# USING THE STOCHASTIC FRONTIER APPROACH TO DETERMINE THE GENDER WAGE GAP AND LABOUR MARKET EFFICIENCY

**Kosovka Ognjenović**
Institute of Economic Sciences
12 Zmaj Jovina, 11000 Belgrade, Serbia
E-mail: kosovka.ognjenovic@ien.bg.ac.rs

**Abstract:** This paper analyzes the gender wage gap, as this issue has been insufficiently studied in the labor market of the Republic of Serbia. Using data from a panel study derived from a survey on income and living conditions, the paper examines whether the crisis caused by the COVID-19 pandemic has affected the extent of the wage gap in the Republic of Serbia. The paper employs the stochastic frontier model, which is used to determine the discrepancy between men's and women's wages and the differences in efficiency in the labor market. The results of applying this approach confirmed that there is a statistically significant difference between men's and women's wages and that participants in the labor market differ in their efficiency, which is measured by the difference between realized and potential wages of workers.

**Keywords:** gender wage gap, potential wage, Serbia, stochastic frontier, survey data.

## 1 INTRODUCTION

The extent and structure of gender differences in wages are observed considering paid work at the main job. The analysis of this practice is important for every society because it can have wider economic and social consequences on the formation of the total labor supply. In post-transition European countries, the issue of gender differences in wages becomes even more significant because it was assumed that the transition to a market affects the worse position of women in the labor market, and, thus deepening of gender differences in wages. However, the results of empirical studies do not lead to a single conclusion and differ from country to country [13, 14]. In most post-transition countries, the economic position of women was worse during the first years of transition. Thereafter, the relative position of women improved, not only because the market prevented discriminatory behaviour, but also because of the structural change that accompanied privatization and the opening of economies. Although there is a general trend toward wage convergence due to women's improved characteristics, the gender wage gap remains deeply rooted [5, 6, 10].

Numerous studies dealing with this problem present results showing that the gender wage gap is due to the greater participation of women in certain economic and property sectors, educational segregation, segregation by occupation with less access to high-paying occupations, which, combined with greater income inequality due to more difficult access to top positions, leads to a deepening of the wage gap [2, 4, 9]. On the other hand, the low participation of women with worse human capital attributes in the labour market leads to a narrowing of the wage gap, reflecting an unrealistic situation.

Therefore, the research presented in this paper aims to show how big the gender gap in wages was during the pandemic caused by the COVID-19 crisis. Basic indicators of the labor market indicated slight movements in the labor force, which led to imbalances. The experiences of European countries with the impact of the COVID-19 pandemic on the labor market are different. In the most developed European economy, imbalances in the labor market that arose under the influence of the pandemic, viewed through the prism of working conditions, are not the most important factor explaining the subjective feeling of differences in well-being among women [15]. Studies dealing with the impact of government measures on monetary poverty and income inequality have confirmed their effectiveness [1]. On the other hand, studies that dealt with the impact of COVID-19 on the position of women in the family indicated a

deepening of gender differences regarding unpaid care of dependent persons, such as children, the elderly, and helpless persons [7, 11]. Those studies confirmed that COVID-19 had an additional impact on existing labor market gaps.

## 2 METHODOLOGY

The stochastic frontier model is applied in estimating the discrepancy between men's and women's wages. This approach is recently used in [3] to establish the empirical relationship between wage determination and the potential impact of market discrimination in European countries. The stochastic frontier approach enables market discrimination to be embedded in a female dummy included in the model of realized wages. Model (1) represents the wage frontier:

$$\ln (wage)_{it} = c + aHCC_{it} + bJRC_{it} + e_{it} - u_i \quad (1)$$

The dependent variable measures hourly net wages from the main job transformed using the natural logarithm, while human capital characteristics (HCC) and job-related characteristics (JRC) are a set of explanatory variables included in the wage model (1) following the theoretical constructs. This part of the model (1) is a mathematical representation of the realized wages, with the first error component $e_{it}$ being a random disturbance term. The second term $-u_i$ is an inefficiency component and, in the empirical model (1), represents the discrepancy between the realized and potential market wages. Each of these error components has a different distributional assumption. Based on the distribution of the composite error term [8] showed that the maximum likelihood (ML) is a consistent estimator of the stochastic frontier model (1).

To perform the empirical exercise, a pooled sample of individuals who were employed over 2019-2020 and self-reported positive wages and hours worked were included in (1). The data come from the Serbian Survey on Income and Living Conditions for 2019-2020 [12].

## 3 RESULTS AND DISCUSSION

Table 1 reports the ML estimates of the stochastic frontier model for wage earners in Serbia. Both individual attributes and job-related characteristics, including those that characterize the employer, are employed in the empirical model estimation. This approach identifies the potential market wage an employee may earn given the attributes mentioned (human capital, job- and employer-related). The difference between the realized and the potential wage measures the inefficiency an employee meets to achieve full market earnings. The estimates of the characteristics in the stochastic frontier model explain employee inefficiency in achieving potential earnings. Since the labor market in Serbia is characterized by persistent differences in wages of men and women, it was of particular interest to investigate whether this difference was significant during the COVID-19 pandemic. Results reported in Table 1 (Model 1, the left-hand side panel) show that being a woman statistically significantly reduces earnings potential in the Serbian labour market given the same attributes as men. Statistical interpretation of this finding is that employed women have a log hourly net wage lower by 0.11 compared to men, given all other characteristics held at the same level. This result leads to the conclusion that there is gender wage discrimination in the Serbian labor market.

The obstacle for women to achieve total market wages is reflected in the negative impact of health conditions, regional dislocation of jobs observed through the level of urbanization, the private sector ownership, and the associations with particular sectors and occupations. These characteristics reduce women's earnings, i.e., increase the wage disparity between men and women. The fact that women have better educational attainment and somewhat less work experience is insufficient to reconcile the observed wage differences.

A parsimonious stochastic frontier model is estimated on a sample of those who made the transition in the labor market, moving from the status of unemployed to the status of an employed person. Selected variables are included (unreported job-related characteristics significantly reduce the initial sample). Results in Table 1 (Model 2, the right-hand side panel) show that women employed during the pandemic may expect log wages lower by 0.09 compared to men.

*Table 1*: ML Estimates of the Wage Model
(Dependent variable log hourly net wage)

| ***Variable*** | ***Model 1*** | | | ***Model 2*** | | |
|---|---|---|---|---|---|---|
| | ***Estimate*** | | | ***Estimate*** | | |
| | *Coeffi-cient* | *95% $CI_{lower}$* | *95% $CI_{upper}$* | *Coeffi-cient* | *95% $CI_{lower}$* | *95% $CI_{upper}$* |
| ***Age*** | 0.02 | 0.00 | 0.03 | 0.01 | -0.02 | 0.04 |
| ***Age squared*** | -0.00 | -0.00 | -0.00 | -0.00 | -0.00 | 0.00 |
| ***Experience*** | 0.01 | 0.00 | 0.01 | 0.00 | -0.01 | 0.02 |
| ***Experience squared*** | 0.00 | -0.00 | 0.00 | -0.00 | -0.00 | 0.00 |
| ***Medium education*** | 0.09 | 0.04 | 0.14 | 0.07 | -0.06 | 0.19 |
| ***High education*** | 0.34 | 0.27 | 0.40 | 0.40 | 0.24 | 0.56 |
| ***Married*** | 0.00 | -0.03 | 0.03 | | | |
| ***Permanent employment*** | 0.03 | -0.01 | 0.06 | | | |
| ***Responsibility*** | 0.17 | 0.13 | 0.21 | | | |
| ***Health status*** | -0.12 | -0.22 | -0.02 | | | |
| ***Region*** | 0.15 | 0.13 | 0.18 | | | |
| ***Degree of urbanization (intermediate)*** | -0.00 | -0.03 | 0.03 | | | |
| ***Degree of urbanization (densely)*** | -0.00 | -0.04 | 0.03 | | | |
| ***Small enterprise*** | 0.09 | 0.06 | 0.12 | | | |
| ***Medium and large enterprise*** | 0.12 | 0.08 | 0.16 | | | |
| ***Privately owned*** | -0.12 | -0.15 | -0.09 | | | |
| ***Female*** | -0.11 | -0.14 | -0.09 | -0.09 | -0.17 | -0.00 |
| ***Intercept*** | 5.10 | 4.83 | 5.37 | 5.01 | 4.47 | 5.55 |
| ***Model fit statistics*** | | | | | | |
| ***No. of obs.*** | 2,840 | | | 432 | | |
| ***LL*** | -998.47 | | | -172.32 | | |
| $\mu$ | -1.99 | | | -1.19 | | |
| $\chi^2(k)$ | 1495.62 | | | 38.31 | | |

*Note*: Sectoral and occupational dummies are included. Model 1 includes k=22, and model 2 k=7 (k=variable).
*Source*: Author based on SILC 2019-2020 data.

## 4 CONCLUSION

In this paper, the stochastic frontier model is used to determine the discrepancy between men's and women's wages and the differences in efficiency in achieving total market wages. The results of applying this approach confirmed a statistically significant difference between men's and women's wages and that participants in the labor market differ in their efficiency, which is measured by the difference between realized and potential wages of workers. These results have implications for public policies, not only in the domain of social policy affairs but the overall vulnerability of women in the labor market.

**Acknowledgement**
The research presented in this paper was funded by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia under contract number 451-03-47/2023-01/200005.

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