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THE INFLUENCE OF REGIONAL LABOR FACTORS ON INNOVATION COSTS OF ENTERPRISES IN RUSSIAN REGIONS

In this paper, we examine the impact of labor loyalty and the labor market situation on companies' costs of innovation in eighty-one Russian regions. First, we determined the mathematical model of workforce loyalty and the economic indicators for this model. We believe that workforce loyalty can be measured as the ratio of number of unemployed people to the number of available job vacancies. If we approach workforce loyalty in such a way, it is important to use the indicators for one specific group of workers (with the same qualification) to exclude the effects of structural unemployment. Second, we identified the factors shaping the loyalty of the workforce in Russian regions and included them in our model to find the relationship between the above-described variables and companies' willingness to invest in research and development. We analyzed the data and applied econometric methods to test our hypothesis that investment in innovation and labor loyalty are interdependent in Russian regions. Our hypothesis was confirmed as we established that a decrease in workers' loyalty to their employers leads to a rise in the motivation of the latter to invest in innovation.

Keywords: unemployment, research and development, demand for labor, employment protection, innovations, employment protection legislation

Introduction. Literature Review

Academic literature has already documented the contradictory effects of employment protection legislation (EPL). According to one group of studies, EPL has a negative effect on productivity due to inefficient worker reallocation. Another group of studies, for example, Pierre and Scarpetta [1], has shown that EPL stimulates companies to innovate and train. Acharya et al. [2] use the case of staggered adoption of wrongful discharge laws in the U.S. to show that EPL spurs innovation and establishment of new firms. Koeniger [3] proves that countries with strict EPL tend to specialize in the improvement of the existing products.

Theoretically, the positive impact of EPL on training and innovation can be explained by the decreased fluctuation of employees [4], [5]; the increased cost of laying off innovating and thus sometimes underperforming employees [2]; and by firms' motivation to improve the existing products in order to ensure their competitiveness [3]. All these explanations are important to understand how EPL influences the economy.

These studies focus on how firms adjust their organization, which means that they are not able to explain why the innovation and manufacturing sectors grow [2], [6] at the expense of others [7].

Researchers in the field of labor economics got interested in issues related to employment protection while studying such problems as flexibility and adjustment, duality and segmentation of the labor market, the dynamics of unemployment and employment. In our paper, we decided to look into the factors that determine the level of employment and unemployment.

Negative productivity effects from inefficient labor reallocation are discussed in a number of previous studies [6], [8], [9], [10], and [11]. Pierre and Scarpetta [1] report that the hard influence of EPL (due to high unemployment in the region or country) is particularly detrimental to the growth prospects of medium-sized firms.

Other authors emphasize the positive aspects of EPL: for instance, Bertola [12] shows that although EPL lowers the returns on irreversible investment and thus the speed of capital accumulation, it shifts the income distribution towards workers with no capital income. This explains why trade unions often favor stricter EPL.

Kessing [13] argues that firms facing EPL have a stronger average market position as they can credibly commit to defending their position against potential competitors, because EPL makes the market exit very costly.

In this paper, we are trying to expand the model of EPL influence to include the market legislation and to look into the notion of labor loyalty and its impact on innovation. We assume that the most significant impact of trade unions and employment protection laws is that they reduce workforce loyalty because employees start having higher expectations concerning their working conditions, wages and perks.

We suppose that the degree of the workforce's loyalty can be measured not only by the strength of the employment protection law but also by the de facto data on the employment structure of the population. Therefore, if we assume that the qualifications of the unemployed correspond to the qualifications required to apply for a vacant workplace, we can make a conclusion that unemployment results from employees' own reluctance to accept the proposed working conditions. This is what we call disloyalty to the employer on the regional level. If we look at the ratio of job vacancies to the number of unemployed people in the region, we may get a general idea of workers' propensity to stay loyal to their employers.

The local firms' investment in innovation was taken as an indicator characterizing innovative development. We understand that the overall development of innovation in the region is not limited to this indicator, but we assume that it is this component that will be influenced the most by the situation in the labor market.

The internal costs of research and development are the actual costs of research and development in the country expressed in monetary terms. These costs include the cost of research funded from abroad except for the payments that were actually made abroad. Their assessment is based on the statistics of organizations' R&D expenditures in the reporting year, regardless of the source of funding.

Methodology and Data

In our paper we used methods of econometric modeling to describe the data on the regions and to find the evidence to support our hypothesis. For better evaluation of the model we used panel data to describe the individual effects of observation groups. The panel data includes both cross-sectional data and time-series data: at each moment of time, there is spatial data corresponding to each economic unit and for each object, the corresponding data form one or several time series.

Due to their special structure, panel data allow us to build more flexible and meaningful models, which, unlike the models based on cross-sectional data, allow us to solve a wider range of problems. In particular, we can take into account and analyze individual differences between economic units, which is crucial for studies based on regional data but cannot be done within the framework of standard regression models.

We conducted econometric research on the basis of the statistical data for 81 Russian regions over the period between 2011 and 2014[1]. Chukotka region, the Jewish Autonomous District, the Crimea and Sevastopol were excluded from our study due to the lack of open access to the necessary information. The choice of the time period was determined by the availability of the necessary data, which helped to create a balanced panel and achieve more accurate estimates.

As an explicable variable reflecting the degree of regional companies' interest in innovation, we chose the indicator of R&D costs. First of all, these include the development of the technological aspects of fixed capital and improvement of production efficiency by updating technology.

To describe the situation on the labor market, we have chosen two key indicators:

1) The unemployment rate among the population with higher education;

2) The demand for qualified personnel with higher education (the number of vacancies).

These indicators were chosen for the following reasons. First of all, we consider unemployment as a factor that can show us the overall situation in the region's economy (it is well known that high unemployment causes economic problems). According to the law of supply and demand, a high level of unemployment signifies that labor in the region already is or is going to be very cheap.

As the second regressor, we took the labor demand indicator. It shows the company's degree of interest in qualified employees as well as its willingness to develop its production, extensively or intensively. In

[1] Federal State Statistics Service. Retrieved from: www.gks.ru

addition, the company's need for staff indicates that it has financial resources which it is ready to invest in new employees, offering them a good salary and training opportunities.

What is particularly interesting, however, is how these indicators interact with each other within one model. Speaking about the delta between the number of unemployed people and vacant jobs, we can explain such important indicator as employee loyalty at the regional level. Employees' loyalty determines the degree of their willingness to continue working for their companies and their enthusiasm in searching for another job elsewhere. If the ratio of the number of vacancies to the number of unemployed people is large (always in the same categories of labor), it can signify a low level of employees' loyalty.

The direct analysis of the data was carried out in Stata program. We applied descriptive statistics for more comprehensive description of the collected data.

Table 1.

Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
R&D costs	8468.243	30170.96	6.068	298249
Unemployment	15266.65	19567.16	70	149549
Demand for qualified personnel	55755.56	41411.51	1000	238000

The results of direct regression modelling are as follows:

Table 2.

Linear regression

Variable	Coefficient
Unemployment	1.405*** (0.044)
Demand for qualified personnel	-0.117*** (0.02)
Constant	-6439.557*** (1314)
R-Squared	0.7345

The explanatory power of the model is shown by R-squared, which in our case is equal to 73.5%. This is a fairly good level of the model's explanatory ability provided that only two factors are included in it (R ^ 2 always increases with the number of regressors).

Both indicators are significant. Nevertheless, it makes sense to test heteroscedasticity in the model that can make estimates shift and create an incorrect impression of their effect on the endogenous variable.

White's test with the null hypothesis of homoscedasticity is demonstrated below:

```
white's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(5)      =    200.30
         Prob > chi2  =    0.0000

Cameron & Trivedi's decomposition of IM-test
```

Source	chi2	df	p
Heteroskedasticity	200.30	5	0.0000
Skewness	62.54	2	0.0000
Kurtosis	-71349.03	1	1.0000
Total	-71086.19	8	1.0000

Fig. 4. *White heteroscedasticity test*

To deal with heteroscedasticity, error correction is necessary.

Table 3.

Corrected error estimates

Variable	Coefficient
Unemployment	1.405*** (0.16)
Demand for qualified personnel	-0.117*** (0.033)
Constant	-6439.557*** (1396)
R-Squared	0.7345

Furthermore, it is necessary to assess the possibility of multicollinearity between the unemployment rate and the demand for qualified personnel, which we did with the help of the VIF-test in Stata program.

Table 4.

VIF-test

Variable	VIF
Unemployment	1.21
Demand for qualified personnel	1.21

We use VIF <4 to eliminate multicollinearity between the indicators.

Now that we have checked the adequacy of the indicators it is necessary to make sure that the model specification is correct. This will help us to understand whether it is worth looking for some other form of dependence or the linear model describes the existing dependence. Thus, we need to run the Ramsey Reset test.

```
. ovtest

Ramsey RESET test using powers of the fitted values of in_costs
       Ho:  model has no omitted variables
                  F(3, 399) =     167.55
                   Prob > F =     0.0000
```

Fig. 5. *Ramsey test*

Probability is lower than the level of significance, which signifies the correct specification of the model.

Finally, what we need to consider is the kind of individual effects that the data have. In addition to the pooled model, we should also build models that take into account the individual effects of observations.

Between- and within-group regression modelling augments cross-sectional analysis of epidemiological data by supporting the unmasking of non-causal associations arising from hidden confounding at different levels. The between-group regression is the original model rewritten in terms of the time-averaged values of the variables. In this case, the value of R-sq between reflects the quality of the regression fit and is large enough (0.7220), that is, the change in time averages for each region has a more significant effect on each variable than the time variation of these indicators relative to the average.

The results of the between-group regression modelling are as follows:

Table 5.

Between regression

Variable	Coefficient
Unemployment	1.48*** (0.09)
Demand for qualified personnel	-0.149*** (0.044)

Constant	-5819.788** (2735)
R-Squared	
within	0.05
between	0.77
overall	0.73

Our regression and indicators are still applicable, which allows us to go on to make models with fixed and random effects and choose the best model.

Table 6.

Model with fixed effects

Variable	Coefficient
Unemployment	0,156** (0.0789)
Demand for qualified personnel	-0.085*** (0.0264)
Constant	10824*** (2275)
R-Squared	
within	0.069
between	0.2843
overall	0.2573

Table 6.

Model with random effects

Variable	Coefficient
Unemployment	0,7245*** (0.062)
Demand for qualified personnel	0.001 (0.0234)
Constant	-2659*** (2476)
R-Squared	
within	0.0387
between	0.7461
overall	0.7122

First of all, we need to compare the pooled regression model with the random effects model.

```
Breusch and Pagan Lagrangian multiplier test for random effects

        in_costs[region,t] = Xb + u[region] + e[region,t]

        Estimated results:
                             |       Var     sd = sqrt(Var)
                    ---------+------------------------------
                    in_costs |   9.10e+08        30170.96
                           e |   2.69e+07        5190.778
                           u |   1.98e+08        14072.19

        Test:   Var(u) = 0
                                    chi2(1) =    487.99
                                Prob > chi2 =    0.0000
```

Fig. 6. *Breusch and Pagan test*

Since the p-level is <0.01, the main hypothesis is rejected. Thus, the model with random effects describes our data better than the pooled regression model. After that, we need to compare the fixed effects model with the random effects model.

```
        Test:  Ho:  difference in coefficients not systematic

                  chi2(2) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       26.15
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

Fig. 7. *Hausman test*

Since the p-level is <0.01, the main hypothesis is rejected. Thus, the model with fixed effects is better than the model with random effects.

According to the data for 81 Russian regions for a five-year time interval, we obtained the following quantitative dependencies:

- direct dependence of R&D costs on the number of vacancies for people with higher education;
- inverse dependence of R&D costs on the number of unemployed people.

With an increase in the demand for labor in 1 workplace, enterprises are ready to spend 15.96 thousand rubles on research instead of trying to attract an employee to this place. However, with an increase in unemployment (for example, if we add one more unemployed person), companies' investments in research and development decline by 3.34 thousand rubles.

Results

The results of our analysis have confirmed our initial hypothesis that the situation in the labor market correlates with the readiness of regional companies to invest in innovation. The divergent effects of unemployment and the demand for personnel are easily explained. As far as the impact of unemployment is concerned, the higher is the unemployment rate, the less regional companies are ready to invest in innovation.

According to the above-mentioned studies, unemployment negatively affects regional economy. It also leads to declining subsidies in research and development and, therefore, innovation. This trend is associated with the influence of the employment protection law: trade unions are campaigning for less efficient use of the labor force, imposing greater involvement of labor capital in production than it is necessary. Despite all the claims that the main purpose of businesses is to create jobs, no businessman will want to expand their company's staff without a good reason. Therefore, when unemployment in the region is high, legal impediments together with the high labor supply make investing in innovative development less profitable for businesses. We should also point out the role of labor supply: when the labor supply is high, the price of

human resources falls, making the costs of attracting labor capital lower than the marginal costs of fixed capital and, consequently, R&D costs.

As for the workforce demand, it has a positive correlation with investments in R&D because it is impossible to provide the necessary amount of labor resources for the operation of enterprises, which makes it necessary to invest in capital (and increase its efficiency through innovation). This approach has been described and tested by a number of reliable studies [1], [3]. Such behavior of companies fits well with the hypothesis that the production function in most industries is described by the Cobb-Douglas function.

Apart from the above-described reasons, there is one more situation to be considered if the two conditions are fulfilled simultaneously:

1) unemployment co-exists with the demand for personnel;

2) there is little or no structural unemployment (to meet this condition, in our model we use the rate of unemployment only for individuals with higher education; the same principle applies to the demand for personnel).

If both of these conditions are met, we can say that employees are disloyal to their enterprises. Disloyalty may result from an inadequate wage level, inadequate working conditions or strong protection of trade unions. Either way, low employee loyalty makes investment in the workforce less attractive, which creates an additional incentive for innovation and development in terms of fixed capital.

Obviously, when it comes to the impact of the labor market situation on innovation, it is logical to assume some endogeneity, especially if we accept the hypothesis of technological unemployment generated by technological changes and leading to unemployment.

Nevertheless, this hypothesis was repeatedly discussed by the leading economists as early as in the 1930s (for example, by John Maynard Keynes). Among other things, such option as reducing the workforce in order to increase investment opportunities was not considered because it would result in protests on behalf of trade unions.

In order to make sure that there was no endogeneity, we ran the reverse regression, which turned out to be insignificant as well as the coefficient of the cost of investment in R&D.

Conclusion

Our analysis has proven the initial hypothesis about the interdependence between investment in innovation and labor loyalty in Russian regions, which means that a decrease in workers' loyalty increases the employers' motivation to invest in innovation.

It should be noted that the chosen indicator is by no means the only one that affects innovation, even if we focus only on the labor market. For instance, the number of trade unions in the region is another indicator of workers' loyalty and describes the degree of their protection. Moreover, it is possible to adjust the level of structural unemployment in order to dispel any doubts concerning the discrepancy between the qualifications of unemployed people and the qualifications required by companies.

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