

**Commuting in the Moscow region: a methodical and empirical
analysis**

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Running title: Commuting in the Moscow region

The distribution of commuting rates in the Moscow metropolitan area has been investigated in the present work evaluating the full macroeconomic manpower balance in districts of Moscow region from 2001 statistical data. The relations between the fraction of commuters and average monthly wages as well as the distance from a district to a center were analyzed methodically and empirically. It was found that latter parameter strongly determines both commuting and wage levels in suburbs. The values of the corresponding correlation coefficients are reported.

Keywords: commuting, spatial effects, mobility, regional labor market, regional wages

Introduction

Commuting existed in the former Soviet Union during all of the 20th Century reaching its peak in the 1970's and 80's. A paradoxical situation arose after the collapse of the USSR. On the one hand commuting in the new Russia became a more important factor for numbers of citizens as a strategy of survival in the new economic situation. On the other hand there are no official statistics to measure this process in Russia, like many other countries (Moiseenko, 2001). Scientific investigations devoted to eliminate this contradiction are currently topical.

It is evident that commuting is more apparent in the areas adjacent to big cities. Increasing intensity and geometrical size of passenger traffic pattern between a central city and its suburbs clearly indicate commuting processes. Therefore the Moscow urban agglomeration¹ (as the biggest mono-centric metropolitan area) is the most promising subject for studies.

Commuting in Russia with its transition economics differs essentially from those observed in the USA and Eastern Europe, where gender, racial, and ethnic aspects are mainly investigated (Stuart and Rosenthal 1996; Raphael and Riker, 1999; Timothy and Wheaton, 2001). In addition these effects are usually rather small there. Russian reality is the high long-term income differential between citizens of big centers and those living at the fringe. Together with slow mobility of firms mostly concentrated in big cities and the restricted resources of local authorities to stimulate investor activity and thus create new working places this leads to very high long-distance commuting, which the whole population of areas around centers are involved in. Also there are

¹ The term "urban agglomeration" is often used in Russian publications to indicate a (usually big) city with its suburbs. The closest American category is the "metropolitan area", which we will use further as a synonym.

indications, that these processes do not decrease according to long-term equilibrium theory, but are even showing long-term growth.

The quantitative analysis of commuting in the Moscow region was the main goal of the present work with the following tasks to solve:

- adaptation of manpower balance method for analysis of commuting;
- search of significant variables correlated with commuting indicators;
- tests and quantitative calculations in the frame of empirically confirmed hypotheses.

The results of the first such investigations for Russia are reported in the present article.

Recent evaluations of commuting in the Moscow metropolitan area

Despite the wide spread of evaluations of commuting in the Moscow region (see Table 1) one can see three clear tendencies:

1. Commuting in the Moscow metropolitan area has always existed including the Soviet period;
2. The commuting flow from the districts to the center always exceeded the commuting in the opposite direction;
3. The flow of commuters is continually increasing.

Table 1

The last circumstance indicates that commuting in the Moscow region is escaping from local frames and reaching the macroeconomic scale. The existence of problems has been indicated by two events:

1. Commuting was specially investigated² in Moscow and its suburbs as part of 2002 census.
2. At the beginning of 1999 governments of Moscow and Moscow region established a special joint committee to coordinate management of commuting. However, their views of this problem differ substantially. Regional officials are convinced that districts suffer worse conditions. Commuters create profit and leave taxes in the capital getting the main social transfers (pensions, welfare, etc.) from local budgets. Regional authorities wish to see compensation, which Moscow should pay to its suburbs for the usage of their manpower as the possible solution to the problem. From the point of view of metropolitan bureaucrats districts with their problem of unemployment should be grateful to Moscow for accepting hundreds of thousands of workers. Furthermore, commuters challenge metropolitan residents on the labor market. In this situation new commuting studies are required in order to give impartial assessments of these debates. The current article presents the results of such an attempt.

The analysis was based on the data of Mosoblkomsat³ (Collection, 2001; Collection 2002) and monitoring information of the government of the Moscow region⁴. Table 2 contains combined information about 39 districts arranged according their distance from the Moscow city center.

Table 2

Theoretical aspects of commuting

Commuting is often treated in Russian economic studies as particular case of migration. Whereas a large *apparatus criticus* was developed for analysis, simulation,

² The results are still not published.

³ Statistical Committee of Moscow region <http://www.bisinfo.ru/oblstat/>

⁴ <http://mineconom.ru/PaspWeb/PaspQuest.aspx>

and prediction of interregional and international migration processes (Korovkin, 2001), this is not the case for commuting. The growing macroeconomic impact of the last process calls for new and adequate theoretical and empirical approaches.

Existing methods for commuting evaluation

Classical **explicit control** of commuting should be permanent monitoring on the basis of regular polls. But in practice they are not performed for two reasons:

1. High costs. E.g., as mentioned above, the commuting study during the 2002 census cost Moscow region and Moscow budgets around 1 and 3 million USA dollars respectively.
2. Organizational and methodical problems. As commuters are often prefer to hide their status, commuting polls have low reliability due to high levels of refusals and false answers. These facts were revealed in a pilot poll, which was performed together with a pilot census in Moscow (Preobrazhenskij department) and a Moscow region (Krasnogorskij district) in October of 2000.

The evaluation of total daily passenger flux between the center and fringes is an **implicit method** of checking commuting. It seems that this is currently the only source of information about commuting. At the same time it is a rather rough integral estimation, which does not allow commuting details to be seen. The new methods are expected to be better.

The balance method of evaluating commuting

The extension of information currently collected by regional statistical agencies allows us to define more precisely the structure of manpower in districts gaining commuters. On the one hand commuters escape the official statistical registration, but on the other hand precise calculation of the balance of labor structure

uncovers missed people. We suppose that the major part of this "unoccupied group" are commuters:

$$\delta^T \approx \delta_{MP} = \frac{WP^U \cdot (1 - \delta_{IS}^U) + WP^R \cdot (1 - \delta_{IS}^R) - E - SB - U}{WP} \quad (1)$$

where:

WP – working-age population;

δ^T – total rate of commuters, % of WP;

δ_{MP} – rate of "missing persons" escaping official statistics, % of WP;

δ_{IS} – rate of workers employed in the informal sector and self-employed, % of WP;

E – employees of big and middle-sized firms;

SB – persons employed in small-scale business;

U – unemployed, people.

Here and hereafter 'T', 'U', and 'R' indices belong to the total, urban and rural population respectively.

The only unknown parameters in the balance equation (1) are rates of workers in informal business and self-employed people. Having escaped statistical registration, together with commuters they form the group of missing persons. It means that equation (1) allows us to determine rate of informal workers at known level of commuters and vice versa. We will use here both approaches, but the former requires some knowledge about informal employment taken from other sources.

Informal employment became an inevitable feature of post-reform Russian economics⁵. Although international standards to evaluate this indicator were fixed by

⁵ According to some data (Milyaeva, 2001) rate of missed labor in "full-employed" soviet economics was up to 15%.

1993, the State Committee of Russian Federation on Statistics (Goskomstat)⁶ approved the corresponding method only in 2001. Such a long delay leads to considerable complexity and ambiguity in the "informal economics" category⁷. According to the 2001 data given by Goskomstat the informal sector covers 14-15% of the whole working-age population: 23-30% of the rural population and 10-12% of citizens (Gorbacheva and Ryzhikova, 2002). For the calculation in the current article we used the following values:

$$\overline{\delta_{IS}^U} \approx 0,15; \quad \overline{\delta_{IS}^R} \approx 0,3; \quad (K_{RU} \equiv \overline{\delta_{IS}^U} / \overline{\delta_{IS}^R} = 2). \quad (2)$$

Using assumption (2) one can obtain from (1) values of commuting rates for districts of Moscow region (last column in the Table 2).

Investigating commuting into the center from suburbs we need especially to focus on **interdistrict commuting** (IDC). Large district centers accept some of the commuters violating the main radial commuting pattern (Figure 1).

Figure 1

To reduce the systematic error introduced by IDC-flux δ^{IDC} , an averaging through a set of concentric neighbor districts was performed. Mutual compensation of IDC-flux takes place inside such groups. The later comparison of results obtained for separate districts with those determined for groups formed in different ways allows us to evaluate the systematic error. Furthermore, these discrepancies in results give the approximate absolute value of the total IDC-flux in the region.

The next step of our work is the search of independent variables correlated with the commuting rate and tests of existing models and hypotheses determined in relation to commuting and other indicators.

⁶ <http://www.gks.ru>

⁷ There are many other terminologies, such as "shady", "dark", "criminal", etc. economics.

Correlation between commuting and distance from district to center

The distance from the center to district R is a recognized parameter influenced on the microeconomic indicators of areas around big cities. Therefore one can suppose that commuting should also depend on this factor. The farther a suburb is from a center the greater commuting waste and the smaller the amount of commuters as a result. Thus, one can weight an inversely proportional relation in this case:

$$\delta^T = A \cdot R + B, \quad A < 0, \quad (3)$$

where R is the distance from center to district. The results of calculation confirm the hypothesis (3).

Figure 2

The significant linear correlation was found between total commuting flux δ^T and R with the following parameters:

$$A = -0,155 \pm 0,025_{\text{stat}} \quad r^2=0,73 \quad \text{For separate districts;} \quad (4\text{-a})$$

$$B = 45,7 \pm 2,4_{\text{stat}}$$

$$A = -0,104 \pm 0,037_{\text{stat}} \quad r^2=0,68 \quad \text{For 12 groups;} \quad (4\text{-b})$$

$$B = 40,3 \pm 3,4_{\text{stat}}$$

$$A = -0,109 \pm 0,035_{\text{stat}} \quad r^2=0,84 \quad \text{For 6 groups.} \quad (4\text{-c})$$

$$B = 40,7 \pm 3,1_{\text{stat}}$$

Here and hereafter r^2 is coefficient of determination, "stat" marks statistical errors at 67% CL.

The value (4-a) is overestimated in comparison with (4-b,c) due to the systematic error introduced by inter-district commuting (IDC) discussed above. At the

same time results for both groups (4-b,c) are consistent, indicating mutual compensation of IDC-flux for analysis of groups of districts.

Relation between commuting rate and center-suburbs passenger flux

As commuters form the main daily passenger flux (PF) between center and suburbs, there is a direct relation between PF and commuting parameter δ^T . PF is approximately equal to the sum of commuters from all N districts, which can be calculated by two ways.

1. Using balance equation (1) and data from Table 2 one can obtain⁸:

$$\begin{aligned} PF &\approx \sum_{i=1}^N \delta_i^T \cdot WP_i^T = \\ &\sum_{i=1}^N (WP_i^U \cdot (1 - \delta_{ISi}^U) + WP_i^R \cdot (1 - \delta_{ISi}^R) - E_i - SB_i - U_i) \approx \\ &\sum_{i=1}^N (WP_i^U \cdot (1 - \overline{\delta_{IS}^U}) + WP_i^R \cdot (1 - \overline{\delta_{IS}^R}) - E_i - SB_i - U_i), \end{aligned} \quad (5)$$

2. On the basis of model (3) with parameters (4) we have:

$$PF \approx \sum_{i=1}^N \delta_i^T \cdot WP_i^T = \sum_{i=1}^N WP_i^T \cdot (A \cdot R^i + B). \quad (6)$$

Using (5) we obtain:

$$PF = 1.287 \text{ million}, \quad (7-a)$$

while the second method (6) gives the following evaluation:

$$PF = 1.296 \pm 0.215 \text{ million} \quad (7-b)$$

with parameters (4-b) and:

$$PF = 1.384 \pm 0.215 \text{ million} \quad (7-c)$$

with parameters (4-a) respectively.

⁸ It is assumed that rates of workers in the informal sector changed slightly from district to district so the average rate is used instead.

Agreement between (7-a) and (7-b) indicates that the model (3) with parameters (4-b,c) fits the data well. The difference between (7-a) and (7-c) is due to the systematic error introduced by interdistrict commuting. Moreover, this difference is the approximate value of interdistrict commuting:

$$PF^{IDC} \approx 0.1-0.3 \text{ million} \quad (8)$$

Values (7-a,b) are essentially higher than ones in the Table 1:

$$PF \approx 0.8 \text{ million} \quad (9)$$

If (9) is true, than overestimated value (7-a) can be explained by assuming inaccurate estimations of the rate of workers in the informal sector $\overline{\delta_{IS}}$, as this is the only parameter in (5), which is unknown from statistical data. Adjusting (5) to value (9) by variation of $\overline{\delta_{IS}^U}$ we obtain⁹:

$$\overline{\delta_{IS}^U} = 0,26; \quad \overline{\delta_{IS}^R} = 0,52. \quad (10)$$

Using (10) we obtain the following parameters of model (3) instead of (4-b):

$A = -0,11 \pm 0,05$		
	$r^2=0,63$	For 12 groups
$B = 28 \pm 4$		(11)

Relation between commuting and average monthly wage in district

The essential impact of regional wages on international or interregional migration was found in a set of studies (e.g., Moiseenko, 2001; Alekseev, Zubarevich, 2000). Therefore the expansion of this concept to the commuting seems to be a reasonable step. The lower district wages the higher commuting rate one should expect. As in (3) one can write:

$$\delta^T = C \cdot S + D, \quad C < 0, \quad (12)$$

where S is the level of regional wage.

At the same time one can apply another hypothesis of Ludwig von Mises (1996, Chapter XXI, paragraph 9), which postulates two-component spatial model of wage at the market:

$$S = M + N. \quad (13)$$

Here M is the *standard (base)* wage in the ideal flat market without spatial differentiation of rates of wages for the job of the same qualification. The spatial differentiation of wages in the real market is compensated by an additional *attachment component* N , which prevents migration of workers from regions with smaller wages to areas with higher wages. From this point one can expect that the Moscow agglomeration is the classical system with a spatial gradient of wages in the direction of the center. The closer a district is to the center, the higher the motivation to commute, and the higher wages that should be paid by employers in order to hold workers. According to this assumption N in (13) must be inversely proportional to the distance R between district and center:

$$N = N(R) = E \cdot R + F, \quad E < 0. \quad (14)$$

Putting (14) in (13), we obtain:

$$S = E \cdot R + F + M = E \cdot R + G, \quad E < 0 \quad (15)$$

One should emphasize that if Mises's hypothesis is valid, then the model (12) is the linear combination of (3) and (15). Indeed, the usage of (15) in (12) leads to:

$$\begin{aligned} \delta^B = C \cdot S + D &= C \cdot E \cdot R + C \cdot G + D \equiv A \cdot R + B \\ C &\equiv A/E, \quad D \equiv B - C \cdot G \end{aligned} \quad (16)$$

Moreover, dependence of $\delta^B = f(S)$ to primary $\delta^B = g(R)$ and $S = h(R)$ ¹⁰ is a general one irrespective of type of g and h functions:

$$\delta^B = f(S) = f(h(R)) \equiv g(R), \quad \text{где } g(R) \equiv f(h(R)) \quad (17)$$

⁹ It is supposed that K_{RU} is a constant taken from (2).

We already confirmed above the validity of $\delta^B = \delta^B(R)$ in the form (3). If the correlation $S = S(R)$ in the form (15) is found in addition, it means that the correlation (12) is a consequence of the dependency of δ^B and S on R . It is evident that R is the primary variable here, which cannot depend on commuting δ^B and wages S .

The results of our analysis positively confirm Mises's model (15). The average monthly wages in districts evidently decreases as you move away from center to periphery (Picture 3-a).

Figure 3

Quantitative results demonstrate strong validation of the model (15):

$$\begin{array}{l} E = -13 \pm 2_{\text{stat}} \\ G = 4500 \pm 150_{\text{stat}} \end{array} \qquad r^2=0,85 \qquad (18)$$

The relation between δ^B and S is weaker with the following values of coefficients of model (12):

$$\begin{array}{l} C = 8 \pm 2_{\text{stat}} \\ D = 5 \pm 7_{\text{stat}} \end{array} \qquad r^2=0,34 \qquad (19)$$

As was discussed above the correlation between commuting and wages is a secondary consequence of dependencies of both these parameters from the third variable – distance between district and center R . E.g., it is evident from (16) that the commuting/wage elasticity coefficient C is a ratio of elasticity coefficients A (commuting/distance) and E (wage/distance). Taking the corresponding parameters from (11) and (15) and inserting them in (16) we obtain:

¹⁰ Of course if both these correlation functions really exist!

$$C \equiv A/E = -0.11 / -0.013 \approx 8.5 \text{ \% commuting rate/thousands of rubles}$$

$$\approx 1 \text{ \% commuting rate/100 rubles,} \quad (20)$$

which is consistent with results of regression (19).

Interpretation of (18,20) is simple and obvious. The shift of wages in the Moscow region of 100 rubles leads to the corresponding change of the commuting rate of 1%.

We emphasize once more that this is an indirect relation, as was discussed in above.

Results and conclusions

The efficiency of the balance method for the investigation of commuting was corroborated by the current work. The main results obtained are given below:

1. The distance from the district to the center in agglomeration R was found to be a significant variable for commuting. The commuting rate in Moscow region δ^B linearly decreases on moving away from center to periphery according to (3) with (11):

$$\delta^B = -0.11 \cdot R \text{ (km)} + 28 \text{ (\% from working-age population)}$$

2. R also determines the level of average monthly wages S with high correlation strength in districts of Moscow region given by (15) with parameters (18):

$$S = -0.013 \cdot R \text{ (km)} + 4.5 \text{ (thousand of rubles),}$$

3. The observed relation between commuting δ^B and wages S shown in (12) with

$$(19): \quad \delta^B = 8 \cdot S \text{ (thousand of rubles)} + 5 \text{ (\% from working-age population)}$$

is indirectly correlated from p.1.2 above. At the same time, a simple relation is obtained – a 100 ruble shift of wages corresponds to a 1% change in commuting rate – could be useful for applied calculations.

4. The total daily commuting flow between Moscow and the suburbs was evaluated at the level of $PF \approx 1.3$ million people - contrary to other estimations ($PF \approx 0.8-1$ million people) (see Table 2). This discrepancy can be explained in two ways:
 - Commuting flow is currently underestimated;
 - The informal employment in Moscow region (10) is approximately twice the mean state value (2).
5. Inter-district commuting in Moscow region was roughly estimated to be at level of 100-300 thousand people.

The method proposed in the current article could be further developed in three ways:

1. Investigation of the time dynamics of dependencies found,
2. Extension of analysis including data from other regions,
3. Application of additional information from other studies.

Methodical and practical results of the current study could be useful in the fields of budget relations, monitoring, forecasting and formation of regional investment policy in Russia.

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Table 1 Evaluation of commuting in the Moscow region.

Date	Commuting flux (thousands of people per day)		References
	From Moscow to suburbs	To Moscow from suburbs	
before 1986, (Epoch before "Perestroika")	150-200	250-300	(Sats, 1999)
February 1999	200	700	
80-ties	120-150/200-250	600-700	(Pekhtereva and Bylov, 2000)
1985		473,4*	(Komarov, 2000)**
1990		588,1*	
1995		633,2*	
1999		700*	
2000-2001		750-800	(Decision, 2001)
April 2002	200-250	800-850	***
August 2002		850-900	(Milyukov, 2002)****

* - excess in the Moscow direction

** - online book version <http://www.nasledie.ru/bibliot/kniga6/>

*** - News cite of government of the Moscow region from 26.04.02
<http://government.mosreg.ru/pgobladm/nov2002/nov2604b.htm>

**** - <http://mpg.ru/index.php?partID=8&ID=1233>

Table 2 Balance of manpower in districts of Moscow region in 2001.

№	District	Distance to Moscow km*)	Working-age population, persons.		Workers of big and middle firms, peop.		Workers of small firms, peop.	Unemployed peop-les	Average monthly wage, Rub **)	Commuters, %of work- ing age persons***)
			urbans	rurals	urbans	rurals				
1	Lyuberetskij	20.4	196241	4951	57957	2098	14297	654	3886	47.4
2	Krasnogorskij	21.0	74452	14326	29258	1116	6174	305	4809	41.1
3	Balashikhinskij	21.9	206920	8654	68784	1702	4902	1414	4124	48.8
4	Khimkinskij	24.0	102650	1265	53336	144	9457	549	5764	23.7
5	Mytischinskij	25.1	185639	12448	57327	1198	17179	1099	4554	45.3
6	Odintsovskij	26.3	112824	50672	46395	5426	11023	968	4559	41.3
7	Leninskij	29.0	34058	45166	37186	7126	6736	491	6403	11.4
8	Domodedovskij	30.0	53058	20068	34246	3292	6430	538	3362	20.0
9	Schelkovskij	36.0	150695	18762	50659	2267	9693	1227	3724	45.7
10	Podolskij	38.4	192942	37744	82456	3490	16274	943	4090	37.8
11	Pushkinskij	40.5	148080	16013	92732	1502	20929	1636	3857	12.4
12	Ramenskij	42.3	140253	53985	72613	5390	12232	1075	3401	33.8
13	Istrinskij	50.0	38543	30774	24416	3365	5079	407	3986	30.3
14	Noginskij	57.1	207652	20680	108089	1695	14021	1940	3826	28.6
15	Solnechnogorskij	69.0	44993	28783	25444	2868	5537	693	4535	32.3
16	Chehovkij	74.0	40057	17077	24376	1718	2509	448	3877	29.7
17	Pavlovo- Posadskij	74.4	54090	8402	22937	504	3478	551	3287	39.0
18	Naro- Fominskij	75.0	61599	42239	25536	4634	3614	691	3449	45.7
19	Dmitrovskij	80.0	60661	28249	31786	3390	4312	843	3536	34.9
20	Sergievo- Posadskij	80.0	107594	30262	52723	3607	8293	2586	3077	33.0
21	Voskresenskij	90.0	74325	18325	40110	1589	4306	514	3408	31.8
22	Ruzskij	91.0	25394	14864	14586	1430	1869	634	3164	33.5
23	Kolomenskij	92.0	92679	22236	56841	8418	6436	1046	3173	18.8
24	Klinskij	94.0	62807	17439	33792	3731	4012	1043	3624	28.7
25	Orehovo- Zuevskij	97.0	116894	31537	53198	1772	5496	1902	3164	39.8
26	Volokolamskij	99.0	14622	15449	11952	2487	1176	437	2823	23.9
27	Egorevskij	99.0	47673	15310	24768	1279	1851	1121	2629	35.3
28	Serpuhovskij	101.4	118556	14661	62176	1193	6688	963	3107	30.0
29	Stupinskij	111.0	47013	17687	32484	3704	3796	526	4741	18.3
30	Luhovitskij	115.0	24603	13366	14591	4129	1316	746	3050	25.0
31	Mozhajskij	117.0	19487	20240	15601	2108	1915	304	3076	27.2
32	Kashinskij	124.0	32753	10796	19099	3526	1724	347	3029	24.6
33	Taldomskij	128.0	65096	5501	24651	1354	4808	909	3230	38.9
34	Shahovskoj	130.0	6778	7640	5244	1094	392	445	2392	27.3
35	Lotoshkinskij	133.0	3398	7080	4988	2696	330	339	2692	- 4.9
36	Zarajskij	140.0	15965	10941	11506	3555	485	627	2188	18.8
37	Ozerskij	141.0	16711	5924	9754	1275	480	741	2682	27.0
38	Shaturskij	148.9	44090	12584	24768	1384	1637	1561	3929	29.9
39	Serebryano- Prudskij	178.0	5220	9018	5625	2311	172	309	2261	16.4

*) - distance to the district capital

**) 2001 average exchange rate was 29,18 Rubles per USA dollar

***) calculation according (1) assuming (2)

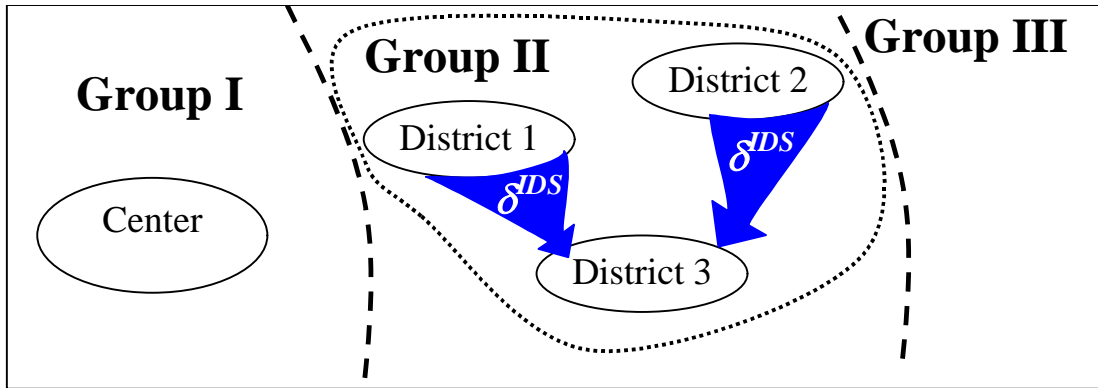


Figure 1 Inter-district commuting fluxes in a metropolitan area.

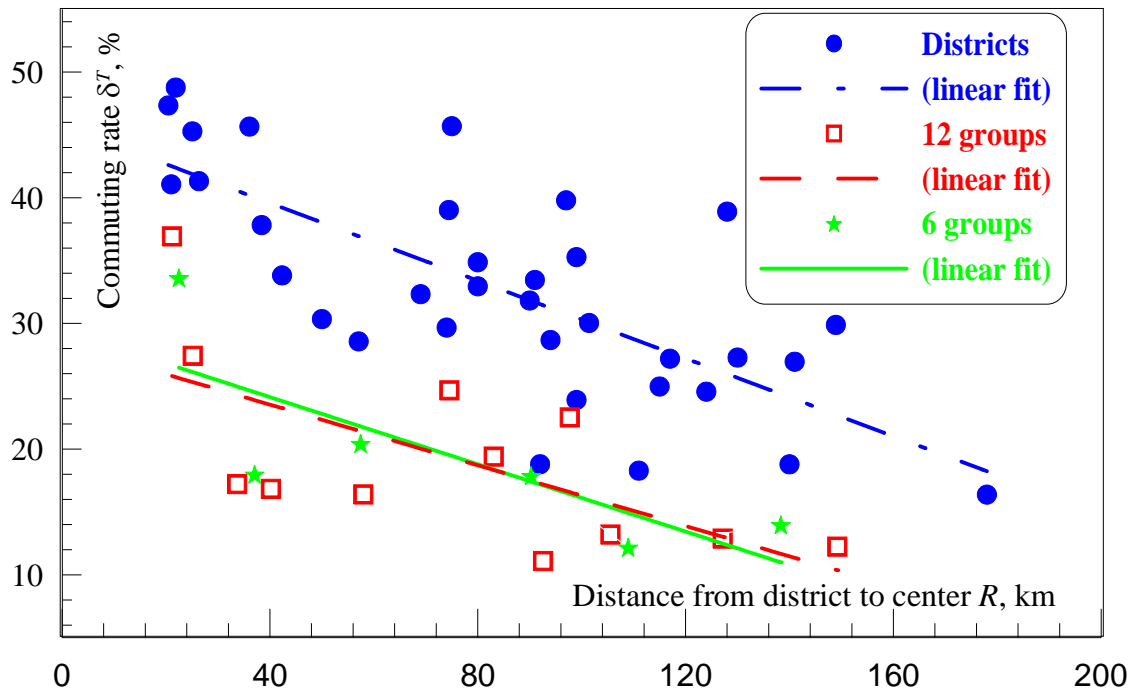


Figure 2 Relation between commuting rate δ^B and distance from suburb to center

calculated for separate districts as well as different groups of adjacent regions.

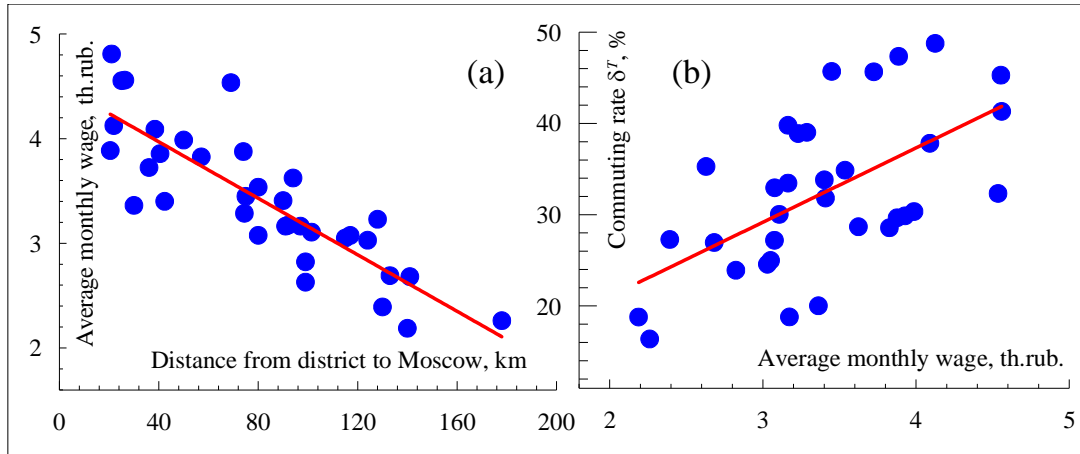


Figure 3 Relations between average monthly wages in districts and distance from suburb to center (a) as well as commuting rate in districts (b).