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MODEL OF EMPLOYMENT IN THE CMEA COUNTRIES

1. Introduction

In many scientific centres both in capitalist and socialist countries macromodels are built and applied in the economic and plan analysis. One of the main blocks in these models is the sector of manpower. Modelling of employment in capitalist countries has a slightly different character than in socialist countries due to cycles of the economic development and private ownership of the capital. Demand for manpower depends mainly on gross output or on national income, wages, fixed assets and profit rate. Supply of manpower is determined by manpower resources, wages yand unemployment rate. Equations describing unemployment occur very often.

In the models constructed in socialist countries in some cases only the manpower supply has been considered. Only in the W-models built at the Institute of Econometrics and Statistics, University of Łódź, the function of demand for manpower is separated from the function describing manpower supply.

Models of employment should be built taking into consideration demand and supply of manpower. The analysis of employment from these points of view enables to detect both general and partial disequilibria and tensions occurring at the labour market. However, due to links of the employment sector with other blocks of the macromodels of national economies of CMEA countries more attention was paid to the analysis of manpower supplics in particular countries being considered[1].

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[1] Sectors of production, investment and fixed assets are supply-oriented.

The model was divided into material production sector covering industry, construction, agriculture and forestry, transport and communication, and trade, and into non-material services sector (total). Particular equations of the model were estimated on the basis of annual statistical data for the years 1963-1978. These data are included in the data bank of CMEA. They are a result of studies carried out within the problem 11.6.

2. Manpower Supply

The term "manpower supply" denotes usually people employed in the national economy and those seeking job in an active way, irrespectively of the fact whether they are registered in employment agencies or not.

Thus, the level of such a manpower supply is unobservable in a longer period of time practically. It can be assumed, however, that in the case of active and full employment policy the demand for manpower follows the supply. As a measure of this category the actual level of employment resulting from the processes at the labour market is assumed. The size of manpower supply is determined mainly on the potential labour resources and professional activity of the population. The dynamics of potential labour resources and their structure depend on long-term demographic processes. That is why both the structure and size of manpower resources according to sex and age in a short- or medium-term can be assumed as predetermined variables. Having this on mind the manpower supply is determined to a large extent by the level of professional activity of the population. The basic manpower resources are characterized by heterogenous professional activity. It depends mainly on the following elements:

1) the structure of population by sex, age, residence (urban and rural population);

2) economic, social and cultural elements.

Total supply of manpower can be presented as

$$N(S) = NU(S) + NW(S) + NPW(S)$$

where:

N(S) - total supply of manpower,

NU(S) - adolescents willing to undertake work,

NW(S) - supply of manpower at professionally active age,

NPW(S) - supply of manpower at professionally non-active age[2].

The motives for taking up work by these three groups are different. In all CMEA countries being analysed the number of working adolescents begining work before achieving the professionally active age is insignificant in relation to total employment and has a decreasing tendency. The value of this supply is in general insignificant and it is assumed to be a residual value. Similarly, the supply of manpower at professionally non-active age is not significant either in relation to total manpower supply.

The level of professional activity of elderly people is affected by demographic and economic situation and the government policy. European societies reveal a general tendency to ageing. This process occurs also in the CMEA countries.

Generally, the legal regulations in CMEA countries enable the employees to retire earlier and hamper the continuation of proffesional activity in order to prepare new posts. Only in these countries in which manpower resources decrease, i.e. in Poland, GDR, Czechoslovakia, and Hungary, the regulations permit to continue professional work or to undertake part-time jobs. However, also in this case it was assumed that the supply of manpower at professionally non-active age was residual. Hence, total manpower supply is almost wholly determined by the supply of people at professionally active age. This is not a homogenous category. On the contrary, it is highly differentiated as far as sex, qualifications, and residence are concerned. Professional activity of each group is different and depends on many various socio-economic factors. However, due to the fact that statistical data on the size and structure of sex, age and qualifications in a long time period are not available, it is not possible to analyse manpower supply divided into these categories. Besides, economic and non-economic instruments affecting professional activity of particular groups are usually unmeasurable and impossible to define, e.g. infrastructure, individual preferences of particular professional groups, development of social facilities system etc.

The subject of analysis included manpower supply function - total and separately for particular branches of the national economy. The

[2] Generally women over 60 and men over 65 years of age.

determinants of manpower allocation in particular sectors of the national economy are usually unmeasurable and result from the economic policy of the state.

In some socialist countries labour force is allocated in an administrative way. This refers mainly to young employees being just introduced to the labour market, and especially graduates. There are also temporary limitations in the number of posts and blocking-up of jobs etc. However, the decision whether to begining a job or not belongs to an employee although there might be various kinds of more or less strict institutional control. In most cases the decision on begining a job is made on the basis of economic premises. Thus, changes in the wage structure should be accompanied by a fluctuation of employees between particular sectors of economy, or by undertaking job in a given sector by new employees. Wages should be, therefore, an instrument which controls the behaviour of manpower ot the labour market. However, this hypothesis has not been confirmed in the course of investigations. It appeared that changes in wage structure had no significant influence on the level of employment in particular sectors of the national economy. The labour force mobility was limited as we can speak about the unmeasurable "cost" of the job change.

Such results of the analysis follow from different roles of wages which apart from being a stimulating factor also influence the living standard, distribution of consumers' goods and services, market equilibrium and so on. There is a contradiction between income and consumption functions of wages and their role as an economic stimulus. Depending on real production requirements wages should be differentiated respectively. Besides, their increase should be in a proper relation to changes of labour productivity because of keeping appropriate economic proportions affecting supply and demand of consumers' goods. On the other hand one of the mainlines of the state economic policy is to guarantee still increasing standard of living. The state, having control over the wages, cannot allow significant disproportions between incomes to occur in particular sectors of the national economy. Thus, wage proportions should be determined in such a way as to guarantee the satisfaction of the important needs of the employees on the one hand, and to stimulate the redistribution of the actual manpower resources among sectors of the national economy on the other. Besides, they should be a stimulus to increase professional qualifications and labour productivity.

The allocation of manpower is also influenced by other socio-economic factors, such as organization and conditions of work, human relationships, logging conditions, possibilities of undertaking job in an acquired profession etc. The influence of these factors is the highest in the case of young people who form the most mobile group. The older generation of employees change job much less frequently. Socio-economic factors such as social rise, increasing of professional qualifications, possibilities of improving financial situation of a family must be very strong to induce important reshuffles in this group of labour force.

A very important problem in formation of manpower supply structure is the migration of people from villages to cities. This phenomenon does not influence to a large extent total professional activity, it causes however, the increase of manpower supply to non-agricultural sectors (especially manufacturing and building industries) and a decrease of manpower supply to agriculture and forestry in relation to the total level. This regularity appears in all socialist countries, the smallest changes being observed in Poland. That tendency follows mainly from technological development. Agriculture engineering and land accumulation release the excess of manpower in that sector. Besides, a very important role is played by socio-economic factors, living conditions in villages and changes in the level and structure of country youth's education.

As mentioned above, total manpower supply and its structure are determined by many factors which are usually unmeasurable and thus cannot be specified in an econometric model. For some CMEA countries it was impossible to acquire statistical data reflecting economic policy of a given country. This limited the possibility of constructing such a model which would take into account all the above-mentioned factors influencing labour supply.

3. General Characteristics of the Model

An econometric model for manpower supply contains equations describing both total manpower supply as well as in particular economic spheres and branches of the national economy. This is one of the sectors in the system of CMEA macromodels characterizing particular economies of European socialist countries.

For each category several alternative equations were considered both concerning the analytical form of functions and their specifications. Additionally for total values the functions of professional activity were analyzed.

Manpower supply was assumed as a function of the number of people at professionally active age representing potential labour resources. This variable is exogenous in the system.

Alternatively, in order to study inertia in employment the previousyear supply level was introduced to the model. This approach makes it possible to analyze short-term elasticities of endogenous variables in relation to factors specified in the equations.

The feature which should influence directly professional activity and therefore also the total supply level is the relation between an average wage and per capita income (ZP/YL). This coresponds to the hypothesis that if the wage growth rate is slower than the growth rate of per capita income the family's economic situation is improved due to an increase of the number of working members of the family. This lagged variable can therefore characterize economic motives of people undertaking job.

For Romania and GDR as a symptomatic variable of personal income (YL) the value XL = X/L, i.e. national income produced per capita, was assumed (since no statistical data on the levels of income were available).

The formation of labour supply in particular sectors of the national economy was affected by many different factors and the state economic policy. Determined tasks and economic assumptions should agree with the policy of locating production capacities and hence also labour resources. To realize the production tasks various instruments aiming at correct allocation of manpower supply are applied. They are unmeasurable and therefore difficult to quantify. Besides, no appropriate statistical investigations are carried out and the influence of these factors can be described only indirectly. Thus we introduced into the model a variable reflecting production structure from the previous period $(X_j/X)_{-1}$ as a symptomatic variable expressing to some extent the steps undertaken from the point of view on rational employment policy. This variable reflects also power of a given sector. The higher is the reaction of labour supply to changes of that factor, the better this sector can realize its production tasks in relation to other sectors. While introducing this variable with some lag we had in mind the assumption that it was impossible to achieve rational

employment by means of institutional instruments in the present period.

In the case when manpower reserves appear and when real labour resources are relatively small, there is a tendency to maximize labour costs and investments creating new job opportunities. That was of special importance in the countries being at low economic level where significant disproportions between manpower resources and fixed assets in the national economy occur (e.g. Romania and Bulgaria). Economic development of these countries is impossible without rich investment policy. In an opposite case, when there is a deficit of manpower, declining trends in the labour costs are observed. Investment outlays increase labour productivity. It should be added that investments and technological progress also influence the development and efficient utilization of labour resources. They also affect indirectly the increase of professional qualifications (this is a feedback type dependence).

Investment policy of the state influences manpower supply both in long-term and short-term periods. By creating possibilities of new jobs the level and structure of real manpower resources change. Besides, as a result of a feedback between science, technological progress and increased qualifications of the employees it is possible to activate professionally still wider social groups. And thus, a variable expressing the value of investment outlays per 1 employee lagged by a year $(J/N)_{-1}$ was introduced to the model. This variable can be assessed generally as an accelerator of professional activity especially in these countries and sectors of the national economy where the manpower reserves are not completely utilized. On the other hand, it may be a measure of the most recent technological progress. Therefore, this factor can impose two kinds of influence on the explained variables:

a) it creates new job opportunities and hence makes the manpower allocation possible (this refers especially to manpower increase);

b) it enables labour productivity to increase and thus relative saving of labour costs.

Therefore, according to the situation on particular labour markets the estimate of the parameter standing at this variable in the model can be positive or negative. It should be stressed that investment outlays in agriculture allow generally manpower of the rural population to transfer to other sectors of the national economy. As a result of mechanization in agriculture usually the excess of manpower

appears. It increases the manpower supply in other sectors of the economy.

A variable reflecting investment structure $(J_j/J)_{-1}$ was also introduced into the model. This coefficient reflects both power of a given sector and the state policy concerning manpower allocation.

Thus employment functions were analysed in the following forms:

1) total employment

$$N = f[N_{-1}, (Z/YL)_{-1}] \quad (1a)$$

$$N = f[N_{-1}, (J/N)_{-1}] \quad (1b)$$

$$N = f[LE, (Z/YL)_{-1}] \quad (1c)$$

$$N = f[LE, (J/N)_{-1}] \quad (1d)$$

2) total professional activity

$$N/LE = f[(N/LE)_{-1}, (Z/YL)_{-1}] \quad (2a)$$

$$N/LE = f[(N/LE)_{-1}, (J/N)_{-1}] \quad (2b)$$

3) employment in the sectors and branches of the national economy

$$N_j = f[N_{j-1}(J_j/N_{j-})_{-1}] \quad (3a)$$

$$N_j = f[N_{j-1}(J_j/J)_{-1}] \quad (3b)$$

$$N_j = f[N_{j-1}(X_j/X)_{-1}] \quad (3c)$$

$$N_j = f[LE, (J_j/N_j)_{-1}] \quad (3d)$$

$$N_j = f[LE, (J_j/J)_{-1}] \quad (3e)$$

$$N_j = f[LE, (X_j/X)_{-1}] \quad (3f)$$

where:

j = the symbol of a sector or branch of the national economy;

LE - number of people at professionally active age;

(ZP/YL) - the ratio of an average nominal wage to per capita income;

(J/N) - the level of investment outlays per 1 employee, total;

(J_j/N_j) - the level of investment outlays per 1 employee in a given sector;

(J_j/J) - the share of investments of the branch j in total investment outlays;

(X_j/X) - the share of net output of the branch j in total national income produced.

Besides, dummy variables were used in the model in order to describe the effect of changes on the level and structure of employment.

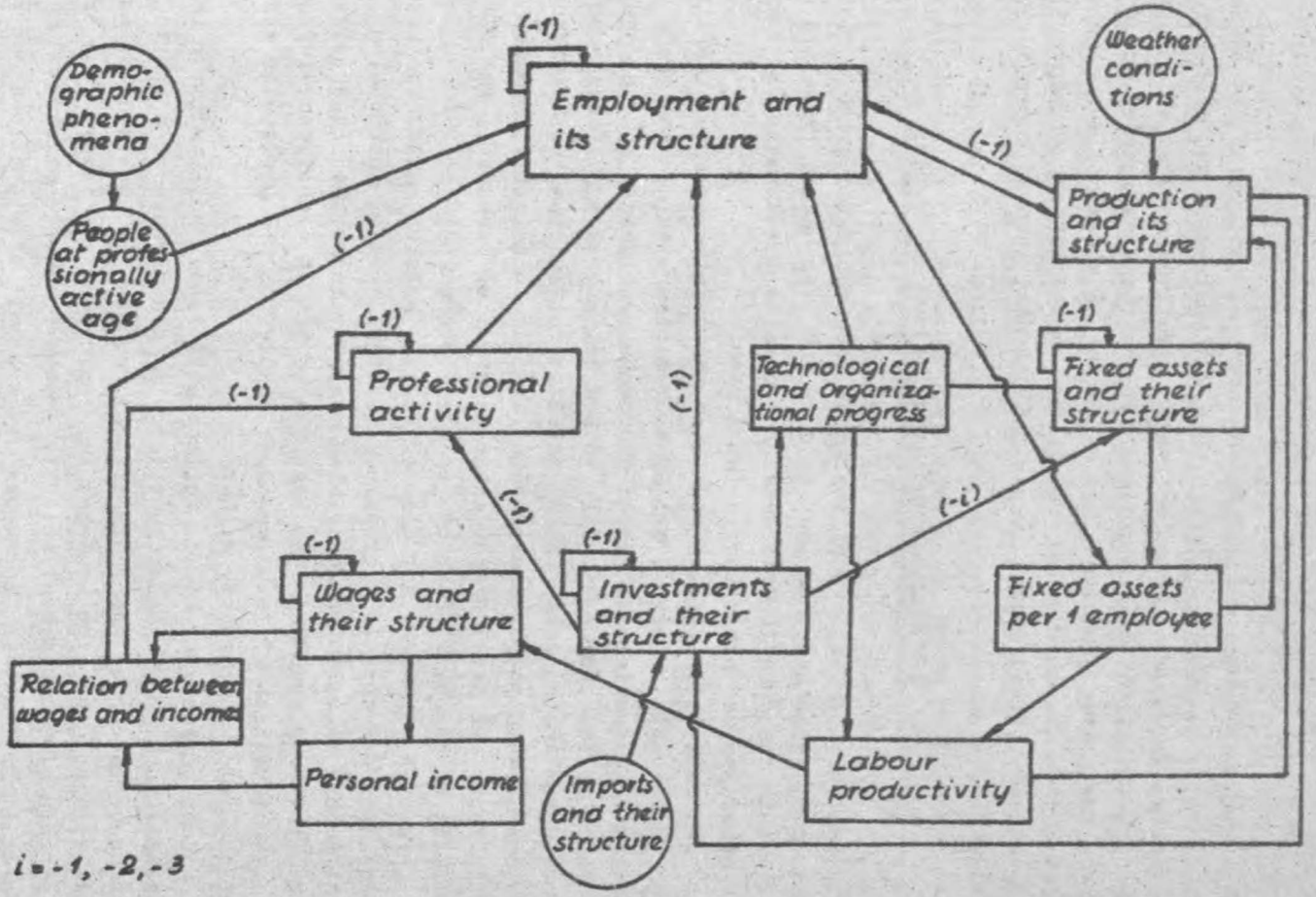

Fig. 1. Scheme of supply version of the employment model

$$U_{jk} = \begin{cases} 1 \text{ in the years } j - k \\ 0 \text{ in other years} \end{cases}$$

As a measure of manpower supply the level of employment was assumed. Only in the case of agriculture the employment and professional activity functions were estimated simultaneously as only in this sector significant disproportions between these categories occur and even the rates of changes are different. A scheme of a supply version of the employment model in relation to the sectors of production, investments, fixed assets, wages and personal income is presented in Figure 1.

4. The Analysis of Model Estimation Results

Particular equations of the model were estimated using a classical least squares method and the data for the years 1963-1978 contained in the CMEA/12 Data Bank. The results of estimation of selected equations are presented in the Appendix.

The estimation results confirmed the hypothesis about inertia in manpower supply in almost all CMEA countries being analysed. The estimated parameters at lagged endogenous variables ranged usually between 0.75 and 0.95, only in GDR being 0.55-0.67 for almost all considered categories. Such results follow from the situation on labour markets in particular countries. If in Bulgaria, Romania and USSR there are still pretty large reserves of manpower, in GDR the deficit of manpower resources is still deepening.

For GDR, Romania and Czechoslovakia better estimation results were obtained for autoregressive equations than by introducing into the model a variable describing manpower resources. Especially in the first two countries the variable LE had in significant influence on the formation of total manpower supply and in particular sectors of the national economy either.

Such estimation results reflect differentiated situation on labour markets in both of these countries. In GDR because of a shortage of manpower resources and insignificant changes in the level of people at working age, the changes in employment are mainly due to the increase of professional activity. Manpower supply in particular non-agricultural sectors increases as a result of migrations of rural population. A high level of agricultural engineering enabled a pretty

intensive employment of rural population in other sectors of the GDR national economy.

In Romania the increase of manpower resources is quite big and is not wholly incepted to the production process. The decrease of professional activity in this country and changes in employment structure cause that a potential labour supply cannot be realized at a given stage of economic development. The rate of increase of the number of people at professionally active age was in that country higher than the rate of changes in employment.

On the basis of the analysis of employment elasticities in relation to changes of potential manpower resources it was stated that the strongest reaction occurs in Bulgaria, while in GDR, Poland and Czechoslovakia these elasticities are relatively small. This can be explained by a rate of changes in professional activity. In the countries where there is a declining trend in the level of activity the reaction to changes in manpower supply is not strong (see Table 1).

T a b l e 1

Elasticities of employment in relation to manpower resources (in %)

Manpower supply	Bulgaria	Czechoslovakia	GDR	Poland	Romania	Hungary	USSR
Total	5.83 (2.11)	2.22 (5.95)	1.11 (2.21)	1.61 (3.21)	3.26 (5.26)	2.45 (6.25)	2.69 (8.33)
Material sector	6.17 (3.58)	1.68 (3.73)	1.48 (1.95)	1.36 (2.22)	2.47 (3.98)	4.19 (10.35)	2.76 (25.76)

N o t e: In brackets the values of t-Student statistic are given

Such high levels of elasticity for Bulgaria in relation to other countries result among others from the fact that in this country relatively large manpower resources were eliminated in a short time.

As a main variable explaining the total manpower supply or professional activity coefficients the relation between average nominal wage and personal income was taken. Interrelationships betwenn these two economic categories determine in a different way professional activity of men and women.

The main motive for undertaking job by women are economic resons although other causes (e.g. increase of the educational level, professional ambitions etc.) are not without meaning. The level of men's professional activity is usually very high and is not a subject to significant changes. Economic factors affect mainly women's professional activity and these perturbations are reflected in the total professional activity level.

The variable $(Z/YL)_{-1}$ introduced to the model had an important influence only in Bulgaria, Poland, USSR and Czechoslovakia. In Bulgaria and USSR the estimated elasticities were very close and equal -0.64 and -0.61, respectively. In Poland it was -0.45. Thus, it follows that the stimulating role of wages in the two first countries was much stronger than in Poland. The variable XL introduced to the model as a symptomatic one for YL (for GDR and Romania) did not yield positive results.

The specification of a variable characterizing the state investment policy, namely the coefficient $(J/N)_{-1}$ improved to a great extent the results of estimation especially in the equations describing total manpower supply in Czechoslovakia, GDR and Romania.

T a b l e 1

Elasticites if total manpower supply in relation to $(J/N)_{-1}$ (in %)

Elasticities	Czechoslovakia	GDR	Romania	USSR
Short-term	0.044 (3.58)	0.092 (3.11)	0.068 (3.25)	0.060 (2.25)
Long-term	0.177 (4.66)	0.267 (2.16)	0.084 (4.28)	0.079 (2.51)

N o t e: In brackets the values of t-Student statistic are given.

Both short- and long-term dependences were analyzed (see Table 2). In Czechoslovakia and GDR there were significant differences in the short-term reaction of employment in relation to long-term changes. Thus, manpower supply and professional activity are created to a large extent by the state investment policy in long time periods. On the other hand, current changes do not cause significant fluctua-

tions in employment. In Romania and USSR both estimated parameters do not differ significantly and are quite small. It follows, therefore, that in this case investments are a significant instrument of current employment policy.

The allocation of manpower to particular sectors of the national economy is determined by factors representing investment policy in particular branches. In most cases the variable $(J_j/N_j)_{-1}$ characterized properly the tendencies "attracting" manpower supply in main branches and sectors.

In the equations discribing non-agricultural sectors the estimated parameters standing by that variable were usually positive. Thus, the assumed hypothesis that investments can be established generally as an accelerator of professional activity, was confirmed. Using investments as instruments it is possible to allocate manpower according to assumed economic tasks of the country.

It appeared that the reaction of employment to changes of this factor was the strongest in Romania (especially in building industry) and the lowest in Czechoslovakia and GDR. Also in these two last countries there are clear differences between the values of estimated long-term and short-term elasticities (e.g. in Czechoslovakia for industry the long-term elasticity is 0.14 and short-term one 0.062, while in GDR it is 0.23 and 0.088, respectively). The estimated parameters standing at the variable $(J_j/N_j)_{-1}$ had a negative sign for industry and building (or for one of these branches) in Hungary, USSR, Bulgaria and Poland.

Such results seem to be correct for the first two of the above-mentioned countries. Both in Hungary and USSR, and even in Poland there have been recently observed large changes in the employment structure. The sector of services develops dynamically, while employment in industry and building does not reveal too high dynamics of changes. Migrations of manpower supply are possible if in two basic sectors of the national economy labour productivity increases significantly. The economic processes can be intensified together with a simulatenous increase of technological level. Thus, in this case investments represent an influence of changes in technological progress. It seems that with the economic development this process will occur in many socialist countries. The hypothesis that investment outlays in agriculture allow for transfer of manpower from the country to other sectors of the national economy has been also

confirmed. Relative investment outlays cause a significant decrease of the level of professionally active people in agriculture. Short--term elasticities were very close in all countries (except Poland) and ranged between -0.084 to -0.115. In Poland quite significant fluctuations in dynamics of professionally active people were observed in agriculture. Investment outlays in that sector had no important influence on manpower supply and the estimated value of short--term elasticity coefficient was only -0.014.

The model specifies additionally the variables representing total policy instruments dealing with manpower supply and characterizing the allocation possibilities in a given sector. A variable describing a branch structure of production $(X_j/X)_{-1}$ was introduced to the model most frequently in the case of manufacturing and building industry and in some other material sectors, including trade.

In all the estimated equations a positive sign of the parameter estimate at the variable was obtained. This means that when net output of a given sector increases various types of stimuli are introduced to attract real manpower resources. However, such a specification of model equations was better than other variants from a statistical point of view only in Bulgaria.

The processes determining the level of employment in the non-material production sectors are slightly different than in material production sectors. In all countries pretty high inertia of employment was observed. This phenomenon is determined to a large extent by previously formed people's needs and habits. Besides, employment in services sector is determined both by changes in the level of fixed assets and the state investment policy. The estimated short--term elasticities in relation to investment outlays per 1 employee in non-material production sector were the highest in GDR, Czechoslovakia and Hungary (they range between 0.15-0.18) and much lower in Bulgaria, USSR and Romania (0.08-0.11). Thus, it follows that in the first group of countries tendencies towards development of the service sector can be observed.

In some countries in particular years various institutional measures were used even in an administrative way the manpower was allocated according to the current needs of the national economy. The effects of this policy were taken into account by introducing dummy variables U_{jk} to the model. In Czechoslovakia the variable U7678 describes some kind of "statistical" change of infor-

mation concerning the categories of employment in the sample period. It is presumed that in those years a different way of converting the number of part-time workers to full-time ones was applied. In all sectors of the national economy (excluding building industry) employment decreased by about 7% in 1976 as compared with 1975.

It seems that the obtained estimation results can be considered correct. Selected variants of equations are characterized by a high level of consistence (in most cases being $R^2 > 0.95$) and a low level of mean standard error of the estimates (usually below 1%). In almost all cases significant estimates of structural parameters were obtained. The values of these estimates are correctly interpreted from the economic point of view. In few equations the random term autocorrelation was noted.

Appendix

Symbols and critical values of statistical structure of the model:

R^2 - determination coefficient;

t - the value of t-Student statistic (below the estimate of structural parameter);

Significance level	Number of parameters estimated in the model			
	2	3	4	5
t_α for $\alpha = 0.02$	2.624	2.650	2.681	2.718
t_α for $\alpha = 0.05$	2.145	2.160	2.179	2.601
t_α for $\alpha = 0.1$	1.761	1.771	1.782	1.796

D-W - the value of Durbin-Watson test;

k' - the number of explanatory variables in equations;

Significance level	k' = 1		k' = 2		k' = 3		k' = 4	
	d_l	d_u	d_l	d_u	d_l	d_u	d_l	d_u
$\alpha = 0.01$	0.844	1.086	0.737	1.252	0.633	1.446	0.532	1.663
$\alpha = 0.05$	1.106	1.371	0.982	1.539	0.857	1.728	0.734	1.935

SE/MY - the value of mean estimate error.

BULGARIA

$$N/LE1 = \underset{(2.41)}{0.3568} + \underset{(2.27)}{0.7779}\,(N/LE1)_{-1} - \underset{(2.27)}{0.00147}(ZP/YL1)_{-1}$$

$R^2 = 0.987$ D-W = 1.453 SE/MY = 0.0242

$$N1 = N/LE1 \times LE1$$

$$\ln NM1 = \underset{(7.96)}{-96.73} + \underset{(3.58)}{6.17}\ln LE1 - \underset{(2.34)}{0.442}\ln (JMP/NM1)_{-1}$$

$R^2 = 0.967$ D-W = 1.024 SE/MY = 0.0060

$$NM1 = EXP[\ln NM1]$$

$$NQ1 = \underset{(1.19)}{-115.45} + \underset{(17.13)}{0.830}\,(NQ1)_{-1} + \underset{(2.31)}{684.34}\,(XQP/XP1)_{-1} + 48.83\ U6667$$

$R^2 = 0.996$ D-W = 2.108 SE/MY = 0.0099

$$NB1 = \underset{(9.34)}{-1422} + \underset{(11.09)}{0.3241} - \underset{(3.99)}{72.77}\,(JBP/NB1)_{-1} - \underset{(3.97)}{21.82}\ U6166$$

$R^2 = 0.998$ D-W = 1.699 SE/MY = 0.0180

$$NT1 = \underset{(2.58)}{-428.27} + \underset{(3.12)}{0.1037}\ LE1 + \underset{(3.24)}{646.22}\,(XTP/XP1)_{-1} + \underset{(3.11)}{15.62}\,(JTP/NT1)_{-1}$$

$R^2 = 0.984$ D-W = 1.467 SE/MY = 0.0264

$$\ln NR1 = \underset{(4.33)}{-84.50} + \underset{(4.67)}{10.58}\ln LE1 - \underset{(6.02)}{0.9643}\ln (JRLP/NR1)_{-1} + \underset{(2.55)}{0.2379}\ U7375$$

$R^2 = 0.962$ D-W = 2.435 SE/MY = 0.0226

$$NR1 = EXP\ [\ln NR1]$$

$$\ln NARL1 = \underset{(2.93)}{2.236} + \underset{(6.11)}{0.6711}\ln (NARL1)_{-1} - \underset{(3.24)}{0.1330}\ln(JRLP/NARL1)_{-1}$$

$R^2 = 0.997$ D-W = 2.067 SE/MY = 0.0015

$$NARL1 = EXP\ [\ln NARL1]$$

$$NO1 = \underset{(11.70)}{-1377} + \underset{(12.96)}{0.3012}\ LE1 + \underset{(2.27)}{46.64}\,(JOP/NO1)_{-1} - \underset{(10.40)}{37.21}\ U6670$$

$R^2 = 0.989$ D-W = 1.978 SE/MY = 0.0253

$$NN1 = \underset{(14.27)}{-3331} + \underset{(13.12)}{0.674\ LE1} + \underset{(3.32)}{1309\ (JNP/JP1)_{-1}} - \underset{(1.41)}{31.62\ U66}$$

$R^2 = 0.971$ D-W = 1.497 SE/MY = 0.0350

CZECHOSLOVAKIA

$$\ln N2 = \underset{(3.61)}{-11.93} + \underset{(5.95)}{2.2235\ \ln LE2} + \underset{(4.66)}{0.1765\ \ln (J/N2)_{-1}} + \underset{(7.49)}{-0.0777\ U7678}$$

$R^2 = 0.983$ D-W = 1.667 SE/MY = 0.0013

$N2 = EXP\ [\ln N2]$

$$\ln NM2 = \underset{(1.84)}{-7.3156} + \underset{(3.73)}{1.6832\ \ln LE2} + \underset{(3.72)}{0.1813\ \ln(JM/NM2)_{-1}} - \underset{(5.46)}{0.0636\ U7678}$$

$R^2 = 0.973$ D-W = 1.423 SE/MY = 0.0015

$NM2 = EXP\ [\ln NM2]$

$$\ln NQ2 = \underset{(3.69)}{-9.410} + \underset{(6.45)}{1.8663\ \ln\ LE2} + \underset{(3.76)}{0.1401\ \ln (JQ/NQ2)_{-1}} - \underset{(7.02)}{0.0753\ U7678}$$

$R^2 = 0.969$ D-W = 1.759 SE/MY = 0.0014

$NQ2 = EXP\ [\ln NQ2]$

$$\ln NB2 = \underset{(3.77)}{1.0112} + \underset{(18.55)}{0.8343\ \ln NB2_{-1}} + \underset{(3.47)}{0.0444\ \ln (JB/NB2)_{-1}} - 0.00516\ U63$$

$R^2 = 0.998$ D-W = 2.104 SE/MY = 0.0010

$NB2 = EXP\ [\ln NB2]$

$$\ln NRL2 = \underset{(3.61)}{3.3832} + \underset{(3.39)}{0.4891\ \ln(NRL2)_{-1}} - \underset{(3.34)}{0.1148\ \ln (JRL/NRL2)_{-1}} - \underset{(3.07)}{0.0834\ U72}$$

$R^2 = 0.903$ D-W = 1.040 SE/MY = 0.0045

$NRL2 = EXP\ [\ln NRL2]$

$$NARL2 = \underset{(4.46)}{1328} + \underset{(5.11)}{0.4932\ (NARL2)_{-1}} - \underset{(3.81)}{4.1714\ (ZRLP/YL2)_{-1}} - \underset{(6.07)}{87.57\ U7278}$$

R^2 = 0.996 D-W = 1.943 SE/MY = 0.0067

$$\ln NTO2 = \underset{(2.89)}{1.0721} + \underset{(13.48)}{0.8204}\ \ln(NTO2)_{-1} + \underset{(3.27)}{0.0699}\ \ln(JTOP/NTO2)_{-1} + \underset{(2.68)}{-0.0258}\ U7678$$

R^2 = 0.991 D-W = 1.638 SE/MY = 0.0017

$$NTO2 = EXP\ [\ln NTO2]$$

$$NN2 = \underset{(10.51)}{-4906} + \underset{(12.43)}{0.7114}\ LE2 + \underset{(4.46)}{11.93}\ (JN/NN2)_{-1} + \underset{(4.67)}{96.32}\ U70 + \underset{(9.87)}{-182.50}\ U7678$$

GERMAN DEMOCRATIC REPUBLIC

$$\ln N3 = \underset{(2.82)}{2.7404} + \underset{(5.84)}{0.6738}\ \ln(N3)_{-1} + \underset{(3.11)}{0.0918}\ \ln (J/N3)_{-1} + \underset{(2.52)}{0.0249}\ U7678$$

R^2 = 0.992 D-W = 1.489 SE/MY = 0.0010

$$N3 = EXP[\ln N3]$$

$$NM3 = \underset{(2.55)}{1530} + \underset{(4.30)}{0.6212}\ (NM3)_{-1} + \underset{(3.04)}{93.75}\ (JM/NM3)_{-1} + \underset{(2.04)}{71.98}\ U6667 + \underset{(1.94)}{89.55}\ U7678$$

R^2 = 0.988 D-W = 1.324 SE/MY = 0.0084

$$\ln NQ3 = \underset{(2.83)}{3.421} + \underset{(3.59)}{0.5596}\ \ln(NQ3)_{-1} + \underset{(2.75)}{0.0878}\ \ln (JQ/NQ3)_{-1} + \underset{(2.28)}{0.023}\ U7678$$

R^2 = 0.983 D-W = 1.583 SE/MY = 0.0013

$$NQ3 = EXP\ [\ln NQ3]$$

$$\ln NB3 = \underset{(2.21)}{1.0796} + \underset{(9.84)}{0.8194}\ \ln(NB3)_{-1} + \underset{(2.39)}{0.09643}\ \ln (JB/NB3)_{-1} + \underset{(0.74)}{-0.0195}\ U7678$$

P^2 = 0.979 D-W = 2.039 SE/MY = 0.0051

$$NB3 = EXP\ [\ln NB3]$$

$$\ln NT3 = \underset{(4.97)}{2.8087} + \underset{(6.02)}{0.5487}\ \ln(NT3)_{-1} + \underset{(3.45)}{0.0513}\ \ln (JT/NT3)_{-1} + \underset{(3.81)}{-0.0246}\ U6169$$

R^2 = 0.987 D-W = 2.251 SE/MY = 0.0010

NT3 = EXP [ln NT3]

$$NRL3 = \underset{(4.80)}{-1349} + \underset{(5.97)}{0.1733\ LE3} - \underset{(3.16)}{1.9102\ (JRL/NRL3)_{-1}} - \underset{(2.16)}{16.67\ U7677}$$

R^2 = 0.873 D-W = 1.919 SE/MY = 0.0321

$$\ln NARL3 = \underset{(1.08)}{0.7014} + \underset{(10.10)}{0.9021\ \ln (NARL3)_{-1}} - \underset{(1.69)}{0.3455\ \ln(JRL/NARL3)_{-1}} + \underset{(2.19)}{0.01415\ U7478}$$

R^2 = 0.997 D-W = 2.268 SE/MY = 0.0009

NARL3 = EXP [ln NARL3]

$$NO3 = \underset{(0.31)}{55.28} + \underset{(2.43)}{0.4357\ (NO3)_{-1}} + \underset{(2.02)}{2171\ (XO/X3)_{-1}} - \underset{(1.63)}{12.27\ U7173} + \underset{(2.83)}{37.45\ U7678}$$

R^2 = 0.937 D-W = 1.222 SE/MY = 0.0137

$$NN3 = \underset{(1.85)}{176.15} + \underset{(5.29)}{0.6627(NN3)_{-1}} + \underset{(2.72)}{92.67\ (JN/NN3)_{-1}} + 54.11\ U7678$$

R^2 = 0.981 D-W = 1.404 SE/MY = 0.0257

POLAND

$$N4 = \underset{(2.09)}{5344} + \underset{(8.27)}{0.8090\ (N4)_{-1}} - \underset{(2.00)}{1.3413\ (ZP/YL4)_{-1}} - \underset{(2.88)}{195.53\ U7678}$$

R^2 = 0.997 D-W = 2.113 SE/MY = 0.0049

$$NMY = \underset{(3.44)}{-3845} + \underset{(11.22)}{0.5286\ LE4} + \underset{(3.67)}{8993(JM/J4)} - \underset{(5.97)}{588.39\ U7678}$$

R^2 = 0.980 D-W = 1.705 SE/MY = 0.0071

$$\ln NQ4 = \underset{(10.32)}{-14.72} + \underset{(15.39)}{23706\ \ln LE4} - \underset{(2.14)}{0.0627\ \ln (JQ/NQ4)_{-1}} + \underset{(4.51)}{0.0598\ U7678}$$

R^2 = 0.993 D-W = 1.739 SE/MY = 0.0016

NQ4 = EXP [ln NQ4]

$$\ln NB4 = \underset{(2.51)}{-8.549} + \underset{(5.71)}{1.7476\ \ln LE4} + \underset{(3.49)}{0.7114\ \ln (XB/X4)_{-1}} + \underset{(2.92)}{0.0803\ U7578}$$

R^2 = 0.978 D-W = 1.608 SE/MY = 0.0042

NB4 = EXP [ln NB4]

$$NT4 = \underset{(11.54)}{-737.31} + \underset{(31.83)}{0.0824\ LE4} + \underset{(3.47)}{1498(JT/J4)_{-1}}$$

$R^2 = 0.988$ D-W = 1.257 SE/MY = 0.0146

$$\ln NRL4 = \underset{(8.10)}{-2.3436} + \underset{(49.79)}{1.2318 \ln(NRL4)_{-1}} + \underset{(2.54)}{0.0483 \ln (ZRLP/XL4)_{-1}}$$

$R^2 = 0.995$ D-W = 1.310 SE/MY = 0.0005

NRL4 = EXP[ln NRL4]

$$NARL4 = \underset{(0.14)}{166.25} + \underset{(4.80)}{0.9734(NARL4)_{-1}} - \underset{(1.92)}{6.962(JRL/NARL4)_{-1}}$$

$R^2 = 0.991$ D-W = 0.837 SE/MY = 0.0047

$$NO4 = \underset{(7.08)}{-535.33} + \underset{(11.69)}{0.06789\ LE4} + \underset{(3.83)}{9.048\ (JO/NO4)_{-1}} + \underset{(1.74)}{1083(XO/X4)} - \underset{(2.86)}{37.97\ U71}$$

$R^2 = 0.994$ D-W = 1.443 SE/MY = 0.0123

$$\ln NN4 = \underset{(1.16)}{0.2269} + \underset{(26.14)}{0.9887 \ln(NN4)_{-1}} + \underset{(0.97)}{0.0798 \ln (JN/J4)_{-1}}$$

$R^2 = 0.997$ D-W = 1.389 SE/MY = 0.0014

NN4 = EXP [ln NN4]

ROMANIA

$$N5 = \underset{(4.98)}{-8300} + \underset{(6.33)}{0.9952\ LES} + \underset{(4.03)}{78.07\ (J/N5)_{-1}}$$

$R^2 = 0.995$ D-W = 0.818 SE/MY = 0.0135

$$NM5 = \underset{(3.64)}{-7345} + \underset{(4.36)}{0.8368\ LES} + \underset{(2.92)}{66.88\ (JM/NM5)_{-1}}$$

$R^2 = 0.993$ D-W = 0.612 SE/MY = 0.0182

$$\ln NQ5 = \underset{(3.49)}{1.5039} + \underset{(16.31)}{0.8288 \ln(NQ5)_{-1}} + \underset{(3.45)}{0.2721 \ln(XQ/X5)_{-1}}$$

$R^2 = 0.995$ D-W = 1.571 SE/MY = 0.0012

NQ5 = EXP [ln NQ5]

$$NB5 = \underset{(5.43)}{113.88} + \underset{(17.55)}{0.7667(NB5)_{-1}} + \underset{(5.31)}{7.7194\ (JB/NB5)_{-1}} + \underset{(4.94)}{33.44\ U6772}$$

$R^2 = 0.991$ D-W = 2.369 SE/MY = 0.0168

$$\ln NT5 = \underset{(3.58)}{1.9795} + \underset{(4.93)}{0.5938 \ln (NT5)_{-1}} + \underset{(2.81)}{0.1529 \ln(JT/NT5)_{-1}}$$

$R^2 = 0.989$ D-W = 2.162 SE/MY = 0.0031

NT5 = EXP [ln NT5]

$$NRL5 = \underset{(5.23)}{173.49} + \underset{(4.42)}{0.4439}(NRL5)_{-1} + \underset{(5.23)}{2.9043}(JRL/NRL5)_{-1} + \underset{(2.64)}{28.59}\ U66 + \underset{(2.20)}{17.08}\ U7273$$

$R^2 = 0.963$ D-W = 2.125 SE/MY = 0.0217

$$NARL5 = \underset{(2.15)}{1.346} + \underset{(11.83)}{0.8451}\ (NARL5)_{-1} - \underset{(3.36)}{0.0717}\ (JRL/NARL5)_{-1}.$$

$R^2 = 0.999$ D-W = 1.638 SE/MY = 0.0008

$$\ln NO5 = \underset{(2.34)}{0.8585} + \underset{(12.76)}{0.8484}\ \ln (NO5)_{-1} + \underset{(2.51)}{0.06342}\ \ln (JO/NO5)_{-1}$$

$R^2 = 0.992$ D-W = 2.471 SE/MY = 0.0029

NO5 = EXP [ln NO5]

$$NN5 = \underset{(2.50)}{137.39} + \underset{(11.26)}{0.8504}\ (NN5)_{-1} + \underset{(2.92)}{5.0434}\ (JN/NN5)_{-1} - \underset{(2.08)}{33.56}\ U70$$

$R^2 = 0.991$ D-W = 1.829 SE/MY = 0.0127

HUNGARY

$$N6 = \underset{(4.54)}{-5721} + \underset{(6.77)}{1.3912} + \underset{(3.43)}{9.7161}\ (JP/N6)_{-1}$$

$R^2 = 0.983$ D-W = 1.763 SE/MY = 0.0128

$$NM6 = \underset{(9.41)}{-8258} + \underset{(12.30)}{1.7538}\ LE6 - \underset{(3.85)}{8.9314}\ (JMP/NM6)_{-1}$$

$R^2 = 0.971$ D-W = 1.273 SE/MY = 0.0128

$$NQ6 = \underset{(9.34)}{-3642} + \underset{(13.09)}{0.8272}\ LE6 - \underset{(5.26)}{5.7291}\ (JQP/NQ6)_{-1} + \underset{(5.46)}{80.58}\ U6869$$

$R^2 = 0.965$ D-W = 1.696 SE/MY = 0.0116

$$NB6 = \underset{(11.62)}{1898} + \underset{(8.42)}{0.2935}\ LE6 - \underset{(3.56)}{4.6884}\ (JBP/NB6)_{-1} + \underset{(3.43)}{3025}\ (XB/X6) + \underset{(3.18)}{22.16}\ U7475$$

$R^2 = 0.986$ D-W = 1.785 SE/MY = 0.0229

$$NT6 = \underset{(6.60)}{240.46} + \underset{(2.24)}{0.2713}(NT6)_{-1} + \underset{(3.25)}{0.6797}\ (JTP/NT6)_{-1} - \underset{(7.32)}{25.36}\ U6169$$

$R^2 = 0.988$ D-W = 1.373 SE/MY = 0.0098

$$\ln NRL6 = \underset{(5.34)}{3.2478} + \underset{(4.43)}{0.4854} \ln (NRL6)_{-1} + \underset{(4.04)}{0.2243} \ln (JRLP/JP6)_{-1} + 0.0861\ U6367$$

$R^2 = 0.914$ D-W = 1.980 SE/MY = 0.0037

$$NRL6 = EXP\ [\ln NRL6]$$

$$NARL6 = \underset{(1.20)}{125.26} + \underset{(5.07)}{0.5889}(NARL6)_{-1} - \underset{(1.89)}{0.859}\ JRLP/NARL6_{-1} + \underset{(2.57)}{3.2192}(ZRLP/YL6)_{-1}$$

$R^2 = 0.992$ D-W = 0.526 SE/MY = 0.0085

$$NO6 = \underset{(6.36)}{-1221} + \underset{(7.73)}{0.2410}\ LE6 + \underset{(3.10)}{4.2584}(JOP/NO6)_{-1} - \underset{(2.03)}{19.39}\ U7678$$

$R^2 = 0.985$ D-W = 1.446 SE/MY = 0.0193

$$\ln NN6 = \underset{(4.40)}{2.884} + \underset{(3.66)}{0.4417} \ln (NN6)_{-1} + \underset{(5.06)}{0.1886} \ln (JNP/NN6)_{-1} + \underset{(5.52)}{0.2203}\ U7778$$

$R^2 = 0.983$ D-W = 1.224 SE/MY = 0.0046

SOVIET UNION

$$N7 = \underset{(3.86)}{-80.456} + \underset{(8.87)}{1.5246}\ LE7 - \underset{(5.26)}{197.08}\ (ZP/YL7)_{-1} - \underset{(2.11)}{18.977}(J/N7)_{-1}$$

$R^2 = 0.998$ D-W = 1.697 SE/MY = 0.0057

$$NM7 = \underset{(2.13)}{-16855} + \underset{(32.34)}{0.7487}\ LE7 - \underset{(5.36)}{156.24}\ (ZP/YL7)_{-1}$$

$R^2 = 0.997$ D-W = 1.108 SE/MY = 0.0065

$$NQ7 = \underset{(6.70)}{-47671} + \underset{(9.03)}{0.6343}\ LE7 - \underset{(4.15)}{14054}\ (JQ/NQ7)_{-1}$$

$R^2 = 0.986$ D-W = 1.310 SE/MY = 0.0129

$$NB7 = \underset{(11.04)}{-11223} + \underset{(11.16)}{0.1206}\ LE7 + \underset{(4.40)}{80704}\ (JB/J7)_{-1}$$

$R^2 = 0.991$ D-W = 0.905 SE/MY = 0.0167

$$\ln NI7 = \underset{(29.58)}{-11.25} + \underset{(61.77)}{1.7341} \ln LE7 + \underset{(5.59)}{0.1549} \ln (JI/J7)_{-1}$$

$R^2 = 0.998$ D-W = 1.406 SE/MY = 0.0005

$$NT7 = EXP\ [\ln NT7]$$

$$\ln NRL7 = \underset{(4.35)}{4.2775} + \underset{(4.83)}{0.5272}\ \ln (NRL7)_{-1} + \underset{(4.50)}{0.1376}\ \ln(JRL/NRL7)_{-1} + 0.02834\ U6566$$

$R^2 = 0.994$ D-W = 1.337 SE/MY = 0.0009

$$NRL7 = EXP\ [\ln NRL7]$$

$$\ln NO7 = \underset{(14.65)}{-29.42} + \underset{(18.75)}{3.278}\ \ln LE7 + \underset{(2.40)}{0.1741}\ \ln (JO/NO7)_{-1} + \underset{(3.86)}{0.1597}\ \ln (XO/X7)_{-1}$$

$R^2 = 0.993$ D-W = 1.423 SE/MY = 0.0019

$$NO7 = EXP\ [\ln NO7]$$

$$\ln NN7 = \underset{(3.49)}{-11.63} + \underset{(4.49)}{0.1584}\ \ln LE7 + \underset{(3.32)}{0.2913}\ \ln(JN7)_{-1}$$

$R^2 = 0.993$ D-W = 0.837 SE/MY = 0.0016

$$NN7 = EXP\ [\ln NN7]$$

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MODEL ZATRUDNIENIA W KRAJACH RWPG

Artykuł stanowi próbę modelowania zatrudnienia w siedmiu krajach wchodzących w skład RWPG. Ze względu na powiązania sektora zatrudnienia z innymi blokami makromodelu gospodarki krajów RWPG w głównej mierze analizowano kształtowanie się podaży siły roboczej w podziale na sferę produkcji materialnej (w rozbiciu na podstawowe działy gospodarki narodowej) oraz sferę niematerialną (ogółem).

Poszczególne równania modelu były estymowane na podstawie rocznych danych statystycznych za lata 1963-1978. W pierwszym paragrafie scharakteryzowano czynniki wyznaczające rozmiary podaży siły roboczej. W dalszej części artykułu przedstawiono schemat i charakterystykę modelu oraz dokonano analizy wyników estymacji modelu.