

Equal Pay and Employment in Serbia During the COVID-19 Pandemic

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Abstract:

Introduction and objectives: Before the COVID-19 pandemic, Serbia belonged to the group of post-transition countries that were determined to reduce gender inequalities in the labour market through an improved institutional framework and measures to promote women's employment. However, the gender wage gap remains significant. This paper uses data from the Survey on Income and Living Conditions to examine the gender wage gap in Serbia. **Methods:** The estimates of the stochastic frontier model were obtained using the maximum likelihood estimation method. **Results:** The results indicate a statistically significant gender wage gap, showing that women on average have a log hourly wage 0.109 and 0.098 lower than men in 2019 and 2020, respectively. The labour market shows similar efficiency of employees. **Conclusion:** It is predicted that women are paid less than men, even after controlling for the observed factors. Comparing this with the results of previous studies, it can be concluded that the COVID-19 pandemic has contributed to a slight worsening of gender inequalities in the Serbian labour market. **Implications and research limitation:** Women's financial vulnerability can be exacerbated by leaving the workforce, taking up part-time employment or working in a job with lower benefits. The latter position of women in the labour market or their recognition as potential beneficiaries by pension and social security systems are two ways in which this has practical implications for the public policy. Similar research using data from the post-COVID-19 period would be of great value in assessing changes in women's position in the labour market.

Keywords: COVID-19, Employed, Pay Gap, Serbia

JEL Classification: J16, J31, D31

1. Introduction

The gender wage gap plays a key role in explaining the pattern of wage formation in many countries. This is well documented in recent publications. Relevant papers for developed economies encompass Fudge and Mundlak (2022), Kaya (2023), and Olivetti and Petrongolo (2016). For transition economies, this topic is recently studied in Ognjenovic (2022), Ognjenovic (2021a), Anic and Krstic (2019), and Blunch (2018). The magnitude and structure of the gender wage gap began to attract the attention of economists as female labour force participation increased in developed economies (Blau & Kahn, 1996). The first empirical studies of gender wage gaps relied on a theoretical wage model in which wages are determined primarily by the influence of human capital factors on their evolution over an individual's life span. According to Oaxaca's approach in measuring the wage gap, gender wage differentials are perceived through differences in observed characteristics and the resulting effect of different wage structures, including possible discriminatory impacts (Oaxaca, 1973).

This approach to measuring gender wage gaps has served many authors to develop empirical models and disaggregate this discrepancy (e.g., Kaya, 2023; Ognjenovic, 2021a; Blunch, 2018; Olivetti & Petrongolo, 2016). This paper uses an alternative strategy to measure the gender wage gap. This methodological ap-

*Corresponding author: Kosovka Ognjenović, e-mail: kosovka.ognjenovic@ien.bg.ac.rs

proach to measure gender wage gaps is based on the empirical strategy recently applied in labour market studies (e.g., Garcia-Prieto & Gomez-Costilla, 2017; Angeles Diaz & Sanchez, 2011; Ogloblin & Brock, 2006). The applied empirical strategy allows the estimation of the potential wage who difference from the actual wage determines the (in)efficiency of a person in the labour market. If there are enough observable characteristics, it can be assumed that in an ideal situation the same characteristics lead to the same rewarding and similar potential wages for all workers irrespective of gender. However, if there is a gap, it may be filled by part of the wage differential that has arisen due to unobserved factors, including the possible effects of discrimination.

Empirical studies have shown that the COVID-19 crisis is currently affecting global labour markets in a way that does not affect men and women equally (e.g., Christl et al., 2022; Farcnik & Istenic, 2022; Tverdostup, 2022; Dang & Nguyen, 2021; Doorley et al., 2021; ILO, 2021; Ognjenovic, 2021b; Alon et al., 2020; SeCons, 2020). The analysis presented in this paper, however, focuses only on the Serbian labour market. In order to maintain the economic activity and the purchasing power of citizens at a level that does not compromise the normal functioning, as well as to reduce the negative effects on the labour market, the Serbian Government (2020) has launched a package of financial assistance measures. They were created for companies operating in the formal sector, provided that they can ensure the stability of the number of employees, i.e., do not allow a decrease in the number of employees by more than 10% (Ministry of Finance of the Republic of Serbia, 2022).

Despite these measures, the GDP declined by 1% in real terms in 2020, and the economy did not fall into a deeper recession and recovered in 2021. The labour market also responded, with a slight decline in the number of employed persons of 0.2%. Employment in the primary sectors of agriculture and manufacturing declined equally among women in relative terms, while men left the agricultural sector faster than women. On the other hand, the construction industry absorbed some of the male labour force. In the service sector, the female labour force exceeded the male labour force by more than one-fifth in 2020 (Ognjenovic, 2021b). In lockdown industries like HORECA, administration, and education, as well as in fields like health care and commerce that were crucial in fighting the COVID-19 pandemic, women were overrepresented. The main research question is therefore whether the sectoral redistribution of female employment during the COVID-19 crisis has led to wage losses that have affected the gender wage gap in the Serbian labour market.

2. Literature Review

Numerous studies show that COVID-19 has done more harm to women than men. It was not only in terms of the current labour market prospects, job losses, and the fact that women are more vulnerable, as they earn less than their male counterparts, but also because of the expectation that the accumulated effects of job losses will harm women's future wages (Carli, 2020). The ILO report warns that the post-COVID-19 recovery of the global labour market is slow (ILO, 2021). It is assumed that COVID-19 affected the early termination of schooling. It also reduces the chances for training or other types of in-work learning, which creates additional difficulties for those entering the labour market for the first time and opens space for poorer working conditions and lower wages. Some stylized facts for the Serbian labour market show that the labour market slack in 2020 was 19.6% as a percentage of the extended labour force (or 0.5 percentage points less than in 2019). This rate, however, is primarily a result of the increase in the inactive population by 25.8 thousand. The 2020 labour force survey data show that the pandemic affected the rapid growth of the inactivity rate of young people (1.1 percentage points vs. 1.6 percentage points respectively for males and females) rather than the adult population (0.7 percentage points vs. 0.6 percentage points). SeCons (2020) used real-time data to examine the impact of COVID-19 on employment and working conditions for men and women in Serbia. They found that women are more exposed to the infection and risk of losing jobs if they work in the private sector. But both men and women are at equal risk of losing jobs if they work in the wholesale and retail trade and repair of motor vehicles, the provision of accommodation and food services, and the manufacturing industry. Similarly, Shalamanov's (2022) analysis identified the most vulnerable sectors in Bulgaria (the HORECA industry and air transport). Also, adoption of different strategies for reducing the adverse effects of crisis may negatively affect not only organizations but also employees (Osievskyy et al., 2020).

Alon et al. (2020) also confirmed that COVID-19 sharply affected women in the U.S. labour market due to distance-keeping measures and sectoral distribution of women's employment. They also found some positive effects of the current crisis on gender equality, such as work-life balance promotion, greater involvement of men in taking care of children, promotion of the division of labour in the household, etc. However, not all studies point to the affirmation of gender equality, but some suggest that the current crisis has meant

that women take on a greater burden of childcare and household chores (Farre et al., 2022). The results of Dang and Nguyen (2021) further support these findings. The authors showed for several of the world’s most developed economies that the crisis has contributed to an increase in the probability of permanent job losses for women and the expected loss of earnings. Economic measures to combat the impacts of COVID-19 in some European countries have reduced gender pay gaps but have also shown that women are bigger losers regarding market earnings (Christl et al., 2022). Occupational choice and industry played an essential role in determining gender disparities in wages before the pandemic. It was well documented in empirical studies that men disproportionately worked in high-paid occupations, while the opposite was true for employed women (Kaya, 2023). However, the current pandemic has changed recent trends so that women are now employed in industries and professions that give them a specific advantage in earning opportunities (Doorley et al., 2021). Tverdostup (2022) found similar results showing that COVID-19 reduced gender disparities in employment and wages in Estonian economy, while Farcnik and Istenic (2022) identified a reducing of the gender gap in unpaid work in Slovenia. However, the categories of workers that may be affected stronger are employees in the vulnerable sectors as well as mothers with young children.

Blunch (2018) estimated the gender gap in wages across six countries of Eastern Europe and Central Asia, including Serbia, using the 2009 UNDP Social Exclusion Survey, and found that a sizeable portion of the pay gap can be attributed to unobserved factors such as discrimination. These results are derived from the experiment which uses the observed factors such as age, education, sector of employment, type of contract, and type of settlement to test their impact on men’s and women’s wages determination. The approach applied in the paper did not test for mediator and confounder effects (Hernan & Robins, 2020). However, according to the methodology applied in this paper (Oaxaca, 1973), which relies on the decomposition of the total pay gap, the significant presence of an unexplained portion of the difference in the wages of men and women can be attributed to the impact of discrimination. The author also provided evidence about the essential role of education in reducing the pay gap. The portion of the unexplained gap for Serbia stood at 19.1%, while the explained part was negative, reducing the overall wage difference by 4.7%. Using data from the 2007 Living Standards Measurement Survey for Serbia, Ognjenovic (2021a) found a negative part of the explained wage gap of 5.4%, while an unexplained portion was 12.1%. Anic and Krstic (2019) pointed further to a mild increasing tendency in the gender wage gap in Serbia.

3. Methodology

3.1 Methods

The concept of quantifying the gender pay differentials utilizes the methodology provided by Greene (2012) and applied in, for example, Garcia-Prieto and Gomez-Costilla (2017), Angeles Diaz and Sanchez (2011), and Ogloblin and Brock (2006). This approach enables the assessment of the potential wage and, based on the difference between the actual and the potential wage, determines (in)efficiency of a person in the labour market. According to this empirical strategy, the standard Mincerian wage equation is provided in the following semi-logarithmic regression form:

$$\ln y = \beta_0 + \beta'x + \omega. \tag{1}$$

In model (1), the dependent variable y is the natural logarithm of an individual's wage, x is a set of independent variables that includes personal, job-related, and firm-related characteristics, whereas β 's represent the unknown parameters to be estimated. The composite error term $\omega = \varepsilon - \vartheta$ in the expression (1) includes the stochastic term ε normally distributed with the parameters 0 and σ_ε^2 and an inefficiency term ϑ , which has the truncated normal distribution with the parameters μ and σ_ϑ^2 . In this specification, ϑ is the variable of interest because this term measures the difference between actual (y) and potential (y') wages.

The estimates of the stochastic frontier model (1) are obtained using the maximum likelihood estimation method (Greene, 2012). This method is adopted using the Stevenson (1980) approach, where the log likelihood function ($\ln L$) of the regression model (1) can be expressed in the following form:

$$\ln L = \ln(y|\beta_0, \beta, \sigma^2, \mu, \lambda) = -\frac{n}{2} \ln \sigma^2 - \frac{n}{2} \ln 2\pi - \frac{1}{2\sigma^2} \sum_{i=1}^n [(y_i - \beta_0 - \beta'x_i) - \mu]^2 + \sum_{i=1}^n \ln \left\{ 1 - F' \left[-\frac{1}{\sigma} \left(-\frac{\mu}{\lambda} - (y_i - \beta_0 - \beta'x_i) \right) \right] \right\} - n \ln \left[1 - F' \left(-\frac{\mu}{\sigma} \sqrt{\frac{1}{\lambda^2} + 1} \right) \right]. \tag{2}$$

In expression (2), in addition to the parameters of the regression model (1) explained above, n stands for the number of sampling units, the square root of the variance of the composite error term is given in the following form $\sigma = \sqrt{\sigma_\varepsilon^2 + \sigma_\vartheta^2}$, the ratio of corresponding standard deviations of the composite error term is equal to $\lambda = \frac{\sigma_\varepsilon}{\sigma_\vartheta}$, and $F'(\cdot)$ is a cumulative distribution function. The literature suggests taking the first-order derivatives of the log likelihood functions (2) and using the numerical maximisation in order to compute the maximum likelihood estimates of the parameters $(\beta_0, \beta, \sigma^2, \mu, \lambda)$ set at the $\ln L$. In the empirical exercise performed in this paper the maximum likelihood estimates are calculated using the procedure of numerical maximisation provided in the statistical software Stata.

The stochastic frontier analysis is widely used in labour market studies (see, for example, Garcia-Prieto and Gomez-Costilla (2017), Angeles Diaz and Sanchez (2011), Ogloblin and Brock (2006), mentioned a few papers). Treating the model (1) as a stochastic frontier model provides the estimate of the frontier wage, further implying that the (in)efficiency of an individual in achieving this potential wage can be calculated by using the following expression:

$$I_{ineff} = 1 - \exp(-\vartheta). \quad (3)$$

The statistical formula for calculating the gender wage gap is based on the ratio of the difference between men's and women's wages expressed as a percentage of men's wages. When estimating for the combined sample, the coefficient measuring the differential between men's and women's wages can be obtained by including a female dummy variable in the wage regression. This approach to examining the gender wage gap has recently been used in the literature and can be viewed as an extension of the earlier Oaxaca approach (Oaxaca, 1973). Given the same observed characteristics, men and women are assumed to be able to earn their potential wages in the same way; any deviation from this can be considered a gender wage gap.

3.2 Data

This paper uses the microdata from the Survey on Income and Living Conditions for 2019 and 2020 (The Statistical Office of the Republic of Serbia, 2022; The Statistical Office of the Republic of Serbia, 2021a). The first year corresponds to the pre-COVID-19 situation, and the second-year data are used to examine the gender wage disparity during the COVID-19-related crisis. The results of earlier studies and of the Eurostat's Structure of Earnings Survey that allow comparisons of Serbia with other European countries, are used to obtain an accurate picture of the development of the gender wage gap before COVID-19 (The Statistical Office of the Republic of Serbia, 2020).

The data generation procedure based on probability theory, which states that a random sample of households and individuals was selected, forms the basis for the Survey on Income and Living Conditions. The sampling frame takes into account both the actual selection of sample units and the achieved sample of households and individuals who agreed to participate in the survey by answering the questions. With regard to the section of the questionnaire in which information on wages is collected, these are the after-tax amounts earned by the respondents in the month prior to the survey. For all household members who were at least 18 years old and employed, information was collected on their employment and wages. Age, sex, marital status, relationships with dependent family members, health status and education are the main demographic characteristics of the respondents. All other attributes relate to job description, working conditions and employer. Therefore, it cannot be guaranteed that all variables that directly or indirectly affect employees' wages are controlled during the data generation process. However, all relevant variables collected in the survey are included in the estimation of the wage model. After 2021, information on monthly net wages will no longer be collected in the same form in the survey questionnaire. The process of statistical data collection (sampling and fieldwork) is described in more detail in the methodological descriptions of the Statistical Office of the Republic of Serbia (2022, 2021a).

The COVID-19 pandemic had a modest impact on male and female labour market performance in Serbia. However, the labour force participation of women shrunk. And it is still below the 2019 level (47.1%) by 0.1 percentage points (the female activity rate was 47% in 2021, while the same rate for the male population was 62.9%, showing an improvement of 0.2 percentage points). Thus, a certain number of unemployed women left the labour market and became inactive (Ognjenovic, 2022). Likewise, a certain number of unemployed women turned into employment, which preserved the employment rate of women during the first year of the

COVID-19 pandemic (the female employment rate increased from 41.9% in 2019 to the level of 42.1% in 2020). As a result, the gender employment gap in 2020 decreased marginally from 14.7 to 14.5 percentage points (The Statistical Office of the Republic of Serbia, 2021b).

In contrast to the pre-COVID-19 time, men's and women's employment rates went down (over the 2020-2021 sub-period). The disparate impact (d_i) of the employment rate (e_r) decreased from $d_{i_{2020}} = e_{r_{2020}}^f / e_{r_{2020}}^m = 0.744$ to $d_{i_{2021}} = e_{r_{2021}}^f / e_{r_{2021}}^m = 0.731$, which resulted in a slight widening of the gender inequality in employment. As for comparison, the gender employment gap deepened to 15.2 percentage points in 2021, while the difference in activity rates of men and women increased to 15.9 percentage points (the 2021 activity rates for both population groups were higher than in 2020, as can be noticed in Figure 1).

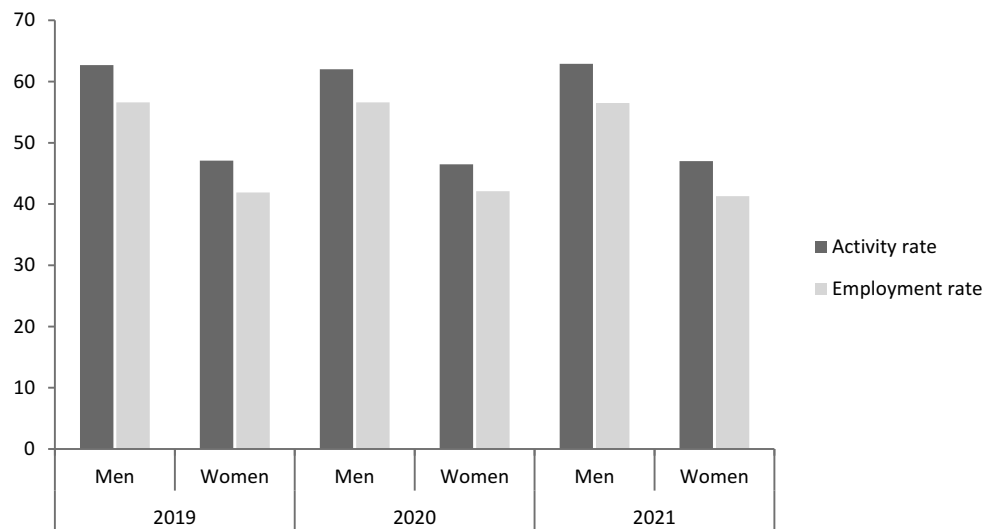


Figure 1: Annual rates of activity and employment in Serbia by gender (%).

Although net wages increased in 2020 (by 9.5% and 7.8% in nominal and real terms, respectively), there were specific shifts among wage earners by wage intervals. In 2020 the net (monthly) minimum wage was around RSD 30 thousand, while in 2019, it was lower because the net wage per working hour increased by 11% in 2020 and 6.6% in 2021. However, the share of men and women who received a net wage equal to or below the threshold of RSD 30 thousand was 24.3% and 27.1% in 2019; whereas in 2020, the shares of male and female wage earners below this threshold substantially increased to 30.6% and 32.5%, respectively. In other words, although wages grew in 2020, the number of low-wage earners increased, more among women than men, indicating a pronounced sectoral division of labour. The anti-COVID-19 measures affected these developments in the labour market. Also, anti-COVID-19 measures affected more wage earners in the private than in the public sector. Consequently, those with low skills are disproportionately affected by the COVID-19 crisis irrespective of gender.

3.3 Empirical model

The empirical model uses a sample of 4,156 (4,168) observations (of which 2,284 (2,286) are employed men and 1,872 (1,882) are employed women) from the 2019 (2020) Serbian Income and Living Conditions Survey. The survey contains a rich set of variables that describe an individual's characteristics, the situation in the household and family characteristics, features of the working place, as well as basic information about the employer. The sample of employees (wage earners) is limited to those aged 18 years and over. The outcome variable, the hourly wage in the primary job, expresses net wages earned in the month that precedes the survey, divided by the positive hours worked. This variable is transformed and provided in the form of the natural logarithm. The initial empirical model of the log of the hourly wage for worker i ($i = 1, \dots, n$) is provided in the following expression:

$$\begin{aligned}
\ln wage_i = & \beta_0 + \beta_1 age_i + \beta_2 agesq_i + \beta_3 experience_i + \beta_4 experiencesq_i + \beta_5^{medium} education_i + \beta_6^{high} education_i + \\
& \beta_7 married_i + \beta_8 children_i + \beta_9^{permanent} contract_i + \beta_{10} supervisory_i + \beta_{11} Serbia - North_i + \beta_{12}^{densely} populated_i + \\
& \beta_{13}^{intermediate} populated_i + \beta_{14} small_i + \beta_{15}^{medium and large} i + \beta_{16} private ownership + \beta_{17}^{manufacturing and construction} i + \\
& \beta_{18} services_i + \beta_{19} unemployed_i + \beta_{20}^{poor} health_i + \beta_{21} female_i + \omega_i.
\end{aligned}
\tag{4}$$

By definition, the values of the dependent variable (*lnwage*) in the empirical model (4) are bounded to the positive values, whereas the set of independent variables, in addition, to continuous variables (*age* in years, *squared age*, *working experience*, *squared working experience*) can also include dummy variables (an indicator variable for education {*low*, *medium*, *high*}, marital status {*married*}, presence of children of preschool age in the household {*children*}, type of employment contract {*permanent contract*}, managerial position {*supervisory*}, region {*Serbia-North*, *Serbia-South*}, the urbanization degree {*densely*, *intermediate*, *thinly populated area*}, size of the company {*micro*, *small*, *medium and large*}, type of the ownership {*private*}, macro sector of economic activity {*agriculture*, *manufacturing & construction*, *services*}, previous status on the labour market, i.e., if the person was unemployed before getting the present job {*unemployed*}, health status {*poor health*} and gender {*female*}) as factors which explain worker's wages. The coefficient of the female dummy in the wage model (4) includes the difference between the potential wages of men and women, which may indicate the existence of a wage gap. This coefficient has a negative sign and its statistical significance can be determined. Expression (4) has the form of an additive model. Multiplicative effects of the employment sector on potential women's wages are calculated based on two additional terms in the expanded earnings equation. The interactions between a female dummy and macro sectors of economic activity are included in the wage model by the terms *manufacturing & construction x female* and *services x female*. A negative sign of the estimates indicates the potential sectoral gender wage gap. However, these results are not reported in the paper. Table A1 contains the definitions of the variables used in the econometric modelling.

In the empirical model of the dependent variable *lnwage* [$m_1=5.448$, $\sigma_1=0.440$, $m_2=5.550$, $\sigma_2=0.420$], mean (*m*) and standard deviation (for continuous variables only) (σ) of independent variables for a subsample of employed men are as follows, where indices 1 and 2 indicate corresponding year 2019 and 2020: [*working hours*, $m_1=185.99$, $\sigma_1=28.24$, $m_2=182.35$, $\sigma_2=25.56$]; [*age*, $m_1=41.28$, $\sigma_1=11.78$, $m_2=41.29$, $\sigma_2=11.90$]; [*agesq*, $m_1=1842.57$, $\sigma_1=985.89$, $m_2=1846.69$, $\sigma_2=993.21$]; [*experience*, $m_1=17.15$, $\sigma_1=11.42$, $m_2=17.00$, $\sigma_2=11.39$]; [*expersq*, $m_1=424.64$, $\sigma_1=446.96$, $m_2=418.54$, $\sigma_2=443.04$]; [*low=excl.*, $m_1=0.085$, $m_2=0.081$; *medium=1*, $m_1=0.757$, $m_2=0.757$; *high=1*, $m_1=0.158$, $m_2=0.161$]; [*married=1*, $m_1=0.615$, $m_2=0.605$]; [*children=1*, $m_1=0.228$, $m_2=0.219$]; [*permanent=1*, $m_1=0.793$, $m_2=0.807$]; [*supervisory=1*, $m_1=0.160$, $m_2=0.149$]; [*Serbia-North=1*, $m_1=0.451$, $m_2=0.445$]; [*thinly populated area=excl.*, $m_1=0.290$, $m_2=0.290$; *intermediate populated area=1*, $m_1=0.284$, $m_2=0.289$; *densely populated area=1*, $m_1=0.426$, $m_2=0.420$]; [*micro=excl.*, $m_1=0.292$, $m_2=0.298$; *small=1*, $m_1=0.464$, $m_2=0.497$; *medium and large=1*, $m_1=0.244$, $m_2=0.203$]; [*private=1*, $m_1=n/a$, $m_2=0.656$]; [*agriculture=excl.*, $m_1=0.021$, $m_2=0.019$; *manufacturing & construction=1*, $m_1=0.036$, $m_2=0.039$; *services=1*, $m_1=0.943$, $m_2=0.938$]; [*unemployed=1*, $m_1=0.076$, $m_2=0.050$]; [*poor health=1*, $m_1=0.024$, $m_2=0.018$]; [*male=1*, $m_1=0.550$, $m_2=0.548$].

Descriptive statistics for a subsample of employed women, where indices 1 and 2 indicate corresponding year 2019 and 2020, include: *lnwage* [$m_1=5.351$, $\sigma_1=0.435$, $m_2=5.466$, $\sigma_2=0.391$]; [*working hours*, $m_1=178.81$, $\sigma_1=24.14$, $m_2=176.86$, $\sigma_2=22.38$]; [*age*, $m_1=41.31$, $\sigma_1=10.75$, $m_2=41.54$, $\sigma_2=10.97$]; [*agesq*, $m_1=1822.00$, $\sigma_1=891.82$, $m_2=1846.42$, $\sigma_2=911.03$]; [*experience*, $m_1=15.18$, $\sigma_1=10.59$, $m_2=15.27$, $\sigma_2=10.70$]; [*expersq*, $m_1=342.55$, $\sigma_1=382.99$, $m_2=347.80$, $\sigma_2=388.53$]; [*low=excl.*, $m_1=0.068$, $m_2=0.067$; *medium=1*, $m_1=0.678$, $m_2=0.691$; *high=1*, $m_1=0.254$, $m_2=0.241$]; [*married=1*, $m_1=0.673$, $m_2=0.672$]; [*children=1*, $m_1=0.231$, $m_2=0.229$]; [*permanent=1*, $m_1=0.820$, $m_2=0.796$]; [*supervisory=1*, $m_1=0.130$, $m_2=0.135$]; [*Serbia-North=1*, $m_1=0.480$, $m_2=0.463$]; [*thinly populated area=excl.*, $m_1=0.370$, $m_2=0.339$; *intermediate populated area=1*, $m_1=0.302$, $m_2=0.301$; *densely populated area=1*, $m_1=0.327$, $m_2=0.359$]; [*micro=excl.*, $m_1=0.365$, $m_2=0.361$; *small=1*, $m_1=0.400$, $m_2=0.441$; *medium and large=1*, $m_1=0.235$, $m_2=0.198$]; [*private=1*, $m_1=n/a$, $m_2=0.610$]; [*agriculture=excl.*, $m_1=0.011$, $m_2=0.011$; *manufacturing & construction=1*, $m_1=0.004$, $m_2=0.009$; *services=1*, $m_1=0.985$, $m_2=0.977$]; [*unemployed=1*, $m_1=0.065$, $m_2=0.060$]; [*poor health=1*, $m_1=0.022$, $m_2=0.020$]; [*female=1*, $m_1=0.450$, $m_2=0.452$].

4. Results

The results of testing for the presence of multicollinearity of the regressors in the empirical model (3) are presented in Table 1. Two standard methods of multicollinearity diagnosis are used, including variance inflation factor (VIF) analysis and tolerance measures. As explained in the methodology section, the empirical model of wage determination includes human capital factors, other factors explaining the household situation, and working conditions. The former consists of the worker’s age (in years), actual work experience (in years), and educational attainment (three binary variables are extracted from a categorical variable, with low educational attainment being an excluded category). As human capital accumulation increases over the life course, these variables are expected to exhibit some degree of interdependence. As shown in Table 1, these variables have the highest VIF values (between 3 and 5) and the lowest values of the tolerance measure (the reciprocal value of VIF) for possible multicollinearity detection. However, since all the values of VIF are below 10 it is safe to conclude that the assumption of no or little multicollinearity is not violated (Thompson et al., 2017). The average VIF values for 2019 and 2020 data are 1.95 and 1.91, respectively (presented in the bottom row of Table 1) far below the more conservative cut score of 3.

Table 1: Results of testing for multicollinearity

Variable	2019 (Before COVID-19)		2020 (During COVID-19)	
	VIF	Tolerance (1/VIF)	VIF	Tolerance (1/VIF)
Age	4.80	0.208	4.63	0.216
Experience	4.74	0.211	4.61	0.217
Medium education	2.99	0.334	3.08	0.325
High education	3.19	0.314	3.37	0.297
Married	1.34	0.747	1.36	0.735
Children of preschool age	1.18	0.849	1.19	0.842
Permanent contract	1.23	0.813	1.16	0.859
Managerial position	1.11	0.903	1.11	0.901
Health status poor	1.02	0.978	1.04	0.965
Serbia-North	1.07	0.934	1.08	0.923
Intermediate populated area	1.37	0.728	1.39	0.717
Densely populated area	1.49	0.669	1.53	0.652
Small-sized	1.35	0.740	1.32	0.758
Medium and large-sized	1.34	0.745	1.32	0.759
Private ownership	1.20	0.832
Manufacturing & construction	2.28	0.439	2.38	0.419
Services	2.30	0.435	2.38	0.420
Previously unemployed	1.17	0.853	1.12	0.891
Female	1.09	0.919	1.07	0.935
Mean VIF	1.95		1.91	

Note: The Survey data for 2019 do not include the variable of ownership disaggregation.

Source: The author, based on the Serbian Survey on Income and Living Conditions for 2019 and 2020 (The Statistical Office of the Republic of Serbia, 2022; The Statistical Office of the Republic of Serbia, 2021a).

The results of estimation are provided in Table 2. The first regression gives the estimates of the wage model estimated using the 2019 SILC data. The second regression additionally estimates the wage model taking the 2020 SILC data. The variables of human capital accumulation are statistically significant factors of wage determination. Working experience forms a concave relationship with wages showing that the more experience a worker has, the higher the salary. The level of educational attainment has a positive, statistically significant impact on wages. Compared to those with low degree of education, employees with secondary education may expect, on average, 0.110 (2019) and 0.081 (2020) higher potential log wages, while the effect of tertiary education is higher, given that every other variable held at the same rate. On the other hand, the presence of a spouse or partner and dependent children has a positive but statistically insignificant impact on wages.

The supervisory position generates a positive and statistically significant effect on potential wages, similarly as a permanent employment variable, but the estimate is not statistically significant. Larger companies provide higher wages (micro firms are an excluded category). However, privately owned companies, on average, offer lower wages than those in the public sector. The effect of the region is positive and statistically

significant. Workers employed with the companies in the northern part of the country may expect higher potential wages than those in the southern regions. On the other hand, the degree of urbanization has a low and negative impact on potential wages; the estimate of the densely populated area is statistically significant at the 90% level (the thinly populated area is the excluded category). Poor health is expected to have a negative impact on the wages of employees (reduces potential log wages on average by 0.096 and 0.117). The influence of this factor is under increased scrutiny due to the current pandemic. If the person was unemployed immediately before getting the present job, this would have a negative impact on potential log wages (decreasing rates of -0.020 and -0.005 are estimated). However, the effect is low, and it is not statistically significant. This is probably because the labour market slack results from increased inactivity.

Table 2: Regression model ML estimates for 2019 and 2020, dependent variable lnwage

Variable	2019 (Before COVID-19) Regression 1		2020 (During COVID-19) Regression 2	
	Coefficient	Standard error	Coefficient	Standard error
Age	-0.002	0.005	0.006	0.005
Age ^ 2	-0.000	0.000	-0.000*	0.000
Experience	0.016***	0.003	0.008**	0.002
Experience ^ 2	-0.000**	0.000	-0.000	0.000
Medium education	0.110***	0.022	0.081***	0.021
College & university education	0.507***	0.025	0.294***	0.027
Marital status	0.0001	0.140	0.007	0.013
Children of preschool age	-0.012	0.015	0.010	0.014
Permanent contract	0.055***	0.016	0.023	0.015
Managerial position	0.201	0.017	0.172***	0.016
Health status poor	-0.096**	0.038	-0.117***	0.039
Serbia-North	0.107***	0.012	0.125***	0.011
Intermediate populated area	-0.038**	0.015	-0.030*	0.013
Densely populated area	-0.054***	0.014	-0.024	0.013
Small-sized	0.109***	0.013	0.100***	0.012
Medium and large-sized	0.115***	0.015	0.133***	0.015
Private ownership	n/a	n/a	-0.107***	0.012
Manufacturing & construction	0.540***	0.059	0.361***	0.051
Services	0.168***	0.045	0.129***	0.039
Previously unemployed	-0.020	0.024	-0.005	0.022
Female	-0.109***	0.012	-0.098***	0.011
Intercept	4.915***	0.117	5.223***	0.097
Log-Likelihood	-1716.790		-1385.695	
μ	0.226***	0.059	0.236***	0.023
No. of observations	4,156		4,168	

Notes: ***, ** and * represent significance at 99.9%, 99% and 95%, respectively.

Source: The author, based on the Serbian Survey on Income and Living Conditions for 2019 and 2020 (The Statistical Office of the Republic of Serbia, 2022; The Statistical Office of the Republic of Serbia, 2021a).

Controlled for the observed factors in the experiment, there is still a significant gender wage gap in both years 2019 (0.109) and 2020 (0.098), as shown by a coefficient of a female dummy (the estimates are statistically significant at a 99.9% level). Macro sectors, manufacturing, construction, and services generate higher potential wages than the excluded sector of agriculture.

The hypothesis was tested that the estimates of the female variables obtained based on the estimation of two regressions from independent samples are equal. The z-test was adjusted according to Paternoster et al. (1998), and the test results are shown in Table 3. The second regression, based on data collected during the COVID-19 crisis, was re-estimated without the variable representing the ownership sector in order to equalize the set of variables in the two regressions. The estimate of the female variable from this regression is shown in Table 3. The comparison of the coefficient values shows that the wage gap narrowed slightly during the recent crisis, although this difference is not statistically significant. In other words, it can be concluded that the social effect of the crisis has led to the current convergence of average wages for men and women, if all other attributes remain the same in both regression models.

Table 3 : Testing the difference in coefficients from two independent regressions

Regression	Estimate ($ \widehat{\beta}_{21} $)	Difference	Squared standard errors	z -test statistics
Before COVID-19	0.109***		0.00014	
During COVID-19	0.099***	0.0100	0.00013	0.59492

Notes: *** represents significance at 99.9%.

Source: The author, based on the Serbian Survey on Income and Living Conditions for 2019 and 2020 (The Statistical Office of the Republic of Serbia, 2022; The Statistical Office of the Republic of Serbia, 2021a).

The distributional assumptions of the stochastic frontier model are tested using the generalized one-sided likelihood ratio (LR) test. If H_0 is true (e.g., inefficiency term equals zero), this model becomes reduced to a traditional linear regression model. Empirical values of the LR test statistics for the regression models for 2019 (132.32) and 2020 (86.619), imply that H_0 of no inefficiency component cannot be proven. Hence, the stochastic frontier model estimates in Table 2 are consistent and asymptotically efficient.

5. Discussion

Because the Serbian labour market is characterized by a relatively high unemployment and inactivity rates, uncertainties caused by the prolonged effects of the current pandemic may lead to job search inefficiencies being stuck at a certain level. Conducting similar analysis on the data from the post-COVID-19 era would enable a more realistic evaluation of efficiency in the job search process. Labour market analyses based on real-time data during the COVID-19 crisis further support these conclusions (Ognjenovic, 2021b; SeCons, 2020). Tomic (2014), for example, applied stochastic frontier methodology in evaluating the matching process on regional labour markets in Croatia before the pandemic. The author found that matching efficiency largely depends on active labour market policies, and that fluctuations in labour demand may also affect the matching efficiency. On the other hand, Roy-Mukherjee and Udeogu (2021) found the institutional framework, economic complexity and the density of labour unionization in the Balkan countries as the factors that negatively affect income inequalities. Consequently, these factors may also reduce labour market inequalities in the countries with low gender equity.

The efficiency of an employee in achieving the potential wage differs slightly between men and women. For all employees, the actual and potential wage ratio ranges between 85.4% and 85.8% (the efficiency scores are estimated using the regression models presented in Table 2). A ratio between women’s actual and potential wages ranges from 86.1% (2019) to 86.5% (2020). On the other hand, the mean wage efficiency for men is ranged from 84.8% to 85.2%, depending on the estimated wage model. Since the statistical significance of the estimate of the dummy variable female was confirmed, its negative value points to the possible presence of a gender difference in wages. This result confirmed the initial hypothesis of this research. As an illustration, the survey data for 2020 show that employed men have more work experience (17.00 vs. 15.27 years), while women have a better educational structure (24.1% vs. 16.1% with high and 6.7% vs. 8.1% with low education, respectively). These results are comparable to previous findings. The Structure of Earnings Survey, conducted before the COVID-19 pandemic, indicated the existence of the unadjusted gender wage gap in the interval from 8.7% to 9.6% (Eurostat, 2020). Wages from both full-time and part-time jobs are included. Using the regression analysis, Blunch (2018) and Ognjenovic (2021a) provide evidence of the gender wage gap in Serbia of 14.4% and 6%, respectively, depending on the observed factors included in the experiments. The analysis presented in this paper does not deal with all aspects of gender differences in paid work, and in particular it does not deal with differences in unpaid work. COVID-19-related crisis has influenced changes in the gender gap. Therefore, a statistically significant gender wage gap was identified in both years, however, the crisis acted in the direction towards a slight narrowing of the pay gap (showing the difference of 0.011 log points). A test carried out showed that this difference was not statistically significant. Farcnik and Istenic (2022) analysed the Slovenian labour market and found different effects of COVID-19 on the gender gap in paid and unpaid work – the former widened while the latter narrowed during the crisis providing the inputs for policies that support work-life balance practices.

Economic sectors such as agriculture, manufacturing, and construction, favour the male workforce. At the same time, services provide a largest number of jobs for both men and women, with the share of employed women in this sector being 3.9 percentage points larger. Women employed in the manufacturing and con-

struction sectors in Serbia earn only three-fifths of men's average potential log wage. The additional analysis indicated that the gender wage gap in the services sector was lower in 2019 (-0.074) than in 2020 (-0.099) (although this difference in wages is not statistically significant). However, the structure of sectoral employment, especially with a higher share of employed women, is negatively correlated with the gender wage gap. As this analysis confirmed, mean wage efficiency is higher for women (86.2%) than for men (84.8%) employed in the services sector in 2020. In 2019, mean wage efficiency was larger for both genders - 89.4% (men) vs. 89.1% (women). In the EU, for example, the existing gender wage gaps may be explained by the ownership structure of the companies and the share of women employed in economic sectors (Hedija, 2017).

It is also possible to find studies that show that women are less represented in senior managerial roles in the public sector organizations in European countries (Eydis Gudmundsdottir et al., 2021). These findings do not differ substantially among the countries. As the results for Serbia show, a supervisory position positively affects the average wage further implying that the representation of women in those positions can lead to narrowing of the gender wage differential contributing to the promotion of equal pay policies.

Conclusion

Since it was thought that the transition to a market economy would affect women's lower status on the labour market and bigger gender discrepancies in pay, the gender wage gap was even more of an issue in Central and Eastern European countries. However, not one conclusion has been reached as a result of empirical study. In certain nations, the relative position of women has improved due to structural changes that came about as a result of privatization and the opening up of economies, in addition to the market discouraging discriminatory behaviour. Gender gaps in earnings are entrenched in both post-transitional and old European countries, notwithstanding a tendency of wage convergence brought about by the improved observed features of women (e.g., Ognjenovic, 2021a; Blunch, 2018; Olivetti & Petrongolo, 2016). Accordingly, a larger share of women employees through economic or ownership sectors, occupational partition, or the altered structure of the female labour force as a result of the dropout of low-skilled women are all explanations for the gender differences in wages (e.g., Kaya, 2023; Garcia-Prieto & Gomez-Costilla, 2017; Hedija, 2017; Blau & Kahn, 1996). Compliance with the *acquis communautaire* and full implementation of laws that forbid discrimination and stop the worsening of gender disparities in the workplace are expected of nations aspiring to join the EU, including Serbia and other Balkan countries outside the Union. However, women in the EU continue to fight for greater representation in decision-making positions (Kresal, 2021). Differences in income between men and women are also reflected in other financial indicators such as the gap in economic dependency, which is particularly important for (European) societies with an ageing population (Istemic et al., 2018).

Understanding the extent and structure of the gender wage gap and the potential impact of discrimination in determining women's wages is critical, as it can negatively impact the economic well-being of working women and their career advancement, as well as women's decision to pursue employment. In order to determine with certainty whether discrimination exists, the causality between wages and the factors that determine them must be proven. Such an approach requires additional analysis, which is necessary for further research on this important topic. Situations caused by COVID-19 can further worsen the position of already vulnerable groups in the labour market, on one hand, and create room for the growth of sectors and occupations that are resistant to foreclosure measures due to technological change, on the other.

The results of this study indicate that the gender wage gap persists even in a situation where the labour market is "at rest". This is due to both COVID-19-related crisis and government policies aimed at maintaining employment at a stable level. There are sectors of the economy where there is a larger wage gap due to the higher proportion of male workers, which affects gender wage inequality overall. The situation triggered by the pandemic was unique because financial measures were aimed at maintaining employment mainly in the private sector, which offers lower wages on average. This is also reflected in an increase in the share of low-wage workers, especially women, so the actual wage distribution may also be skewed. This analysis has shown that women almost reach their wage potential when observable factors are controlled for. The existence of a gender wage gap is an indicator of the importance of the unexplained portion, which may be partly influenced by gender discrimination, as has been found in numerous empirical studies.

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Note: The author dedicates this work to her cat Mićko (2007-2022).

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About the Author

Kosovka Ognjenović

Institute of Economic Sciences, Welfare Economics Department, Serbia
 kosovka.ognjenovic@ien.bg.ac.rs



Kosovka Ognjenović is a research associate at the Institute of Economic Sciences, where she has been working for more than twelve years. She holds a PhD in economics from the University of Belgrade. Her area of expertise is labour economics, with a particular focus on labour market imbalances, gender gaps and in-work poverty.

In her recent research articles, Dr Ognjenović analyses gender wage gaps, the impact assessment of employment policies and the propensity of young people to entrepreneurship. She is an active member of several scientific associations of economists.

Appendix
Table A1: Variable definition

Variable	Description	Source
Log of wages	Natural log of hourly net wages in the main job	SILC
Age	Age in years	SILC
Experience	Working experience in years	SILC
Without & low education	ISCED code 0 – 1, excluded category	SILC
Medium education	Dummy, ISCED code 2 – 4=1, otherwise 0	SILC
College & university education	Dummy, ISCED code 5 – 8=1, otherwise 0	SILC
Marital status	Dummy, married=1, otherwise 0	SILC
Children of preschool age	Dummy, presence of children of preschool age in the household=1, otherwise 0	SILC
Permanent contract	Dummy, permanent employment=1, otherwise 0	SILC
Managerial position	Dummy, supervisory position=1, otherwise 0	SILC
Health status poor	Dummy, general health conditions poor=1, otherwise 0	SILC
Serbia-North	Dummy, Region of Serbia-North=1, otherwise 0	SILC
Thinly populated area	Degree of urbanization, thinly populated area, excluded category	SILC
Intermediate populated area	Dummy, intermediate populated area=1, otherwise 0	SILC
Densely populated area	Dummy, densely populated area=1, otherwise 0	SILC
Micro	Company size, micro, excluded category	SILC
Small-sized	Dummy, small-sized =1, otherwise 0	SILC
Medium and large-sized	Dummy, medium and large -sized=1, otherwise 0	SILC
Private ownership	Dummy, privately owned companies=1, otherwise 0	SILC
Agriculture	Economic sector, NACE Rev. 2 code A, excluded category	SILC
Manufacturing & construction	Dummy, NACE Rev. 2 code B-E=1, otherwise 0	SILC
Services	Dummy, services sector=1, otherwise 0	SILC
Previously unemployed	Dummy, previous labour market status, if unemployed=1, otherwise 0	SILC
Female	Dummy, female=1, male=0	SILC

Source: The author, based on the Serbian Survey on Income and Living Conditions for 2019 and 2020 (Statistical Office of the Republic of Serbia, 2022; Statistical Office of the Republic of Serbia, 2021a).