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Crowd work in STEM-related fields: A window of opportunity from a gender perspective?

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Abstract

After the Global Financial Crisis (2008) many people found new job opportunities on crowd platforms. The COVID-19 crisis reinforced this trend and virtual work is expected to increase. Although the working conditions of individuals engaged on these platforms is an emerging topic, of research, the existing literature tends to overlook the gendered dimension of the gig economy. Following a quantitative approach, based on the statistical analysis of 444 profiles (platform Freelancer.com in Spain and Argentina), we examine the extent to which the gig economy reproduces gender inequalities such as the underrepresentation of women in STEM-related tasks and the gender pay gap. While the findings reveal lower participation of women than men, this gap is not higher in Argentina than in Spain. Moreover, gender variations in hourly wages are not as marked as expected, and such differences disappear once STEM skill levels are controlled for. Asymmetry in individuals' STEM skill level provides a better explanation than gender of the hourly wage differences. This finding opens a window of opportunity to mitigate the classical gender discrimination that women face in technological fields in traditional labor markets. Finally, the paper identifies some issues concerning the methodological bias entailed by the use of an application programming interface in cyber-research, when analyzing gender inequalities.

KEYWORDS
crowd work, digital platforms, gender pay gap, gig economy, STEM skills

1 | INTRODUCTION

The groundbreaking impact of digital technologies is reshaping the future of work and its long-term implications (UNDP., 2019). This fact translates into an increased number of digital platforms, approximately 300 worldwide (Evans & Gawer, 2016), as well as an increased number of registered users, at 47.8 million (Kuek et al., 2015). Furthermore, between 2014 and 2016, 1.5% of the global workforce was involved in the gig economy (Hunt & Samman, 2019), significantly influencing the global economy. The COVID-19 pandemic has accelerated this trend, and in the coming years knowledge-work will mainly be done virtually (Malhotra, 2021, p. 1091).

Despite growing academic interest in the digital economy, the literature shows little interest in researching the gendered dimension of the gig economy (Barzilay & Anat, 2017; Churchill & Craig, 2019; Hunt & Samman, 2019) and, therefore, how crowd-work platforms[1] affect women's professional lives. Evidence from the studies tackling these issues shows a smaller share of women than men involved in gig work (Hunt & Samman, 2019), regardless of the type of platform (microtask platforms or freelance marketplaces) (Kuek et al., 2015). Nevertheless, women have a stronger presence in countries where platform work is mainly a supplementary form of income (Ipeirotis, 2010).

The main reasons for this underrepresentation are related to the multiple barriers that hinder the digital inclusion of women: unequal access and control of technology, the cost of devices or services, and sociocultural obstacles (European Parliament, 2018; OECD, 2018). In terms of the gender pay gap, except for some job categories—Administration and Design (Dubey et al., 2017, p. 19), Design and Creation, Translation, and Writing (Barzilay & Anat, 2017)—females earn less than males in digitally mediated home-based work (Arroyo & Valenduc, 2016; Hunt & Samman, 2019; Lewis, 2018).

The literature review on this topic raises two aspects that this article attempts to problematize. First, the need to pay particular attention to the skills displayed by the individuals on these platforms. In the last decade, the gig economy has expanded to encompass different kinds of work, from microtasks to complex and highly skilled projects (Balaram et al., 2017, p. 12) requiring a wide range of skills (BEIS., 2017; Green et al., 2014). Since most studies use "task categories" as central variables in their analysis of the gender pay gap, they tend to replicate the labor categories created by each platform based on the tasks offered. Such aspects challenge the pertinence of comparison between the existing studies, introducing methodological biases that may eventually affect the internal and external validation of the results (see the methodological section, below).

Second, not all skills are equally valuable or personally rewarding (Barnes et al., 2015; Irani, 2019). Proficiency in software development and technology, followed by creative and multimedia work, are the skills most in demand on these platforms (Kässi & Lehdonvirta, 2018, p. 246). The kind of skills displayed affects remuneration, which tends to be higher on platforms that trade complex online services (Codagnone et al., 2016, p. 36). As some studies show, gender wage gaps are higher among crowd workers with the lowest earnings, while they decrease among those with the highest earnings (Adams & Berg, 2017, p. 15). Ultimately, the kind of skills required may better explain the gender pay gap.

In an effort to bridge the existing gaps in the literature, this article examines to what extent the crowdsourcing platform Freelancer.com[2]—in Spain and Argentina—simply reproduces the gender gap already identified in traditional labor markets, or whether it also creates a window of opportunity for women engaged in STEM[3]-related tasks. While gender underrepresentation and wage inequalities in STEM fields in the traditional labor market are broadly documented (Grogan, 2019; Petroff et al., 2021), no studies address this topic in the platform economy.

By focusing on Freelancer.com in Spain and Argentina, we also respond to an identified gap in the empirical literature on crowd work in these geographical contexts. In Europe, most of the research focuses on the UK, Germany,

France, or northern countries (Huws et al., 2017; Huws & Joyce, 2016). Outside Europe, the USA and, to a lesser extent, other countries such as India or Pakistan are in the spotlight of these studies (Adams & Berg, 2017; Dubey et al., 2017; Hyperwallet, 2019). Hence, both Spain and Argentina are two contexts that lack empirical evidence and further theoretical considerations regarding the effects of gender and STEM-related tasks in the digital economy.

2 | THEORETICAL FRAMEWORK AND HYPOTHESES

2.1 | Horizontal and vertical gender segregation in STEM fields

Despite research and policy efforts, STEM fields of study and occupations remain gender segregated in most Western countries (Thébaud & Charles, 2018). According to UNESCO (2017), within the female student population in higher education, around 30% choose STEM studies. Nevertheless, the underrepresentation of women in STEM-related fields is uneven. Female students' enrollment is particularly low in information and communication technologies (3%); natural sciences, mathematics, and statistics (5%); and engineering, manufacturing, and construction (8%); while the highest participation is in health studies (15%) (UNESCO., 2019).

Burgeoning literature has explored the main factors explaining horizontal segregation and it pinpoints gender stereotypes that portray STEM fields as more appropriate for men than for women (Eagly, 2001; Sáinz et al., 2019), shape women's STEM attitudes, and diminish their interest in these fields (Dasgupta & Stout, 2014). Mass media (Steinke, 2017), families, and schools also contribute to reproducing these gendered traits (Eccles, 2007). During the transition to adult life and eventually to the labor market, the underrepresentation of women in STEM-related fields sharpens, particularly for those linked to technological fields, leading to what literature metaphorically refers to as a "leaking pipeline." This expression depicts women as passively leaking out of STEM careers with no discussion of why those leaks occur (Grogan, 2019, p. 3).

The theoretical model proposed by Rajenderan and Zawawi (2019, 1165) emphasizes that the lack of retention of women in technological fields is linked to a mix of work-family conflicts, techno-stress due to the constantly evolving ICT industry, and the lack of mentorship programs. Likewise, life stages are also relevant, as motherhood is a crucial moment for women in these masculinized fields. While some women postpone the decision to have children, others readjust their professional expectations, even switching to less demanding sectors (Petroff et al., 2021). Beyond these social arrangements, marked by national policies and traditions, such vertical segregation also responds to other macro-level explanations (Thébaud & Charles, 2018). The features of workplaces and work organizations play a significant role in making environments inhospitable for women, affecting confidence in their abilities, and eventually leading them to drop out of these sectors (Wynn & Correll, 2017).

At first glance, the gig economy provides flexible job opportunities which may mitigate some of the longstanding obstacles faced by professional women in these fields (Blaire, 2016; OECD, 2018, p. 41). Nevertheless, these barriers are not evenly distributed, and specific geographical contexts can enhance or reproduce them to a greater or lesser extent. Regions in the Global South have both the challenge and the opportunity to promote women's participation in the gig economy. Among the challenges that require careful consideration are the unequal access to and control of technology; the cost of devices and services, and the lack of job opportunities in the formal labor market (Balaram et al., 2017; OECD, 2018). Moreover, in specific geographical contexts, cultural attitudes and preconceptions about the societal role of women (Kuek et al., 2015, p. 31) can further obstruct their access to the gig economy.

Despite these challenges, the platform economy also represents a significant opportunity for the Global South. A recent study shows that of the 22 countries surveyed the five Latin American countries (Argentina, Colombia, Peru, Paraguay, and Guatemala) are the richest in terms of gross national income per capita and exhibit the lowest digital gender gap (Gillward & Mothobi, 2018). Beyond the economic implications, the increased participation of women in crowd work may also help to reduce the global shortage of professionals in technological fields, which can benefit from the talent of women while smoothing out their career paths.

In sum, considering the current underrepresentation of women in STEM fields (Hunt & Samman, 2019; Kuek et al., 2015), and the digital gender inequalities between the Global North and South (with some exceptions such as Argentina), we propose the following hypothesis:

H1. *We expect to identify a lower participation of women on Freelancer.com, reproducing the gender gap already identified in STEM fields in traditional labor markets. Nonetheless, this gap is not expected to be larger in Argentina than in Spain.*

2.2 | Gender pay gap in STEM fields

In traditional labor markets, women face what Grimshaw and Rubery (2007) call "undervaluation" processes, which means that women receive lower rewards from investing in education or from their own work experience. According to these authors, the undervaluation links together the three causes of the gender pay gap: (1) occupational segregation, (2) discrimination, and (3) women's disproportionate share of family responsibilities. In addition, particular opportunity structures resulting from welfare state institutions (i.e. family policy expenditure, Gender Equality Plans), or the lack of them, may also contribute to reducing or enhancing these inequalities (Lightman & Kevins, 2021).

Regarding occupational segregation, the classical theory of labor segmentation shows the coexistence of a dual labor market with a direct impact on incomes (Piore, 1973). From a gender perspective, this segmentation leads to the consolidation of primary jobs (high-skilled, male-dominated, high-paying) versus secondary jobs (less specialized and thus lower-paying), in which the proportion of women is greater (Segovia-Pérez et al., 2019).

Discrimination, on the other hand, may operate through different dimensions, such as class, gender, and ethnicity. Particularly in technological fields, gender stereotypes concerning the availability, commitment, and skills of prospective female employees (Sáinz et al., 2020) reinforce personal beliefs about the appropriateness of women for some STEM professions (Sterling et al., 2020). As a consequence, 'male-typical tasks' like computing/IT are performed more often in occupations dominated by men, who are considered to be more suitable for these sectors (Leuze & Strauß, 2016). Additionally, occupations dominated by women pay less because they require more frequent performance of 'female-typical' tasks, enhancing the gender wage gap among the highly qualified (Leuze & Strauß, 2016, p. 5). This discriminatory system stunts women's career development, keeps them from strengthening their abilities, and ultimately leads to wage inequalities (McRobbie, 2007).

Lastly, strongly linked to the previous factors is women's disproportionate share of family responsibilities (Grimshaw & Rubery, 2007). The difficulties in balancing professional and personal life (Judge & Livingston, 2008) translate into a "motherhood penalty" (Anxo et al., 2011). Therefore, occupations dominated by women involve not only 'female-typical' work tasks but also distinct working-time arrangements (part-time employment and telework) (Leuze & Strauß, 2016). In contrast, occupations that are considered 'male' in terms of working-time norms (e.g., overtime and night work) are assumed to represent authority, are better paid, and are associated with greater 'status worthiness' (Leuze & Strauß, 2016).

The few studies tackling wages in crowd work show the same tendency: overall, women earn less than men through the gig economy. Women only earn around 81.4% of the hourly wage of their male counterparts, they tend to bid later, and they accept tasks with a lower budget (Liang et al., 2018). Other studies also point out similar findings. In the UK, Balaram et al. (2017) found that 75% of female gig workers earned less than £11,500 per annum, compared with 61% of all workers; while Lepanjuuri et al. (2018) found that 49% of female gig workers had earned less than £250 in the previous year, compared with 35% of men.

Individuals who participate in the gig economy are more likely than average to have degree-level qualifications (European Parliament, 2017), and by gender, 45% of men and 43% of women hold a tertiary qualification (Churchill & Craig, 2019). Nevertheless, women's average hourly rates—after controlling for educational attainment—are 37% lower than men's (Barzilay & Anat, 2017).[4] Summing up, despite earning more than other female workers, men experience a higher pay return than women in STEM jobs (Corbett & Hill, 2015). In line with these contributions, we propose the following hypothesis:

H2.1. *We expect to find that the Freelancer.com platform replicates the gender gap in wages per hour (in euros) identified in STEM-related tasks in the traditional labor market.*

Given the predominantly descriptive nature of the existing research, it fails to shed light on the factors that explain the gender pay gap, while assuming that the gig economy reproduces to a similar extent the classical discriminations women experience in the traditional labor market. However, a recent survey in the USA shows that 86% of female gig workers believe digital platforms offer an opportunity to make as much as their male counterparts, while only 41% of them believe the same regarding traditional work (Hyperwallet, 2019).

ICT skills should not be treated as a unitary whole, but instead differentiated according to the types of skills and the level of expertise (Liu & Grusky, 2013, p. 1338). For example, in the case of programming or development work, entry qualifications are more diversified than in software services, where degrees are not always required, although programming qualifications or experience are usually needed (Valenduc & Vendramin, 2016).

The new dynamics of the digital economy entail a progressive hybridization of ICT skills (Valenduc & Vendramin, 2016). Consequently, professionals are split into two camps: (1) individuals possessing strong STEM skills (software production or technical support) and enjoying better labor conditions (wages), mainly men; and (2) individuals (mainly women) possessing hybrid STEM skills—with a lesser emphasis on technological capabilities (Sáinz et al., 2020)—and gaining less than their peers (Arroyo & Valenduc, 2016). The key point here is the relevance of skills as an underlying factor that allows us to explain hourly wage differences between individuals.

The case studies analyzed by Valenduc and Vendramin (2016) show that the use of technical skills, especially problem-solving skills, is one of the most satisfying tasks of women in ICT because they perceive such skills as creative. Nevertheless, the MéTIC survey, conducted by the same authors, shows that men are more expected to develop better paid skills (operating systems and security, hardware, and network design), while technically soft skills (web design and multimedia design) are more required from women. In other words, even when women access male-dominated professions (i.e STEM-related fields) in the labor market, they tend to display lower core ICT skills than men (OECD, 2018, p. 14), which may ultimately affect (i.e., lower) their wages. In this regard, we argue the need to emphasize the role of skills as a key variable explaining the pay gap. As such, we propose the following alternative hypothesis to H2:

H2.2. *The Freelancer.com platform does not replicate the gender gap in wages per hour (in euros) independently of individuals' STEM skill level. Instead, asymmetry in individuals' STEM skill level explains the hourly wage differences among them.*

3 | METHODS

3.1 | Research design and sample

The research design follows a quantitative approach based on what Sheller and Urry (2006) call "cyber-research." This type of research explores people's features through their public profiles, which, in our study, allows us to gain insight into the phenomenon of crowd work and its gender implications. The crowdsourcing platform Freelancer.com was chosen as a case study because, with 18 million users, it ranks first among platforms based in Western countries (Codagnone et al., 2016).

While it is common for studies on the gig economy to employ a computational approach that uses the application programming interface (API) of platforms to build extensive databases (Barzilay & Anat, 2017; Dubey et al., 2017), after extracting massive amounts of data they lack explanations regarding the sample's methodological treatment. That is a major issue that must be tackled, especially when we analyze the level of participation or hourly wages on these platforms. Estimations suggest that only 10% of registered users on these platforms are active workers (Kässi & Lehdonvirta, 2016). In our view, the variable *number of reviews* provides relevant information since it estimates

individuals' level of engagement with the platforms, a variable not considered in previous analyses tackling gender participation and the pay gap. Considering these aspects, we have used the *number of reviews* (starting from a minimum of 10 reviews) both as a discriminatory criterion in building the sample[5] and as a control variable in the analysis.

In a second step, we set the criterion for identifying the categories. According to Lehdonvirta (2018), software development and technology work are the occupations with the largest number of posted tasks on crowdsourcing platforms, followed by creative and multimedia tasks. Based on this criterion,[6] we have considered the following four categories: (1) Websites, IT & Software; (2) Mobile Phones & Computing; (3) Design, Media & Architecture; and (4) Engineering & Science. In each category, the platform displays the number of offered projects, depending on the specific technical skills required by the employers. We selected the first two categories with the highest numbers of jobs available in September 2019. For the Websites, IT & Software category, the most in-demand skills were PHP (3963 jobs) and HTML (2904 jobs); for the Mobile Phones & Computing category, they were mobile app development (1473 jobs) and Android (1244 jobs); for the Design, Media & Architecture category, they were graphic design (3259 jobs) and website design (3153 jobs); and for the Engineering & Science category, they were engineering (147 jobs) and AutoCAD (142 jobs).[7]

To build the database, we examined those profiles possessing such skills, incorporating any additional information available for each profile. The database (elaborated from September 2019 to February 2020) contains variables of 444 crowdsources from Argentina (266 cases) and Spain (178 cases). SPSS software was used to perform a bivariate analysis, followed by a multiple linear regression analysis to test the effects of gender and skills on wages per hour in euros (after controlling for other individual factors). Finally, the statistical analysis was complemented by using the bootstrap method to estimate more accurate standard errors and confidence intervals. We replicated 5000 bootstrap samples. Cases beyond 3 standard deviations were excluded from the multiple linear regression analysis to minimize potential biases due to outliers.

3.2 | Measurement

The *dependent variable* is wages per hour (in euros), while the *independent variables* are sex[8] (1 = Female, 0 = Male) and skills (measured as Top three skills). Based on the profile's information regarding the most relevant skills needed for the freelancer to complete the tasks, a new variable was built (identifying different grades of STEM skill). This variable included four categories: 0 = Three non-STEM skills,[9] 1 = One STEM skill and two non-STEM skills, 2 = Two STEM skills and one non-STEM skill, and 3 = Three STEM skills.[10] Generating a continuous measure of STEM-intensity, rather than a binary STEM versus non-STEM definition, gives us a better understanding of the gender implications (Dockery et al., 2021). Moreover, the reviewed studies tackling this topic reveal that the variable "skills" was not included in the statistical models, posing an important limitation in terms of the internal validation of the findings.

The following variables were included as *control variables*: educational field, number of reviews, time on the platform, link with the platform, residence in the capital city, and country of residence. The educational field—the areas of educational specialization that each profile includes (or does not)—was recoded in nine dummy variables: (1) Computer Science & Systems Analyst; (2) Computer Engineering & Telecommunications; (3) Other Engineering; (4) Graphic Design; (5) Fine Arts; (6) Advertising/Marketing & Audiovisual Communication; (7) Architecture & Industrial Design; (8) Other Specializations; and (9) No Mention of Specialization. The number of reviews is a continuum variable, starting from a minimum of 10 reviews. Time on the platform was recoded as 1 = 0–3 years, 2 = 4–6 years, 3 = 7–9 years, and 4 = 10 or more years. Finally, the city of residence takes the values 1 = Capital and 0 = Other Cities, and the country of residence 1 = Spain and 0 = Argentina.

4 | DATA ANALYSIS AND FINDINGS

The results (Table 1) show a marked underrepresentation of women on the Freelancer.com platform. The presence of men practically quadruples that of women (77% vs. 23%), which confirms H1. The persistence of gendered segregation

in the gig economy and STEM-related fields is well known (OECD, 2018; Sassler et al., 2017; UNESCO., 2019) and has been observed in several regions (Churchill & Craig, 2019; Fletcher, 2021; Hunt & Samman, 2019). Even though the fact that digital platforms may reduce some of the labor market entry barriers for women due to greater working time flexibility (Blaire, 2016; Balaram et al., 2017, p. 12; OECD, 2018, p. 41), the crowdsourcing platform Freelancer.com—both in Spain and Argentina—tends to replicate the structural inequalities women encounter in the traditional labor markets. Unfortunately, women's lower educational enrollment in STEM disciplines, their more limited use of digital tools, and scarcer presence on platforms reinforce a scenario of widening unequal gender participation (OECD, 2018, p. 13).

However, also in line with H1, this gender gap is no higher in Argentina than in Spain. Table 1 displays no statistical differences in the participation of women on Freelancer.com in either country. This finding represents an opportunity to mitigate traditional gender inequalities in the Global South by increasing women's participation in the gig economy. One distinctive feature of this region is the unequal access and control of technology (OECD, 2018), the lack of job opportunities in the formal labor market (Balaram et al., 2017), and the negative cultural attitudes about the societal role of women (Kuek et al., 2015).

Moreover, Table 2 shows that gender variations are not as marked as expected when looking at average hourly wages (in euros). Men are paid on average 11% more than women, which, in turn, may be explained by differences in the top three skills or the length of time they have been active on the platform. Both variables are correlated with the average hourly rate, as well as the number of reviews, the link with the platform, and the city of residence. However, residence in the capital city and most of the educational fields (except for "Computer Engineering & Telecommunications" and "Other Engineering") are not correlated with the average hourly rate. In these latter cases, what likely matters is the number of STEM skills.

Table 3 displays, in Model 1, significant statistical differences in the hourly wage rate (in euros) by gender: in line with H2.1, women tend to charge less (or are paid less) than men. Nonetheless, such a difference disappears when STEM skills are introduced (see models 2 and 3). In other words, ceteris paribus, gender does not explain the differences in the average hourly rate; STEM skills do (see interactions in Model 3). Once the STEM skill level is controlled for, the gender effect tends to vanish, as expected by H2.2. Therefore, if women possess the same STEM skill level as men, they can earn similar hourly wages on Freelancer.com (Spain and Argentina). This is a significant finding since it represents a window of opportunity in providing decent job chances (Fudge & Hobden, 2018; Hunt & Samman, 2019) for women engaged in these sectors. This result is consistent with the gender wage gap in the USA, which tends to be lower in those industries where working arrangements are more flexible (OECD, 2018, p. 41), becoming more appealing and avoiding the "leaking pipeline". Having STEM skills in crowd work can further bridge gender pay gaps, allowing women who usually encounter gender discrimination in the traditional labor markets to fulfil their expectations (Hyperwallet, 2017) and to develop their careers in safer environments (less hostile and chilly).

Hence, one of the main issues at stake here is the level of STEM skills, insofar as not all skills are equally rewarding on these platforms (Barnes et al., 2015; Irani, 2019). This aspect may also explain why the educational field (Table 2) exhibits no statistical association with the hourly rate (see models 1, 2, and 3). According to the OECD (2018, 78), strengthening women's STEM skills constitutes a key aspect in narrowing the gender wage gap. Likewise, since time on the platform is positively related to the hourly rate (models 1, 2, and 3), this may imply that "labor market rewards

TABLE 1 Gender by country on freelancer.com platform

	Argentina	Spain	Total
Male	78.5%	74.3%	76.8%
Female	21.5%	25.7%	23.2%
	100%	100%	100%

Note: $N = 444$ cases. Significance of Pearson Chi-Square test = 0.305.

Source: Own elaboration.

TABLE 2 Determinants of wages per hour (in euros)

	%	Mean of hourly wages	Correl. with hourly wages
Sex			−0.104*
Male	77	22.3	
Female	23	19.9	
Educational field			
Computer science & Systems analyst	11	21.6	−0.004
Computer engineering & Telecommunications	13	24.7	0.117*
Other engineering	6	18.1	−0.097*
Graphic design	14	20.6	−0.045
Fine Arts	7	20.3	−0.039
Advertising/Marketing & Audiovisual communication	9	21.2	−0.015
Architecture & Industrial design	6	21.6	−0.004
Other specializations	5	22.3	0.019
No mention of specialization	29	22.1	0.026
Top 3 STEM skills			0.191**
0 top skills	41	19.8	
1 top skills	9	19.4	
2 top skills	12	23.3	
3 top skills	38	23.9	
Number of reviews	-	-	0.214**
Time on the platform			0.215**
0–3 years	23	17.9	
4–6 years	40	22.3	
7–9 years	21	21.9	
10 and more years	16	25.6	
Link with the platform			−0.130**
Start up	14	24.9	
Freelancer	86	21.2	
Residence in the capital city			0.054
No	65	21.3	
Yes	35	22.5	
Country of residence			0.109*
Argentina	60	20.8	
Spain	40	23.1	

Note: In the case of categorical variables with two categories (sex, link with the platform, residence in the capital city, and country of residence), the first category is considered as reference. $N = 440$ cases.

Source: Own elaboration.

to experience rise over time; allowing women to accumulate working experience is likely to reduce the gender pay gap" (Ibid, 78). However, none of the models is statistically significant regarding the type of link with the platform.

Further attention should also be paid to the influence of the place of residence (capital/country) in explaining hourly wages (models 1, 2, and 3). While this form of work appears to offer individuals the opportunity to self-select jobs located worldwide, the place of residence is a source of pay differentials. As pointed out by Hunt and

TABLE 3 Ordinary least square regression: Determinants of hourly wages (in euros)

	Model 1	Model 2	Model 3
Gender (Female)	−2.742**	−1.831	−0.916
Top 3 STEM skills		1.460***	1.633***
Education field (ref. Computer science & Systems analyst)			
Computer engineering & Telecommunications	1.863	1.651	1.566
Other engineering	−2.758	−2.412	−2.461
Graphic design	0.096	2.803	2.864
Fine Arts	−0.968	1.761	1.819
Advertising/Marketing & Audiovisual communication	−0.727	1.463	1.521
Architecture & Industrial design	2.795	3.212	3.676
Other specializations	2.855	4.165	4.061
No mention of specialization	1.226	2.287	2.364
Number of reviews	0.025**	0.026**	0.026**
Time on the platform	1.762**	1.414**	1.466**
Link with the platform (Freelancer)	−1.614	−1.585	−1.581
Residence in the capital city (Yes)	2.288*	2.284*	2.273*
Country of residence (Spain)	2.471*	2.287*	2.295*
Interactions			
Top 3 STEM skills * Sex			−1.282
Constant	15.774***	13.130***	12.670***
R square	0.144	0.168	0.171

Note: The figures represent unstandardized B coefficients. Bootstrap results are based on 5000 bootstrap samples.
***$p < 0.001$, **$p < 0.01$, *$p < 0.05$. Outliers beyond 3 standard deviations excluded. $N = 436$ cases.
Source: Own elaboration.

Samman (2019, 1), the implications of the gig economy for workers vary according to specific geographical contexts and the pre-existing configuration of the labor markets, which differs significantly between low and middle-income countries and high-income countries (Hunt & Samman, 2019, p. 15). Finally, the number of reviews, as a proxy of experience on the platform, is important in explaining the average hourly rate (models 1, 2, and 3).[11]

5 | CONCLUSIONS

The share of men involved in the gig economy is higher than that of women, regardless of the tasks they perform (Hunt & Samman, 2019; Kuek et al., 2015). The underrepresentation of women in these sectors replicates the multiple discriminations they face during their education and, afterwards, in the traditional labor markets (Petroff et al., 2021; Sáinz et al., 2019). Our findings reinforce such results in the specific case of professional women engaged in STEM-related tasks, a profile not specifically addressed in previous studies. However, while the findings reveal lower participation of women than men on Freelancer.com, this gap tends to be no higher in Argentina than in Spain. This may represent an important opportunity for the Global South since some countries exhibit lower digital gender gaps than the rest of Latin America (Gillwald & Mothobi, 2018). In fact, the deficit between the increase in demand and an insufficient ICT workforce supply has become a major concern for governments and corporations in the Global North due to its negative impact on economic development (ILO., 2020).

For its part, gender discrimination in people's wages in the traditional labor market is widely documented too by the literature. Being a woman automatically leads to lower incomes than men, even when the level of study or qualification is the same (ILO., 2019). In line with the literature (Balaram et al., 2017; Lepanjuuri et al., 2018; Liang et al., 2018), the findings show that our case studies also replicate the gender pay gaps identified in the traditional labor market and in the gig economy. Nevertheless, the gender pay gap is not as sharp as expected. In the traditional labor market, occupational working-time arrangements (the share of part-time employment and the share of working overtime) are particularly important in predicting the gender wage gap in ICT fields (Leuze & Strauß, 2016). Because of the gig economy's flexibility feature, its working time arrangements could lose importance as a discriminatory variable in explaining wage inequalities. Moreover, the demand for software development and multimedia skills are strongly linked to remuneration, especially on platforms that trade in high-skill or complex online services (Codagnone et al., 2016; Yordanova & Kirov, 2017), an aspect which might explain why the gender pay gap is lower than expected.

More importantly, the findings also show that gender variations in hourly wages are not as marked as expected, and such differences disappear once STEM skill level is controlled for. Asymmetry in individuals' STEM skill level provides a better explanation than gender of hourly wage differences. Our study reveals that the gender effect on wages tends to blur once the focus of the analysis switches to the STEM skill level displayed on the platform. This result is particularly relevant as it opens a window of opportunity for bridging the gender pay gap. Therefore, particular attention needs to be paid to skills as a key variable for consideration in further studies on gender and the pay gap in the gig economy.

Related to the above, STEM skills should not be treated as a unitary whole (Liu & Grusky, 2013) since asymmetry in STEM skill levels is a central variable in explaining wage differences among men and women. This consideration brings into discussion several methodological aspects that should not be neglected in future studies. One of them is linked to the methodological treatment of "occupations:" we suggest considering "skills" rather than "task categories" as a central variable. This would facilitate comparison between platforms, by tackling different types of categories depending on the targeted tasks they offer. Another methodological aspect is a recommendation to include in further studies the "number of reviews" variable, neglected in previous studies, as our models show its statistical significance. This variable can also be used as a criterion to ensure that the final sample only provides information on those individuals with a minimum of experience on the platform (according to Kässi & Lehdonvirta, 2016, only 10% of the profiles are active members). Therefore, to avoid potential methodological biases, we suggest considering this variable and the most appropriate number of reviews for inclusion in a study. In our case, we have used a minimum of 10, but it is a topic that requires in-depth discussion.

Finally, there are some policy implications from the results that deserve a mention. Fostering the participation of women from Latin American countries in the gig economy could benefit their national economies (Gillwald & Mothobi, 2018), and it can reduce the labor force shortage in these fields in the Global North, leading to a win-win situation. Moreover, these platforms may blur the organizational traits of the traditional labor market, which is marked by hostile and chilly working environments (Wynn & Correll, 2017). Accordingly, women from the Global North and especially the Global South may encounter a much "friendlier and safer" space in the gig economy to develop their career aspirations in technological fields and avoid the "leaking pipeline," a hypothesis worth testing in future studies. The medium-term efforts of governments and other stakeholders to mitigate the gender pay gap should focus on measures to reduce the loss of female talent and to ensure the acquisition of STEM skills during education (Sainz et al., 2020). Lifelong learning and training are also crucial, as crowd platforms seem not to pay particular attention to fields of specialization or formal credentials. On the other hand, in organizational terms, the weak formal links between participants and the platform may be a limitation for policy intervention (e.g. in the implementation of Gender Equality Plans). Instead, another kind of strategy should be designed to grasp and reverse these structural sources of discrimination.

AUTHOR CONTRIBUTIONS

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us. We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with respect to intellectual property. In so doing we confirm that we have followed the regulations of our institutions concerning intellectual property.

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CONFLICT OF INTEREST

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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ENDNOTES

[1] The term crowd work was coined by Howe (2006) to designate the outsourcing of work to a "crowd", that is, a group of individuals whose numbers, heterogeneity, and knowledge is determined by the requirements of the crowdsourcing initiative (Estellés-Arolas & González-Ladrón-De-Guevara, 2012, p. 194)

[2] Kuek et al. (2015) estimate that in 2013, three platforms—Upwork, Freelancer, and the Chinese professional task platform Zhubajie/Witmart—together held 50% of the global online professional task market.

[3] STEM stands for science, technology, engineering, and mathematics.

[4] Except for some categories, that is, Design and Creation, Translation, and Writing.

[5] We included only those members with some experience with the platform: minimum 10 reviews indicating at least 10 tasks performed on the platform. To avoid duplication of cases, we followed a double-check process of the profiles (Table A1 and Table A2 of Appendix).

[6] The web offers projects linked to 12 categories: Websites, IT & Software; Mobile Phones & Computing; Writing & Content; Design, Media & Architecture; Data Entry & Admin; Engineering & Science; Product Sourcing & Manufacturing; Sales & Marketing; Freight, Shipping & Transportation; Business, Accounting, Human Resources & Legal; Translation & Languages; and Local Jobs & Services.

[7] The reason for making this methodological decision is linked to the fact that in previous studies the occupational/labor categories displayed by the platform is the central variable in the data collection process. The classification of individuals in the occupational/labor categories of analysis are not the same in all the studies, which can generate a problem of validity in the results obtained. In short, both the criteria for classifying individuals and the classification taxonomy itself are not standardized across studies, thus making comparisons difficult. This has also been a methodological difficulty in our study: deciding which individuals belong to which categories, as well as the reasonable number of categories resulting from such classifications.

[8] Although the theoretical framework includes the discussion in terms of gender, the analysis contemplates the variable sex in binomial terms, as the profiles' information does not allow us to identify the gender identification of the participants.

[9] Graphic Design, Logo Design, Animation, Photoshop, Illustration, Caricature & Cartoons, Brochure Design, Infographics, Video Editing, Social Media Marketing, Corporate Identity, and Visual Arts.

[10] PHP, SQL, 3D Rendering, 3D Modeling, 3D Animation, C# Programming, .NET, HTML, Maya, AutoCAD, Unity 3D, XML, Python, JavaScript, Mobile App Development, Drupal, and Linux.

[11] For more details, see Table A3 (Appendix).

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APPENDIX A

TABLE A1 Argentinian subsample

Category	Number of available profiles by category	Number of profiles excluded
PHP	1.049	935
HTML	1.134	1.018
Mobile App Development	91	53
Android	296	264
Graphic Design	1.244	1.115
Website design	417	267
Engineering	379	317
AutoCAD	441	419

Source: own elaboration

TABLE A2 Spanish subsample

Category	Number of available profiles by category	Number of profiles excluded
PHP	752	625
HTML	775	667
Mobile App Development	81	49
Android	285	247
Graphic Design	841	681
Website design	400	295
Engineering	240	215
AutoCAD	217	196

Source: own elaboration

TABLE A3 Ordinary least square regression: Determinants of hourly wages (in euros) by different cut-off points in the number of reviews

	Cut 10	Cut 11	Cut 12	Cut 13	Cut 14	Cut 15	Cut 16	Cut 17
Gender (Female)	−0.916	−1.253	−1.778	−1.711	−1.824	−1.322	−1.633	−1.421
Top 3 STEM skills	1.633***	1.533***	1.727***	1.780***	1.913***	2.078***	2.062***	2.148***
Education field (ref. Computer science & Systems analyst)								
Computer engineering & Telecommunications	1.566	1.439	1.963	1.732	1.788	3.463*	4.583	4.701
Other engineering	−2.461	−1.818	−1.263	−0.923	−0.850	−2.317	−1.334	−1.296
Graphic design	2.864	3.074	4.061*	4.742*	5.086*	4.617*	5.520*	5.590*
Fine Arts	1.819	2.193	2.328	2.991	3.170	3.016	3.628	3.523
Advertising/Marketing & Audiovisual communication	1.521	1.287	2.180	2.522	2.929	2.692	3.857	3.849
Architecture & Industrial design	3.676	3.590	5.129*	5.867*	5.924*	5.549*	6.030*	6.432*
Other specializations	4.061	5.779	6.607*	7.185*	7.342*	7.635*	8.154*	8.129*
No mention of specialization	2.364	2.462	3.532	4.020*	4.342*	3.841	4.285*	4.345
Number of reviews	0.026**	0.026**	0.027**	0.026**	0.027**	0.025**	0.025**	0.025**
Time on the platform	1.466**	1.354**	1.199*	1.301*	1.075	0.893	0.646	0.519
Link with the platform (Freelancer)	−1.581	−2.222	−2.363	−2.695	−2.568	−3.212	−3.258	−3.215
Residence in the capital city (Yes)	2.273*	2.632*	2.873**	2.882**	3.210**	3.418*	3.691**	3.777*
Country of residence (Spain)	2.295*	2.277*	2.123*	1.328	1.376	1.878	2.385*	2.272
Interactions								
Top 3 STEM skills * Sex	−1.282	−1.439	−1.671	−1.688	−1.791	−2.036	−1.872	−1.895
Constant	12.670***	13.720***	13.249***	13.225***	13.162***	13.904***	13.714***	13.762***
R square	0.171	0.129	0.143	0.145	0.147	0.169	0.172	0.172
N	436	398	374	350	338	318	298	289

Note: The figures represent unstandardized B coefficients. Bootstrap results are based on 5000 bootstrap samples.

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$. Outliers beyond 3 standard deviations excluded.

Source: Own elaboration.

Comments: The new models (re)confirm the hypotheses under study at the different cut-off points in the number of reviews. However, it can also be seen that: (a) from cut-off point 12 onwards, some educational fields start to show statistically significant differences, and, on the other hand, (b) from cut-off point 14 onwards, time on the platform is no longer statistically significant. This later result is explained, at least in part, by the fact that time on the platform is highly correlated with the number of reviews.