Post-Communist Economies, Vol. 17, No. 1, March 2005

Estimation of the Natural Unemployment Rate in the Russian Federation, 1994–2004

VLADIMIR A. BRAGIN & VLADIMIR V. OSAKOVSKY

Abstract

To specify the problem of unemployment in Russia, we estimate the natural rate of unemployment by consecutively estimating the optimal size of the labour force and the optimal employment. For estimation of the optimal values we used a modified Hodrick–Prescott filter technique. The results show that the natural rate of unemployment in Russia during 1994–97 was stable around 13–13.5% and decreased to 7.1% by mid-2004. Moreover, before 1998 the actual unemployment was significantly lower than the natural rate and today practically equals it.

Unemployment is one of several new economic phenomena brought into the lives of ordinary Russians by the liberalisation of the economy at the end of the twentieth century. However, despite numerous catastrophic forecasts, very popular at the beginning of the reforms, throughout the whole period up until today unemployment has not become the dominant factor on the Russian labour market. Although within a few years Russian GDP fell by almost 50%, total employment fell by less than 18%, with the unemployment rate rising to at most 13–14% of the labour force. By 2004 the unemployment rate had declined to just over 7% of the labour force.

The major explanation for this phenomenon is the fact that the initial job market response to recession was reduction of real wages, instead of reduction of employment. This was largely induced by the soft monetary policy of the Russian Central Bank, which led to hyperinflation at the beginning of the 1990s.

Another major trend on the job market over the last decade was a reduction in the size of the labour force. According to statistics, from 1992 to 2001 the working-age population not in the labour force increased by more than 6.6 million, and the labour force participation rate fell by over 6%. This is equivalent to removal of more than 7.7 million from the labour market.

Another major reason for a relatively low unemployment rate in Russia is movement towards balance between labour supply and demand. At the start of the reforms the characteristic feature of the Russian labour market was a sharp labour deficit. According to a number of estimates (Korovkin, 1990, 2001; *Sotsial'nye*, 1990) the problem of unequal growth of vacancies and labour force was observed in the RSFSR since 1970.

Dr Vladimir A. Bragin, Expert, and Dr Vladimir V. Osakovsky, Senior Expert, The Institute for an Open Economy, 101990 Moscow, Kolpachnyi pereulok d.4 str. 3, Russian Federation. VBragin@openecon.ru and VOsakovsky@openecon.ru.

ISSN 1463-1377 print/ISSN 1465-3958 online/05/010033-14
DOI: 10.1080/14631370500052514

The problem reached critical levels in the second half of the 1980s, when the number of vacancies grew to over 50% of the population not engaged in the economy and more than 10% of the number of employed. In this situation the initial adaptation of the labour market to reforms was elimination of vacancies. As a result, in a few years, the number of vacancies fell to 1–2% of the total number employed.

On the other hand, some researchers (Kapelyushnikov, 2001; Otsu, 1992) note that the labour deficit in the Soviet economy existed only because the employment rate in pre-reform Russia exceeded its optimal level by as much as 15%. In this respect, as one might have expected, with the beginning of reforms, companies could have started massive reduction of 'unnecessary' workers, which would have resulted in significant or even catastrophic growth of unemployment. Notwithstanding the fact that this scenario failed to materialise, the reduction of excessive employment is yet another major factor which influenced and continues to influence the Russian labour market.

Overall, throughout the whole period of reforms and up until today, the labour market in Russia has been influenced by a broad range of factors, which have an extremely wide-ranging and complex influence (reduction of the labour force, economic recession, change in employer behaviour towards 'unnecessary' workers etc.).

In this respect, considering the social and political importance of the labour market, the purpose of this research is estimation of the unemployment rate which would exist in Russia under conditions of long-term market balance, i.e. the rate adjusted for short-term effects of recession and effects of overcoming the 'heritage of the planned economy'. Estimation of this level can give a more objective view of the unemployment problem in the country, and can also help to determine the most effective set of policy measures.

Using the standard terminology, the purpose of this research is estimation of the natural rate of unemployment in Russia, or the rate of unemployment for which the underlying reasons, according to Friedman (1968) are 'natural' (demographic, institutional, social) rather than monetary or cyclical factors. This is the rate of unemployment which can be achieved in the absence of short-term effects due to unexpected changes in inflation and/or productivity.

Given the importance of the subject, it is surprising that there is no research on the natural unemployment rate in Russia in the existing literature. A number of researchers (Kapelyushnikov, 2001; Korovkin, 1990, 2001; *Ekonomika truda*, 2003) make comments on the general structure of existing unemployment, but without undertaking any attempt to estimate quantitatively and qualitatively the level of conformity of the actual rate to the optimal or natural rate.

The Model

There are several techniques to estimate the natural rate of unemployment (as also the 'natural' levels of other variables). For example, the Economic Planning Agency (2000) in Japan uses historical averages. Other researchers (Kamada & Masuda, 2001) take the natural level as the level at which all other factors of production are completely utilised. A third alternative definition is the unemployment rate with stable inflation (CBO, 1995; Eisner, 1995; Gordon, 1982; Steiger, Stock & Watson, 1997; Tootell, 1994; Weiner, 1993, 1994).

Given the wide range of factors influencing the labour market, we use an alternative approach, estimating the natural unemployment rate through consecutive estimation of the major constituents of this level, i.e. the optimal level of employment and the optimal size of the labour force.

One of the positive features of such an approach is that, in addition to the estimate of the target parameter, we also get other interesting variables, such as the optimal level of employment and long-term size of the labour force.

Technically, our method represents a combination of the first and third estimation methods. As the natural employment rate we take the employment rate at stable inflation taking into account the economy-wide recession. At the same time, as the optimal size of the labour force we take its level in the absence of demographic changes and with stable monetary incomes.

Model of Employment

As a theoretical background for the estimation of the optimal employment rate we use two relationships provided by economic theory. One is the dependence of unemployment on inflation first formulated by Phillips (1958) and later modified by a number of researchers (Friedman, 1968; Phelps, 1967, 1970), which can be written as

$$\left(Y_t - Y_t^*\right) = \gamma\left(\pi_t - \pi_t^e\right) \tag{1}$$

Another is the relationship between employment and output, or a modification of Okun's (1962) law, which can be outlined as

$$\left(E_t - E_t^*\right) = k\left(Y_t - Y_t^*\right), \tag{2a}$$

where starred terms represent optimal values of the parameters. Here we suggest that in the case of significant deviations of the actual level from its optimal value the relationship between employment and output is not the same as in the case of normal business cycle variations. In particular, in the short term the actual level of employment fluctuates around some 'normal' (for a given level of Y_t) amount of employment $\tilde{E}_t$, which itself gradually approaches its optimal level. Overall we assume that the adaptation mechanism takes the form of the following error correction model:

$$\Delta E_t = \alpha \Delta \tilde{E}_t + \beta(\tilde{E}_{t-1} - E_{t-1}) \tag{3}$$

In addition, with this assumption, the short-term version of equation (2a) would look more like

$$\left(\tilde{E}_t - E_t^*\right) = k\left(Y_t - Y_t^*\right), \tag{2b}$$

which in the long run converges to (2a), as 'normal' employment reaches its optimal level. In dynamic form, with some normalisation, (2b) would look like

$$\Delta \tilde{E}_t = k \Delta Y_t. \tag{4}$$

Note that here we assume that the actual GDP depends on changes in short-term 'normal', not actual employment. Using equations (1) and (2b) we reach the following:

$$\left(\tilde{E}_t - E_t^*\right) = k \cdot \gamma\left(\pi_t - \pi_t^e\right), \tag{5a}$$

or

$$\tilde{E}_{t-1} = k \cdot \gamma(\pi_{t-1} - \pi^e_{t-1}) + E^*_{t-1}. \tag{5b}$$

Since here we are not interested in $\tilde{E}_t$, we substitute $\Delta\tilde{E}_t$ from equation (4) and $\tilde{E}_{t-1}$ from equation (5b) into equation (3) to get the following:

$$\Delta E_t = \alpha \cdot k \Delta Y_t + \beta \cdot \left(E^*_{t-1} - E_{t-1}\right) + k \cdot \gamma \cdot \beta(\pi_{t-1} - \pi^e_{t-1}) \tag{6}$$

or

$$\Delta E_t = \alpha_1 \left(E^*_{t-1} - E_{t-1}\right) + \alpha_2 \Delta Y_t + \alpha_3 (\pi_{t-1} - \pi^e_{t-1}). \tag{6a}$$

Here, assuming adaptive inflationary expectations $\pi^e_t = \pi_{t-1}$, equation (6) could be rewritten as

$$\Delta E_t = \alpha_1 \left(E^*_{t-1} - E_{t-1}\right) + \alpha_2 \Delta Y_t + \alpha_3 \Delta \pi_{t-1}, \tag{7}$$

and might include more lags on inflation, given the assumption of a more complex expectations structure.

The relationship above can also be interpreted as a decomposition of employment changes into three major components, which are represented by three terms on the right-hand side of the equation. The first is adaptation of the actual level of employment to its optimal level; the second is dependency on changes in real factors, e.g. GDP changes; and the third represents the influence of monetary factors, e.g. inflation.

The latter, or the estimation of the Phillips curve on Russian data, presents significant difficulty given the deep changes in monetary regimes over the past decade. Such changes can make the influence of inflation on unemployment equivocal. The possibility of such a discrepancy given deep changes in inflation regimes is mentioned by Friedman (1977). Besides, the time period under consideration is very short for estimation of the long-term optimal level. In this respect, changes in inflation can have quite an ambiguous influence on the labour market, depending on the time and level of price changes.

As an attempt to deal with this problem we distinguish three major inflationary periods since the beginning of reforms in Russia: the hyperinflation of 1992–94, the period of the exchange rate corridor (1994–98) and the floating rate period which began after the 1998 financial crisis. To differentiate between these periods we include two dummy variables: one for the hyperinflation period (from the beginning of a time trend with quarterly inflation rates exceeding 10%) and the second for all periods after the third quarter of 1998.

As a result, the model can be written as

$$\Delta E_t = \alpha\left(E^*_{t-1} - E_{t-1}\right) + \beta_1 \Delta Y_t + \beta_2 \Delta \pi_t + \beta_3 \Delta \pi_{t-1} + \gamma_1 D_1 + \gamma_2 D_2 + \varepsilon_t \tag{8}$$

where

π_t — inflation,
Y_t — cumulative demand (GDP),
$D_{1,2}$ — inflationary period dummy variables,
E_t — employment,
E^*_t — optimal employment.

With data for E_t^*, or given the assumption of its constant level over the whole period, one could estimate all the unknown parameters (α, β and γ) by a simple OLS. However, in our case the assumption of a constant optimal level does not apply. Therefore it is necessary to use a different technique which allows simultaneous estimation of E_t^* and all other parameters.

In this research we use the technique applied by Hirose & Kamada (2001), who simultaneously estimate the Phillips curve and the potential (natural) GDP level on the assumption that this parameter changes smoothly over the whole time interval. In their work the potential output level is a moving average of a GDP trend, adjusted for inflation, which is estimated using a modified version of a Hodrick–Prescott (HP) filter (Hodrick & Prescott, 1997).

A Hodrick–Prescott filter is a time series technique which estimates the series x_t^{HP}, which minimises the following objective function:

$$\sum_{t=1}^{T}\left(x_t - x_t^{HP}\right)^2 + \lambda\sum_{t=2}^{T-1}\left(\Delta x_{t+1}^{HP} - \Delta x_t^{HP}\right)^2, \qquad (9)$$

where λ is a parameter of smoothness of x_t^{HP} changes, which is a moving average for the x_t series.

However, since x_t^{HP} is a simple moving average for x_t, correlation with other independent variables is practically absent. Therefore x_t^{HP} can not be considered a good estimate for the natural unemployment level, given the assumption that it is influenced by a number of external factors (inflation etc.). The modification of the HP filter applied deals with precisely this problem.

The main idea of the technique is that we filter not the E_t series but a new series g_t, which is derived from the model of employment (1) and equals

$$g_t = \{E_t - (1+\alpha)E_{t-1} - \beta_1\Delta y_t - \beta_2\Delta\pi_{t-1} - \beta_3\Delta\pi_{t-2} - \gamma_1 D_1 - \gamma_2 D_2\}/\alpha. \qquad (10)$$

In this case the objective function is defined as

$$W\left(\alpha, \beta_1, .., \beta_5, \gamma_1, \gamma_2, E_1^N \ldots E_{T-1}^N\right) = \sum_{t=1}^{T}\left\{g_t - \alpha E_{t-1}^N\right\}^2 + \lambda\sum_{t=2}^{T-1}\left(\alpha\Delta E_{t+1}^N - \alpha\Delta E_{t-1}^N\right)^2 \qquad (11)$$

To obtain values for all necessary parameters of the objective function we use the following approach. First of all, the parameters of the model (8) ($\alpha, \beta_1, \ldots, \beta_3, \gamma_1$ and γ_2) are fixed at arbitrary values and, given them, we solve for T unknowns $\left(E_1^N, \ldots, E_T^N\right)$ by HP filtering the g_t series. After that we choose optimal values of other parameters, which minimise the objective function W. In this procedure, for a smoothness parameter λ we use the standard value for quarterly data ($\lambda = 1600$). The estimation is followed by standard tests for statistical significance of parameters obtained.

Labour Force Model

Since the beginning of reforms the Russian labour force has been under the influence of structural and institutional factors arising from transition to a market economy. In particular, Kapelyushnikov (2001) points to the reduction of employment opportunities for women with children and pensioners, which led to a 'more rational model of labour distribution among economic activities, similar to those of more mature economies'. In other words, the economic transition led to a shift from the abnormally high level of labour force participation in the Soviet period to the much lower level of a market economy. Therefore, we suggest, the optimal size of the labour force in the period of transition is close to the trend of this parameter value.

Among other factors which might influence the size of the labour force we can point to demographic factors (population changes affect the number of potential labour market participants) and also real incomes of the population. The latter is included in the analysis given some background from standard economic theory, according to which growth of real incomes increases opportunity costs of leisure, which might increase labour supply.

Taking into account all of these factors, the optimal size of the labour force is defined as the trend of labour force size weighted by changes in population and real incomes.

Thus the model of economic activity can be defined as follows:

$$A_t = A_t^* + \eta \Delta POP_t + \mu \Delta w_t + \varepsilon_t, \tag{12}$$

where

ΔPOP_t — changes in the population aged from 15 to 72 years, or potential labour supply,
Δw_t — real income changes,
A_t and A_t^* — actual and optimal size of the labour force respectively.

Using the technique applied for the estimation of the optimum level of employment, the temporal series for the labour force model (12) is set as follows:

$$h_t = A_t - \eta \Delta POP_t - \mu \Delta w_t, \tag{13}$$

and the objective function as

$$H\left(\eta, \mu A_1^* \ldots A_T^*\right) = \sum_{t=1}^{T} \left\{h_t - A_t^*\right\}^2 + \lambda \sum_{t=2}^{T-1} \left(\Delta A_{t+1}^* - \Delta A_t^*\right)^2. \tag{14}$$

Using the same technique and the same initial parameter as for the model of employment, we estimate T unknowns $A_1^*, \ldots, A_T^*$.

Results

We used quarterly data from the beginning of 1994 till the first quarter of 2003. For the model of employment we used data on the number of people employed in all sectors of the economy, the CPI and real GDP changes. For the labour force model we used data on the size of the Russian labour force, population aged from 15 to 72 years and real income changes. All data are provided by the Russian statistical agency Goskomstat.

First, we estimate regressions for the models outlined above and take measures for their possible restriction (for the methodology see Appendix). Second, we conduct a comparative analysis of natural and actual levels and explore their important characteristics. Finally, we use the natural levels of employment and labour force obtained to calculate the natural rate of unemployment.

Optimal Employment

By consecutive elimination of insignificant parameters in equation (8) we come to the following restricted model:

$$\Delta Et = \alpha\left(E^{*}_{t-1} - E_{t-1}\right) + \beta_1 \Delta Y + \beta_2 \Delta \pi_{t-1} + \gamma_2 D_2 + \varepsilon_t \qquad (15)$$

The estimation results are given in Table 1. As we can see, the signs of all the coefficients comply with the predictions of the model with significant R^2. Dummy D_2 here represents all periods before the third period of 1998.

The values of the optimal employment level $E^*_1, \ldots, E^*_T$ obtained are shown in Figure 1. As can be seen, optimal and actual employment in the Russian economy declined gradually from the beginning of reforms, reaching absolute minima in 1998 and 1999.

The major reason for this development is the sharp reduction in labour demand in Russia caused by reduction of the country's aggregate demand (GDP). At the same time, according to the results of this research, until the end of 1999 actual employment was higher than its optimal level. This result provides some background for theories of the presence of excessive employment (Kapelyushnikov, 2001; Otsu, 1992) in the Russian economy at the beginning of reforms. The gap between the two parameters gradually shrank and practically disappeared by mid-1999. After then the actual employment in the Russian economy started to follow its optimal level closely.

Optimal Size of the Labour Force

The results of the estimation of the labour force model presented in equation (12) are given in Table 2.

Both coefficients are statistically insignificant and close to zero. Therefore we come to the conclusion that the optimal size of the labour force is a simple moving average of the actual labour force.

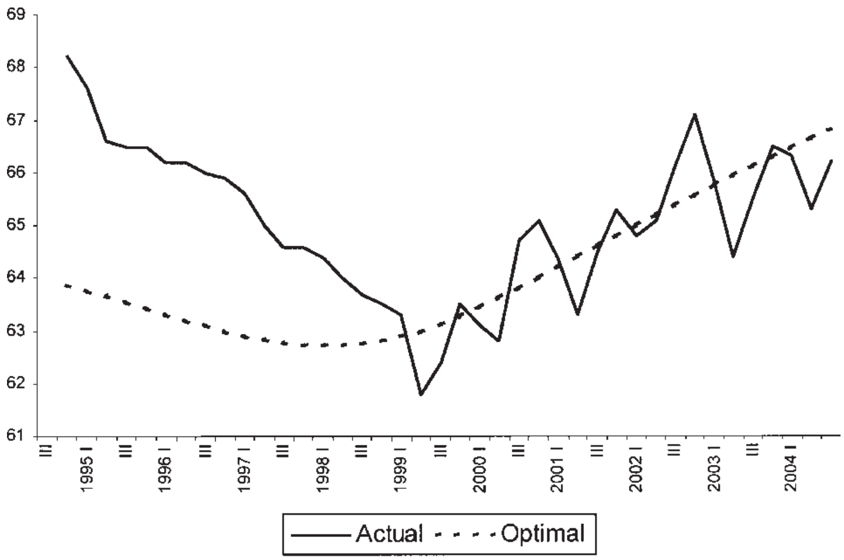
Such a result is not surprising, given the fact that the size of the labour force is a very static variable, not readily influenced by external factors. The resulting values for the optimal size of the labour force are given in Figure 2. As we can see, the optimal size of the labour force was steadily falling over the whole period.

Natural Rate of Unemployment

The natural rate of unemployment is calculated using the standard formula — the number of unemployed as a percentage of the total labour force. Here the optimal number of unemployed is the difference between the optimal size of the labour force and optimal employment. The results are shown in Figure 3.

Table 1. Estimation results, optimal employment

	Coefficient	T−statistic
α	0.331	3.797
β_1	0.054	5.233
β_2	0.010	1.630
γ_1	0.655	1.125



Sources: Actual—Goskomstat RF; Optimal—Institute for an Open Economy.

Figure 1. Changes in optimal and actual employment in the Russian economy (millions).

One of the major results is that since the beginning of reforms and up to the end of 1998 the natural unemployment rate remained on a rather high, and remarkably stable level, varying between 13% and 13.5% of the total labour force. This provides some background for the presence of a situation on the Russian labour market which Kapelyushnikov (2001) describes as 'adaptation without restructuring', or preservation of an inefficient structure of employment by development of a network of informal interrelationships between employers and employees.

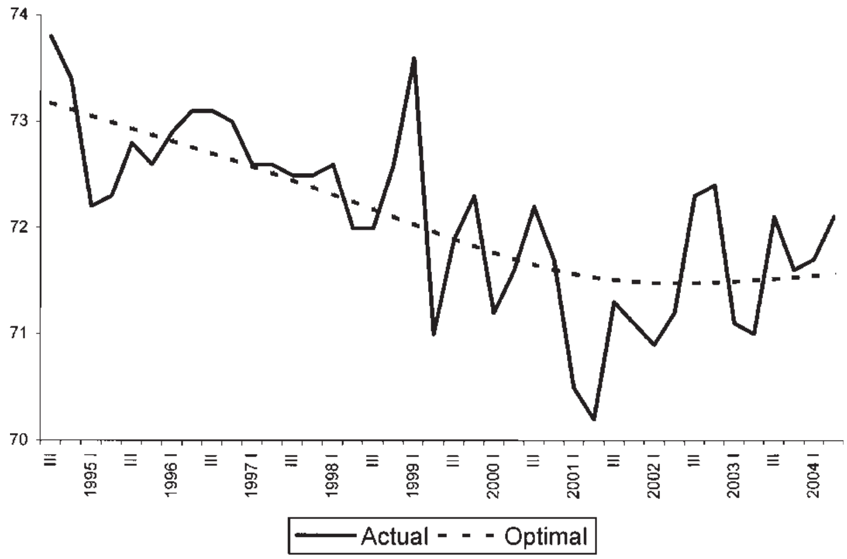
In particular, before 1998, because of the widespread use of such forms of firm–worker relationship as massive wage arrears and administrative leave, the formal institutions of the labour market lost their function as uniform and obligatory 'rules of the game'.

First of all, this softened the initial adaptation to market economy management. However, such uncertainty in firm–worker relations also opened wide opportunities for preservation of disproportions in the labour market left over from the planned economy. Primarily, this uncertainty gave a lot of opportunities for numerous inefficient enterprises and helped to preserve employment in the depressed sectors of the economy and regions of the country. Under other conditions these regions would have been forced into more radical reduction of employment. The existence and

Table 2. Estimation results, optimal labour force

	Coefficient	Standard error	t-statistic
η	− 0.001282	0.00133	− 0.00128
μ	0.000343	0.00589	0.05818

$R^2 - 0.6781$

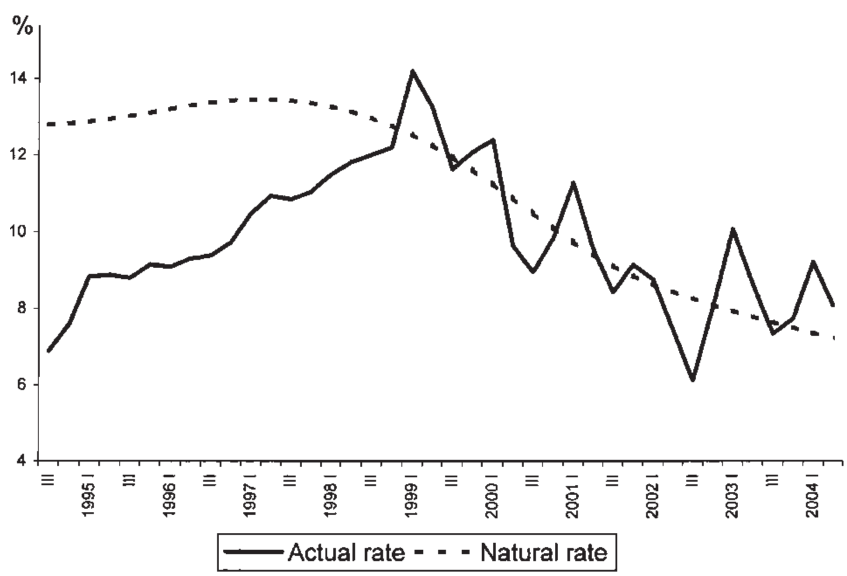


Sources: Actual—Goskomstat RF; Optimal—Institute for an Open Economy.

Figure 2. Changes in optimal and actual size of the Russian labour force, (millions).

propagation of this uncertainty resulted in the formation of a high natural unemployment rate.

Another quite unexpected result is that before 1998 the actual rate of unemployment was significantly lower than its natural rate, and after 1999 has practically equalled it.



Sources: Actual—Goskomstat RF; Natural—Institute for an Open Economy.

Figure 3. Changes in natural and actual rates of unemployment in Russia (% of the labour force).

First of all, this means that the Russian economy currently has full employment, and the major constituent of existing unemployment is structural rather than cyclical unemployment. In fact, more or less significant levels of cyclical unemployment in Russia were observed only in the period just after the 1998 financial crisis and since then it has shown only seasonal fluctuations. This result contradicts widespread academic opinion (Korovkin, 1990; *Sotsial'nye*, 1990) on the primarily cyclical character of unemployment in Russia.

Second, this result shows that the Russian economy retained excessive employment up until the end of 1998. Thus the process of optimisation of the level of employment took almost eight years.

Nevertheless, starting from 1999, as actual employment reached its natural level, further reductions of employment led to restructuring and optimisation of the employment structure. This created a clear trend to reduction of the natural unemployment rate. As a result, by the middle of 2004 massive reallocation of labour resources towards successful sectors and enterprises had resulted in a reduction of the natural unemployment rate by almost 5 percentage points to just 7.1%.

Policy Implications

In the traditional area of application of the natural unemployment rate, i.e. for determination of monetary and fiscal policy measures, our results allow us to draw the conclusion that, at the current moment, further softening of monetary and fiscal policy will not be effective in reducing unemployment, since the actual rate of unemployment today practically equals its natural level.

At the same time, the most effective policy set for the reduction of unemployment should include not job creation as such (i.e. investment climate improvement, investment promotion etc.) but rather measures aimed at smoothing out the existing structural disproportions in the Russian labour market. One such measure is to increase the efficiency of labour utilisation by labour redistribution towards labour shortage regions and sectors of the economy through the improvement of geographical and social labour mobility.

To illustrate the main idea of this measure we present changes in the unemployment rate in the regions with the lowest and highest unemployment levels. As Table 3 shows, in almost all the regions with the lowest unemployment rate in 2003

Table 3. Ten regions with the lowest unemployment in 2003 (%)

Rank	Region	2001	2003	Change since 2001 r.	2001 rank
1	Moscow	2.1	1.4	− 0.7	1
2	Evenkia	2.9	2.6	− 0.3	2
3	St Petersburg	3.9	3.6	− 0.3	3
4	Moscow *oblast'*	5.5	3.8	− 1.7	5
5	Yaroslavskaya *oblast'*	7.1	4.2	− 2.9	16
6	Chukotsky A.O.	7.4	4.7	− 2.7	20
7	Tverskaya *oblast'*	7.8	5.0	− 2.8	24
8	Lipetsk *oblast'*	6.6	5.1	− 1.5	13
9	Tulskaya *oblast'*	5.2	5.2	0.0	4
10	Kostromskaya *oblast'*	6.0	5.7	− 0.3	7

Source: Goskomstat RF.

Table 4. Ten regions with the highest unemployment in 2003 (%)

Rank	Region	2001	2003	Change since 2001 r.	2001 rank
79	Buryatia	18.5	13.5	− 5.0	82
80	Karachaevo-Cherkessia	18.6	14.5	− 4.1	83
81	Marii-El	9.4	15.0	5.6	36
82	Adygeya	14.1	15.3	1.2	75
83	Kalmykia	19.1	17.4	− 1.7	84
84	Aginsky-Buryat A.O.	23.0	18.7	− 4.3	85
85	Tuva	23.9	19.4	− 4.5	86
86	Dagestan	28.8	21.8	− 7.0	87
87	Kabardino-Balkaria	16.8	22.5	5.7	80
88	lngushetia	34.9	45.2	10.3	88

Source: Goskomstat RF.

the situation on the labour market continued to improve (the unemployment rate has decreased since 2001). At the same time, in 4 of 10 regions with the highest unemployment rate, over the same period the problem just got worse (see Table 4).

Similar trends and unemployment rate differences can be observed in comparison of regions located close to each other. For example, in the Central Federal District, while there was a reduction of unemployment in Moscow *oblast'* from 5.5% in 2001 to just 3.6% in 2003, the unemployment rate in neighbouring Smolensk *oblast'* rose from 9.9% to 12.9% over the same period. In the North-Western Federal District, there was a reduction of unemployment in St Petersburg from 3.9% to 3.61% while unemployment in the surrounding Leningrad *oblast'* increased from 6.9% to 7%, despite robust economic growth.

The same problem can also be seen on intraregional labour markets. In the majority of Russian regions there is one or a few centres of economic activity with a more or less competitive labour market. At the same time, the population living outside such centres is forced to choose between a minimal number of employers (primarily government agencies or budgetary organisations) or to engage in subsistence agricultural production.

This situation shows the importance of restrictions on labour mobility in Russia, which exert a strong influence on the Russian labour market. In particular, today one can speak of labour shortage in several industrial regions of the country (first of all Moscow and St Petersburg), which can hinder further development by increasing labour costs. Under these conditions, the creation of additional incentives by relaxing monetary or fiscal policies is most likely to result in further growth in labour market disproportions, with limited influence on the unemployment rate.

Furthermore, the finding of a disproportionately low rate of unemployment in Russia until 1998 can also provide some background for discussions about the effectiveness and validity of monetary and fiscal policies over that period, or reasons for the generally higher inflation rates during the 1990s. However, considering the amount of analysis required, we leave these questions as themes for further research.

Conclusion

In this study we estimated the natural unemployment rate in the Russian Federation in 1994–2003. Considering the complex and wide-ranging character of factors which influenced the labour market over that period, we estimated the natural rate by consecutive estimation of its major constituents, i.e. optimal employment and the optimal size of the labour force. The estimation was made using a modified Hodrick–Prescott filter, which allows the estimation of a moving average series weighted by the influence of external factors.

Our estimates confirm earlier findings on the presence of overemployment in the Russian economy at the beginning of reforms. The results also show that until 1998 the actual rate of unemployment was much lower than its natural level.

Such results contradict existing opinion on the mainly cyclical character of general unemployment in Russia. According to our results, cyclical unemployment of more or less significant levels was observed only shortly after the 1998 financial crisis and practically disappeared by the middle of 2000. Today the actual rate of unemployment is very close to its natural level, which implies that its major constituent is structural unemployment.

This result has direct application for determination of government labour policies. In particular, based on our results, we can conclude that fiscal and monetary policies will have limited effectiveness for further reduction of unemployment and job creation. Further softening of monetary or fiscal policy would lead only to an increase in the labour shortage problem in a few industrial centres in the country while having limited influence on the general unemployment rate.

In the current conditions of growing disproportions in the labour market, the most effective policy measures could be redistribution of the available labour force towards developing regions and sectors of the economy by increasing the social and geographical mobility of the population.

References

Congressional Budget Office (CBO), ‘CBO’s Method for Estimating Potential Output’, CBO Memorandum, October 1995.

Economic Planning Agency, *Keizai Hakusho Fiscal 2000*, Tokyo, 2000.

Eisner, R., ‘Opening Up the Growth Debate’, *Wall Street Journal*, 25 September 1995, A18:3.

Ekonomika truda: (sotsial’ no-trudovye otnosheniya), pod red. N.A. Volgina & Yu. G. Odegova (Moscow, Izdatel’ stvo ‘Ekzamen’, 2003).

Friedman, Milton, ‘The Role of Monetary Policy’, *American Economic Review*, March 1968, pp. 1–17.

Friedman, Milton, ‘Nobel Lecture: Inflation and Unemployment’, *Journal of Political Economy*, 85, 3, 1977.

Gordon, Robert J., ‘Price Inertia and Ineffectiveness in the United States’, *Journal of Political Economy*, 90, December 1982, pp. 1087–1117.

Hirose, Y. & Kamada, K., ‘A New Technique for Simultaneous Estimation of the Output Gap and Phillips Curve’, Bank of Japan Working Paper Series, Working Paper 01–7,October 2001.

Hodrick, R.J. & Prescott, E.C., ‘Postwar U.S. Business Cycles: An Empirical Investigation’, *Journal of Money, Credit and Banking*, 29, 1, 1997, pp. 1–16.

Kamada, R. & Masuda, K., ‘Effects of Measurement Error on the Output Gap in Japan’, *Money and Economic Studies*, 19, 2, 2001, pp. 109–154.

Kapelyushnikov, R.I., *Rossiiskii rynok truda: adaptatsiya bez restrukturizatsii* (Moscow, GU VShE, 2001).

Korovkin, A.G., *Dvizhenie trudovykh resursov: analiz i prognozirovanie* (Moscow, Nauka, 1990).

Korovkin, A.G., *Dinamika zanyatosti i rynok truda: voprosy makroekonomicheskogo analiza i prognozirovaniya* (Moscow, MAKS Press, 2001).

Okun, A., 'Potential GDP: Its Measurement and Significance', *Proceedings of the Business and Economics Statistics Section, American Statistical Association*, 1962, pp. 98–103.
Otsu, S., *Sovetskii rynok truda* (Moscow, Progress, 1992).
Phelps, E.S., 'Phillips Curve, Expectations of Inflation and Output Unemployment over Time', *Economica*, 34, 1967, pp. 254–281.
Phelps, E.S., 'Money Wage Dynamics and Labor Market Equilibrium', in E.S. Phelps (ed.), *Microeconomic Foundations of Employment and Inflation Theory* (New York, Norton, 1970).
Phillips, A.W., 'The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861–1957', *Economica*, 25, 1958, pp. 283–299.
Sotsial'nye resursy i sotsial'naya politika, otv. red. akademik S. S. Shatalin, k. e. n. V. G. Grebennikov (Moscow, Nauka, 1990).
Steiger, Douglas, Stock, J.H. & Waston, M.W., 'The NAIRU, Unemployment and Monetary Policy', *Journal of Economic Perspectives*, 11, 1, Winter 1997, pp. 33–49.
Tootell, G., 'Restructuring the NAIRU, and the Phillips Curve', *New England Economic Review of the Federal Reserve Bank of Boston*, September/October 1994, pp. 32–44.
Weiner, S., 'New Estimates of the Natural Rate of Unemployment', *Economic Review of the Federal Reserve Bank of Kansas City*, 78, Fall 1993, pp. 53–69.
Weiner, S., 'The Natural Rate and Inflationary Pressures', *Economic Review of the Federal Reserve Bank of Kansas City*, 79, Summer 1994, pp. 5–9.

Appendix

Equations (8), (12) and (15) in a general view can be shown as

$$Y = X\beta + Y^* + \varepsilon, \tag{A1}$$

where

Y — dependent variable,
X — matrix of explanatory variable,
β — coefficient vector,
ε — error term,
Y^* — smoothly varying parameter.

As opposed to the objective function used for the least squares method, the objective function in this case looks as follows:

$$V(\beta, Y^*) = \varepsilon'\varepsilon + \lambda(D_2Y^*)'(D_2Y^*), \tag{A2}$$

or

$$V(\beta, Y^*) = (Y - X\beta - Y^*)'(Y - X\beta - Y^*) + \lambda(D_2Y^*)'(D_2Y^*) \tag{A3}$$

where λ is a 'smoothness' parameter for a Y^* series, D_2 — second difference operator, or the following matrix:

$$\begin{pmatrix} 1 & -2 & 1 & 0 & 0 & \cdots & 0 \\ 0 & 1 & -2 & 1 & 0 & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ 0 & \cdots & 0 & 1 & -2 & 1 & 0 \\ 0 & \cdots & 0 & 0 & 1 & -2 & 1 \end{pmatrix}$$

This objective function is an extension for Hodrick–Prescott objective function (10) in the case of existence of an explanatory variable. As a result, for any value of β, vector $Y*$ is determined by HP filtering $(Y - X\hat{\beta})$ series, with smoothing parameter λ, or

$$Y* = HP^{-1}(Y - X\hat{\beta}), \tag{A4}$$

where HP^{-1} is smoothing operator, or a matrix inverse to

$$HP = \lambda {D_2}' D_2 + E, \tag{A5}$$

where E — identity matrix.

Substituting equation (A4) into equation (A3) and simplifying, we get

$$\begin{aligned} V(\beta) = {} & [(E - HP^{-1})(Y - X\beta)]' \cdot [(E - HP^{-1})(Y - X\beta)] \\ & + \lambda[D_2 HP^{-1}(Y - X\beta)]' \cdot [[D_2 HP^{-1}(Y - X\beta)] \end{aligned} \tag{A6}$$

Taking into account equation (A5) we get

$$\begin{aligned} V(\beta) &= (Y - X\beta)'[(E - HP^{-1})(E - HP^{-1}) + HP^{-1}(HP - E)HP^{-1}](Y - X\beta) \\ &= (Y - X\beta)'[E - HP^{-1} - (E - HP^{-1})HP^{-1} + (E - HP^{-1})HP^{-1}](Y - X\beta) \\ &= (Y - X\beta)'[E - HP^{-1}](Y - X\beta) \end{aligned} \tag{A7}$$

As one can see, in this function there is no $Y*$, which allows us to minimise the objective function with respect to β. Therefore, the first order condition is

$$\frac{dV(\beta)}{d\beta} = -2X'(E - HP^{-1})X\beta + 2X'(E - HP^{-1})Y = 0 \tag{A8}$$

Thus coefficient vector β can be estimated as

$$\hat{\beta} = [X'(E - HP^{-1})X]^{-1}X'(E - HP^{-1})Y. \tag{A9}$$

Using equations (A1) and (A4) it is possible to get the equation for the error term:

$$\hat{\varepsilon} = (E - HP^{-1})(Y - X\hat{\beta}), \tag{A10}$$

whereas the coefficients covariance matrix looks like

$$\hat{\mathrm{cov}}[\beta] = (X'(E - HP^{-1})X)^{-1}X'(E - HP^{-1})\hat{\sigma}_\varepsilon^2(E - HP^{-1})X(X'(E - HP^{-1})X^{-1}). \tag{A11}$$