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Analysis of Inter-Sectoral Labor Flows in Russia

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Вступление развивающихся стран и стран с переходной экономикой в крупные торговые объединения может приводить к значительному изменению межотраслевой структуры рабочей силы. При этом, в рамках классического анализа распределения факторов производства при переходе экономики к международному равновесию может не учитываться такой важный фактор как сегментированность рынков труда, который может иметь особое значение в развивающихся и переходных экономиках.

В данной работе сегментированность рынков труда моделируется с помощью введения параметра издержек переобучения, которые должен нести работник для перехода из отрасли в отрасль. В качестве базовой модели для теоретического анализа в первой части работы используется модель поиска, модифицированная для исследования потоков рабочей силы между отраслями. Построенная теоретическая модель позволяет нам определить круг экономических параметров, оказывающих влияние на межотраслевое распределение рабочей силы и сформулировать гипотезы относительно направления этого влияния.

Затем в работе обсуждаются вопросы эмпирического анализа теоретической модели. В частности, предлагается методика расчета компонент матрицы межотраслевого перехода работников и на основании данных для России строится эконометрическая модель, описывающая влияние основных макроэкономических факторов на эти компоненты. Кроме того, изучение межотраслевых переходов работников проводится на основе анализа временных рядов занятости в России. Как показывают оценки, интенсивность межотраслевого перемещения рабочей силы мала. Кроме того, исследование временных рядов позволяет рассмотреть ряд дополнительных зависимостей, определяющих отраслевое распределение рабочей силы.

Ключевые слова: мобильность рабочей силы; структура занятости; переходная экономика; российский рынок труда.

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As a result of accession of transitional and developing countries to large trade unions there occurs a substantial change in the structure of labor force. Classical international trade theory does not take into account sectoral segmentation in the labor market though segmentation may have significant impact on transitional and developing economies.

Sectoral segmentation is modeled in this paper through introduction of cost of additional training faced by worker when moving from one industry/sector to another.

Search model is taken as a baseline for theoretical analysis in the first part of the paper. The model is modified so that to take into account inter-sectoral labor flows. The model allows determining the range of economic variables, which influence inter-industry labor force distribution, as well as formulating hypotheses about the possible trends.

Empirical analysis is presented further. I suggest a method to estimate the matrix of probabilities that the workers move from one industry to another. In addition, I test the determinants of these probabilities using Goskomstat regional data. Apart from cross-sectional analysis, estimation of equations of model on time series data is presented. As estimations show, the intensiveness of inter-sectoral labor flows is small. In addition to this derivationtime-series analysis allows performance of some dependences, which were not considered on time-series data.

Key words: labor mobility; structure of labor force; transition economy; Russian labor market.

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Introduction.

From economic point of view labor not only is the key production factor, but it also serves as a source of income for individuals, supplying labor in the market. For this reason the structure of labor market, its ability to adapt to macroeconomic changes determines both structural response of production to changes, and social consequences of these changes. Thus, studying of reaction of a labor market on macroeconomic shocks is a necessary aspect of research of influence of macroeconomic changes on welfare of the society.

Importance of research of this kind is especially emphasized by that fact, that in the countries with transition economy there occurs extremely low mobility of labor (see Svejnar (1999)). Low labor mobility can be explained by two groups of factors: first, institutional factors among which the major role is played by liquidity constraints, and, second, the behavioral factors. The first group of the factors is connected with administrative and institutional restrictions on movement of workers, such as attempts of regional authorities to influence directors of enterprises not to allow growth of unemployment. On the other hand, there also exist institutional restrictions on mobility of workers connected with market failures. For example, poor conditions on credit market mean also poor development at mortgage market. In that case the worker appears to be limited by spatial factors in questions of a choice of work. In Russia the questions connected with opportunity of migration, represent one of the most important social problems. In more detail these questions in application to the Russian labor market were considered in work (Friebel, Guriev, 2002).

The second group of factors predominantly explains low mobility between different branches of economy. Similar research was carried out for some advanced economies. One should note the work (Jovanovic, Moffit, 1990), which results are considered further in this thesis. Nevertheless, the question of inter – sectoral mobility of labor is insufficienly represented for transition economies and is a subject of research in this work. In the given thesis an attempt was made to study the influence of macroeconomic changes on inter – sectoral distribution of labor. The research is focused on the study of labor supply.

Analysis of behavioral responses of workers in different sectors on the basis of search model allows formulating the hypotheses in order to verify empirical model and to confirm the formulated theoretical hypotheses. An important applied feature of the given work is that the obtained results can give some insight into the structure of inter - sectoral labor market in Russia.

The paper is split into three parts in the following way. The review of theoretical and empirical literature discussing labor mobility, presented in the first part of the paper, gives the notion of approaches to studying the given with were used by other authors, and also allows to select model which structure fits best to the problem under discussion. In the second part of this thesis the theoretical model, describing flows of a labor between different branches of economy is developed and the basic hypotheses about interrelation of key parameters of model are formulated. In the third

part of the work the empirical model is verified on the basis of the conclusions from theoretical model.

Empirical analysis, developed within the framework of the given paper consists of two parts. In the beginning, the model of vector autoregression for inter - sectoral dynamics of employment was built. Analysis of this model gives reasons in favor of conclusions drawn by other authors about low mobility of a labor in Russia. From the analysis of vector autoregression it is possible to conclude that the matrix of probabilities of inter - sectoral labor flows in Russia is stable. Usage of exogenous variables in the model allows testing some hypotheses concerning influence of macroeconomic parameters on probabilities of inter - sectoral movements of workers. Tests of empirical model allow drawing conclusion that the matrix of probabilities of inter - sectoral displacements of workers in steady enough conditions is constant in time. In such conditions the matrix of probabilities of inter - sectoral movements of workers before and after the crisis of 1998 for regions of Russia is constructed. Then the factors determining changes of matrixes after crisis from their pre-crisis values are investigated.

From the point of view of scope, the given work concerns only a small group of problems concerning mobility of a labor. For more complete analysis, certainly, it is necessary to consider broader variety of factors determining mobility of labor (for example, opportunities of inter-regional migration). It can serve as a direction of the further research of problems discussed in the given paper.

1. Literature Review.

In this chapter there will be considered some works, concerning the phenomenon of labor mobility. The core model in the review on which the original model of this paper is based, is the search model. Search model allows studying dependence of reservation wage and probability of displacement of worker from one job to another from exogenous factors: frequency of job offers to the worker, the alternative income and variance of the stream of wages for the analyzed worker. Thus, search model helps to find a connection between the optimum decision of the worker and conditions at labor market. For the worker the process of search of job is connected both with direct costs (monetary and time expenses of search), and with the indirect costs in terms of foregone benefit from refusal of vacancy. The class of models of labor market microstructure, which study optimum strategy of job search by the worker under stochastic circumstances, is referred to as models of search.

Diamond (Diamond, 1982) has considered a model of an individual, who searches new job, time being discrete. The author neglects specific features of different vacancies offered to an individual and uses wage as the universal characteristic of different job offers. In the model it is supposed, that the number of wage offers at each particular moment of time and values of wages are

casual. Considered worker bears some costs during search, and when she does not accept any wage offer, she receives some alternative earnings. The problem of an individual is to maximize discounted value of her expected income. Thus it is considered, that the individual solves the problem of choosing the optimum moment of a stop of new job search. The condition for maximum of expected value of discounted income of an individual can be written out with the aid of Bellman maximization principle. The drawn first order condition has clear economic interpretation: at the optimum trajectory the cost of continuation of search in the current period of time is equal to the sum of alternative income of the worker and expected surplus of the worker (as expected wage is higher than reservation wage) minus the cost of search. Besides there exist an additional condition of participation, which implies search occurs only if the given expected surplus of worker exceeds costs of search. The stationary solution of a problem is found in a class of " threshold rules", namely decisions at which the individual agrees to accept vacancy in the event that the offered wage exceeds some threshold value and do not accept the offer if the wage appears to be below this threshold. Such threshold wage is usually named the reservation wages. The condition for the maximum of discounted expected income of worker represents an implicit function for reservation wage. One can find that, reservation wage grows under growth of alternative income of the worker, diminishes with growth of costs job search, and also grows with growth of variance of offered wages. Formal representation for Diamond's model is given in the Appendix 1 of this paper. Moreover, in the Appendix 1 some conclusions, which have been not mentioned in the main text, are described.

Basic Diamond's model is simplified to some extent. However it can be modified to take into account specific features and imperfection of labor market. An example of such extension can be found at the work (Danforth, 1979) in which it is supposed, that the worker faces liquidity constraints. As follows from economic intuition, under liquidity constraint individual's planning horizon is contracted (that is search can last only limited time) that can cause reduction of reservation wage. This intuitive result corresponds to Danforth's conclusions. In his work it is underlined, that reservation wage given liquidity restriction positively depends on the size of monetary wealth, in case of risk - averse worker.

Modeling labor supply in under liquidity constraints is also realized in work (Lentz, 2001). The author offers a model of maximization of expected utility as a function of consumption and labor given restriction on volume of available wealth in each period. The basic conclusions of the model are, that under condition that consumption of an individual during employment exceeds her consumption during unemployment, and also under assumption, that during unemployment the optimum wealth in the current period positively depends on size of wealth in the previous period, intensity of search is reduced with growth of wealth. Meanwhile it appears, that growth of wages causes growth of intensity of search at any allowable level of wealth.

Other important extension of basic model is introduction of monopsony of an employer. Monopsony at labor market causes some negative effects. First of all, when employer has an

opportunity to manipulate wages there inevitably arise efficiency losses. In neo - classical models of monopsony, a monopsonist puts (in the optimum point) marginal product of labor to be equal to corresponding marginal expenses. The wages established by a monopsonist appear to be below competitive equilibrium price, and equilibrium employment also appears to be below equilibrium level. In work (Albrecht, Jovanovic, 1986) it is shown, that monopsony does not influence efficiency of search from the point of view of labor supply (and, accordingly, does not cause corresponding deadweight losses), in contrast to intuitive considerations. On the other hand, monopsony involves classical monopsonic losses of efficiency. Difficulty which arises during the analysis of search model under monopsony of employer is that monopsonic wage cannot be analyzed by introduction of specific multipliers to the value of competitive market wages. In particular, in work (Ballentine, Eris, 1974) it is shown, that in model of general equilibrium monopolic pricing cannot be considered with the aid of proportional terms to equilibrium competitive prices.

Essential drawback of search models is that the flow of wages on the part of employers is taken to be exogenous within the framework of these models. This problem is partly solved when instead of search models the models of a combination of efforts of search (matching) models are analyzed. A basis of models of bilateral search is the system of two optimizational problems: the worker and the employer determine time of a stop of search, accordingly, of new job and the new worker. The statement of problems is similar to that of search Diamond's model which was described above. A link between two problems is realized by the so-called matching function. Matching function determines the probability at which the given opened vacancy can be offered to the worker. Final result of modeling of bilateral search is an equilibrium rate of unemployment and number of vacant places. One of the first models of bilateral search is the model offered in work (Jovanovic, 1979). The author assumes, that workers can have different productivities and can work in different firms. Firstly, the author shows, that there is some equilibrium contract for wage of a worker. This optimum contract implies, that at each moment of time wages of workers are equal to a conditional expected value of marginal product of worker according with respect to accessible information. On the basis of this conclusion there can be made some inference concerning connection of duration of stay of a worker on a certain job with duration of job search, and also concerning connection of time of work on a job with her wage. Jovanovic's model predicts, that workers remain in those firms where their efficiency is rather high and leave firms where their productivity is small. As, according to the conditions of optimum contract the wage is determined by expected productivity of the worker, wages grow with growth of time a worker spends at a certain firm. Besides, the probability of being fired from a job diminishes as a worker works at a certain place longer. It occurs because the wrong choice of workers and employers according to properties of the optimum solution becomes clear to workers and employers relatively early.

Generally speaking, apart from the effects found out by Jovanovic, which take the form of wage growth as a worker stays at a certain enterprise longer due to reduction of informational

asymmetry, there is an effect of accumulation of the human capital on job. This human capital can be both universal, and specific, and, accordingly, can or cannot be applied to another job.

An example of paper taking into account human capital accumulation is a work (Sabirianova, 2000). Sabirianova uses stochastic model for the description of change of structure of employment in Russia in the period from 1994 to 1998. In Sabirianova's paper the theoretical model is constructed as follows. Firstly, it is constructed a model of worker's wage w_t^i as a function of accumulated human capital K_t^i. In the case when the worker does not change her job at the moment *t*, her current wage is determined by the certain fixed size *E* determining outcome from worker's education and outcome from the human capital, accumulated at his occupation *i*, $w_t^i = E + r_i(K_t^i + \beta K_{t-1}^i) + \varepsilon_i$, where ε_i – is a casual component with exogenously determined distribution function. In the case when the worker changes a place of work, she inevitably loses a part of accumulated human capital, nevertheless, a part of capital γ_{ij} can be used by the worker at her new job *j*. Then the wage is defined by the following expression: $w_t^j = E + r_j(K_t^j + \gamma_{ij}\beta K_{t-1}^j)$. Change of a place of work occurs in the event when benefit from such change exceeds the appropriate costs: $w_t^j - w_t^i > c$. Thus, the appropriate probability of change of work is equal to $P\{w_t^j - w_t^i > c\}$.

The obtained expressions drew the author to conclusions that the probability of change of occupation grows under decrease in income on the current job, increase in income at an alternative job, growth of "transferability" of specific human capital γ_{ij},, decrease in costs of change of occupation and decrease in shock ε_i. The shock connected to compatibility of the worker with a post plays an important role in stationary circumstances.

Construction of solutions for search models for actual distributions of wages appears to be a complicated problem. Calculation of equilibrium parameters, however, is possible under some assumptions about distribution functions of exogenous variables. Thus, it is not the model itself, which is tested but the direction of dependence of final conditions from the parameters individual behavior. Such method has found application in works devoted to studies of unemployment structure.

In the paper (Eckstein, Wolpin, 1990) empirical analysis is based on the data on duration of unemployment and earnings right after the ending of search period. As it appears, the data give arguments in favor of conclusions of theoretical model about the duration of unemployment. At the same time, the data on wages do not allow to verify validity of conclusions of model, which may be, probably, caused by various estimations of cost of leisure by different individuals.

Besides estimation of regression models, some authors also apply calibration techniques, in order to compare their results with actual figures. An example of such analysis is a work (van den Berg, Ridder, 1998), which allows concluding that search model corresponds to empirical data.

An attempt to use the assumption of heterogeneity of workers in the empirical analysis was used in a paper (Bowlus, Kiefer, Neumann, 1997). The authors assume the presence of finite number of various types of workers with various productivities of work. As a result of an estimation there is a conclusion that distribution of wages in USA for the white population younger than 26 years dominate stochastically the distribution for the black population of the same age. At the same time, the distribution of job offers appeared to be identical for these two groups.

The works studying mobility of a labour between sectors of economy are of interest for our research. Sabirianova's work, mentioned above, in particular, concerns this problem. In her work Sabirianova constructs the model of "work profitability" for various kinds of works, and derives dependence of probabilities of change of occupation on parameters of "profitability". As it was shown in author's estimations, structural changes in the economy were the major determinant of mobility of labor in Russia. Empirical analysis has shown, that growth of probability of change of occupation is determined by reduction of wages on the primary occupation. As it appears, the probability of change of occupation tends to decrease with growth of experience on a similar position, time of stay at the enterprise and profitability of enterprise. Sabirianova has shown, that workers as a result of negative shocks on the demand side and low profitability of firms move to occupations where lower skills are required. Besides the analysis has shown, that the important role is played by variation in conditions at labor markets in Russian regions.

Other example of the analysis of inter - sectoral mobility of labor force is a paper (Jovanovic, Moffit, 1990). Jovanovic and Moffit argue that the aggregated data on mobility of labor substantially underrepresent labor flows inside sectors and between sectors. They emphasize the necessity of association of the sectoral approach with studying the unemployment connected to casual shocks from labor demand. For the empirical analysis authors use individual micro-data. As it appears, the workers who have lost work as a result of a casual shock of demand for labor, as a rule, come back to work in similar sector, and do not move to other sector. The basic conclusions from the empirical model are similar to those of search models. The carried out tests give arguments in favor of conclusions of the constructed model.

To summarize, it is possible to note, that conclusions of theoretical models of search appear to be similar even taking into account possible imperfections of the market, such as credit rationing and labor market segmentation. Conclusions of search models tend to be confirmed empirically. Moreover, empirical results allow answering a number of applied questions connected to measurement of intensity of flows of labor in different sectors.

2. The Model of Inter- Sectoral Labor Mobility.

It is necessary to note, that displacements of workers between sectors occur not only by the decision of worker, but also in accordance with labor demand in particular branches of the economy.

In contrast to Sabirianova's model, search model allows including explicitly in model demand characteristics through parameter of frequency of receipt of job offers.

In the review of the theoretical literature it was mentioned, that there are several approaches to the problem of labor mobility. In particular, the theoretical model offered by Sabirianova for the analysis of the Russian labor market, implies, that the opportunity of inter - sectoral mobility of labor is determined by model of wage - formation according to her accumulated human capital. To make the process of change of occupations stochastic, casual additive component in model of wage determination is inserted. The model of search as an alternative to the model of wage determination assumes, that casualty is an intrinsic feature of search process when the worker can agree to one of offers in some casual sample of vacancies. Within the framework of the second approach, as well as within the framework of the first approach, process of change of occupation by an individual can be considered.

Generalization of search model, offered in this paper, implies that a worker considers job offers not only in the area of her specialization, but also on some set of other specialties. Thus, at each moment the worker faces a vector of vacancies which dimension corresponds to the number of sectors in which the worker searches job. Change of sector brings to worker some costs which amount is given exogenously. Let us take demand for labor as an exogenous factor. Given assumptions of Diamond's model, multy – sectoral model can be made. Suppose the following mechanism of job search by worker. At the first stage individual receives a number of offers of vacancies from different sectors of the economy in each period of time. An individual chooses job offer with maximum wage taking into account costs of reallocation and additional training from the vector of job offers. On the basis of discounted values of search and expected wage streams an individual decides whether to continue search or to accept the chosen maximum offer. The stream of wages which are received by an individual working in sector j, represents a set n vectors $w_1,\ldots,w_n$ (each coordinate represents the offer of wages in given sector).

It is supposed, that at each moment of time the number of sectors in which the individual searches job is fixed, and this number is designated N. Thus the individual has three options: to continue search, to start to work according to her specialization or to change specialization. The optimality condition for the decision problem of an individual making search, takes the form:

$$V(\Omega(t)) = (b-c)i + \beta(i)E[\max\{V(\Omega(t+i)), W(\max_k[w_k(t+i) - c_{kj}])\}\big|\Omega(t)]. \quad (1)$$

In the given expression b - is the value of alternative income of worker, c - costs of search, $\beta(i)$– discount - factor by the end i-th the period, $W(w)$ – discounted value of worker's income if she accepts to participate at job with wage w, $V(\cdot)$ – discounted value of continuation of search given accessible information, $\Omega(t)$ – the set of information accessible for individual at moment t. Costs which are carried by a worker from sector j, after displacement to sector k, will be designated as c_{jk}, assuming c_{jj}=0.

We will find stationary solution of maximization problem. Let us assume, that the number of offers of wages at each moment of time corresponds to Poisson distribution function. One can designate probability of receipt of j vacancies by worker during the period of length i as $q(i, j)$ and distribution of maximal value in sample of received vacancies during length i designate $G(x, i)$. The bottom index at variables corresponds to number of sector. Then optimality condition for the task of job search for an individual from l - th sector can be written down as follows:

$$(1-\beta)V = (b-c)i + \beta \sum_{k_1=1}^{N} \ldots \sum_{j_k=1}^{\infty} q(i, j_k) \int_0^{\infty} \ldots \int_0^{\infty} \max[0, W(w_{k_1}(t+i)) - c_{lk_l} - V, \ldots$$

$$\ldots, W(w_N(t+i)) - c_{lN} - V] dG_{k_1}(w_{k_1}, j_{k_1}) \ldots dG_N(w_N, j_{k_N}) \quad (2)$$

We will assume, that discount - the factor is an exponential function of length of period: $\beta(i)=e^{-ri}$, and the parameter of distribution function $q(i, j)$ in sector k is equal to λ_k. If length of period i tends to zero, then as in this case Poisson distribution of number of receipt of vacancies tends to exponential distribution, it is possible to write down optimality condition in the following way:

$$rV = (b-c) + \int_0^{\infty} \ldots \int_0^{\infty} \max[0, \lambda_1 \{W(x_1 - c_{l1}) - V\}, \ldots, \lambda_N \{W(x_N - c_{lN}) - V\}] dF_1(x_1) \ldots dF_N(x_N)$$

. (3)

Here $F_k(x_k)$ – is the distribution of job offers in sector k at each moment of time (it is supposed, that it is persistent in time). From this equation it is possible to determine reservation wage, assuming that if a worker receives several job offers, she prefers the job with the highest wage taking into account her costs of additional training and reallocation. We will consider a threshold rule of decision making by an individual, who does not agree to participate on job, which wage is below certain level. As the search problem examined is stationary in time, this level can be considered constant.

Without providing formal proof, we will try to find expression for the solution of problem of multivariate maximization. The worker chooses work in sector k in the event that, on the one hand, the chosen job offer gives her maximum wage from the sample of the offered vacancies, and, on the other hand, exceeds reservation wage. Thus, the probability of receipt of wage x in sector k which is higher than reservation wage, is equal to the product of conditional probability of receipt of wage x, provided that this value is maximum, costs reallocation taken into account, and probability that all other job offers give less surplus. Then it is possible to receive the following equation to find reservation wage for the worker from sector j:

$$\frac{\lambda_j}{r} \int_{w^*}^{\infty} [x - w^*] \left(\prod_{k \neq j} F_k(x)\right) dF_j(x) + \frac{\lambda_1}{r} \int_{w^*}^{\infty} [x - c_{j1} - w^*] \left(\prod_{k \neq 1} F_k(x - c_{jk})\right) dF_1(x - c_{j1}) + \ldots +$$

$$+ \frac{\lambda_N}{r} \int_{w^*}^{\infty} [x - c_{jN} - w^*] \left(\prod_{k \neq N} F_k(x - c_{jk})\right) dF_N(x - c_{jN}) = c + w^* - b. \quad (4)$$

Let's group in the left side of equation the terms, connected to benefits of worker: expected surplus of an individual and value of alternative income. To the right part we will move the terms connected to costs: expected costs of displacement to other sectors, costs of search and forgone benefit in terms of reservation wage. Thus, the equation for reservation wage for workers from sector *j* looks like:

$$\frac{1}{r}\int_{w^*}^{\infty}[x-w^*](\prod_k F_k(x-c_{jk}))d(\sum_i \lambda_i \ln\{F_i(x-c_{ji})\})+b=$$

$$=\frac{1}{r}\int_{w^*}^{\infty}(\prod_k F_k(x-c_{jk}))d(\sum_i c_{ji}\lambda_i \ln\{F_i(x-c_{ji})\})+c+w^*. \qquad (5)$$

The solution for the problem of finding reservation wage assuming that that wages, lower than reservation wage are offered to the worker seldom enough (that is equivalent to that $P\{x<w^*\}<<1$ takes place), looks like for the worker from sector *j*:

$$w^*=\frac{\lambda^*}{r+\lambda^*}E(x-c_{ij})+\frac{r}{r+\lambda^*}(b-c)^{1}.$$

This expression was obtained when limits of integration in the formula (5) were posed to be zero. It is necessary to note, that the character of dependence of reservation wage from key parameters in the model under discussion is different from that in one-dimensional case.

As it appears, there are two variants of such dependences. We shall consider dependence of reservation wage on costs of search and alternative earnings. Differentiating (5) as an expression for an implicit function $w^*(b, c)$, it is possible to obtain a relationship for marginal reservation wage with respect to alternative income:

$$\frac{\partial w^*}{\partial b}=-\frac{\partial w^*}{\partial c}=\frac{r}{r+\int_{w^*}^{\infty}(\prod_k F_k(x))d\sum_l \lambda_l d\ln\{F_l(x)\}-(\prod_k F_k(w^*))\sum_l c_{il}\lambda_l \frac{\partial \ln F_i(w^*)}{\partial x}}.$$

One can notice, that reservation wage depends on alternative earnings with regard to the value of cost of training and reallocation. There is a certain level of average costs of training and reallocation, such that in the event when average costs are higher than this level, reservation wage diminishes upon growth of alternative earnings and grows upon growth of cost of search. When costs of additional training and reallocation are small enough, the same dependence, as in an one-dimensional case is observed. If one considers equation (5) as an expression for implicit function $w^*(\lambda_i)$ it is straightforward to obtain the expression for marginal reservation wage with respect to frequency of receipt of vacancies from sector *i*:

[1] Here λ* - is an effective frequency of job offers (mean frequency).

$$\frac{\partial w^*}{\partial \lambda_i} = \frac{\int_{w^*}^{\infty} [x - w^* - c_{ij}](\prod_k F_k(x)) d \ln\{F_i(x)\}}{r + \int_{w^*}^{\infty} (\prod_k F_k(x)) d \sum_l \lambda_l d \ln\{F_l(x)\} - (\prod_k F_k(w^*)) \sum_l c_{il} \lambda_l \frac{\partial \ln F_i(w^*)}{\partial x}}$$

From the obtained expression the trend of dependence of reservation wage from frequency of receipt of vacancies can be also seen. When cost of additional training and reallocation is small the reservation wages performs positive dependence from frequency of receipt of vacancies. When this cost is high, reservation wage tends to reduce with growth of frequency of job offers.

In the similar way an expression for reservation wage as a function of cost of additional training and reallocation for the displacement to the sector *i* can be found as:

$$\frac{\partial w^*}{\partial c_{ij}} = -$$

$$\frac{\int_{w^*}^{\infty} \{[x - w^* - c_{ij}]\{\frac{d^2 \ln F_i(x)}{dx^2} - \frac{d \ln F_i(x)}{dx}\}(\prod_k F_k(x))\lambda_i dx + \sum_l \int_{w^*}^{\infty} [x - w^* - c_{kj}](\prod_k F_k(x)) \frac{d \ln F_i(x)}{dx} \lambda_l d \ln\{F_l(x)\}}{r + \int_{w^*}^{\infty} (\prod_k F_k(x)) d \sum_l \lambda_l d \ln\{F_l(x)\} - (\prod_k F_k(w^*) \sum_l c_{il} \lambda_l \frac{\partial \ln F_i(w^*)}{\partial x}}$$

One can notice, that the connection between cost of additional training reallocation and reservation wage is also not unequivocal. In the event when cost of displacement are small on average, and the variance of wage offer distribution is high enough, reservation wage will diminish while these costs grow. After the average costs achieves certain level, the reservation wage starts to grow in response to growth of cost.

Summarizing, one can note that in this section expression for reservation wage in multy – dimensional search model was obtained, and on the basis of this expression conclusions about the dependence of reservation wage from exogenous parameters of model were made.

The value of reservation wage is an individual characteristic of the worker. For studying group characteristics of model it is necessary to expand the results of the model to probabilistic terms. Consider the process of displacement of workers from sector to sector. The probability of that the worker starts to work in the considered sector is determined by higher level of reservation wages than that other sectors from the point of view of costs of additional training and reallocation, and exceeds reservation wage. For each sector the level of reservation wage is determined by an implicit function described above. Assume, that in process of achievement of equilibrium wages in different sectors tend to alignment (taking into account costs). In that case probability that the worker moves from sector *i* to sector *j* is equal to probability of that for the worker from branch *i*, who has received an offer from sector *j*, this offer appears maximal of all the set of offers taking into account costs, and thus will exceed wages of reservation. Consequently, this probability is determined by the expression

$$p_{ij}=\int_{w^*}^{\infty}(\prod_k F_k(x-c_{ik}))d\ln\lambda_j F_j(x-c_{ij}).$$

Probabilities of displacements from sector to sector form a stochastic matrix having dimension NxN for one sector: $\boldsymbol{P}=(p_{ij})$..

Let's assume, that elements of probability matrix are constant in time. If at a particular moment the distribution of workers in industries is determined by vector x, such that $\sum_i x_i$ =1. The expression for displacement of workers between sectors, as the time is considered discrete, can be obtained as: $\boldsymbol{P}x$.. Thus, dynamics of distribution of workers within sectors is determined by Markov's equation: $x_{t+1}=\boldsymbol{P}x_t$. In that case equilibrium distribution is an eigen vector of matrix $\boldsymbol{P}$ (distinct from unit vector). One can find, how elements of matrix of displacements depend on parameters of search model. It is possible to notice, that for probability p_{ij} and reservation wage there is a simple connection:

$$\frac{\partial p_{ij}}{\partial w^*}=-(\prod_k F_k(w^*-c_{ik}))\lambda_j\frac{d\ln F_j(w^*-c_{ij})}{dx}<0.$$

Hence, the probability of displacement diminishes upon growth of reservation wage. Thus, dependence of probability of displacement of the worker between sectors of economy depends on key parameters of model in the opposite way to dependence for reservation wage. The system of dependences can be represented in the agenda of the model as a table.

Table 1.

Dependence of probability of displacement from key parameters of the model

Variable	High cost of education	Low cost of Education
Alternative Income	-	+
Cost of search	+	-
Job Arrival Rate	-	+
Mean Wage in other Sectors	-	+
Cost of Additional Education	+	-
Variance of Wage Offers	-	+

It is necessary to note, that the offered model has both substantial theoretical, and methodological differences from model of Sabirianova. First, the model takes into account the

influence on reservation wage from the demand for work for equilibrium distribution of workers in sectors. Second, the constructed model allows estimation in dynamic state of affairs. That is, it allows to model transition from one equilibrium to another. And, at last, in Sabirianova's model probabilistic properties during the process of movement of workers between different sectors are created by artificial introduction of the additional term in wage equation responsible for casualty. At the same time, offered extension of search model is stochastic in essence and allows operating directly in terms of probability of transition of workers between branches.

3. Empirical Analysis of Inter - Sectoral Labor Mobility.

3.1. Patterns of labor mobility in time.

In the previous section it was obtained, that when probability matrices of reallocation between sectors are constant, the dynamics of distribution of labor between sectors meets Markov's equation. In other words, according to result of the model, it is possible to describe dynamics of distribution of labor with the aid of first order vector autoregression. If there are enough of observations, it is possible to build a model of vector autoregression and to discuss the direction and intensity of flows of labor in Russia with the aid of this model.

Data sources used for research of inter - sectoral dynamics of employment includes those from Goskomstat of the Russian Federation such as " Social and economic position of Russia, 1998 - 2003 " and " Short-term economic parameters of Russian Federation, 2003 ".

As the length of analyzed time series is not sufficient for complete research of labor flows between all 17 and 35 branches offered in statistics of Goskomstat. Consideration of economic structure with smaller number of sectors instead of 17 sectoral structure of the economy by means of integration of some groups of sectors can serve as a possible solution to this problem.

Integration of sectors was made in two ways. The first way proposes construction of three-sector structure of the economy in order to describe large structural changes of Russian labor market. The formed large sectors include: sectors making goods, sectors offering services and unemployment. Thus, it was performed a closed system of flows of population, who is able to work. Offered integration of sectors is given in the table of A 2.1.[2]

The second type of sector extraction supposes integrating sectors into groups of sectors: making intermediate goods and raw materials, and sectors, making final products. Employment in sectors, offering services, was divided into employment in the sector of financial services and management and employment in the sector offering other services. Division of sectors on "raw" and what make end production ("processing"), is given in the table A.2.3. On the basis of integration, time series for employment in examined sectors and their fraction in the population, able to work, were received.

[2] Here A.2 means that the table is in Appendix 2 and 1is the number of table.

3.1.1. Regression Analysis of Time – Series Models of Labor Mobility.

3.1.1. a.Three- Sectoral Model

The first estimated model was the model describing flows of labor between three basic groups of sectors: sectors making goods, sectors making services and unemployment. These sectors were consolidated in the model of vector autoregression in the form:

$$\begin{pmatrix} Manufacturing \\ Services \\ Unemployment \end{pmatrix}_t = \boldsymbol{P} \begin{pmatrix} Manufacturing \\ Services \\ Unemployment \end{pmatrix}_{t-1} .$$

At the initial stage the opportunity of change in matrix components throughout time was taken into account by introduction of the artificial variable equal to zero till August, 1998 and equal to one - after August 1998. As the sum a component of the constructed vector of inter - sectoral distribution of labor is equal to one at any moment, it is impossible to estimate the appropriate dependence for the constructed vector directly: one of a component of constructed vector needs to be removed with introduction of the appropriate restrictions on factors of the estimated equations. There were considered two variants of the model. In the first variant the share of employment in services was excluded, and in the second variant - the share of labor in industrial sectors was removed. Firstly the equation of vector autoregression of the second order was estimated. Coefficients for lagged terms of the second order appeared insignificant. It fits the conclusion that the dynamics of inter - sectoral distribution of labor under steady matrix of probabilities of displacements of workers can be described by Markov equation. In the table A 2.4 estimation results for components of a matrix of probabilities for the case of excluded share of employment in services are given. One can notice, that obtained matrix of probabilities of displacements of labor between sectors appeared diagonal. Diagonal elements of a matrix were revealed to be the only significant coefficients. So, estimation results give arguments in favor of insignificance of pure flows of labor between extracted sectors in time. In particular, it can be treated as evidence that more significant role is played by streams of labor inside the extracted sectors. Similarly it is possible to estimate a matrix of probabilities of displacements of workers between sectors, having omitted a variable of share of employment in manufacture. Results of an estimation of this model are given in the table A 2.5. From this table it is possible to note, that the remarks stated above, are valid in this case.

For studying influence of external macroeconomic factors on inter - sectoral flows of labor in Russia it is possible to consider models of vector autoregression with exogenous variables. There were considered three macroeconomic parameters representing key parameters of the model as exogenous variables. The demand for workers, measured by Employment service served as an indicator of frequency of receipt of vacancies. The volume of an industrial output was used as an indicator for the volume of demand for labor in industrial sectors, and the ratio of average incomes

of the population to average wages as the indicator for alternative earnings. These parameters were included in the model one by one (in order to prevent its complication).

Firstly the research was carried out for the three-sector model. As for this model it is possible to estimate considered system of the equations only on big enough data file. Actually we possess 61 observations in time, so attempt of construction of full structural model was made. Nonlinearity of model was taken into account by inclusion in it the pair products of shares of employment in the appropriate sector and values of macroeconomic factors. It provided linearity of dependence of probability of displacement of worker from one branch to another from investigated exogenous parameters.

In fact the estimated equation looks like: $x_t = \boldsymbol{P} x_{t-1} + \boldsymbol{Z_t}\, x_{t-1}$, and it can be transformed to expression $x_t = (\boldsymbol{P} + \boldsymbol{Z_t})\, x_{t-1}$, and the matrix of probabilities of displacement depends in such formulation from the matrix of exogenous parameter $\boldsymbol{Z_t}$.

Results of an estimation of model are given in the table A 2.6. It is possible to notice, that diagonal elements of the matrix became significant. Thus, insignificance of non - diagonal elements of matrix of probabilities of displacements of workers between sectors may be caused by the fact that these elements have changed the under the influence of changes at the labor market.

Estimations, mentioned above, allow drawing some important conclusions. It appears, that the probability for the worker to stay in sector of manufacturing is increased by growth of demand for workers. At more high level of output the probability to remain in manufacture sector is reduced (with growth of probability of unemployment). Reservation wage grows upon growth of frequency of receipt of job offers under low costs of additional training and reallocation so there occur a decrease in probability of employment in the appropriate branch. On the other hand, when there is growth of demand for workers, the probability of displacement of workers from the sectors producing goods to sectors, which offer services is reduced. Thus, the obtained results correspond to theoretical hypotheses formulated on the basis of the analysis of theoretical model.

3.1.1.b. Five – Sectoral Model

In the previous section the structure labor flows was considered within the framework of three sector groups forming population, able to work. In this section the similar analysis will be carried out within the framework of five-sectoral division of population, able to work. The appropriate reduced form of the equation of vector autoregression looks like:

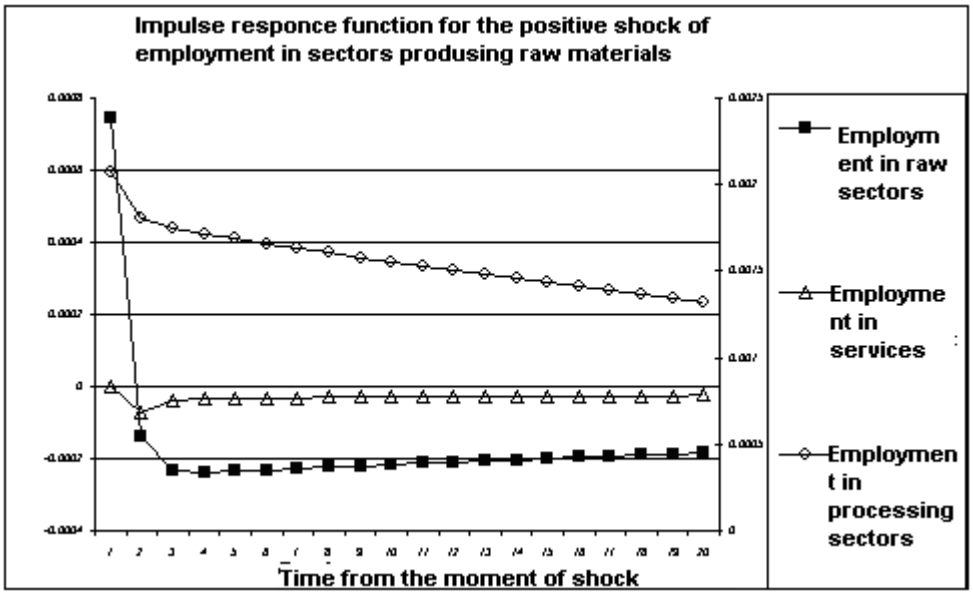
$$\begin{pmatrix} \textit{Raw material sector} \\ \textit{Processing sector} \\ \textit{Finance credit and management} \\ \textit{Other services} \end{pmatrix}_t = \boldsymbol{P} \begin{pmatrix} \textit{Raw material sector} \\ \textit{Processing sector} \\ \textit{Finance credit and management} \\ \textit{Other services} \end{pmatrix}_{t-1}.$$

According to the hypothesis that the dynamics of inter - sectoral flows of labor fits Markov property, the estimation of equation of vector autoregression of the second order, as well as at the

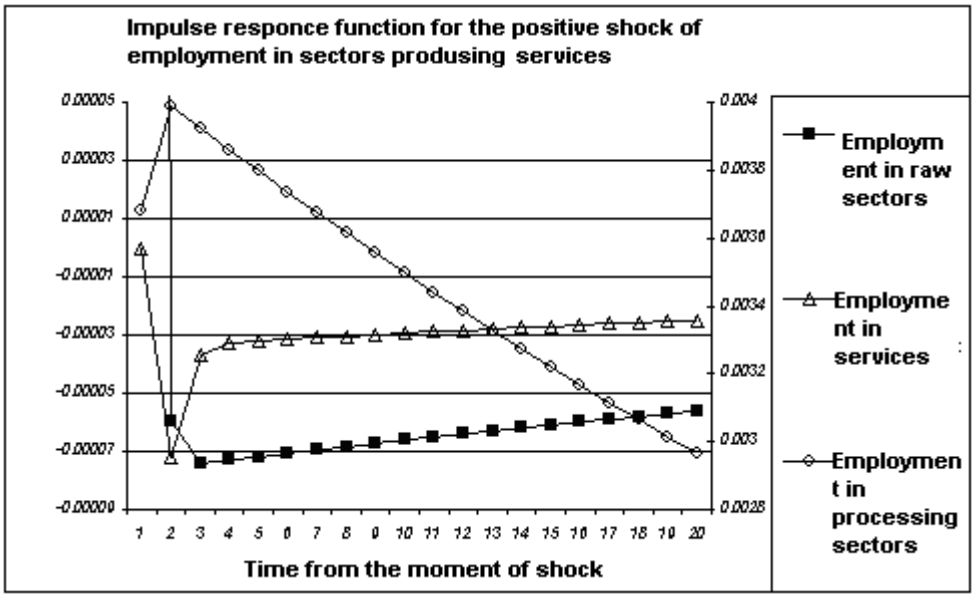
first variant of extraction of sectors, has shown, that terms with lags of the second order appeared insignificant. Results of an estimated of model of vector autoregression of the first order are given in the table A 2.7. It is possible to notice, that the model results is a notion that pure flows of labor from processing sectors to raw material sector, and also to sector offering services, are small (the appropriate coefficients are insignificant). However the interesting fact is that the probability at which labor moves from sectors, offering other services (including transport, communications, public health services and education) to the sectors offering services of financial intermediary is high enough (17,6%).

Similarly to the analysis of three-sectoral model one can consider displacement of workers from unemployment to extracted sectors. In the table A 2.8 it is possible to see the results of estimation of vector autoregression in which the variable of a share of employment in sector of services of financial intermediary and management was omitted. Results of an estimation of the given model of vector autoregression are similar to those received during the analysis of other models considered above. Five-sectoral model was considered with account of exogenous parameters. The estimated equation of vector autoregression with excluded variable of share of the unemployed looked like given in the table A 2.9. According to the hypothesis following from the theoretical model, probability for the worker to keep work in raw sectors grows with growth of employment and of demand registered in Employment service. Moreover the probability of displacement from processing sectors to raw is reduced by growth of volume of industrial output. Besides it is possible to notice, that the probability of displacement from sectors, offering services to raw sectors diminishes with growth of demand for workers and the registered demand for labor. Under growth of registered demand for workers the probability of displacement from raw sectors to processing also grows, but the probability of displacement to processing sectors of workers from the sectors, offering services is reduced. Growth of registered demand for workers causes the probability for workers to keep work in the sectors, offering services rise, but the probability of displacement to sectors, offering services of financial intermediary and management from other branches of services is reduced.

Pictorial representation of the empirical model constructed on the basis of the given time series, is possible with the aid of impulse response functions. We shall consider in more detail the results of model with extraction of five sectors. From the diagram of impulse response given below for the shock of employment in raw sectors, it is possible to note, that the considered dynamic system passes to a new equilibrium with small growth of employment in all other sectors.



The similar situation arises when there is growth of employment in processing sectors. When there is change of employment in the branches giving services, the general picture of employment will be a little different. From the diagram given below, showing reaction employment on change of employment, in the sectors, offering other services, it is possible to notice, that such change takes place in terms of reduction in employment in all sectors, offering services, and increase of employment in industries.



Functions of the impulse response allow analyzing reaction of sectoral structure of employment to macroeconomic shocks of general nature.

Thus it is possible to analyze reaction of employment to concrete shocks. As an example of such modeling the estimation of reaction of labor market on Russian WTO accession can serve. In work (Nekipelov etc., 2002) there were constructed forecasts for changes in sectors of Russian economy, which should take place after accession of Russia to WTO. Unfortunately, the work did

not consider in detail changes within particular sectors. According to the submitted forecast caused by WTO accession, the change of output is between 0,001-0,09%. Without change in services in case of gradual change of tariffs and the same scale of change in case of increase of tariffs in 2003 with their subsequent reduction by 2004. Forecasting by means of model which was constructed by us on the basis of the time series data, shows that the change of output appeared so little that the results are within the limits of a standard error of the forecast. Thus, it is possible to draw conclusion that the changes arising on labor market as a result of predicted changes of sector output are insignificant.

Summarizing, it is possible to draw a conclusion that the estimations made on the basis of time- series of employment reveal stability of matrices of probabilities of inter - sectoral displacements. However it was obtained, that probabilities are subject to influence of the external factors predicted by theoretical model.

3.2. Analysis of Inter- Sectoral Mobility from regional Prospect.

Empirical research on the basis of the given time series, carried out in the previous section, can be considered as a confirmation of the fact of stability of a matrix of probabilities of inter - sectoral displacements of workers under constant values of exogenous variables. The idea of the analysis, which results are given in the this part of work, is, that it is possible to study change in matrices of probabilities of displacements of workers between sectors on the basis of the data for regions of Russian Federation at the moment of crisis of 1998. Thus it is possible to treat structure of matrices of probabilities of displacement between sectors in the period before crisis constant according to the conclusion of the empirical analysis, which has been carried out in the previous section. A particular feature of Russian regional data on employment is that the sectoral data at the regional representation are accessible only till 2001. It is necessary to note, that the matrix of probabilities $\boldsymbol{P}$ is a priori asymmetrical. As a result, there is a necessity to estimate N^2 components in this matrix. Taking into account, that the matrix is stochastic, for the data for k years it is possible to receive $(k+1)N$ the equations for estimation. To make the solution unique, it is necessary to have $N \leq k+1$. It limits the number of considered sectors as it is supposed to compare models of inter - sectoral distribution of workers before and after crisis. Presence of the data only for two years after crisis limits number of sectors to three. For this purpose at studying inter - sectoral structure of employment the extraction of sectors applied at the analysis of time numbers(lines) of employment was used.

3.2.1. Estimation Procedure.

Let's consider the general problem of search of matrix $\boldsymbol{P}$ on a basis of k supervision observations of realization of distribution of workers in sectors $x_1, \ldots, x_k$. Observation file allows us to build k-1 the equations for calculation of a component of matrix $\boldsymbol{P}$ of a $x_N=\boldsymbol{P}x_{N-1}=\boldsymbol{P}^2x_{N-2}=\ldots\ \boldsymbol{P}^{N-1}x_1$. Besides as matrix P is stochastic, it has a property of $\boldsymbol{P}\cdot 1=1$. In deterministic situation when

matrix $\boldsymbol{P}$ has dimension NxN if $N > k$, components of matrix cannot be determined unequivocally. If N < k unequivocal restoration of components of matrix $\boldsymbol{P}$ is possible only if among k vectors of distribution is exactly N linearly independent. Generally restoration of matrix $\boldsymbol{P}$ in the determined case is probable only when N=k. In this case the system of the equations can be written down in the matrix form: $\boldsymbol{P}(x_1\ x_2 \ldots x_{k-1}\ 1) = (x_2\ x_3 \ldots x_k\ 1)$. Then the solution is $\boldsymbol{P} = (x_2\ x_3 \ldots x_k\ 1) \cdot (x_1\ x_2 \ldots x_{k-1}\ 1)^{-1}$.

More general problem arises, when vector x contains some casual component. Let's designate $X_{k-1} = (x_1\ x_2 \ldots x_{k-1}\ 1)$ и $X_k = (x_2\ x_3 \ldots x_k\ 1)$.

. Direct calculation of a matrix of probabilities of transition of workers between branches results in paradoxical results: the part of probabilities appears greater than one or smaller zero. It occurs first of all because the initial data contain a significant share of errors, and also that under influence of the certain external factors, the process of displacement of workers between sectors can deviate from Markov's. For maintenance of additional degrees of freedom, and also for simplification of initial problem, initial problem, $\boldsymbol{P}(x_1\ x_2 \ldots x_{k-1}\ 1) = (x_2\ x_3 \ldots x_k\ 1)$, looks like: $\sum_i p_{ij} \to \max$ for all j.

Under condition $\boldsymbol{P}(x_1\ x_2 \ldots x_{k-1}) = (x_2\ x_3 \ldots x_k)$ и $0 \le p_{ij} \le 1$.

The given problem(task) of linear programming was solved with the help of package GAUSS using the method of search of turning out polyhedron. Additional step which can seem not quite correct, was that restriction $\boldsymbol{P}(x_1\ x_2 \ldots x_{k-1}) = (x_2\ x_3 \ldots x_k)$ in a case of overidentification of matrix $\boldsymbol{P}$ (for the data from 1995 to 1998) was replaced with non –rigid restriction. Thus, for regions of Russian Federation matrices of transition of workers between considered sectors before and after crisis of 1998 were obtained. In the Appendix 2 histograms for change of the received elements of matrixes of probabilities of transition of workers between branches after crisis of 1998 are given in comparison with pre-crisis values. From the given diagrams it is possible to draw a conclusion that on a background of increase in probability to keep work in manufacture, the probability to remain on work in branch of services had no certain tendency to change. At the same time the probability to continue a condition of unemployment has remained former in overwhelming majority of regions.

3.2.2. Variables for the Analysis.

The empirical model has allowed to formulating hypotheses about dependence of wages of reservation and probability of transition of workers between branches from several factors used in model: alternative wages of workers, the costs connected to search of work, frequency of receipt of vacancies, the discount - factor and variance of offered vacancies. It is necessary to choose economic parameters which can describe variables of the models. It is possible to allocate four basic groups of such variables.

The first group of parameters should reflect opportunities of alternative earnings of workers. The alternative wages should reflect both size of the unemployment benefit, and an opportunity of

earnings in the branches which have been not reflected in the basic branch breakdown, in particular, employment in informal sector. As alternative of work at the large and average enterprises which are included in branch breakdown of Goskomstat of the Russian Federation, apparently, work can serve in small business. As a measure reflecting development of sphere of small business, we use a parameter of the attitude of the population occupied in small business, to mid-annual number of working population. The sense of using this parameter is, that with growth of number people, occupied in small business, in it(him) also there are opportunities of employment for other workers. The second group of parameters should reflect costs of conversion training for workers. Such costs, apparently, should depend on "affinity" of branches and qualification of the concrete worker. The third group of variables should reflect frequency of receipt of vacancies to the worker. Frequency of receipt of vacancies, apparently, reflects the general situation at the labor market: more advanced labor market provides more intensive receipt of new job offers besides for more qualified employees this frequency is higher. Besides as it was mentioned above, with change of conditions of trade parity of frequencies of receipt of new job offers from sectors, which have different conditions being changed. Development of labor market and job availability in one segment of labor market, are represented by a group of parameters. As the basic parameters of need for workers serve one can use GRP per capita and profitability of the enterprises in the region. While the first parameter reflects absolute demand for workers, the second parameter can serve as a parameter of efficiency of use of labor at the enterprises of region. Really, there can be a hypothesis that enterprises having unsuccessful financial parameters, use factors of production being used less effectively, in particular, work. While the first variable is intuitively proved, use of the second variable demands additional discussion. The hypothesis which has allowed us to include this variable in the equation, was, that more export - producing regions have more reliable commodity markets. As a consequence, regions with the greater share of export in a total regional product have steadier labor market. As a parameter describing structure of a labor market in regions, share of GRP, made in the industry was used. In particular, it is meant, that in those regions where the share of GRP in the industry is higher, higher demand for workers from the industrial enterprises. And, at last, the fourth group of variables reflects uncertainty in a labor market. In particular, she should include the factors determining spread of wages, offered to the worker by different employers. As one of groups of parameters which are necessary for using at empirical research of model, is the group of parameters connected to uncertainty on a labor market was marked. Unfortunately, at the Russian labor market employees does not pay off on a regular basis of the indexes similar to " an index of consumer moods ", reflecting value judgment of uncertainty. Moreover, characteristics of regional distribution of wages on regions of the Russian Federation, given by Goskomstat of Russian Federation, are not quite exact. As approach parameters of uncertainty of the offer of vacancies the parameter of actual distribution of wages - decile factor of differentiation of the charged wages on regions of the Russian Federation was used.

3.2.3. Regression Analysis of Regional Model

For received on the basis of the method of values of probability of transition of workers described above between the allocated sectors the estimation of dependence of these probabilities from the described macroeconomic variables was carried out. As the data had regional structure, the model with the fixed effects was used. Results of the received estimations are given in the table of A2.2. The result of econometric exercise for this dependence can be summarized on the basis of the following table:

	Production	Services	Unemployment
Production	*Profitability(-), Relative wage(-), Fraction of value added (+)*	*Profitability(+), Relative wage(+), Fraction of value added(-)*	*GRP (+), Fraction of export (-), Profitability (-), Fraction of employed in small bus. (+), Fr. of value added (-)*
Services	*GRP (+), Decile ratio(+), Relative wage(-)*	*GRP (-) Decile ratio(-) Relative wage(+) Fract. of value added(-)*	*Profitability(+), Fraction of value added(-)*
Unemployment	*Fr. of export (-), Decile ratio(-), Relative wage(+)*	*GRP (-), Decile ratio(+), Fraction of value added(+)*	*Fraction of value added(+)*

Trends of significant dependences which have been found out at are specified in the table. Columns of the table correspond to sectors from which there is a movement of labor, and rows - to sectors in which there is a movement of workers. One can notice, that results of estimations give arguments in favor of the hypotheses formulated above and concerning the basic dependences. It can also be considered as an argument for well performance of constructed theoretical model. Some of the obtained dependences not quite correspond to simple economic intuition, as, for example, reduction of probability of employment in the industry with growth of profitability of the enterprises of region. Thus especially it is necessary to emphasize that in the given work labor supply, instead of demand for labor is studied. Therefore on the side of demand, for example, dependence of probability of employment in industrial branches from profitability can cause growth of reservation wage with growth of demand for labor and, accordingly, reduction of probability of employment in the appropriate sectors.

Conclusion.

Problems of mobility of work play an important role in transition economy. The opportunity of labor market to adapt to macroeconomic changes in many respects determines flexibility of economy and social consequences of these changes. The purpose of this paper was the research of mobility of labor between sectors of economy in Russia. The offered research is based on theoretical

model of inter - sectoral mobility of labor, constructed with the aid of search model. The idea of theoretical model is that there can be made a transition from one-dimensional model of search to multivariate model in which the worker chooses one of vacancies from several sectors. One of the important characteristics of the offered model was reservation wage. On the basis of analysis of model results, regarding dependence of reservation wage and probability of transition of the worker between sectors from key parameters, which were considered, such as: alternative earnings, costs of search, demand for labor, variance of distribution of wages. The key factor of theoretical model appears to be average size of costs of displacement in the new sector. As it appears, there is some boundary value of this size, such that if average costs of transition in new sector exceed it, the character of all dependences will be opposite. Thus, under segmented labor markets, the results of the model do not coincide with results of classical model of search.

Empirical research on the basis of model was carried out in two stages. At the first stage dynamics of inter - sectoral displacements of a labor was investigated on the basis of time series of employment in different sectors. The theoretical model has allowed drawing a conclusion that in case of stable values of probabilities of transition of workers between sectors, the dynamics of inter - sectoral displacements can be described with the aid of Markov's equation. As a result of empirical analysis of model without exogenous variables it appeared that the matrix of probabilities of displacements has a diagonal structure, which initiated conclusion that in case of absence of exogenous influences on examined system, a main role in mobility of labor is played by displacements inside sectors. Introduction of exogenous variables in the model has allowed looking after their influence on probabilities of workers' displacement between sectors. The estimation of model of vector autoregression has shown, that the direction of influence of exogenous variables on probability of inter - sectoral displacements of workers corresponds to conclusions of theoretical model. The second stage of empirical research was based on one of conclusions of the analysis of time series of employment which pointed to insignificance of inter - sectoral transitions of workers under condition of stable values of exogenous factors. The assumption was put forward, that the three-year periods before crisis of 1998 and after it in Russia can be counted as rather stable for labor market. According to this assumption, it was supposed, that matrices of probabilities of displacements in the Russian regions were constant during these periods. According to such assumption matrices of probabilities of displacement of workers between sectors in regions of Russia before crisis of 1998 were calculated. Then change of these probabilities was investigated as a result of crisis. On the basis of inter-regional regressions of change of probabilities of inter - sectoral displacement of workers there were considered for some macroeconomic parameters. As it appeared, the empirical analysis of inter-regional dependences points, as well as for that on the basis of time series, that the basic conclusions of theoretical model are valid. Thus, the empirical analysis has confirmed the basic conclusions of theoretical model.

In the given work it was impossible to capture all spectrum of the problems arising on the part of the labor supply in Russia under influence of macroeconomic changes. At the further papers in the field of inter - sectoral mobility of labor in Russia it will be possible to take into account existence of institutional restrictions arising during displacement of labor between sectors and also to take into account regional specifics during construction of empirical models.

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Appendix 1.

In a survey part of the given work it was emphasized, that as a starting point for construction of original model of the given work the model of search in representation of Diamond was used. In the given appendix more formal framework of base model is made. Statement of model of search means, that the individual who is looking for job is considered, and job offers move to her as casual exogenous stream of wages. The number of offers of wages at each moment of time is casual and is distributed according to Poisson's distribution. In turn, realizations of offered wages are also casual and submit to some known continuous law of distribution. It is supposed, that the worker maximizes the expected income, choosing the optimum moment of a stop of search of vacancy. Thus it is considered, that search of vacancies brings to the worker the certain costs, and in case when the worker does not accept any offer of wages, she receives some alternative earnings. We shall assume, that in n the consecutive periods the worker receives a casual set of offers of work with wages $w_1,\ldots,w_n$.

The problem(task) of the worker consists in a choice of the moment in which she can receive the maximum wage from this set of offers. Let's assume, that distribution of wages w is described by continuous function of distribution F, known to the worker, not excluding reception by the worker the offer of zero wages. If the b- is alternative income of the worker, costs of search for the worker are equal c, discount the factor by the end i-th the period is equal $\beta(i)$, $W(w)$ - discounted value of a stream of incomes on job with wage w, V (·) the discounted expected income of an individual, $\Omega(t)$ - set of the information accessible for an individual at moment t. The problem of the worker can be presented as Bellman's equation:

$$V(\Omega(t)) = (b-c)i + \beta(i)E[\max\{V(\Omega(t+i)), W(w_{t+i})\}|\Omega(t)]$$

If distribution of wage, which is the best in sample of n offers is described by function $G(w, n)$, and probability of receipt of n (nonzero) offers during period of length i is described by Poisson distribution, that is the probability is equal $q(i, n) = e^{-\lambda i}\frac{(\lambda i)^n}{n!}$, then Bellman's equation for the stationary solution in time can be written as:

$$(1-\beta(i))V = (b-c)i + \beta(i)\sum_{j=1}^{\infty} q(i,j)\int_0^{\infty}\max[0, W(w_{t+i}) - V]dG(w_{t+i}, j).$$

Solution for optimum strategy of search is reduced finding of the reservation wage, that is such stationary level of wage w^*, that any offer of wage, higher than this level will be accepted by the worker. Assuming, that for discount – factor $\beta(i)=e^{-ri}$ holds, and letting length of one period tend to zero (we shall notice, that here Poison distribution tends to exponential distribution with parameter λ).

It is possible to obtain an expression for an initial problem:

$rV=b-c+\lambda\int_0^{\infty}\max\{0,W(x)-V\}dF(x)$.

This equation allows to find reservation wage: w * = rV.

In that case, we have: $\frac{\lambda}{r}\int_{w^*}^{\infty}[x-w^*]dF(x)$=c+ w*- b. This expression is an implicit function for dependence of reservation wages on key parameters of model: costs of the search, alternative wage, parameters of function of distribution of wages. The problem of worker in a continuous case looks like:

$rV=b-c+\lambda\int_0^{\infty}\max\{0,W(x)-V\}dF(x)$.

Thus, considering, that the value $\int_0^{w^*}xdF(x)$ is small, it is possible to obtain an expression for the reservation wage with the aid of parameters of the model: w*=$\frac{\lambda}{\lambda+r}\int_0^{\infty}xdF(x)+\frac{r}{\lambda+r}$ (b-c).

Taking into account, that the rational individual will go to work in the market only in case when the wages received by her exceed her alternative income, one can obtain the condition of participation of an individual on labor market: $\frac{\lambda}{r}\int_0^{\infty}[x-b]dF(x)$>c.

Thus, reservation wage positively depend on alternative earnings and negatively depends on costs of search. We shall consider results of change of key parameters of model on wages of reservation more in detail. The marginal reservation wage with respect to alternative income appear to be equal to marginal reservation wage with respect to costs of the search, taken with the opposite sign $\frac{\partial w^*}{\partial b}=\frac{r}{\lambda[1-F(w^*)]+r}=-\frac{\partial w^*}{\partial c}$

It means, that reduction of costs of search of job (for example, increase of information volume for the unemployed) is equivalent to increase of the unemployment benefit within the framework of considered model. It is possible to consider marginal reservation wage with respect to frequency of receipt of vacancies and discount factor and also to look at connection between marginal reservation wage and rate of receipt of vacancies: $\frac{\partial w^*}{\partial\lambda}=\frac{1}{\lambda[1-F(w^*)]+r}\int_{w^*}^{\infty}[x-w^*]dF(x)$>0.

Thus, reservation wage grows with growth of frequency of receipt of offered jobs. Besides it is possible to receive expression for the second derivative: $\frac{\partial^2 w^*}{\partial \lambda^2} = -\frac{\int_{w^*}^{\infty}[x-w^*]dF(x)}{\lambda[1-F(w^*)]+r}\{2[1-F(w^*)]+\lambda\frac{dF(w^*)}{dx}\int_{w^*}^{\infty}[x-w^*]dF(x)\} <0.$

Thus, with growth of frequency of receipt of job offers, the marginal gain of reservation wage is diminishes. For marginal reservation wage with respect to discount factor the expression looks like: $\frac{\partial w^*}{\partial r} = -\frac{\frac{\lambda}{r}\int_{w^*}^{\infty}[x-w^*]dF(x)}{\lambda[1-F(w^*)]+r} <0.$

Thus, reservation wage tends to growth with reduction of the discount - factor. In fact the discount - factor can be interpreted as probability per unit of time of termination of the current stream of incomes. Growth of this probability, obviously, causes " the threshold of participation" on labor market to reduce. There is simple dependence between marginal reservation wage with respect to frequency of receipt of vacancies and that with respect of discount - factor: $\lambda\frac{\partial w^*}{\partial \lambda}+r\frac{\partial w^*}{\partial r}=0$ or for the sum of elasticities $\varepsilon_{w^*}^{\lambda}+\varepsilon_{w^*}^{r}=0$. Thus, reservation wage is determined by the linear equation in partial derivatives.

An important point is research of dependence reservation wage from variance of job offers. Differentiating expression for wages of reservation, it is possible to receive: $\frac{\partial w^*}{\partial \sigma}=\frac{\lambda\int_0^{w^*}\frac{\partial F}{\partial \sigma}dx}{r+\lambda[1-F(w^*)]} >0$ for smooth distributions. Thus, the wages of reservation grow with growth of variance of job offers.

Appendix 2.

Tables.

Table A.2.1.

Extraction of industries for the analysis.

Industry	Production
Agriculture	Production
Forestry	Production
Building	Production
Transportation	Services
Telecommunications	Services
Trade and food services	Services
Information technology	Services
Commerce in real estate	Services
Utilities	Services
Health and sport	Services
Education	Services
Culture	Services
Science	Services
Finance	Services
Management	Services
Other	Services

Table A.2.2.

Results for inter – regional regression.

	P_{11}	P_{12}	P_{13}	P_{21}	P_{22}	P_{23}	P_{31}	P_{32}	P_{33}
GRP per capita	-0.302	0.051	0.534	0.521	-0.567	-0.138	0.064	-0.401	-0.167
	[1.65]	[0.31]	[4.31]**	[3.27]**	[2.25]*	[1.15]	[0.34]	[2.85]**	[0.87]
Fraction of export in GRP	0.306	-0.074	-0.309	0.429	0.074	-0.058	-1.189	-0.208	0.401
	[1.16]	[0.37]	[1.99]*	[1.31]	[0.15]	[0.29]	[2.84]**	[0.59]	[1.58]
Profitability of enterprises	-55.897	59.331	-26.491	18.487	-11.039	24.45	-5.288	-23.669	-0.3
	[2.78]**	[4.95]**	[2.12]*	[1.40]	[0.40]	[2.92]**	[0.28]	[1.81]	[0.02]

Decile differentiation ratio	-0.003	0.004	0.001	0.013	-0.014	-0.002	-0.01	0.009	0
	[0.70]	**[1.17]**	**[0.38]**	**[2.70]****	**[3.03]****	**[0.86]**	**[2.55]***	**[2.27]***	**[0.12]**
Fraction of employed at small enterprises	-1.49	0.387	1.113	-0.649	1.134	-0.337	1.102	0.668	-0.337
	[1.94]	**[0.87]**	**[3.00]****	**[0.76]**	**[1.57]**	**[1.04]**	**[1.50]**	**[0.80]**	**[1.30]**
Fraction of wage in industry to average wage	-0.46	0.306	0.119	-0.554	0.631	0.072	0.431	-0.286	-0.026
	[2.68]**	**[2.44]***	**[1.62]**	**[3.04]****	**[3.72]****	**[0.95]**	**[3.66]****	**[1.49]**	**[0.34]**
Value added in industry	0.008	-0.004	-0.006	0.003	-0.008	-0.006	-0.004	0.008	0.005
	[2.87]**	**[2.51]***	**[3.82]****	**[0.89]**	**[2.45]***	**[4.14]****	**[1.50]**	**[3.02]****	**[2.45]***
Intercept	1.088	-0.074	0.175	0.689	0.553	0.339	0.028	0.113	0.712
	[4.02]**	**[0.40]**	**[1.14]**	**[2.11]***	**[1.78]**	**[3.13]****	**[0.11]**	**[0.42]**	**[4.88]****
Number of obs.	157	157	157	157	157	157	157	157	157
Number of groups	79	79	79	79	79	79	79	79	79

Table A.2.3.

Extraction of sectors for time – series analysis.

Sector	Type
Electric energy	Raw
Oil extraction	Raw
Oil production	Raw
Gas	Raw
Coal	Raw
Ferrous metallurgy	Raw
Non – ferrous metallurgy	Raw
Chemical	Processing
Machinery	Processing
Wood processing	Processing
Production of materials fro building	Processing
Glass industry	Processing
Light industry	Processing
Food industry	Processing
Microbiological	Processing
Wheat processing	Processing
Printing	Processing
Building	Processing
Agriculture	Raw
Forestry	Raw

Table A.2.4.

VAR estimation[3].

	Production	**Unemployment**	**Binary variable**	**F - statistics**
Production	0,99	0,027	0,002	**104,79**
	0,01* **	**0,20**	**0,80**	
Unemployment	0,0001	0,977	0,0007	**930,45**
	0,03	**0,02*** **	**0,0006**	

Table A.2.5.

VAR estimation

	Services	**Unemployment**	**Binary variable**	**F - statistics**
Services	0,99	0,10	-0,001	**123,14**
	0,02* **	**0,13**	**0,003**	
Unemployment	0,003	0,955	0,0001	**949,15**
	0,003	**0,02*** **	**0,0006**	

[3] There are standard errors under coefficient estimates and *** - implies 1% significance of coefficient, ** - 5% significance, * - 10% significance.

Table A.2.6.

VAR estimation

	Production	Services	Production· Demand for labor	Production · Production	Services· Demand for labor	F - statistics
Production	0,511	0,512	0,468	-0,179	-0,401	**104,79**
	0,20***	**0,21*****	**0,23****	**0,03*****	**0,23***	
Services	0,129	0,869	-0,070	0,136	**-**	**930,45**
	0,03***	**0,03*****	**0,02*****	**0,04*****	**-**	

Table A.2.7.

VAR estimation

	Raw sectors	Processing sectors	Services financial intermediation and management	Other Services	F - statistics
Raw sectors	0,975	0,013	0,005	-0,003	**216,84**
	0,15***	**0,06**	**0,05**	**0,03**	
Processing sectors	0,047	0,912	0,034	-0,017	**154,78**
	0,45	**0,14*****	**0,039**	**0,03**	
Services financial intermediation and management	-0,072	0,183	0,890	0,176	**42,42**
	0,29	**0,48**	**0,11*****	**0,07*****	
Other Services	-0,137	0,038	0,109	0,654	**10,11**
	0,52	**0,68**	**0,19**	**0,13*****	

Table A.2.8.

VAR estimation

	Raw sectors	Processing sectors	Other Services	Unemployment	Binary variable	F - statistics
Raw sectors	0,975	0,013	0,005	-0,003	-0,003	**217,47**
	0,15***	**0,06**	**0,05**	**0,03**	**0,03**	
Processing sectors	0,047	0,912	0,034	-0,017	-0,017	**153,21**
	0,45	**0,14*****	**0,039**	**0,03**	**0,03**	
Other Services	-0,072	0,183	0,890	0,176	0,176	**38,06**
	0,29	**0,48**	**0,11*****	**0,07*****	**0,07*****	
Unemployment	-0,137	0,038	0,109	0,654	0,654	**516,82**

	0,52	**0,68**	**0,19**	**0,13*** **	**0,13*** **				

Table A.2.9.

VAR estimation

	Raw sectors	**Processing sectors**	**Services financial intermediation and management**	**Other Services**	**Raw sectors· Demand for labor**	**Process industry· Production**	**Other Services · Demand for labor**	**Services finance intermed· Demand for labor**	**F - statistics**
Raw sectors	0,406	0,085	0,102	0,257	0,551	-0,129	-0,256	-0,053	**216,84**
	0,09* **	**0,09**	**0,02*** **	**0,03*** **	**0,06*** **	**0,03*** **	**0,03*** **	**0,03***	
Processing sectors	-0,261	0,932	0,04	0,179	0,394	-0,021	-0,198	-0,019	**154,78**
	0,08* **	**0,08*** **	**0,02** **	**0,03*** **	**0,05*** **	**0,08**	**0,03*** **	**0,03*** **	
Other Services	0,240	0,259	0,647	0,328	-0,608	0,023	0,381	-0,475	**10,11**
	0,18	**0,17**	**0,07*** **	**0,04*** **	**0,11*** **	**0,06**	**0,06*** **	**0,05**	
Services financial intermediation and management	0,346	-0,249	0,034	0,151	0,005	0,091	-0,187	1,130	**10,11**
	0,16* **	**0,15** **	**0,04**	**0,06*** **	**0,10**	**0,05**	**0,05*** **	**0,05*** **	

Table A.2.10.

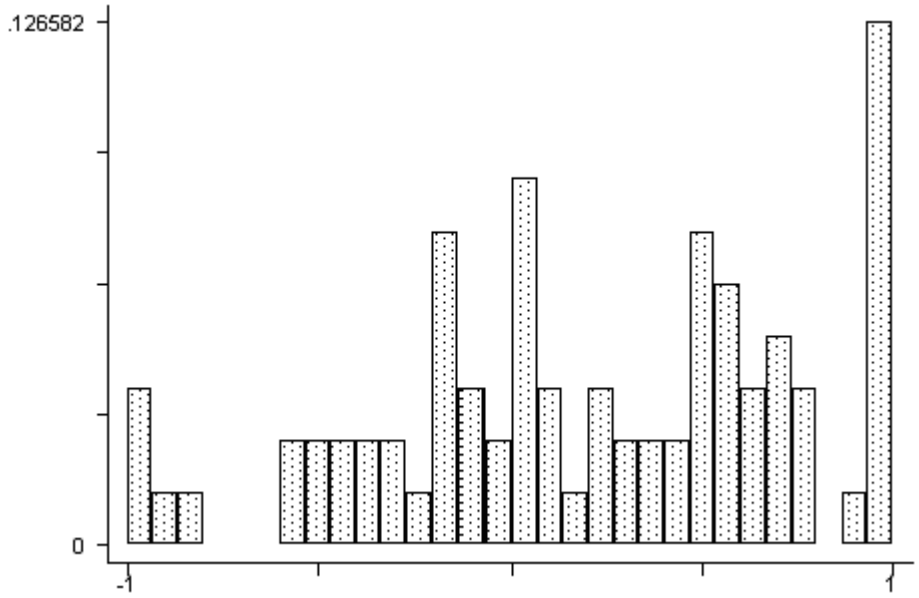
VAR estimation

	Raw sectors	**Processing sectors**	**Other Services**	**Services financial intermediation and management**	**Process industry· Production**	**Raw sectors· Demand for labor**	**Other Services · Demand for labor**	**Services finance intermed· Demand for labor**	**Process industry· Real exchange rate**	**Raw secto Real exchange rate**
Raw sectors	0,106	0,358	0,231	0,085	-0,009	0,262	-0,204	0,474	-0,024	0,074
	0,10*	**0,11*** **	**0,03*** **	**0,02*** **	**0,02**	**0,06*** **	**0,03*** **	**0,14*** **	**0,01***	**0,01*** **
Processing sectors	-0,016	0,583	0,271	**0,094**	0,0005	0,144	-0,164	0,578	0,067	-0,020
	0,12	**0,12*** **	**0,03*** **	**0,02*** **	**0,02**	**0,07** **	**0,03*** **	**0,15*** **	**0,02*** **	**0,01**
Other Services	0,058	0,655	0,474	0,210	0,034	-0,155	-0,001	0,470	-0,081	0,005
	0,14	**0,15*** **	**0,04*** **	**0,02*** **	**0,03**	**0,08***	**0,04**	**0,18*** **	**0,02*** **	**0,01**

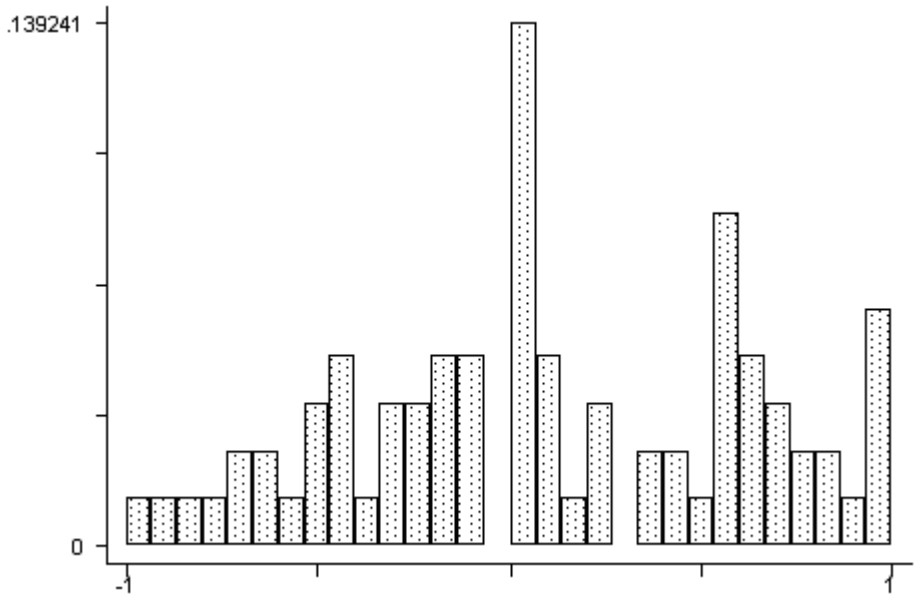
Services financial intermediation and management	0,075 **0,21**	0,023 **0,23**	0,088 **0,06**	-0,001 **0,04**	-0,020 **0,05**	0,133 **0,13**	0,0007 **0,06**	0,407 **0,28***	-0,035 **0,02**

Picture 3

Histogram for probability to stay in production



Histogram for probability to stay in services.



Histogram for probability to stay unemployed.