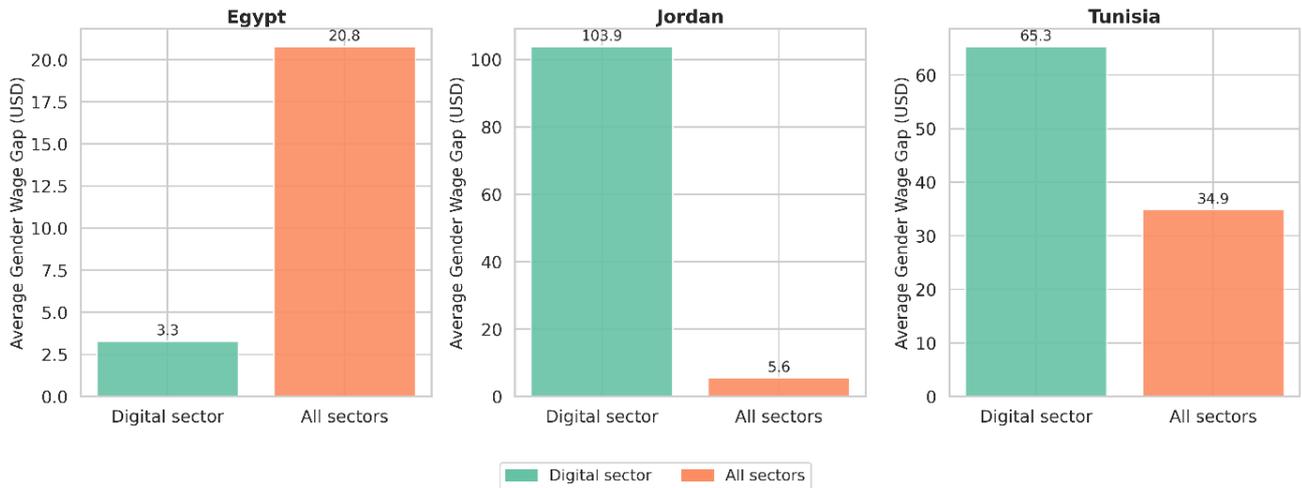
Data from 2019 on Tunisia's wage gap show a similar, albeit less pronounced, pattern in digital sectors. The average monthly wage gap in digital employment is 65.33 USD, which is nearly double the gap observed in the broader economy (34.89 USD). These results suggest that persistent wage inequalities exist within Tunisia's digital jobs and that the expansion of digital employment has not eliminated gender-based pay disparities.

Relative wage ratios (female-to-male) complement these absolute gap measures (Figure 9). In Egypt, digital-sector wage ratios occasionally approach or exceed parity. For example, in 2020, the ratio reached 106.6%, indicating that women's average earnings slightly exceeded those of men in digital roles that year. By comparison, women's wages in the broader economy remained below men's wages at around 84.4 percent in the same year. From 2016 to 2023, women's wages in Jordan's digital sectors ranged from 77.8% to 89.3% of men's wages. In contrast, wage ratios in the overall economy fluctuated around parity, reaching 105.8% in 2022. Only one year of digital wage data is available for Tunisia, and the 2019 data point in Figure 9 shows that women's wages represented 83.3 percent of men's earnings in digital sectors compared to 86.9 percent in the broader economy.

These results highlight that wage gaps in digital sectors can be narrower than in the overall economy, as in Egypt, or substantially wider, as in Jordan and Tunisia. They also show that relative wage ratios

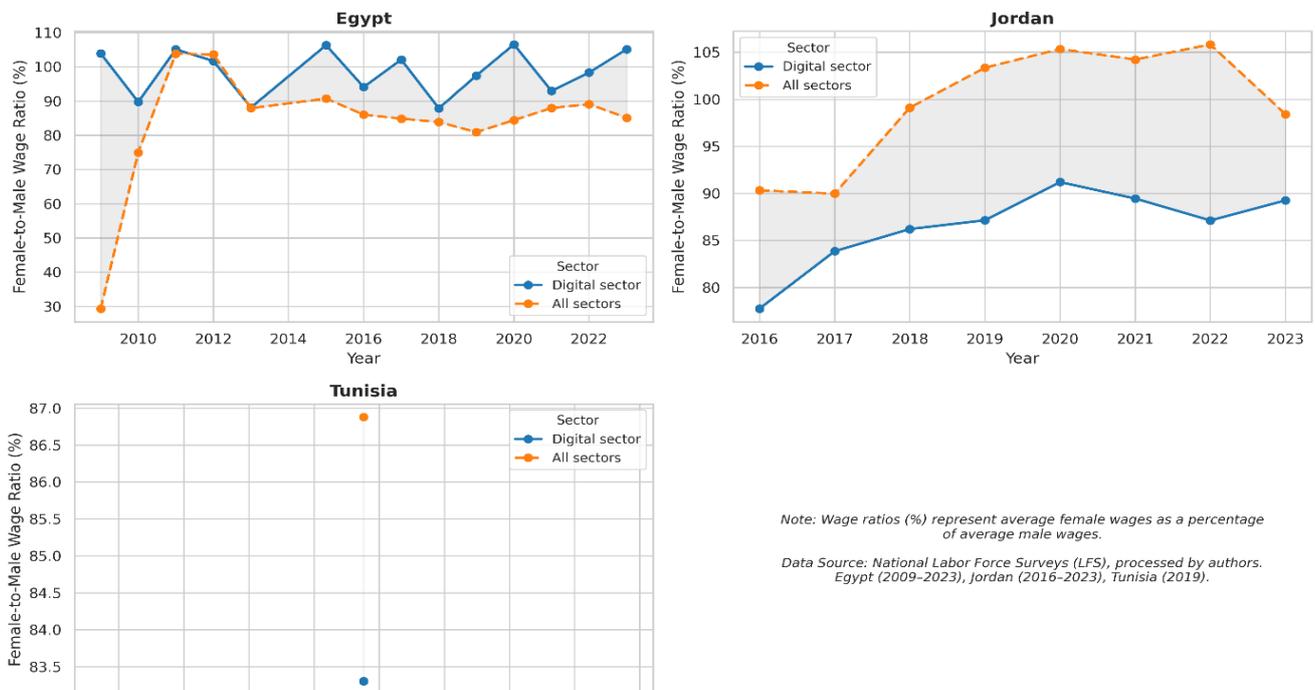
often diverge between digital and non-digital employment. These patterns underscore the need to consider both sectoral composition and institutional context when designing policies to reduce gender wage gaps in digital labor markets.

**Figure 8. Average gender wage gap (male minus female, in USD) comparing digital and all sectors**



Note: Gender wage gap represents average monthly earnings of males minus females (USD).  
 Data Source: National Labor Force Surveys (LFS), processed by authors.  
 Egypt (2009–2023), Jordan (2016–2023), Tunisia (2019).  
 No data available for United Arab Emirates.

**Figure 9. Trends in gender wage ratios (female-to-male, in %) comparing digital and all sectors**



Note: Wage ratios (%) represent average female wages as a percentage of average male wages.  
 Data Source: National Labor Force Surveys (LFS), processed by authors.  
 Egypt (2009–2023), Jordan (2016–2023), Tunisia (2019).

#### 4.9. Econometric analysis: Determinants of women's employment outcomes earnings

##### 4.9.1. Cross-sectional regression analysis: Determinants of women's average monthly

Based on descriptive evidence and decomposition results, the econometric analysis examines the association between observable characteristics and women's average monthly earnings in Egypt and Jordan, paying particular attention to digital employment. The objective is to describe the wage structure among employed women, not to estimate causal effects.

To summarize the contributions of several correlated predictors in relatively small country-sector samples, we estimate a regularized wage equation using the least absolute shrinkage and selection operator (LASSO) regression method. LASSO combines ordinary least squares with a penalty on the absolute size of the coefficients and tends to shrink the coefficients of variables that provide limited additional information once other covariates are included. Here, we use it as a parsimonious method to identify which observed characteristics are more strongly associated with wages, not as a structural model.

The wage equation can be written as:

$$\begin{aligned} \text{Average Monthly Earnings}_i &= \beta_0 + \beta_1 (\text{Advanced Education}_i) \\ &+ \beta_2 (\text{Large Establishment (50+ employees)}_i) + \beta_3 (\text{Public Sector}_i) \\ &+ \beta_4 (\text{Formal Job}_i) + \beta_5 (\text{High Skill Level}_i) + \beta_6 (\text{Employee Status}_i) \\ &+ \beta_7 (\text{Country Jordan}_i) + \beta_8 (\text{Digital Sector}_i) + \varepsilon_i \end{aligned}$$

Where  $\text{Earnings}_i$  denotes the average monthly earnings of woman  $i$ , expressed in PPP-adjusted US dollars. The dummy variable  $\text{AdvancedEducation}_i$  captures whether the woman has an advanced education (post-secondary or tertiary).  $\text{LargeEstablishment}_i$  indicates employment in firms with 50 or more employees.  $\text{PublicSector}_i$  identifies public-sector jobs.  $\text{FormalJob}_i$  captures formal employment, which is defined by social security coverage, as discussed in Section 3.2.  $\text{HighSkill}_i$  indicates high-skill occupations, according to ISCO-08, such as managers and professionals. Finally, the variable,  $\text{EmployeeStatus}_i$ , distinguishes employees from self-employed workers.  $\text{Jordan}_i$  is a country dummy variable, equal to one for Jordan and zero for Egypt.  $\text{DigitalSector}_i$  indicates employment in digital sectors.

Table 1 shows the LASSO estimates for the combined sample of Egyptian and Jordanian women from 2017 to 2023. The constant term of 336.7 USD corresponds to the predicted earnings of the reference group: Egyptian women in non-digital, small-to-medium-sized, private, informal, lower-skilled, self-employed jobs. Working in Jordan relative to this benchmark is associated with higher

monthly earnings of about 197.3 USD, reflecting differences in wage levels between the two countries. Working in digital sectors is associated with an additional difference of approximately 45.2 USD per month, while public-sector employment is associated with a difference of 58.4 USD. Jobs in large establishments are associated with an additional difference of 22.4 USD compared to employment in smaller firms.

**Table 1: Determinants of women's average monthly earnings (LASSO regression results, Egypt and Jordan)**

Explanatory variables and robustness metrics	Estimated coefficient or value (USD)
Regression coefficients	
Large establishment (50+ employees)	22.42
Public sector	58.38
Formal job	0.00
High skill level	-56.67
Employee status	-1.90
Advanced education	0.00
Country (Jordan vs Egypt)	197.30
Digital sector	45.15
Constant	336.67
Robustness tests	
R <sup>2</sup> (Coefficient of determination)	0.978
RMSE (Root Mean Squared Error)	28.05
MAE (Mean Absolute Error)	20.75

Some of the coefficients are very small, and in some cases, they are negative. The values reported as 0.00 for advanced education and formal job status result from penalization and rounding. The estimated coefficients are close to zero once the model controls for sector, firm size, occupation, institutional context, and country simultaneously. This outcome is consistent with the high correlation between these variables and other regressors, particularly high-skill occupations, public-sector jobs, and large establishments. In such settings, LASSO tends to concentrate explanatory weight on a subset of correlated predictors and shrink remaining coefficients toward zero. Therefore, these estimates suggest that most of the wage differences associated with education and formality in this specification are indirectly captured through sector, occupation, firm size, and country dummies rather than education or formality being irrelevant in themselves.

Likewise, the negative coefficient on high-skill occupations should be interpreted in light of the correlation structure among regressors. In Egypt and Jordan, high-skill jobs for women are not evenly distributed across sectors, firm sizes, and institutional contexts. They are often concentrated in public-sector and large-firm environments, where pay structures are more compressed. In some cases, they are concentrated in professions that require advanced education, but where pay scales are administratively constrained. Therefore, when the model controls for country, digital sector, public sector, and firm size, the residual association captured by the high-skill dummy may pick up a combination of these effects. Under LASSO penalization, this residual can become small or even negative without implying that the underlying returns to skill are genuinely negative. For this reason, the high-skill coefficient is not used to draw conclusions about the returns to education or skills. These questions are better addressed through decomposition analysis and descriptive patterns.

The LASSO results indicate that the dimensions most robustly associated with differences in women’s monthly earnings in this pooled sample are country context, sector (digital versus non-digital), institutional setting (public versus private), and firm size. Due to the regularized nature of the estimates and the potential for selection bias from estimating the model only for employed women who report wages, these findings are interpreted as descriptive patterns that complement the results from Oaxaca-Blinder decompositions and descriptive statistics rather than as causal estimates of wage determinants.

#### 4.9.2. Oaxaca-Blinder decomposition of gender wage gaps

To complement the regression analysis, we use the Oaxaca-Blinder decomposition (Blinder, 1973; Oaxaca, 1973) to examine the differences in monthly labor earnings between women and men in the digital sector in Egypt and Jordan. In this section, “earnings” and “wages” refer to average monthly labor earnings expressed in PPP-adjusted U.S. dollars. Our goal is to determine if the observed gaps in the digital sector can be primarily attributed to differences in observable characteristics or how these characteristics are rewarded.

The decomposition expresses the mean wage gap between men and women as the sum of two components:

$$\bar{W}_M - \bar{W}_F = (\bar{X}_M - \bar{X}_F)\beta_M + \bar{X}_F(\beta_M - \beta_F)$$

where  $\bar{W}_M$  and  $\bar{W}_F$  are average monthly earnings for men and women, and  $\bar{X}_M$  and  $\bar{X}_F$  are vectors of mean observable characteristics such as the share of workers employed in the public sector, the share in large establishments, and the distribution across occupational skill levels. The vectors  $\beta_M$  and  $\beta_F$  are the corresponding coefficient vectors derived from separate regression models estimated for men and women, respectively. The first term on the right-hand side is the “explained” component, which captures the part of the wage gap that can be attributed to differences in average characteristics, evaluated at men’s returns. The second term is the “unexplained” component, which captures the part of the gap associated with differences in coefficients between men and women, given their characteristics.

Table 2 summarizes the results for digital employment in Egypt and Jordan. In Egypt, the total observed gender wage gap is relatively small at \$2.52 per month in favor of men. However, the explained component is much larger at 93.95 USD, indicating that based on observable characteristics and male wage structures, men are expected to earn substantially more than women. This reflects the fact that male digital workers are more likely to be in combinations of sectors, establishment sizes, and occupations that carry higher average wages. The unexplained component is negative (-91.42 USD), nearly offsetting the explained component. According to the sign convention used here, a negative unexplained component indicates that, given their observable characteristics, women’s average wages are close to or slightly above those of men. This pattern is consistent with strong selection into digital employment, whereby a relatively small group of women with favorable characteristics earn wages close to or slightly higher than those of comparable men. Nevertheless, the overall gap remains slightly in favor of men.

In Jordan, the total gender wage gap in digital employment is much larger, with men earning 79.47 USD more per month. The explained component amounts to \$60.08, and the unexplained component amounts to \$19.39, both of which are positive. The positive explained component suggests that men's average characteristics, such as sector, firm size, and occupation, contribute significantly to the observed wage gap. The positive unexplained component indicates that men still receive higher wages than women in digital employment even after accounting for these differences in characteristics. This points to the influence of unobserved factors or differences in returns consistent with structural disadvantages for women.

**Table 2. Oaxaca-Blinder decomposition of gender wage gaps in digital employment (Egypt and Jordan)**

Country	Gender wage gap (USD)	Explained component (USD)	Unexplained component (USD)
Egypt	2.52	93.95	-91.42
Jordan	79.47	60.08	19.39

*Note: The wage gap is defined as the difference between average male and female earnings. A positive explained component indicates that men's observable characteristics contribute to a larger wage gap between men and women. A positive unexplained component suggests that men receive higher returns for these characteristics than women do, given observable factors.*

The decomposition results indicate that the small observed gap in digital employment in Egypt masks the fact that men, on average, hold higher-paying positions. Meanwhile, the women who participate in digital sectors are a positively selected group whose earnings are closer to those of comparable men. In Jordan, differences in characteristics and returns work in the same direction, resulting in a substantial wage gap in favor of men in digital employment. These findings reinforce the descriptive and regression evidence showing that sector, institutional context, and occupational structure matter for understanding gender wage gaps in digital labor markets. They also highlight the need to address both observable structural inequalities and differential returns to similar jobs.

#### 4.9.3. Logistic regression analysis (Ridge): Determinants of informal employment

The logistic regression analysis provides a descriptive robustness check on the correlates of informal employment among women in Egypt's digital sector. The focus is on employed women only and examines whether jobs in large establishments, the public sector, or high-skill occupations are associated with different probabilities of informality compared with other digital jobs.

A logistic model with ridge (L2) regularisation is estimated using pooled LFS cross-sections for the years in which digital-sector informality can be observed for Egypt. Ridge regularisation adds a penalty on the squared coefficients to stabilise estimates in the presence of correlated regressors and limited sample sizes, without forcing coefficients to zero. The dependent variable, informal employment, equals one when the woman's job is informal (no social security coverage, as defined in Section 3.2) and zero when it is formal. Explanatory variables distinguish employment in large establishments (50 or more employees) from smaller firms, public from private sector jobs, high-skill from lower-skill occupations, and employees from self-employed women.

The model can be written as:

$$\begin{aligned} \text{logit}(P(Y_i = 1)) = & \beta_0 + \beta_1 (\text{Large Establishment}_i) \\ & + \beta_2 (\text{Public Sector}_i) + \beta_3 (\text{High Skill Level}_i) \\ & + \beta_4 (\text{Employee Status}_i) + \varepsilon_i \end{aligned}$$

Where  $Y_i=1$  denotes informal employment for woman  $i$ . Table 3 reports the odds ratios and confidence intervals. Jobs in large establishments are associated with slightly lower odds of informality for women in digital employment (odds ratio of 0.92, with a 95 percent confidence interval that includes 1). Public-sector employment is also associated with odds ratios below 1. There is no clear association between informality and high-skill occupations, with an odds ratio close to 1 and a wide confidence interval. The estimated odds ratio for employee status is slightly above 1, but the effect size is small relative to the baseline odds.

**Table 3. Determinants of informal employment among women in digital employment, Egypt (Ridge Logistic regression results)**

Explanatory Variables	Odds Ratio	95% CI Lower	95% CI Upper	p-value
Large Establishment ( $\geq 50$ employees vs. small)	0.92	0.85	1.00	0.045
Public Sector (vs. private sector)	0.97	0.95	0.99	0.002
High Skill Level (vs. low/medium)	1.00	0.92	1.08	0.951
Employee Status (vs. self-employed)	1.04	1.01	1.07	0.047
Intercept (Baseline Odds)	0.75	0.68	0.83	0.001
Diagnostic Metrics	<b>Value</b>			
Log-Likelihood	-7.84			
Pseudo R <sup>2</sup> (McFadden)	0.48			
AIC (Akaike Information Criterion)	45.68			
BIC (Bayesian Information Criterion)	30.12			

Informal employment among women in Egypt's digital sector is low, and the estimated effects of establishment size, sector, and skill level are modest. The main message is that digital jobs for women, especially in larger organizations and the public sector, tend to be formal and that there is limited residual variation in informality once these structural features are considered. The central channels of gender inequality in digital labor markets, as documented in the preceding subsections, concern access to digital jobs and wage gaps rather than informality within digital employment.

## 5. Discussion

Empirical results indicate persistent, multidimensional gender inequalities in digital employment in Egypt, Jordan, the United Arab Emirates (UAE), and Tunisia. Although women's presence in digital jobs has increased over time, their employment remains systematically lower than that of men. This disparity is strongly influenced by education, firm structure, institutional context, occupational skill level, employment status, and informality. As shown in previous sections, these dimensions interact in different ways across national settings.

One central finding is the strength of educational and occupational selection into digital employment. In Egypt, Jordan, and the UAE, women in digital jobs are predominantly from the highly educated and highly skilled segments, much more so than women in the overall economy and compared to men in the same digital sectors. Tunisia shows a somewhat more balanced distribution, but advanced education still dominates women's access to digital jobs. This combination indicates that digital employment currently absorbs only a narrow segment of the female labor force. Women with basic or intermediate education remain largely confined to non-digital activities or excluded from employment.

A second key finding regards the role of firm size and institutional setting. In all three countries with available firm-size data, women and men in digital jobs are more likely to work in medium-sized and large establishments than in small ones. However, the overall economy relies much more heavily on small firms. This suggests that digital employment is tied to parts of the enterprise structure that have greater resources, formal procedures, and capacity to recruit highly educated workers. At the same time, women's digital jobs tend to be concentrated in these segments even more than men's jobs are, which reinforces the idea that large and medium-sized firms are the primary interface through which women access digital work. The public–private divide also matters, but in different ways across countries. Egypt's digital employment for women retains a significant public-sector component, while digital jobs in Jordan and the UAE are predominantly private. Tunisia sits somewhere in between. Third, analyzing informality and employment status indicates that digital jobs for women tend to be more formal and concentrated in employee positions than the rest of the labor market. Informality rates are substantially lower in digital sectors than in the broader economies of Egypt, Jordan, and Tunisia. In the UAE, overall formality is high. In Egypt, the residual informality in women's digital employment is mainly associated with work in smaller private firms. These findings suggest that women tend to hold relatively protected positions in digital jobs, although this does not eliminate broader disadvantages in access and progression.

Fourth, wage gap patterns show that digital sectors do not systematically favor women. In Egypt, for example, the average gender wage gap is relatively small in the digital sector compared to the overall economy, and wage ratios occasionally approach parity. In contrast, wage gaps in digital sectors in Jordan and Tunisia are substantially larger than in the wider labor market. Oaxaca–Blinder decompositions further clarify this situation. In Egypt, men's average characteristics in digital sectors predict a much larger wage gap than observed. The unexplained component is negative under the chosen convention, which is consistent with the strong positive selection of women into digital jobs. In Jordan, differences in characteristics and returns both contribute positively to the observed wage gap, indicating that women face disadvantages in both the types of jobs they hold and the associated rewards. These results highlight that digitalization can coexist with significant gender wage inequality, and that wage setting within digital sectors reflects structural composition and differential treatment. The evidence suggests that digital employment offers a mixture of opportunities and constraints for women in MENA. On the one hand, digital sectors provide relatively formal, higher-skill jobs for women with advanced education who can access large or public organizations. However, access is highly selective, and substantial wage gaps remain in several cases. Therefore, policies aimed at advancing gender equality in digital labor markets must go beyond general digitalization strategies. These policies must consider the education system, transitions from school to work, support for women in small and medium-sized enterprises, and the regulation of pay and progression in digital occupations in an integrated way.

## 6. Policy implications and recommendations

The analysis shows that digital employment in Egypt, Jordan, Tunisia, and the UAE presents opportunities and challenges for women. Women in digital jobs tend to be better educated and more likely to hold high-skill occupations than women in the overall economy. They are also more likely to be employed by larger, more formal organizations. However, they remain underrepresented in digital sectors, and wage gaps persist in several cases. Access is also highly selective. Therefore, policy interventions must address entry barriers to digital employment and the conditions and rewards women face in digital jobs, paying attention to country-specific labor market structures.

### *6.1. Education and skills development policies*

Descriptive evidence shows that women in digital employment in Egypt, Jordan, and the UAE are overwhelmingly concentrated at the upper end of the educational distribution, and that advanced education is overrepresented among women in Tunisia's digital sector. These findings suggest that education and relevant skills are prerequisites for accessing digital jobs. However, our wage regressions do not identify a significant additional wage premium for advanced education when controlling for job characteristics. Therefore, policies should focus on widening access to the skills needed for digital employment, particularly for women with basic and intermediate education. This approach is preferable to assuming that raising credentials alone will close wage gaps.

Current regional initiatives include Egypt's "Qodwa Tech" program and Jordan's "Tech for Jobs" initiative. These programs provide digital literacy and ICT training to women and young people (UNDP, 2025; USAID, 2025). These programs demonstrate how governments and partners can design courses and outreach initiatives that address the needs and constraints of women, although rigorous causal evidence on their impact on employment is still scarce. Thus, they should be viewed as promising models to be carefully evaluated and adapted rather than interventions whose effectiveness is already established.

Beyond specialized programs, integrating digital skills and STEM content into mainstream education can reduce selection at later stages. For example, Tunisia's participation in "Technovation Girls" shows how exposure to coding and digital problem-solving can encourage girls to pursue technology-related careers (Technovation, 2023). Public-private partnerships that align curricula with labor market needs and certify digital skills according to recognized standards can support transitions from education to digital employment. Regional initiatives, such as the "One Million Arab Coders" program led by the Dubai Future Foundation, illustrate the potential scale of such efforts (Dubai Future Foundation, 2021). However, their specific impact on women's employment still needs to be assessed.

### *6.2. Formalization and reduction of informal employment strategies*

The rate of informal employment among women is substantially lower in digital sectors than in overall labor markets in Egypt, Jordan, and Tunisia. This suggests that digital jobs could provide more stable and regulated employment opportunities. Nevertheless, many women continue to work in the informal sector, and self-employment remains limited in digital sectors.

Therefore, regulatory frameworks that lower administrative and financial barriers to formalization for women's digital businesses are particularly relevant. In Jordan, for example, the Arab Women's Enterprise Fund (AWEF) has collaborated with government officials and local intermediaries to streamline registration procedures and offer assistance to women operating home-based and online businesses (MarketShare Associates, 2020). This experience illustrates the institutional and advisory changes that can make formal channels more accessible: simpler procedures, clearer information, and targeted support. Formal impact evaluations remain limited, however. Similarly, Tunisia's "auto-entrepreneur" regime offers a simplified legal status for freelancers and micro-entrepreneurs in digital occupations, facilitating registration and access to social security (Techpression, 2024).

Expanding gender-responsive social insurance schemes that reduce the initial cost of contributions for women-led SMEs and digital startups can ease the transition into formal status as well. Recent pilots in Egypt, developed with the ILO, move in this direction by adapting contribution thresholds and benefits to the constraints of small firms (ILO, 2024). Complementary advisory services and legal guidance, as in Tunisia's Inclusive Labor Initiative (TILI), can help women navigate registration, taxation, and compliance requirements (DARPE, 2023). These measures aim to make formalization more feasible for women without presuming that digital employment alone will automatically resolve informality.

### *6.3. Wage equity and transparency mechanisms*

A wage analysis shows that digital sectors do not uniformly reduce gender wage gaps. In Egypt, wage differences between women and men are relatively small in the digital sector compared to the overall economy. However, in Jordan and Tunisia, the gaps are significantly larger in the digital sector. Oaxaca–Blinder decompositions further indicate that in Jordan, differences in job characteristics and returns both contribute to the wage gap.

In this context, wage transparency and the enforcement of equal pay provisions are essential. While all four countries have formal legal commitments to gender equality and non-discrimination, empirical work from the joint UN "Gender Justice and the Law" initiative reveals discrepancies between legal frameworks and actual practices, including those related to pay equity (ESCWA, 2019). Strengthening the practical application of existing legislation by requiring the disclosure of aggregate pay gaps by gender, conducting internal pay audits in medium and large firms, and improving labor inspections in digital and ICT-intensive sectors would help align practice with legislation.

International experiences provide reference points. Equal-pay certification schemes and pay transparency laws in countries such as Iceland and Germany require employers to document pay structures and address unjustified pay gaps (Government of Iceland, 2021; Trusaic, 2022). Similar instruments could be adapted to the institutional context of Jordan and Tunisia, focusing on firms that employ significant numbers of digital workers. Certification programs, such as the UNDP's Gender Equality Seal for the Private Sector, support companies in strengthening internal gender policies, including pay equity and career progression (UNDP, 2024). These programs could be implemented in the region as part of broader efforts to improve corporate practices.

#### *6.4. Harmonizing public and private sector employment conditions*

Our findings show that, to a greater extent than in Jordan and the UAE, women's digital employment in Egypt is still anchored in the public sector. In these countries, digital jobs for women are almost entirely in the private sector. Tunisia occupies an intermediate position. However, the private sector remains relatively small across the region and is often unable to create sufficient formal jobs for women and men.

Therefore, a central policy challenge is to expand the private sector's capacity to generate quality digital jobs in addition to regulations for harmonizing conditions between public and private employment. In contexts where the public sector maintains women's digital employment, the state can leverage its role as an employer to establish standards for recruitment, promotion, and pay in digital occupations. At the same time, the state can use procurement, incentives, and partnerships to encourage private firms to adopt similar practices. In countries where private firms are the primary digital employers, policies should focus on alleviating growth constraints for innovative SMEs, improving access to finance and digital infrastructure, and encouraging firms to adopt gender-sensitive human resource practices.

The UAE's Gender Balance Council has developed indices, guidelines, and awards to encourage organizations to review and improve their gender equality performance in both the public and private sectors (The Official Portal of the UAE Government, 2025). Although the direct impact on digital employment outcomes has not yet been systematically evaluated, this type of institutional mechanism demonstrates how governments can coordinate and monitor gender equality efforts across sectors.

#### *6.5. Regional collaboration and coordination mechanisms*

The four case studies demonstrate that progress in women's digital employment varies by country and that policy levers differ accordingly. Nevertheless, common patterns appear across contexts, suggesting that regional collaboration can add value. These patterns include educational selection, occupational segregation, wage gaps, and persistent informality outside digital jobs.

A regional platform devoted to women's digital employment and pay equity could help consolidate data and knowledge. The World Bank's Middle East and North Africa Gender Innovation Lab (MNAGIL) is one such institutional model. It combines impact evaluations, pilots, and analytical work to determine the most effective interventions for promoting gender equality in labor markets (World Bank, 2019b). A similar approach could be used to design and assess regional pilots on digital skills programs, wage transparency tools, and formalization incentives.

More broadly, structured policy dialogues and knowledge-sharing activities under the auspices of regional organizations, such as the Arab Labor Organization and the Union for the Mediterranean, can support convergence on key principles, such as minimum standards for digital skills certification, non-discrimination in recruitment and pay, and access to social protection for digital workers (UfM, 2022). International partnerships aligned with the Sustainable Development Goals, particularly SDGs 5 and 8, can provide technical and financial support for these efforts. The ILO–Sida collaboration on decent work and gender equality in the digital economy in the MENA region is an example of how such partnerships can be structured (ILO, 2021).

## 7. Conclusion

This paper analyzed gender dynamics in digital employment in Egypt, Jordan, Tunisia, and the UAE using harmonized labor force data. The results indicate that, although women's employment in digital sectors has increased in all four countries, it remains consistently lower than men's. Furthermore, women's access to these jobs is strongly influenced by education, firm structure, institutional context, and occupational skill level.

One key finding is that women in digital employment come from a smaller, more privileged segment of the female labor force than women in the overall economy. In Jordan, and the UAE, women in digital jobs are highly educated and concentrated in high-skill occupations. Women with basic or intermediate education are largely absent from digital sectors. Tunisia and, to a lower extent, Egypt display a somewhat more balanced profile; however, advanced education still plays a central role. These patterns underscore the importance of educational attainment and relevant skills for entering the digital workforce.

A second result concerns the structural context of women's digital jobs. In the three countries with firm-size data, women and men in the digital sector are more likely to work in medium and large establishments than in small firms. However, employment in the total economy is much more concentrated in small enterprises. Institutional sectors also matter. Women's digital employment is more prevalent in the public sector in Egypt than in other countries, while it is predominantly in the private sector in Jordan and the UAE. Tunisia occupies an intermediate position. Digital jobs for women tend to be more formal than non-digital jobs, as evidenced by substantially lower informality rates in digital sectors compared to the broader economy.

The wage analysis shows that digital employment does not produce a uniform pattern of gender wage equality. In Egypt, gender wage gaps in digital sectors are relatively small compared to the broader economy, and wage ratios occasionally approach parity. In contrast, wage gaps in digital sectors are higher than in the total economy in Jordan and Tunisia. Oaxaca-Blinder decompositions indicate that in Jordan, differences in job characteristics and returns both contribute to the observed gaps. In Egypt, however, the small aggregate-level gap coexists with strong selection into digital jobs. These findings suggest that the impact of digitalization on gender wage gaps depends on how digital sectors are integrated into a country's labor market structure.

Methodological limitations should be acknowledged. The analysis relies on repeated cross-sectional Labor Force Survey data rather than panel data. Additionally, the econometric models and decompositions are estimated only for employed individuals, particularly those in digital sectors. Consequently, the findings describe patterns among employed women and men and cannot be interpreted as evidence of the determinants of labor market entry or digital employment. Cross-country comparisons are also limited by variations in survey design, variable coding, and data availability.

Future research could address these limitations by using longitudinal microdata that track workers over time and by combining quantitative analysis with qualitative research on job quality and employment trajectories in digital sectors. Further studies evaluating specific policies or programs, such as digital

skills initiatives, formalization measures, or wage transparency tools, would also help identify the most effective interventions for reducing gender gaps in digital employment. Finally, intersectional analyses considering socioeconomic background, location, age, and migration status would deepen our understanding of how digitalization affects different groups of women and men within and across countries.

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