

## Several Applications of Phillips Curve Model to Russian Labor Market Analysis

This paper is a result of the research, performed at the labor resources forecasting laboratory Institute of Economic Forecasting Russian Academy of Sciences. Research is made as a part of work for employment module of the Russian Interindustry Model (RIM) construction [1; 2, pp. 123–138; 3; 4]. In this module, employment functions for different industries are presented as reverse ones to Cobb-Douglas and translog production functions. Labor input is measured in average per year number of employed and number of hours worked. Exogenous factors are gross output, capital assets volume, accrued wage fund for each industry, country's population etc. However, analysis done has shown that the employment dynamics research in isolation from the labor market processes is insufficient.

According to it wage level and consumer prices influence on the labor market situation was studied. Nominal wage<sup>1</sup> is considered as a value that balances demand and supply, because, along with other factors, it determines the volume of employment and unemployment in the economy, as well as the number of advertised vacancies. Depending on its differentiation, wage rate also determines the degree of labor incentive and its quality. It is at simultaneously an indicator of the socioeconomic situation on the labor market and one of the instruments for its regulation. Models of labor market functioning and nominal wage rate dynamics rest on the *Phillips curve concept*.

Nominal wage growth rate ( $\Delta w$ ) and unemployment rate ( $u$ ) dynamics built on the basis of annual Russian statistics for the period between 1992 and 2002 allow to identify the main trends in related change of the indicators under consideration (Fig. 1). The highest nominal wage growth rate and the lowest unemployment rate corresponds to 1992. The later quickly rose, exceeding 13% by 1998, and the nominal wage growth rate slowed down (to almost zero by the same date). Further on unemployment rate decreased to 8,6%, and nominal wage growth rate — to 34,5%.

The *initial model of nominal wage change* is constituted by a modification of the Phillips model [7], model 1:

$$\Delta w_t = \beta_0 + \beta_1 \frac{1}{u_t} + \beta_2 \Delta w_t + \varepsilon_t,$$

---

<sup>1</sup> Hereinafter, nominal wage is interpreted as accrued nominal wage.

where  $w_t$  is nominal wage growth rate;  $1/u_t$  is a value inverse to unemployment rate;  $P_t$  is consumer prices rate of growth;  $\beta_0, \beta_1, \beta_2$  are model parameters;  $\varepsilon_t$  is a regression error,  $\varepsilon_t \sim N(0, \sigma^2)$ .

The obtained statistical characteristics of the regression equation suggests positive conclusion regarding the quality of the equation for the Russian Federation (1993–2002).

	Const	1/u	P	R <sup>2</sup>	d
Economy, total	-2,57	0,19	0,01	0,992	2,802
t-ratio	-4,54	2,96	12,64		

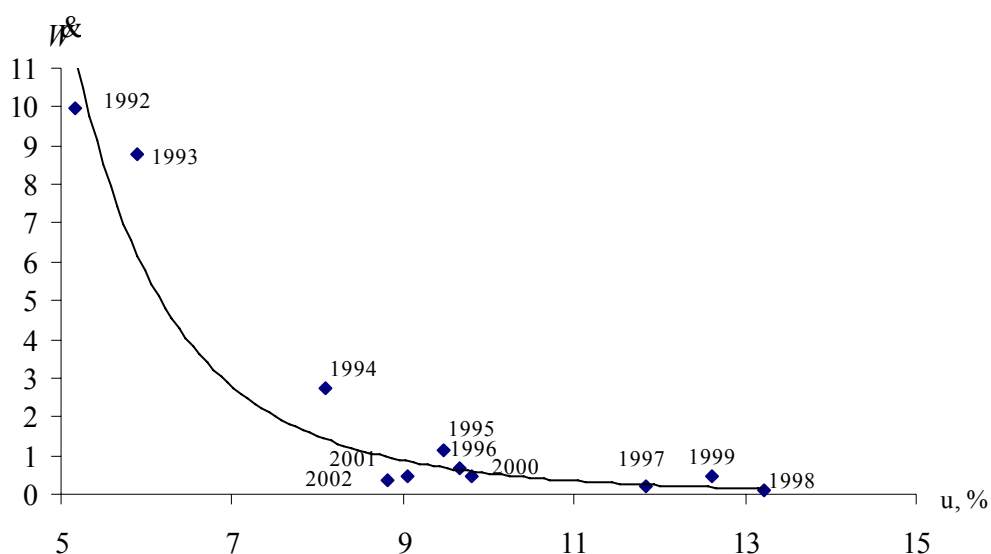


Fig. 1. Nominal wage growth rate and unemployment rate dynamics for Russian Federation

*Joint annual nominal wage growth rate and unemployment rate dynamics for the FDs* shows their high and negative correlation for the period 1992–2002. The lowest absolute value is 0,76 for the North West federal district (FD), and the highest value is 0,89 for the Volga FD. This confirms the existence of the reverse relationship between the mentioned parameters. Graphical comparison of the Phillips curves for the FDs and the economy as a whole shows different impacts of the regional labor markets on the federal one.

At Fig. 2 nominal wage inflation and unemployment rate dynamics is presented to compare federal and regional indicators for the Central and South FDs. Their Phillips curves are situated lower and higher than the Russia's one. The figure shows, that during 1992–1999 period either considerable decline in nominal wage growth rate or unemployment ris-

ing took place. And only in 2000–2002 growth of unemployment rate stopped and wage dynamics was slightly intensified.

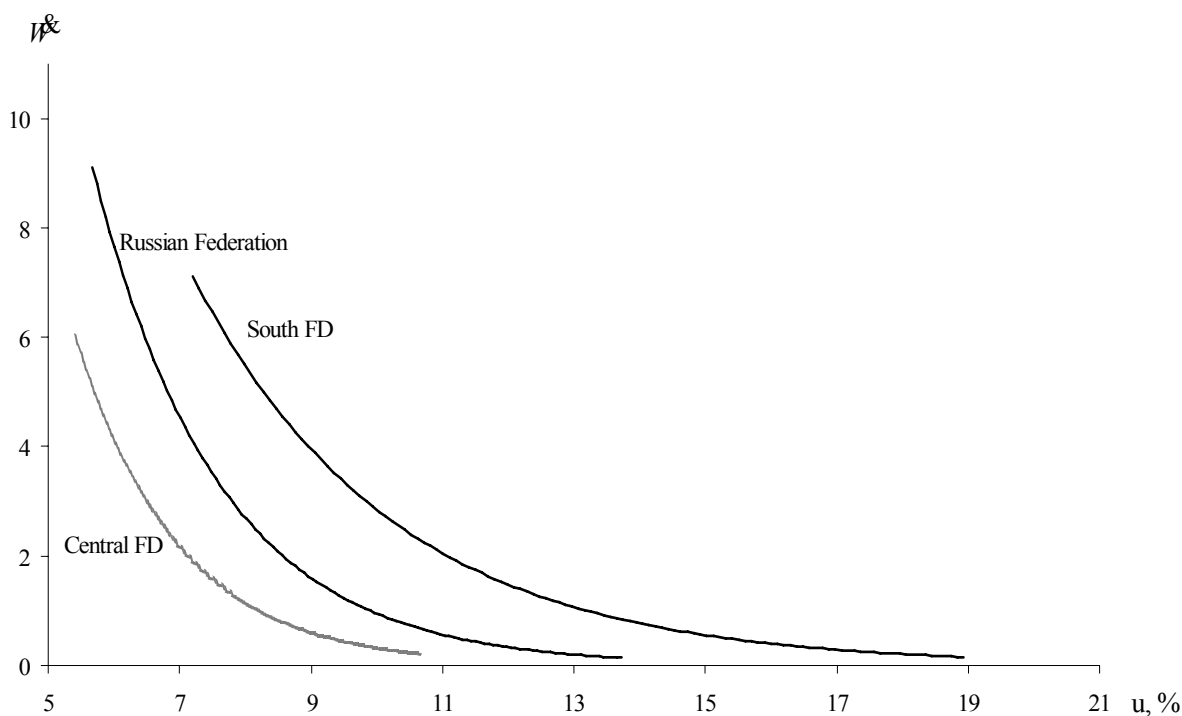


Fig. 2. Smoothed dynamics of nominal wage growth and unemployment rates for Russian Federation, Central and South FDs

*Nominal wage dynamics analysis* over the period under consideration shows its inexorable growth and the presence of the following specific features. Each year December witnessed a significant upward shift of the wage growth rate, while in January of the next year the old trend was restored. This can be explained by the payment of bonuses and other owed sums toward year's end and return of all payments to their usual level in January. Nominal wage growth rate accelerates each March, June and September, although not so much. This can be explained by the payment of quarterly bonuses and nominal wage indexation, which mostly occur at the end of each quarter.

Taking the December 1993 figures as basic, *basic nominal wage and CPI growth rates analysis* would show that between 1993 and 1995 accumulated nominal wage growth rate slightly exceeded the accumulated CPI. Between 1995 and March 2003, accumulated CPI increased at a faster rate than nominal wage (Fig. 3). Since August 1998, basic CPI substantially exceeded the accumulated nominal wage growth rate. Overlooking the December rises, one can say the CPI basic growth rate exceeded that of nominal wage, i.e., since 1995, consumer prices have been growing faster than nominal wage. On the whole since December

1993 through March 2003 nominal wage rose approximately 2500%, and prices approximately 3300%. This means that the real wage has become lower, and this has had a bad effect on the socioeconomic situation. It should be among the top priorities of the government's employment policy to raise real incomes and increase the role of wages in the formation of income and labor motivation.

In this context, a hypothesis on the lag between the nominal wage growth rate and price growth should be considered in the process of modeling. This assumption is only natural, since prices are essentially more flexible than nominal wage. In the contemporary Russian economy, the wage is a rigid enough value. In most cases, the nominal wage can remain relatively unchanged for a fairly long period, often being a part dependent on the minimum wage and fixed in labor and collective agreements, which are usually revised once a year.

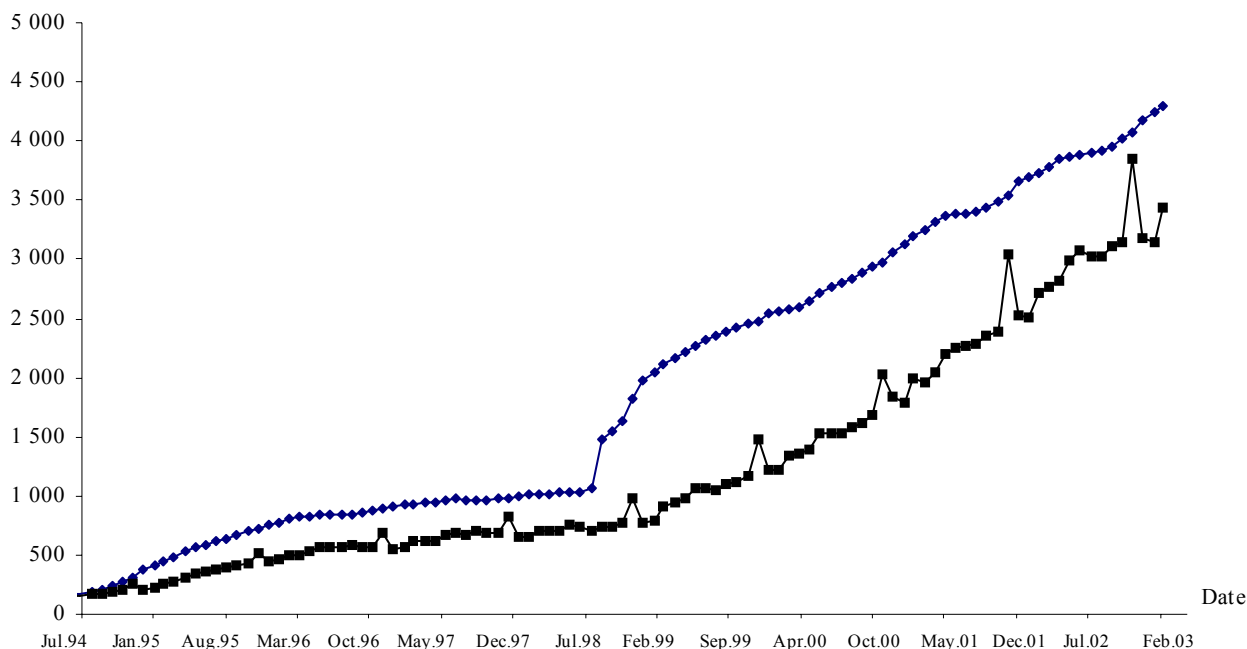


Fig. 3. Nominal wage (—■—) and CPI (—◆—) indices  
(December 1993 = 100%)

In view of these specifics of the examined indicators dynamics, the *initial model 1 was modified*. CPI growth rate with a lag of 3, 5 and 6 months was added to the equation. This made it possible take into account the factor of deferred impact of CPI growth rate upon the nominal wage changes. We also introduced into model 5 dummy variables, which take into consideration the December and January fluctuations in the nominal wage growth rate, as well as the ones that occur throughout the year (Model 2):

$$\dot{w}_t = \beta_0 + \beta_1 \frac{1}{u_t} + \beta_3 \dot{P}_{t-3} + \beta_4 \dot{P}_{t-5} + \beta_5 \dot{P}_{t-6} + \beta_7 D_{1,t} + \beta_8 D_{2,t} + \beta_9 K_{1,t} + \beta_{10} K_{2,t} + \beta_{11} K_{3,t} + \varepsilon_t,$$

where  $D_{1,t}$  is a dummy variable characterizing an upward shift of the nominal wage growth rate in December ( $D_{1,t} = 1$  for upward shift presence,  $D_{1,t} = 0$ , otherwise);  $D_{2,t}$  is a dummy variable characterizing a downward shift of the nominal wage growth rate in January ( $D_{2,t} = 1$  for downward shift presence,  $D_{2,t} = 0$ , otherwise);  $K_{1,t}$ ,  $K_{2,t}$ ,  $K_{3,t}$  are variables, indicating March, June and September upward shifts of the nominal wage growth rate respectively ( $K_{i,t} = 1$  for quarter shift,  $K_{i,t} = 0$ , otherwise,  $i = 1, 2, 3$ );  $\dot{P}_{t-\tau}$  is CPI monthly growth rate with a lag of  $\tau$ ;  $u_t$  is monthly unemployment rate;  $\varepsilon_t$  is a regression error,  $\varepsilon_t \sim N(0, \sigma^2)$ .

This equation has also a good statistical properties (see also Appendix 1).

	Const	1/ $u_t$	$\dot{P}_{t-3}$	$\dot{P}_{t-5}$	$\dot{P}_{t-6}$	$D_1$	$D_2$	$K_1$	$K_2$	$K_3$	$R^2$	$D$
Economy, total	-2,79	0,30	0,15	0,10	0,16	21,74	-18,15	8,13	6,42	3,73	0,95	2,13
t-ratio	-2,17	2,43	3,00	2,04	3,27	27,73	-23,74	10,62	8,03	4,42		

When interpreting, it should be noted a 1% rise of consumer prices in appropriate period in the past (other factors being equal) raises the nominal wage growth rate for approximately 0,15% at the current month. At the same time each December nominal wage rises on average 21,7%, and goes down 18,2% the next January. At the end of the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> quarters nominal wage growth rate rises by an average 8,1%, 6,4% and 3,7% respectively. The value inverse to unemployment rate is related to the economically active population and unemployed persons. It is the ratio of aggregate labor supply to its current part. So the growth of this indicator can mean:

- a rise of employment rate while the number of unemployed persons remains the same, or the growth of economically active population;
- a reduction of the unemployment volume while employment rate remains constant, or decrease of economically active population; or
- a rise of employment rate while unemployment goes down.

In all these cases, nominal wage rate of growth rises 0,3%, provided the other factors remain constant.

*Regional nominal wage levels comparison* for the period 1994–2002 showed its high differentiation. Maximum to minimum levels ratio increased from 7,63 in 1994 to 8,7 in 2002. Regions of the Central and South FDs are standing aside with their in gen-

eral lower nominal wage levels. Thus, region inequity is increasing. According to the Russian Federation State Committee for Statistics, in 2002 average monthly accrued wage was lower the level of the whole economy in 58 regions. The same took place within 54 regions in 1995. Comparison is clear.

For all overviewed regions, monthly nominal wage rate of growth is characterized by increases in Decembers and decreases in Januaries (Fig. 4).

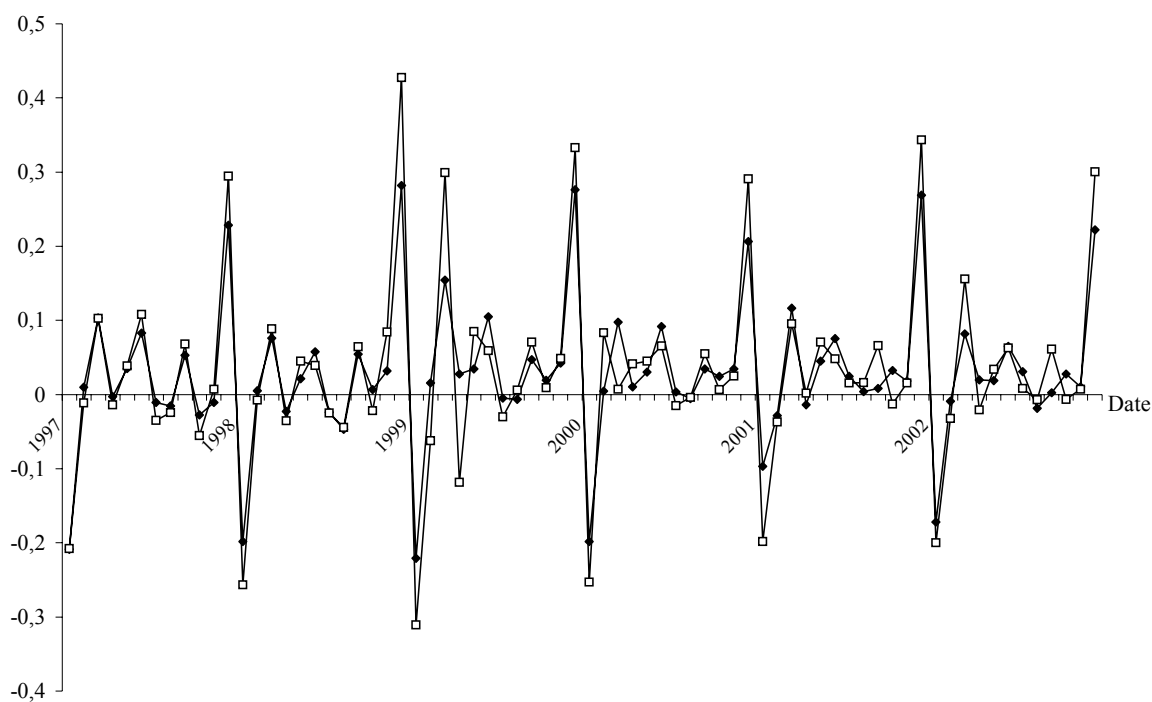


Fig. 4. Monthly nominal wage rate of growth in the Far East FD (—□—) and Russian Federation (—◆—) January 1997 to December 2002

*Nominal wage dynamics model: regional aspects.* On the basis of the monthly statistics for FDs from March 1994 to December 2002 equations analogous to model 2 were estimated. For adequate comparative analysis of the studying relationship through FDs a model with the same structure as for the Russian Federation was examined. That is the relationship between the nominal wage rate of growth and the value inverse to unemployment rate, CPI growth rate lagged backward for 3 months, dummy variables mentioned above. Estimation results of the parameters could be seen in Appendix 2.

Its examination shows that only for the Far East FD there is no statistically significant relationship between nominal wage inflation and unemployment rate. This peculiarity is probably caused by socioeconomic and climatic living conditions in the very FD. For that reasons considerable outflowing migration could be seen. Specially it is true for the qualified workers. All this negatively impacts the intraregional industrial labor market.

Considered relationship is statistically significant for the rest of 6 FDs. They could be divided into 2 groups according to the coefficient level at the  $1/u_t$  variable. The first group, where coefficient level is higher than the average for the Russian Federation, is formed by the South and Urals FDs. The second one, where coefficient level is lower, by the Central, North West, Volga and Siberian FDs.

Districts of the first group are characterized by greater unemployment rate influence on the nominal wage, than the same influence in the equation for the total economy. The peculiarities of Ural FD mentioned above are largely due to significant mining industry share. That mining industry domination determines specific requirements to professional qualification and workers' characteristics. All this brings to a qualified labor resources deficit and stimulates more intensive wages growth.

The South FD's relationship showed that the influence of the all included factors on the nominal wage inflation exceeds average values. This could be caused by the following reasons. Agricultural complex, which was in recession during the considered period, forms the significant part of the district's economy market activity. This, and natural forms of wage led to the lowest values of the average monthly wage. It was 1,5 times lower than average for the total economy. From the other side, more favorable climate conditions attracted population from other districts, which transformed into increased unemployment rate<sup>2</sup>.

Verification of similar dependences for the regions of *Russian Federation* has also discovered existence of *lagged impact that price growing has on changes in nominal wage*. The lag level was estimated using Akaike information criterion (AIC) and Schwarz criterion (BIC). Modified models including the CPI growth rate with lag value from 0 to 12 were examined for each region. Comparison of AIC and BIC indicators allowed to uncover the proper lag levels for each region (see Appendix 3), corresponding to the minimal values of the criteria. Above mentioned lagged CPI influence is, in general, due to the lack of the economic processes flexibility (in particular, the duration of labor contracts limits the opportunity for monthly wages review), and for the regional differences in each lag (from 2 to 7 months). This could be explained by the structure of production, presence of financial resources and different speed of economic agents to price changes adaptation. Under the low

---

<sup>2</sup> *Increasing unemployment rate is also caused by unregistered migration from the CIS countries.*

and stable rate of inflation it is more likely to expect the increase of lag level, which is mostly according to predictability of the price component in wages.

In all regions except for the Republic of Komi, the coefficient at the variable describing inflation appeared to be higher than the value of the coefficient, characterizing the rate of unemployment. That is, a 1% change in CPI has the greater impact on wage growth than the similar change in quantity of unemployed. Thus, the prevailing influence of price factor on the nominal wage growth rate is underlined.

There is a set of regions, where the relationship between the nominal wage growth rate and unemployment rate is statistically insignificant (see Appendix 4). It can be explained, probably, by the impact of various factors including the difference in production structure within regions and industries, the lack of investments, concentration of financial resources in a limited number of regions, climate conditions, etc.

Transition to the market economy at the beginning of the 1990s led to the increase in the labor market unbalance and its transformation to the new forms. Appeared unemployment could be explained not only by macroeconomic decrease, but also by ineffective usage of labor resources.

In paper [8] *structural unemployment* method of calculating is given. The result obtained was the following: the structural balance is at the point, where the unemployment to vacancies ratio of a given sector (occupations, regions, industries) is equivalent to the one of the whole economy. We can measure the volume of structural unemployment as a number of unemployed persons, who have to change sector in order to achieve the equilibrium. So, we consider the following index:

$$SU = \frac{1}{2} \sum_i |U_i - (U/V)V_i| = \frac{1}{2} U \sum_i |\hat{u}_i - \hat{v}_i|,$$

where  $\hat{u}_i = U_i/U$  is the share of sector  $i$  in the total number of unemployed,  $\hat{v}_i = V_i/V$  is the similar share for the number of vacancies. The  $SU$  indicator shows the total volume of the structural unemployment. It can be calculated as a share of total unemployment or as a share of labor force. The estimates of structural unemployment for regions and industries are given in Table 1.

The figures in Table 1 show that there is a high level of structural unemployment on the Russian labor market. Therefore, we can not characterize our labor market as an efficient one. The real level of structural unemployment might, probably, be higher, because regional and industrial unbalances appear at the same time, and they are not totally over-



lapped. There could also be structural misbalances by education, occupation, age and other structures.

Table 1

Estimates of structural unemployment for regions and industries in Russia

Indicator		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Regional structural unemployment	thou pers.	708	916	1085	1434	2121	2037	2564	2560	2089	2836	3188
	% of total unemployment	18,0	20,3	19,1	21,9	29,1	25,0	26,4	28,8	27,3	34,8	38,7
Industrial structural unemployment	thou pers.	1207	1615	1946	2398	2852	3295	3607	2777	2422	1932	1966
	% of total unemployment	30,7	35,8	34,2	36,7	39,2	40,5	37,1	31,2	31,6	30,6	32,2

After calculating the level of *structural unemployment*, we used these estimates in the *Phillips curve model* (model 1). The following results were obtained (see Table 2). ( $u_r$  and  $u_b$  are the levels of regional and industrial structural unemployment, respectively.) As it could be seen, there is a strong significant relationship between minimal wage growth rate and corresponding level of structural unemployment.

Table 2

Model 1 estimates for Russian Federation according to structural unemployment level

	<i>Const</i>	$1/u_r$	$1/u_b$	$R^2$	<i>D</i>
Economy, total	-3,17	0,13		0,904	2,115
<i>t</i> -ratio	-4,58	9,18			
Economy, total	-11,72		0,35	0,856	1,682
<i>t</i> -ratio	-5,96		7,315		

Following the economic theory, nominal wage and its dynamics influence the cyclic unemployment (the unemployment of low demand), but not the structural one. In our case, a different conclusion is to be made, i.e., nominal wage is one of the factors, which determine the mismatching of job and workers characteristics. Suppose that one person receives low wage for a long time. Having no chance to get enough compensation for his efforts he decreases the marginal product of his labor. In the second period, he becomes unemployed and starts to look for a new job. But even if he finds a job, he probably gets troubles because he can not, or do not want to increase his productivity to higher level.

The other problem arises when a person from a highly-paid sector — being unemployed — is looking for the job in the low-paid sector. The reservation wage for such a person is quite high. This reservation wage prevents him from entering the low-paid sec-

tor (at least in the short run, when the unemployed person has enough savings to continue job searching).

Thus, for the entire Russian economy and for most of its regions nominal wage depends on consumer prices inflation (with lag(s)) and on unemployment rate. The influence of the factors differs within regions. Therefore, it is possible to say, that the processes, which determine current and perspective nominal wage dynamics have some substantial peculiarities for FDs and several regions. The most obvious fact is that the nominal wage level does not depend on unemployment rate in some regions, i.e. on labor market dynamics. FDs and regions differ also by inflation influence on the nominal wage. Changes in price dynamics influence the nominal wage with different lags. From one side, that means that the speed of adaptation is different. From the other one, it shows the level of economic agents' certainty in the recent economic trends.

### References

1. Korovkin A. G., Polezhaev A. V. *Dynamics of the Russian Labor Market and Adjustment for Labor Input: An Analysis // Studies on Russian Economic Development, Vol. 14, №5, 2003.*
2. *Institute of Economic Forecasting Russian Academy of Sciences Collection of Articles. Moscow, MAKS Press, 2003.*
3. Korovkin A. G. *Dynamics of Employment and Labor Market: Questions of Macroeconomic Analysis and Forecasting. Moscow, MAKS Press, 2001.*
4. Korovkin A. G., Zaitsev N. M., Parbuzin K. V., Polezhaev A. V. *Employment in the Russian Federation by Industry: An Estimate // Studies on Russian Economic Development, Vol. 11, №4, 1999.*
5. Korovkin A. G., Podorvanova Yu. A., Dolgova I. N. *Relationship Between Nominal Wages and Unemployment: Regional Aspects // Studies on Russian Economic Development, Vol. 14, №6, 2003.*
6. Belyavskii M. O., Korovkin A. G., Polezhaev A. V. *Russia's Labor Market and Nominal Wage Dynamics // Studies on Russian Economic Development, Vol. 11, №6, 2000.*
7. Lipsey R. G., Steuer M. D. *The relation between profits and wage rates // Economica, №110, 1961.*
8. Jackman R., Roper S. *Structural unemployment // Oxford Bulletin of economics and statistics, 49, 1, 1987.*

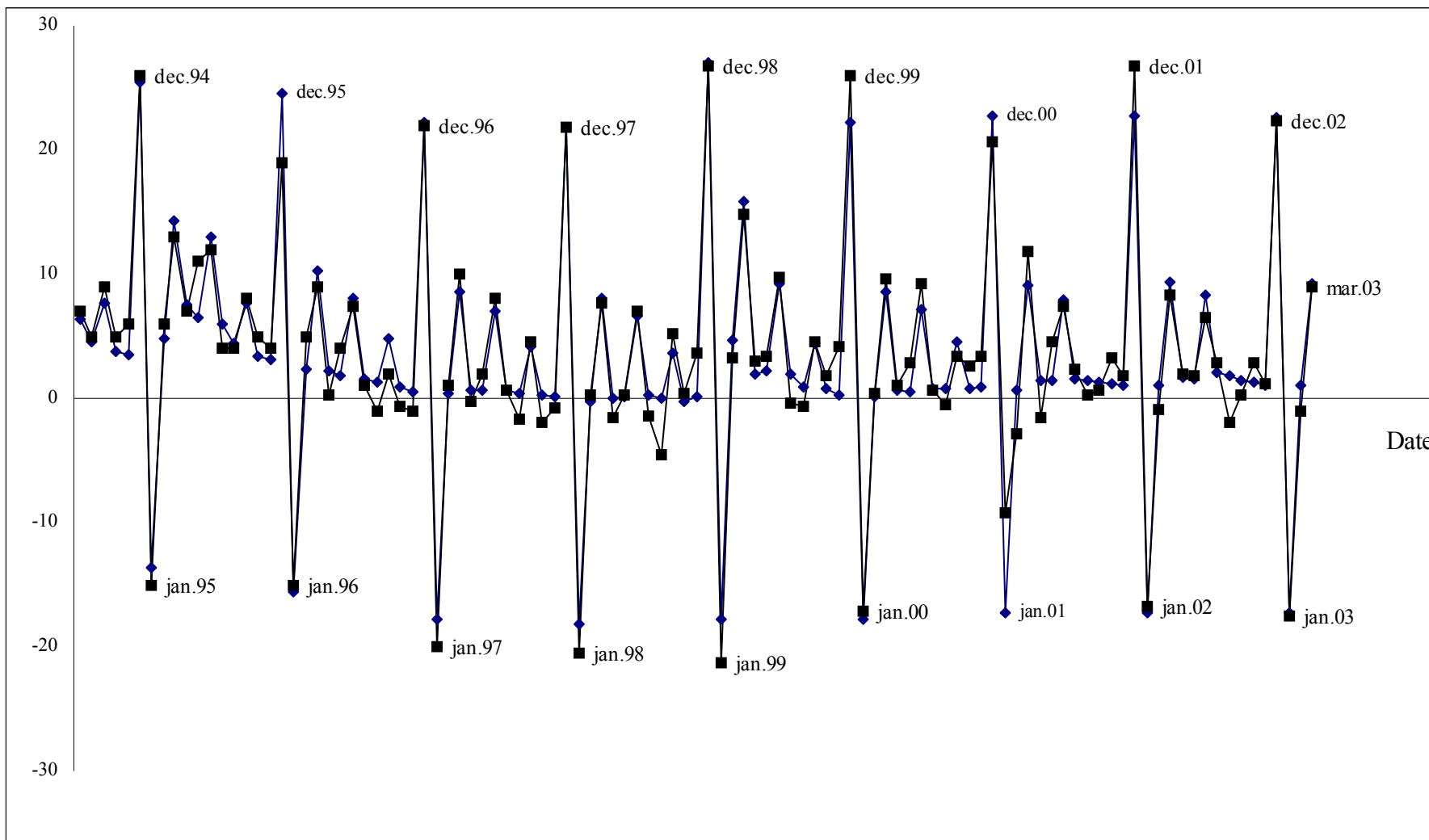


Fig. Actual (—■—) and estimated (—◆—) nominal wage growth rate dynamics

## Model 2 estimation results for FDs and economy as a whole

Federal District	$D1$	$D2$	$K1$	$K2$	$K3$	$P_{t-\tau}$	$1/u$	$Const$	$R^2$	$R^2_{adj}$	$d$
Central	0,204 (17,519)	-0,167 (-13,697)	0,071 (5,823)	0,093 (7,668)	0,021 (2,936)	0,318 (4,979)	0,439 (2,273)	-0,045 (-1,913)	0,8973	0,8885	2,16
North West	0,180 (16,741)	-0,155 (-13,765)	0,082 (7,290)	0,046 (4,056)	0,022 (2,080)	0,337 (6,109)	0,409 (2,316)	-1,913 (-1,714)	0,8941	0,8850	1,83
South	0,294 (21,892)	-0,265 (-18,764)	0,104 (7,308)	0,116 (8,682)	0,051 (3,859)	0,401 (4,458)	0,562 (2,222)	-0,039 (-2,161)	0,9341	0,9284	2,32
Privolzhsky (Volga)	0,208 (20,176)	-0,200 (-18,364)	0,081 (7,424)	0,071 (6,509)	0,027 (2,660)	0,311 (4,755)	0,510 (3,171)	-0,046 (-2,648)	0,9258	0,9195	2,45
Urals	0,200 (14,637)	-0,207 (-14,352)	0,116 (8,007)	0,075 (5,236)	0,028 (2,078)	0,193 (2,350)	0,652 (2,917)	-0,053 (-2,256)	0,8809	0,8707	2,05
Siberian	0,240 (20,188)	-0,206 (-16,434)	0,087 (6,865)	0,075 (5,988)	0,047 (3,968)	0,346 (4,124)	0,381 (2,122)	-0,031 (-1,990)	0,9164	0,9092	2,14
Far Eastern	0,276 (17,591)	-0,246 (-14,902)	0,090 (5,105)	0,076 (4,881)	0,061 (3,879)	0,501 (4,512)	0,208 (0,715)	-0,021 (-0,871)	0,8969	0,8880	2,16
<i>Russian Federation</i>	0,220 (25,006)	-0,210 (-21,410)	0,089 (9,601)	0,074 (8,041)	0,032 (3,759)	0,269 (5,514)	0,540 (3,474)	-0,046 (-2,910)	0,9485	0,9441	1,62

Note. T-ratios are indicated in brackets.

## Russian Federation regions distribution according to CPI lag level in Model 2

CPI lag level	Russian Federation regions (numbers according to Appendix 4)
2	20, 24, 74, 81, 86
3	2, 6–8, 12–14, 19, 21, 26, 29, 31, 33, 39, 40, 43, 46, 48, 63, 64, 66–68, 75, 80, 88
4	10, 65
5	5, 34, 35, 42, 44, 45, 47, 51, 56, 60, 69, 72, 76–78, 82, 83
6	1, 3, 4, 9, 11, 15–18, 23, 25, 28, 30, 38, 49, 52, 53, 55, 57–59
7	27, 41, 50, 87



Russian Federation regions distribution according to presence of the nominal wage growth rate — unemployment level relationship:  
 ■ – relationship found      □ – relationship not found

## Russian Federation regions list to the map

- (1) Belgorod reg.
- (2) Bryansk reg.
- (3) Vladimir reg.
- (4) Voronezh reg.
- (5) Ivanovo reg.
- (6) Kaluga reg.
- (7) Kostroma reg.
- (8) Kursk reg.
- (9) Lipetzk reg.
- (10) Moscow reg.
- (11) Oryol reg.
- (12) Ryazan reg.
- (13) Smolensk reg.
- (14) Tambov reg.
- (15) Tver reg.
- (16) Tula reg.
- (17) Yaroslavl reg.
- (18) The City of Moscow
- (19) Rep. of Karelia
- (20) Rep. of Komi
- (21) Arkhangelsk reg.
- (22) Nenets autonomous area
- (23) Vologda reg.
- (24) Kaliningrad reg.
- (25) Leningrad reg.
- (26) Murmansk reg.
- (27) Novgorod reg.
- (28) Pskov reg.
- (29) The City of Sankt-Petersburg
- (30) Rep. of Adygeya
- (31) Rep. of Dagestan
- (32) Rep. of Ingushetiya
- (33) Kabardian-Balkar rep.
- (34) Rep. of Kalmykiya
- (35) Karachaev-Cherkessian rep.
- (36) Rep. of Noth Ossetiya — Alania
- (37) Chechen rep.
- (38) Krasnodar territory
- (39) Stavropol territory
- (40) Astrakhan reg.
- (41) Volgograd reg.
- (42) Rostov reg.
- (43) Rep. of Bashkortostan
- (44) Rep. of Mariy El
- (45) Rep. of Mordovia
- (46) Rep. of Tatarstan
- (47) Udmurt rep.
- (48) Chuvash rep.
- (49) Kirov reg.
- (50) Nizhny Novgorod reg.
- (51) Orenburg reg.
- (52) Penza reg.
- (53) Perm reg.
- (54) Komi-Permyatsky autonomous area
- (55) Samara reg.
- (56) Saratov reg.
- (57) Ulyanovsk reg.
- (58) Kurgan reg.
- (59) Sverdlovsk reg.
- (60) Tyumen reg.
- (61) Khanty-Mansi autonomous area
- (62) Yamalo-Nenets autonomous area
- (63) Chelyabinsk reg.
- (64) Rep. of Altay
- (65) Rep. of Buryatia
- (66) Rep. of Tuva
- (67) Rep. of Khakasia
- (68) Altay territory
- (69) Krasnoyarsk reg.
- (70) Taimyr autonomous area
- (71) Evenki autonomous area
- (72) Irkutsk reg.
- (73) Ust-Ordyn Buryat autonomous area
- (74) Kemerovo reg.
- (75) Novosibirsk reg.
- (76) Omsk reg.
- (77) Tomsk reg.
- (78) Chita reg.
- (79) Aginsky Buryat autonomous area
- (80) Rep. of Sakha
- (81) Primorsky territory
- (82) Khabarovsk territory
- (83) Amur reg.
- (84) Kamchatka reg.
- (85) Koryak autonomous area
- (86) Magadan reg.
- (87) Sakhalin reg.
- (88) Jewish autonomous oblast
- (89) Chukchi autonomous area