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Estimating effect of marriage on male wages in Russia

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Abstract

Purpose – Purpose of the article is to investigate the effect of marriage on male wages in Russia. The paper provides insight about contribution of observed and unobserved factors to wages of Russian men regarding their marital status.

Design/methodology/approach – Database is the Russian Longitudinal Monitoring Survey (RLMS) for 2016. We add to the literature by introducing Generalized Oaxaca–Blinder Decomposition of the difference in mean wages of married and unmarried men. This generalization is free of conditional mean independence assumption.

Findings – We reveal negative observed price effect and substantial positive effect of changes in unobserved characteristics of married and unmarried men in Russia.

Originality/value – To our knowledge, our study is the first one that gives estimation of the volume and structure of the male marriage wage premium in Russia. The proposed approach is applicable for estimating labor market premiums and penalties for various individual characteristics.

Keywords Marriage premium, Wages, Switching regression, Endogeneity, Oaxaca–Blinder decomposition, Russia

Paper type Research paper

1. Introduction

It has long been observed that, on average, married men receive higher wages than unmarried men. Male marriage wage premium finds empirical evidence for different countries, such as the United States, Great Britain, Australia, China, Vietnam, Norway and Finland (Birch and Miller, 2006). However, the mechanisms underlying this phenomenon are the subject of discussion (Aswin and Isupova, 2014). The authors identify three possible reasons to explain the excess of the wages of married men over the wages of unmarried men: selection effect, specialization effect and discrimination. Selection effect assumes that both success in marriage and the labor market are related to the same characteristics of men. A complete set of such characteristics is extremely difficult to form. The authors suggest cognitive skills, self-esteem, conscientiousness, diligence, compliance and profession of parents. There is also the problem of omitted variables (Aswin and Isupova, 2014). Petersen *et al.* (2011) use matched employer-employee data for Norway from 1979 to 1996 and reveal that 80% of male marriage wage premium refers to the selection effect. However, it is difficult to separate one effect from another.

Specialization effect assumes that there is a distribution of household duties within the family. A woman does housework, and it frees man's time. As a result, the productivity of men in the labor market increases. This hypothesis originates from the article of Becker (1981). As a factor of the specialization of labor within the household, researchers use hours of housework for men. Spending less time for housework contributes to higher productivity and, as a result, higher wages. Sociologists believe that marriage involves more responsible

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decision-making, which helps man become the more productive worker (Fahrney, 2010). Empirical studies both support and reject specialization hypothesis (Aswin and Isupova, 2014). Bardasi and Taylor (2008) support specialization hypothesis for Great Britain on panel data from 1991 to 2003. Mamun (2012) analyzes the US data and supports the view that marriage increases the productivity of men. Ahituv and Lerman (2007) find that marriage quickly increases labor hours of men. At the same time, a higher wage rate and more hours of labor encourage men to marry and stay married. Thus, the presence of marriage and high incomes strengthen each other over time. Loh (1996) investigate the National Longitudinal Survey of Youth for the US and find that "labor productivity differences between married and never-married men are unlikely to be the cause of the marriage premium" (Loh, 1996, p. 566). Hersch and Stratton (2000) investigate data of the National Survey of Families and Households for the US and do not confirm that specialization can explain the existence of male marriage wage premium. Pollmann-Schult (2011) analyzes the German Socio-Economic Panel and finds that "men do not substantially reduce their housework time following marriage; neither does the housework time significantly affect the wage rate" (Pollmann-Schult, 2011, p. 147).

Discrimination effect means that the employer discriminates unmarried men in relation to married men. However, this hypothesis finds little empirical evidence (Peterson *et al.*, 2011). Along with the above-mentioned, the authors put forward other reasons that explain the excess of the wages of married men over the wages of the unmarried. For example, Gupta *et al.* (2007) suggest that married men can appreciate wages above all other job characteristics. Men can put income as a top priority, and it results in higher wages. Rodgers and Stratton (2010) suggest that married men are more involved in training provided by the employer. Married men are more motivated because of higher financial responsibility to the family. Employers perceive them as more stable employees than unmarried men and demonstrate greater willingness to help them. As a result, married men have higher wages. Aswin and Isupova (2014) pay attention to cultural characteristics of the population. Authors consider Russia and conclude that the traditional role of women is housekeeping and childcare while men is a breadwinner in a family. The higher wages of married men can be explained by monitoring and pressure from their wives.

In addition to analyzing reasons for the existence of male marriage wage premium, a very important issue is the estimation of the premium. It is difficult to find a reliable method to answer the question about the existence of this premium and about its value. An important problem in such studies is the selection bias which might originate from sample-selection or self-selection (endogeneity). The problem of decomposition in sample-selection models is considered by Lee (2017). Most of research studies deal with panel data and try to account for endogeneity. Sobel (2012) answers the question whether marriage really increases the wages of men by estimating the treatment effect in fixed effects regression model. He writes that "most researchers, beginning with Cohen and Haberfeld (1991) and Korenman and Neumark (1991), have used panel data, comparing coefficients for marital status variables in pooled cross-sectional regressions that adjust for measured time-varying and time-invariant (baseline) confounders to analogous coefficients in fixed effects regressions that also adjust for unobserved baseline confounders" (Sobel, 2012, p. 521). Titus (2007) shows how propensity score matching allows for a decomposition of treatment effects on outcomes. Pollmann-Schult (2011) finds that married men enjoy a wage premium even after controlling for self-selection into marriage. The author estimates fixed effect regression model with "lagged levels and lagged differences of the possibly endogenous regressor as instruments in a first difference model in order to test for endogeneity" (Pollmann-Schult, 2011, p. 153). It is important to note that both direct and reverse causal relationships are possible here. Married men are more likely to have higher wages and men with higher wages are more likely to get married and possibly remain married (Grossbard-Shechtman and Neuman, 2003; Bonilla and

Kiraly, 2013). Bonilla *et al.* (2019) showed that "labor market decisions and outcomes (including various types of wage premia) may be influenced by expectations and behavior in the marriage market, and vice versa" (Bonilla *et al.* (2019, p. 851).

In our article, we estimate the effect of marriage on male wages in Russia. We extend existing studies by eliminating the assumption of independence of random errors in the equations of marriage and wages. The variable for marital status is endogenous, since both marriage and wage might depend on the same unobserved characteristics of men such as responsibility and attractiveness. We show that ignoring the fact of the endogeneity of marriage leads to the substantial bias of estimates. Results are helpful for planning social support programs.

2. Descriptive analysis

To investigate the effect of marriage on male wages in Russia we use Russian Longitudinal Monitoring Survey (RLMS) for 2016. This is the large-scale survey of the Russian population conducted on an annual basis. This survey is a representative on the socio-demographic structure of the population. It contains necessary questions about incomes and employment of men. The survey is conducted on the territory of different regions of Russia, including Moscow and St. Petersburg, large and small settlements, but this survey is not a representative of the regions of Russia.

Table 1 presents descriptive statistics for subsamples of married men (1,880 observations) and unmarried men (706 observations).

Table 1 shows that, on average, married men are older than unmarried men by 3.7 years. In our study, we are interested in men of working age. Therefore, we limit the minimum age to 25 years, when, on average, all young people are already completing studies in vocational and higher education institutions and entering the labor market. The maximum age is limited to 60 years, which is the retirement age for men in Russia.

In our sample, the average wage of married men is higher than the average wage of unmarried men by about 15% (by 4,431 rubles). Quartiles of the distribution of wages of married men are also substantially higher. We exclude from the analysis those men whose income was less than the established minimum wage of 7,500 rubles on 02.06.2016.

The average working experience of married men exceeds the same figure for unmarried men for almost five years. About 72% of married men and 50% of unmarried men are employed. Most likely, unmarried men can afford to stay out of the labor market longer, as

Variable	Mean	Median	Mean standard deviation	Minimum	Maximum	Lower quartile	Upper quartile
Married							
Age, years	41.1	40	0.22	25	60	33	49
Wage, rubles per month	32,208	28,000	518.13	7,800	400,000	20,000	40,000
Working experience, years	19.3	18	0.24	0	49	11	27
Unmarried							
Age, years	37.41	35	0.37	25	60	29	45
Wage, rubles per month	27,877	25,000	614.66	7,600	150,000	17,000	34,000
Working experience, years	14.51	12	0.38	0	45	6	20

Table 1. Descriptive statistics for subsamples of married and unmarried men

they do not bear financial responsibility for their families. We present wage distribution graphs for married men and unmarried men below.

In Figure 1, graphs for married men are shifted right in relation to graphs for unmarried men. Mann–Whitney test rejects the assumption of equality of distributions at 1% level. Together, this suggests that, on average, married men receive higher wages than unmarried men.

Analysis shows that 60.3% of married men have children. The corresponding indicator for unmarried men is only 27.2%. For men, having children entails higher costs, because there is a need to feed and dress children, as well as to pay for their education. This encourages married men to remain in the labor market.

Figure 2 presents the percentage of married and unmarried men with different education levels in our sample.

Most often, married and unmarried men have secondary education. Among unmarried men, the percentage of those with vocational and higher education is almost the same (22%). The percentage of men with higher education is much higher in the subsample of married men (30.3%). Probably, marriage is correlated with the desire to raise education level and to increase chances in the labor market.

Next, we consider a formal model that allows us to estimate the effect of endogenous variable of "*marriage*" on male wages in Russia.

3. Estimating male marriage wage premium

To estimate male marriage wage premium, we eliminate conditional mean independence assumption that is typically applied in studying the effects of the binary variable on the analyzed indicator. We assume that marital status might correlate with the error in the equation for wage, because unobserved factors such as responsibility and attractiveness may influence both the probability of marriage and wages.

Research studies provide evidence that causal relationship between wages and marriage status can be either direct or reverse (Grossbard-Shechtman and Neuman, 2003; Bonilla and Kiraly, 2013; Bonilla *et al.*, 2019). We propose an econometric model that takes into account the mutual influence of variables "*marriage*" and "*wage*" through the system of equations. We consider the wage equation, the equation for marriage and the equation for employment. There are two specifications. In the first specification (Model 1), the effect of marriage status on the wage is expressed in the fact that the wage equations are different for married and unmarried men. This difference consists in the coefficients and variance of the random error.

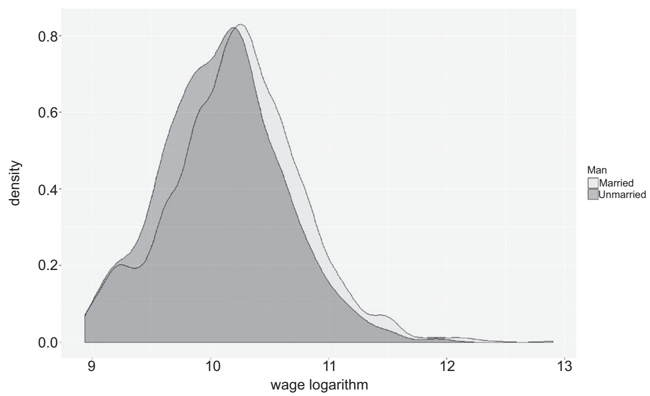

Figure 1.
Kernel estimates of the distribution density of logarithm of wages of married and unmarried men

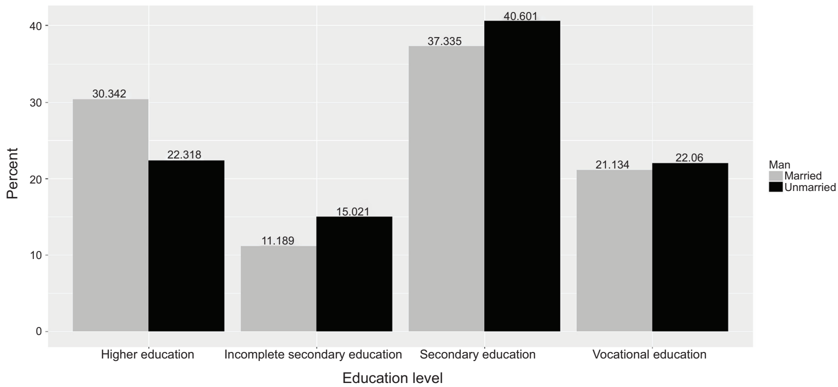

Figure 2.
The distribution of married and unmarried men by education level

Thus, we assume that the "price" of an individual's objective characteristics may differ for married and unmarried men. Also, the distribution of wages of married and unmarried men may differ in the dispersion of values. The reverse causality of the wage on marriage status along with the influence of unobserved factors are included in the model through the assumption of the correlation of random errors in the equations of wages and marriage. Unobserved factors that affect probability of marriage can also affect the probability of employment.

In the second specification (Model 0), we consider a simpler situation, when the effect of the marriage status on the wage is taken into account by including the variable "*marriage*" in the wage equation. Wage equations for married and unmarried men differ only by a constant in Model 0. Similar to Model 1, the reverse causality of the wage on marriage status along with unobserved factors are considered through the correlation of random errors in the wage equation and marriage equation. Thus, the variable "*marriage*" in the wage equation is considered endogenous.

Since the data on wages are available only for working individuals, we also consider the resulting sample-selection. Unobserved factors that affect the probability of marriage can also affect the probability of employment. To account for all these forms of relationships we analyze the system of three equations. Two equations are binary choice equations that determine the probability of marriage and employment. The third equation is the wage equation. The form of this equation may differ for married and unmarried men in the case of a male marriage wage premium.

The formal model is as follows.

Model 1

$$marriage_i^* = w_i' \gamma_2 + u_{2i},$$

$$marriage_i = \begin{cases} 1, & marriage_i^* \geq 0 \\ -1, & marriage_i^* < 0 \end{cases},$$

$$work_i^* = w_i' \gamma_1 + u_{1i},$$

$$work_i = \begin{cases} 1, & work_i^* \geq 0 \\ -1, & work_i^* < 0 \end{cases},$$

$$ln(wage_i^*) = \begin{cases} ln(w_{1i}) = x_i'\beta_1 + \varepsilon_{1i}, \text{ if } marriage_i = 1 \\ ln(w_{2i}) = x_i'\beta_2 + \varepsilon_{2i}, \text{ if } marriage_i = -1 \end{cases},$$

$$ln(wage_i) = \begin{cases} ln(wage_i^*), & \text{if } work_i = 1 \\ \text{not observable}, & \text{if } work_i = -1 \end{cases}.$$

where $wage_i,\ work_i,\ marriage_i$ are individual's wage and dummies for employment status and marital status of an individual $i\ \ (i = 1, ..., n)$. Dummies take the value of 1 for employed men and married men respectively, and (−1) otherwise;

x_i, w_i are vectors of the values of the explanatory variables of the individual I;

$\beta_1,\ \beta_2,\ \gamma_1,\ \gamma_2$ are vectors of unknown coefficients;

$\varepsilon_{1i}, \varepsilon_{2i}, u_{1i}, u_{2i}$ are random errors.

We assume that random errors in equations for marriage, employment and wage might be correlated with each other and have a joint normal distribution.

$$(\varepsilon_{ki}, u_{1i}, u_{2i})' \sim N\left(\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}, \begin{pmatrix} \sigma_k^2 & \rho_{k1}\sigma_k & \rho_{k2}\sigma_k \\ \rho_{k1}\sigma_k & 1 & \rho_0 \\ \rho_{k2}\sigma_k & \rho_0 & 1 \end{pmatrix}\right), \quad k = 1, 2.$$

This model considers the most general case when the same observed characteristics of individuals can have different prices (β_1 and β_2) in the wage equation for married and unmarried men. The difference in the coefficients may be due to discrimination of unmarried men. We suppose that a more reliable version is not discrimination, but a different way of job searching by married and unmarried men. For example, the different impact of the status of marriage on the job offers is mentioned in the article of Kulik (2001). Probably married men are quicker to agree to the proposed job than unmarried men. They do not allow themselves to search long for a job place with high wage, since they must financially support their families.

The switch variable "*marriage*" correlates with random error in both equations. Differences in the correlation coefficients ρ_{12} and ρ_{22} will occur in the case when an employer estimates the same characteristics of the individual that are unobservable by the econometrician, in different ways, depending on whether the respondent is married or not. Another advantage of switch regression is the possibility of considering differences in the variance of wages (σ_1 and σ_2) for married and unmarried men.

If there is no switch, one can consider a single wage equation that is different for married and unmarried men only by a constant. In this case, the random errors coincide $\varepsilon_{1i} = \varepsilon_{2i}$. Then, the following linear constraints on the parameters of Model 1 must be satisfied:

$$\begin{cases} \beta_1 - \beta_2 = (2\alpha, 0, \ldots, 0)' \\ \sigma_1 = \sigma_2, \rho_{11} = \rho_{21}, \rho_{21} = \rho_{22} \end{cases} \tag{1}$$

In a case of no switch the model takes the following form:

Model 0:

$$marriage_i^* = w_i'\gamma_2 + u_{2i}$$
$$work_i^* = w_i'\gamma_1 + u_{1i}$$
$$ln(wage_i^*) = x_i'\beta + \alpha Marriage_i + \varepsilon_{1i}$$

$$marriage_i = \begin{cases} 1, & marriage_i^* \geq 0 \\ -1, & marriage_i^* < 0 \end{cases},$$

$$work_i = \begin{cases} 1, & work_i^* \geq 0 \\ -1, & work_i^* < 0 \end{cases},$$

$$ln(wage_i) = \begin{cases} ln(wage_i^*), & \text{if } work_i = 1 \\ \text{not observable}, & \text{if } work_i = -1 \end{cases}$$

This model assumes that the contribution of the observed and unobserved characteristics into wage is equal for both groups. However, wages of married men and unmarried men might vary both in the constant and in the difference in the unobserved characteristics of married and unmarried men.

Model 1 and Model 0 are estimated by maximum likelihood method, which enables us to avoid the identification problem. The problem of identifying parameters can arise when estimating such models with the two-step procedure. The first step of the maximum likelihood method involves estimation of a participation equation. In our case, it is two equations. The second step requires estimating regression of a dependent variable on independent variables and on the bias estimated in the first step. Using least squares method in the second step requires exclusive restrictions. It is the presence in the equation of participation of at least one variable which is not included in the basic equation. Two-step procedure of estimating generalized Heckman model with two selection equations and the corresponding problem of identifying parameters are discussed in the article of De Luca and Peracchi (2012).

When estimating the system by maximum likelihood method, there is no need for exclusive restrictions for exogenous variables with enough variation in the data (Wilde, 2000). Despite there is no need to perform exclusive restrictions, we estimate the system of equations with unique explanatory variables in the employment and marriage equations. We explain it in detail in the "Estimation results" section. Another advantage of the maximum likelihood method is that we can estimate the system of equations with endogenous binary variable directly, without using instrumental variables, since the IV approach often leads to the problem of weak instruments. Maximum likelihood function is given in Appendix B.

4. Estimating male marriage wage premium

We define MMP as the difference in the wages of married and unmarried men, which cannot be explained by the difference in the observed characteristics of individuals x_i, w_{1i}, w_{2i}. Then MMP can be estimated as the marginal effect of marriage on wages. This is the difference between the conditional mathematical expectations for the same values of the control variables *x, w*. Observation index *i* is omitted below.

$$MMP = E(\ln(wage)|work = 1, marriage = 1, x, w) - E(\ln(wage)|work = 1, marriage = -1, x, w)$$

We use the following designation:

$$E(ln(w_1)|1, 1, x, w) = E(ln(w_1)|work = 1, marriage = 1, x, w),$$

$$E(ln(w_2)|1, -1, x, w) = E(ln(w_2)|work = 1, marriage = -1, x, w),$$

We express MMP as follows:

$$MMP = E(ln(w_1)|1,1,x,w) - E(ln(w_2)|1,-1,x,w) = \\ = \underbrace{x^{'}(\beta_1 - \beta_2)}_{\text{observed price effect}} + \underbrace{E(\varepsilon_1|1,1,x) - E(\varepsilon_2|1,1,x)}_{\text{unobserved price effect}} + \underbrace{E(\varepsilon_2|1,1,x) - E(\varepsilon_2|1,-1,x)}_{\text{effect of different unobservable characteristics}} = J_1 + J_2 + J_3 \tag{2}$$

Formulas for calculating the decomposition components (2) J_1,J_2,J_3 are given in Appendix C.

If there is no MMP, then the hypothesis $H_0 : \beta_2 = \beta_1$ is accepted for Model 1, and the hypothesis $H_0 : \alpha = 0$ is accepted for Model 0.

With that, different value of coefficients $\beta_2 - \beta_1$ is not the only source of difference in the wages of married and unmarried individuals in the presence of correlation between the variable of marriage and random error ε in the wage equation. If MMP exists, it is interesting to investigate its structure. Is this difference the result of different "prices" of observed and unobserved characteristics in the wage equations of married and unmarried men ($J_1 + J_2$) or is it due to an objective difference in the unobserved characteristics of married and unmarried men (J_3)?

We detail the research question as follows. In a case the premium exists, we investigate whether it is a result of differences in prices of observed characteristics (beta) or the same indicators contribute equally to the wages of married and unmarried men.

H1. $H_0 : \beta_1 = \beta_2$ for Model 1, and $H_0 : \alpha = 0$ for Model 0.

Is the wage variation for married and unmarried men the same?

H2. $H_0 : \sigma_1 = \sigma_2$

We analyze if the distributions of random errors ε_1 and ε_2 are the same in the wage equations. We check whether the variation in wages is the same, and the unobserved characteristics of individuals make equal contribution to both wages of married and unmarried men. In that case it is possible to consider a single wage equation with cross variables for marriage.

H3. $H_0 : \sigma_1 = \sigma_2, \rho_{11} = \rho_{21}, \rho_{21} = \rho_{22}$

We investigate whether Model 1 can be reduced to Model 0. This is Hypothesis 4. Mathematical formulation of the hypothesis is determined by the expression (1).

We analyze the possibility to consider the variable of *marriage* as an exogenous one in the wage equation. In this case, errors in the equations of marriage and wages are uncorrelated, that is:

H4. $H_0 : \rho_{12} = \rho_{21} = 0$

We check whether the variable of *marriage* is exogenous in the employment equation. We try to answer the question whether there are unobserved characteristics that affect both the probability of marriage and the probability of employment.

H5. $H_0 : \rho_0 = 0$

Using formulas (2) for each set of values of control variables, we can estimate the value of male marriage wage premium, all components of this premium and check their significance. We can also estimate the value and the significance of male marriage wage premium for a typical sample representative.

5. Estimation results

In our study, we consider the following explanatory variables. Factors of age, education level of an individual and working experience can be found in most empirical studies on wages and their determinants. For example, these are article of Salas-Velasco (2010) on wage determinants among medical doctors and nurses in Spain (Salas-Velasco, 2010) and the research of Brandt (2018) about wage determinants in the Swedish tourism sector (Brandt, 2018). We also consider the fact of disability, which obviously has a significant impact on the position in the labor market and behavior of the individual (Hollenbeck and Kimmel, 2008). In addition, we include the presence of children which is mentioned in various studies devoted to wage penalty for motherhood (Staff and Mortimer, 2012; Oesch *et al.*, 2017). We believe that the presence of children should positively influence the employment of a man, since family with dependents needs more money.

As controls we use place of residence, mean wage level and unemployment rate in the respondent's region of residence. We also consider the share of married men in the relevant age group in the total number of men in this age group in the region. To calculate these indicators, we use the data of the Federal State Statistics Service of Russia. The last two variables are unique for the equation of employment and marriage respectively. They ensure the compliance with exclusive restrictions. Descriptive statistics of control variables are given in Appendix D.

Estimation results for Model 1 and Model 0 are given in Appendix D. All correlation coefficients are significant at 1% level. It means that there are unobserved factors that affect both the probability of marriage and the probability of employment as well as wages. Therefore, the variable of "marriage" is not exogenous to wages and to employment. Hypotheses 5 and 6 are rejected. With that, marriage and employment are positively correlated. Unobserved factors that increase the probability of being married also increase the probability of being employed.

Errors in the equations of employment and wages are negatively correlated while errors in equations of marriage and wages are positively correlated. That is, there are unobserved factors that increase the probability of being employed and reduce the amount of wages (for example, fear of losing a job). There are also unobserved factors that increase the probability of being married and the amount of wages (for example, responsibility, attractiveness and beauty of an individual).

Value of characteristics (coefficients β_1 and β_2) are very close to each other, except for the first component, that is, the constant. Hypothesis 2 is not rejected. Wage variation of married and unmarried men is the same. Hypothesis 3 on the coincidence of distributions of random errors in the equations of wages is not rejected. Hypothesis 1 is rejected, but Hypothesis 4 is not rejected. That is, Model 1 is reduced to model 0.

We conclude that male marriage wage premium exists in the Russian labor market and explore its value and structure.

Using formula (2), we estimate MMP and its components for a typical sample representative (with mean / median values of characteristics) (Figure 3). Here, MMP equals the sum of J1, J2, and J3.

Figure 3 shows that MMP exists, and it is positive. However, the observed price effect (J_1) is negative. That is, the advantage in wages of married men is achieved due to the difference in the unobserved characteristics of married and unmarried men (J_3).

It is important to note that the standard approach to estimating male marriage wage premium is a panel model with fixed effects including the variable for marriage as an exogenous dummy-variable. For example, Ludwig and Brüderl (2018) investigated a wage premium for married men on the longitudinal data for the United States. In this research, male marriage wage premium is considered as the coefficient on marriage. This coefficient is also the marginal effect of the variable "*marriage*" and the price effect of married men, that is $MMP = J_1$.

In our model, we consider marriage as an endogenous variable. The price effect (J_1) differs from MMP, which is the marginal effect of "marriage" variable on the wage ($MMP = J_1+J_2+J_3$). The price effect (J_1) is negative, while ignoring endogenous nature of the variable "*marriage*" makes it positive. With that, there is evidence for the positive price effect in the literature. For example, Ludwig and Brüderl (2018) reported the effect of 0.083 percent with the conventional fixed effects model (Ludwig and Brüderl, 2018, p. 757). They also mentioned the positive effect found by Ahituv and Lerman (2007) and Killewald and Gough (2013). We conclude that positive MMP in our model is obtained due to the correlation of the variables "*marriage*" and "*wage*". This correlation can be caused both by the simultaneous influence of common unobserved factors on them, and by mutual influence of these variables on each other. Other researchers also pay attention to the simultaneous influence of unobserved factors. For example, Bonilla *et al.* (2019) investigated beauty premium, marriage status and labor market outcomes. Negative observed price effect for married men indicates that the difference in the unconditional mathematical expectations of wages of married men is less than that of unmarried men.

Under the assumptions of our model, we confirm the hypothesis about the endogeneity of the variable marriage. It is interesting to analyze how much the size and structure of MMP change, if we ignore the endogeneity of marriage in relation to employment and the amount of wages. Table 2 provides values for MMP and its components for Model 1 and Model 0, OLS

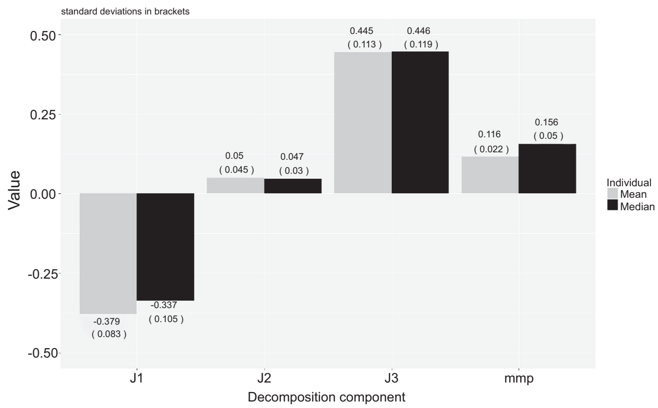

Figure 3.
The distribution of effects for the average and median individual (with higher education and living in the regional center)

Table 2. Estimating male marriage wage premium

	Mathematical expression	Model 1	Model 0	Least squares	Heckman model
Observed price effect J_1	$(\beta_1 - \beta_2)'\bar{x}$	−0.3796	−0.4404	0.1311	0.1152
Unobserved price effect, J_2	$E(\varepsilon_1 \vert 1, 1, x) - E(\varepsilon_2 \vert 1, 1, x)$	0.0500	0	0	0
The effect of changes in unobserved characteristics related to the change in marital status, J_3	$E(\varepsilon_2 \vert 1, 1, x) - E(\varepsilon_2 \vert 1, -1, x)$	0.4491	0.5732	0	0
MMP	$J_1 + J_2 + J_3$	0.1195	0.1328	0.1311	0.1152
Observed difference in wages of married and unmarried men	$\overline{\ln(w_1)} \vert 1, 1, x_1 - \overline{\ln(w_2)} \vert 1, -1, x_2$	0.1192 (0.01269)	0.1192 (0.01269)	0.1192 (0.01269)	0.1192 (0.01269)

model without considering the bias selection with dummy for "*marriage*" and one-dimensional Heckman model with the dummy for "*marriage*" and the equation for employment. Estimations are made for a representative individual.

Table 2 shows that MMP is positive in all models. It is almost identical to the observed difference in average wages, because the difference in the mean values of the explanatory variables is negligible. Though, the structure of MMP is fundamentally different depending on the model used.

According to Model 1 and Model 0, the observed price effect measures for the subsample of married men are negative. Its value is 38% for Model 1 and about 44% for Model 0. Therefore, married men *do not have wage premium*. Moreover, there is anti-premium in relation to the observed characteristics, while the observed difference in the average wages of married and unmarried respondents is positive and about 12%. Such substantial differences are explained by the significant positive contribution of the effect of changes in unobserved characteristics to the observed difference in wages. This contribution is due to a positive correlation of random errors in the marriage and wage equations. The positive correlation might be caused by the fact that married men have more attractive characteristics from the perspective of the employer that the researcher cannot observe. Another possible reason of the positive correlation is the simultaneous influence of the common unobserved factors on the probability to get married and on the wage like beauty premium. Finally, it might be mutual influence of marriage and wage on each other.

Unobserved price effect does not differ significantly from zero. This indicates that the distribution of errors in the wage equations of married and unmarried men does not differ from each other. The contribution of the same unobserved characteristics to both equations is the same. Perhaps, negative observed price effect for married men might be related to the fact that unemployed married men cannot afford to seek a job for a long time that corresponds to their abilities. Married men are financially responsible for the family. They might quickly agree to accept a job position which is minimally acceptable in terms of wages. However, this is only an assumption that needs to be verified with additional information.

OLS model and Heckman model estimate the observed price effect as positive, which almost completely determines the MMP and the observed difference in salaries. Thus, the assumption of endogenous marriage is important for the structure of the MMP. Without this assumption, the positive price effect may indicate discrimination against unmarried men in relation to married men. Under assumption of endogenous marriage, the price effect is negative. In that case, there is no discrimination against unmarried men. Positive MMP is explained by the positive correlation of random errors in equations for marriage and the wage.

6. Conclusions

The fact of marriage, employment and wages may depend on the same unobservable characteristics of men. We reveal that correlation of errors in the equations for wages and marriage is positive, and the same characteristics of a man increase his wage and the probability to be married for him. In the study for Germany, Pollmann-Schult also finds that "a large part of the wage differential between married and single men is due to selection process" (Pollmann-Schult, 2011, p. 160). We cannot investigate the existence of specialization effect as we do not analyze the distribution of housework within the family. As it is mentioned in the paper of Peterson *et al.* (2011), there is little empirical evidence of discrimination of unmarried men in relation to married men in the labor market. In our paper, we support the conclusion that there is no such discrimination, since we reveal the negative observed price effect for married men.

There is an anti-premium in wages of married men in relation to their observed individual characteristics. With that, we find significant positive contribution of the effect of changes in unobserved characteristics to the difference in wages. When the same unobservable factors affect both the probability of marriage and the amount of wages, the use of traditional estimation methods gives biased results and can lead to incorrect conclusions.

The methodological advantage of our approach is as follows. Assuming a joint normal distribution of errors, we can estimate the basic equation, taking into account the selection bias and the endogenous binary explanatory variable without using instrumental variables by considering the distribution of the endogenous variable directly. In our case, the basic equation is the wage equation, and the endogenous binary explanatory variable is marriage. Our approach can be easily generalized to a larger number of selection equations. For example, it allows us to consider different types of marital statuses and compare their effects.

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Further reading

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Appendix A

Let the $(\varepsilon_{ki}, u_{1i}, u_{2i})' \sim N\left(\begin{bmatrix}0\\0\\0\end{bmatrix}, \begin{pmatrix}\sigma_k^2 & \rho_{k1}\sigma_k & \rho_{k2}\sigma_k\\ \rho_{k1}\sigma_k & 1 & \rho_0\\ \rho_{k2}\sigma_k & \rho_0 & 1\end{pmatrix}\right), \quad k = 1, 2.$

Then by the properties of the multidimensional normal distribution

Mathematical expectation and covariance matrix of joint and conditional joint distributions $F_{(\pm u_{1i}, \pm u_{2i})}$ and $F_{(\pm u_{1i}, \pm u_{2i})|\varepsilon_{ki}=y_i - x_i'\beta_k}$ are given by the expressions:

$$E(\pm u_{ri}) = 0, \quad E(\pm u_{ri}|\varepsilon_{ki} = ln(w_{ki}) - x_i'\beta_k) = \pm\rho_{rk}\frac{(ln(w_{ki}) - x_i'\beta_k)}{\sigma_k} \quad (k = 1, 2 \quad r = 1, 2)$$

$$Cov\left((u_{1i}, u_{2i})'|\varepsilon_{ki} = y_i - x_i'\beta_k\right) = \begin{pmatrix}1 - \rho_{1k}^2 & \rho_0 - \rho_{1k}\rho_{2k}\\ \rho_0 - \rho_{1k}\rho_{2k} & 1 - \rho_{2k}^2\end{pmatrix}$$

$$Var\left(-u_{ri}|\varepsilon_{ki} = y_i - x_i'\beta_k\right) = Var\left(u_{ri}|\varepsilon_{ki} = y_i - x_i'\beta_k\right) = 1 - \rho_{rk}^2$$

$$\begin{aligned}
&Cov(-u_{1i}, -u_{2i}) = Cov(u_{1i}, u_{2i}) = -Cov(-u_{1i}, u_{2i}) = -Cov(u_{1i}, -u_{2i}) = \rho_0,\\
&Cov\left((-u_{1i}, -u_{2i})|\varepsilon_{ki} = y_i - x_i'\beta_k\right) = Cov\left((u_{1i}, u_{2i})|\varepsilon_{ki} = y_i - x_i'\beta_k\right) =\\
&= -Cov\left((u_{1i}, -u_{2i})|\varepsilon_{ki} = y_i - x_i'\beta_k\right) = -Cov\left((-u_{1i}, u_{2i})|\varepsilon_{ki} = y_i - x_i'\beta_k\right) = \rho_0 - \rho_{1k}\rho_{2k}
\end{aligned}$$

Appendix B

We denote the set of observations for which $(\text{work}_i = l)$ & $(\text{marriage}_i = s)$ as $i(l, s)$. Then we can express the contribution of the i-th observation to the likelihood function as follows:

$$U_i = \begin{cases}
P(-u_{1i} \le w_i'\gamma_1 + \alpha_1, -u_{2i} \le w_i'\gamma_2|\varepsilon_{1i} = ln(w_{1i}) - x_i'\beta_1)f_{\varepsilon_{1i}}(ln(w_{1i}) \\
\quad -x_i'\beta_1) \quad if \quad i \in i(1,1)\\
P(-u_{1i} \le w_i'\gamma_1, u_{2i} \le -w_i'\gamma_2|\varepsilon_{2i} = ln(w_{2i}) - x_i'\beta_2)f_{\varepsilon_{2i}}(ln(w_{2i}) \\
\quad -x_i'\beta_2) \quad if \quad i \in i(1,-1)\\
P(u_{1i} \le -w_i'\gamma_1 - \alpha_1, -u_{2i} \le w_i'\gamma_2) \quad if \quad i \in i(-1,1)\\
P(u_{1i} \le -w_i'\gamma_1, u_{2i} \le -w_i'\gamma_2) \quad if \quad i \in i(-1,-1)
\end{cases}$$

The likelihood function has the form:

$$L(\beta_1,\beta_2,\gamma_1,\alpha_1,\gamma_2,\sigma_1,\sigma_2,\rho_0,\rho_{11},\rho_{12},\rho_{21},\rho_{22}) =$$
$$= \prod_{i\in i(1,1)} F_{(-u_{1i},-u_{2i})|\varepsilon_{1i}=ln(w_{1i})-x_i'\beta_1}(w_i'\gamma_1+\alpha_1, w_i'\gamma_2) f_{\varepsilon_{1i}}(ln(w_{1i})-x_i'\beta_1)\cdot$$
$$\cdot \prod_{i\in i(1,-1)} F_{(-u_{1i},u_{2i})|\varepsilon_{2i}=ln(w_{2i})-x_i'\beta_2}(w_i'\gamma_1, -w_i'\gamma_2) f_{\varepsilon_{2i}}(ln(w_{2i})-x_i'\beta_2)\cdot$$
$$\cdot \prod_{i\in i(-1,1)} F_{(u_{1i},-u_{2i})|\varepsilon_{1i}=ln(w_{1i})-x_i'\beta_1}(-w_i'\gamma_1-\alpha_1, w_i'\gamma_2)\cdot$$
$$\prod_{i\in i(-1,-1)} F_{(u_{1i},u_{2i})_i|\varepsilon_{2i}=ln(w_{2i})-x_i'\beta_2}(-w_i'\gamma_1, -w_i'\gamma_2)$$

Here, $f_{\varepsilon_{ki}}(k=1,2)$ is the distribution density of the random error ε_{ki}, which, by the assumption of the model, is normal with zero mathematical expectation and dispersion σ_k^2;

$F_{(\pm u_{1i},\pm u_{2i})}$ is the joint distribution function of the components of a random vector $(\pm u_{1i}, \pm u_{2i})$. $F_{(\pm u_{1i},\pm u_{2i})|\varepsilon_{ki}=y_i-x_i'\beta_k}$ is its conditional distribution function, which is also normal by the model's assumption.

Note, that for calculating $F_{(\pm u_{1i},\pm u_{2i})}$ and $F_{(\pm u_{1i},\pm u_{2i})|\varepsilon_{ki}=y_i-x_i'\beta_k}$ it is enough to know the corresponding covariance matrix and the mathematical expectation. Expressions for them are given in Appendix A.

Appendix C

Lemma 1. Let $(\varepsilon,u_1,u_2)' \sim N\left(\begin{bmatrix}0\\0\\0\end{bmatrix}, \begin{pmatrix}\sigma_k^2 & \rho_1\sigma & \rho_2\sigma\\ \rho_1\sigma & 1 & \rho_0\\ \rho_2\sigma & \rho_0 & 1\end{pmatrix}\right)$

Then $E(\varepsilon|u_1<b_1,u_2<b_2)=\sigma(\rho_1\lambda_1^{(u_1,u_2)}(b_1,b_2)+\rho_2\lambda_2^{(u_1,u_2)}(b_1,b_2))$,
where

$$\lambda_1^u(x_1,x_2)=\frac{\partial F_u(x_1,x_2)/\partial x_1}{F_u(x_1,x_2)},\quad \lambda_2^u(x_1,x_2)=\frac{\partial F_u(x_1,x_2)/\partial x_2}{F_u(x_1,x_2)},\quad u=(u_1,u_2)',$$

$$F_u(x_1,x_2)=P(u_1<x_1,u_2<x_2)=\int_{-\infty}^{x_1}\int_{-\infty}^{x_2}\frac{1}{2\pi}e^{-\frac{1}{2(1-\rho_0)^2}\left(t_1^2-2\rho_0t_1t_2+t_2^2\right)}dt_1dt_2$$

This is a special case of the result obtained by Manjunath and Wilhelm (2012).
From Lemma 1 it follows that the elements of the decomposition (2) J_2 и J_3 have the form:

$$J_2=(\sigma_1\rho_{11}-\sigma_2\rho_{21})\lambda_1^{(-u_1,-u_2)}(w'\gamma_1,w'\gamma_2)+(\sigma_1\rho_{12}-\sigma_2\rho_{21})\lambda_2^{(-u_1,-u_2)}(w'\gamma_1,w'\gamma_2))$$

$$J_3=\sigma_2\rho_{21}\left(\lambda_1^{(-u_1,-u_2)}(w'\gamma_1,w'\gamma_2)-\lambda_1^{(-u_1,u_2)}(w'\gamma_1,-w'\gamma_2)\right)$$
$$+\sigma_2\rho_{22}\left(\lambda_2^{(-u_1,-u_2)}(w'\gamma_1,w'\gamma_2)-\lambda_2^{(-u_1,u_2)}(w'\gamma_1,-w'\gamma_2)\right)$$

Appendix D

Table A1. Estimating Model 1

Variable	Wage of married men	Wage of unmarried men	Employment	Marriage
Constant	2.51486*** (0.48641)	2.0518*** (0.74293)	−0.97304** (0.48134)	−2.22483*** (0.41405)
Secondary education	0.08536** (0.04012)	0.06738 (0.05528)	0.15361** (0.07498)	0.12703* (0.07028)
Vocational education	0.17314*** (0.04366)	0.14975** (0.06200)	0.45949*** (0.08743)	0.24691*** (0.07884)
Higher education	0.38095*** (0.04225)	0.34514*** (0.06763)	0.64167*** (0.08607)	0.50189*** (0.07710)
Working experience	0.02194*** (0.00443)	0.01903*** (0.00643)		
Working experience^2	−0.00048*** (0.00004)	−0.00037** (0.00016)		
Age			0.09928*** (0.0234)	0.06472** (0.02588)
Age^2			−0.00132*** (0.00028)	−0.00063** (0.00027)
Disability	−0.15648* (0.08605)	−0.20177 (0.14139)	−1.59953*** (0.11165)	−0.49282*** (0.09574)
Children			0.20767*** (0.06019)	
Ln (mean wage in region)	0.68286*** (0.04698)	0.76908 (0.07144)		
Unemployment rate in region			−0.09813*** (0.01147)	
Share of married men in region				1.60381*** (0.48693)
Moscow	0.04452 (0.0646)	−0.09424 (0.09338)	−0.31489*** (0.11597)	−0.13979 (0.09252)
Saint Petersburg	−0.1266 (0.09198)	−0.08594 (0.10708)	0.65811*** (0.24245)	−0.44645*** (0.16099)
Regional center	0.1913*** (0.03384)	0.15543*** (0.04963)	0.37605*** (0.06949)	−0.10019 (0.06189)
City	0.13036*** (0.03354)	0.11015** (0.05199)	0.51160*** (0.06890)	0.01493 (0.06253)
Town	−0.07468 (0.05437)	−0.05927 (0.08521)	0.22112* (0.11404)	−0.03308 (0.10342)
rho0	0.33340*** (0.03303)			
rho1	−0.39617*** (0.05914)	−0.26676* (0.14391)		
rho2	0.71148*** (0.03701)	0.49464*** (0.12194)		
Sigma	0.5607*** (0.01558)	0.48525*** (0.02809)		
Observations	1880	706	2586	
Log-Likelihood			−5132.334	
AIC			10384.668	

Note(s): *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

Table A2.
Estimating Model 0

Variable	Wage	Employment	Marriage
Constant	2.56638*** (0.41137)	−0.89435* (0.48456)	−2.31491*** (0.4202)
Secondary education	0.07921** (0.03367)	0.15357** (0.07541)	0.13282* (0.07049)
Vocational education	0.17201*** (0.03708)	0.45685*** (0.08776)	0.25757*** (0.0788)
Higher education	0.37461*** (0.03699)	0.63923*** (0.08629)	0.50963*** (0.07691)
Working experience	0.02298*** (0.00364)		
Working experience^2	−0.00051*** (0.00008)		
Age		0.0959*** (0.02355)	0.06663** (0.02627)
Age^2		−0.00127*** (0.00028)	−0.00067** (0.00028)
Disability	−0.19052*** (0.07945)	−1.60596*** (0.11163)	−0.50574*** (0.09586)
Children		0.21302*** (0.06125)	
Ln (mean wage in region)	0.72151*** (0.03944)		
Unemployment rate in region		−0.10135*** (0.01174)	
Share of married men in region			1.69349*** (0.49833)
Moscow	0.00156 (0.0543)	−0.33752*** (0.11686)	−0.13148 (0.09329)
Saint Petersburg	−0.0804 (0.07211)	0.67530*** (0.24668)	−0.42035*** (0.16114)
Regional center	0.1953*** (0.0291)	0.38913*** (0.06977)	−0.07872 (0.06207)
City	0.13946*** (0.02941)	0.50498*** (0.06952)	0.02601 (0.0626)
Town	−0.06668 (0.04696)	0.22739** (0.11464)	−0.02712 (0.10348)
Marriage	−0.43789*** (0.05465)		
rho0	0.31877*** (0.03322)		
rho1	−0.24739*** (0.07968)		
rho2	0.60079*** (0.05086)		
Sigma	0.51658*** (0.01301)		
Observations	2586	2586	2586
Log-Likelihood		−5141.972	
AIC		10373.944	

Note(s): *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

Table A3. Descriptive statistics of control variables

Variable	Mean	Median	Mean standard deviation	Minimum	Maximum	Lower quartile	Upper quartile
Married							
Wage	32208	28000	518.1326	7800	400000	20000	40000
Age	41.1	40	0.22291	25	60	33	49
Seniority	19.3	18	0.23884	0	49	11	27
Mean region wage	34065	28589	263.0216	21486	71129	25422	38103
Unemployment	5.653	5.687	0.04621	1.648	12.045	4.304	12.045
Share of married	0.6430	0.6569	0.00192	0.3380	0.8454	0.6012	0.7149
Unmarried							
Wage	27877	25000	614.6595	7600	150000	17000	34000
Age	37.41	35	0.36812	25	60	29	45
Seniority	14.51	12	0.37862	0	45	6	20
Mean region wage	34996	30485	402.7078	21486	71129	25749	38103
Unemployment	5.534	5.687	0.07085	1.648	12.045	3.953	6.828
Share of married	0.5998	0.6248	0.00342	0.3380	0.8454	0.5064	0.6936