Part III:

Economic Dimensions of Social Change

CHAPTER 10.

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HOUSEHOLD INCOME MOBILITY DURING SYSTEMIC TRANSFORMATION

The hypothesis stating that the transition from a centrally planned to a market-driven economy resulted in an increase in economic and social inequality seems to be widely accepted. This fact is corroborated by numerous empirical investigations (e.g., Cichomski 2001; Kot 1999; Luttmer 2001; Rutkowski 1994). There have also been attempts to explain this phenomenon using formal macroeconomic models, for example, the model proposed by Milanovic (1998), in which two elements play the central role:

1. Economic activities in the public and private sectors are characterized by different objectives of maximization. The public sector aims at maximizing the *employment rate*, while the private sector aims at maximizing the *profit*.

2. The transition from a centrally planned to a market-driven economy involves the development of the private sector at the expense of the public sector.

Milanovic includes both elements in a macroeconomic model that explains the increase in inequality in salaries during transformation.

In this chapter, I focus on the household's per capita income because it is a better indicator of overall family welfare than salary. The analyses are based on the four waves of panel data collected in Poland in 1988, 1993, 1998, and 2003 on countrywide probability samples. I analyze the dynamics of the level of income *inequality* and *mobility* during the past fifteen years of economic and social change in Poland. In this context I formulate the following research questions:

1. What is the shape of the dynamics of household income inequality in the period 1988–2003?

2. What is the shape of the dynamics of household income mobility in the period under study?

3. What portion of the dynamics of income inequality and mobility may be attributed to differences between urban and rural households?

I try to answer these questions using two approaches. The first approach is based on analyzing *changes in income distribution* measured in subsequent time points and *income mobility* related to the extent of changes in incomes between those points. This approach resembles analyses of occupational mobility using contingency tables. In those analyses the dynamics of occupational structure is measured with some statistics of occupational distribution in the population and their changes over time, as well as with indexes of mobility calculated from contingency tables that describe the flow of persons between the occupational categories.

The second approach to analyzing income dynamics resembles models of social status attainment. The main objects of inquiry are trajectories of individual changes in household income over time and patterns of association between characteristics of those trajectories with other (exogenous) variables.

This chapter consists of two parts. The first part contains analyses of trends in total *income inequality* as well as inequality for urban and rural households independently. I also analyze trends in *income mobility* in the period under study. For those analyses I propose a new measure of income mobility. This new measure enables me to decompose the total amount of mobility into within-group components (associated with income transfers within groups) and a between-group component (changes in group shares in total income). With this property I decompose the observed income mobility into: (1) mobility among urban and rural households (within-group component) and (2) mobility of groups of urban and rural households.

The second part of the article tackles the posed research questions using an approach that focuses on individual income trajectories. This analysis consists of the following steps. First, the general shape of an income trajectory is selected, common to all respondents, which satisfactorily explains individual changes in household income in the period under study. Those trajectories are defined by a certain set of parameters, for example, annual rate of income change or the income level in the first period. In the second step of the analysis the values of these parameters are estimated from the data. These parameters and, consequently the trajectories, may vary between households. In the third step the relations between those parameters and other household attributes are analyzed, both on individual and group levels.

Data

The analyzed data are from four waves of the POLPAN survey conducted in 1988, 1993, 1999, and 2003 on countrywide probabilistic samples.[1] The sample sizes are presented in Table 10.1.

Table 10.1. Sample Sizes (1988–2003)

	Number of cases			
Sample	1988	1993	1998	2003
Total	5,817	2,259	2,135	1,699
Effective *n*	5,523	2,174	2,032	1,641
Complete panel records	1,050	1,050	1,050	1,050

The row "effective *n*" in Table 10.1 reflects the number of households for which income information was available. The information about the household's income comes from the survey question:

> *What is the average monthly income in your household? Please take into account all persons in the household and all sources of their income in the past three months.*

The incomes were transformed to a common scale of polski nowy zloty (PLN) because of its introduction in 1994. Since I treat income as a family welfare indicator, the variables were corrected using the equivalency scale of the Organization for Economic Cooperation and Development in the following form (for every household):

$$es = 1 + 0.6 \times (N_{\text{adults}} - 1) + 0.3 \times N_{\text{children} < 14} \quad (1)$$

where N_{adults} is the number of adult persons in the household not including the respondent, and $N_{\text{children} < 14}$ is the number of children younger than fourteen. The income equivalent is calculated as a fraction of original income and the value of the *equivalency scale* for a given household.

[1] More detailed information about the project is available at www.ifispan.waw.pl/socnierowno/projects/index-en.html.

Trends in Income Inequality

The transition from a centrally planned to a market-driven economy resulted in increased income inequality. This trend is examined for Poland in Table 10.2, as measured using Gini and Theil indexes (Theil 1972).

Table 10.2. Household Income Inequality: Values of Theil and Gini Indexes with 95 Percent Bootstrap Confidence Intervals[a] (1988–2003)

Index, CI[b]	1988	1993	1998	2003
		Gini		
Index	0.278	0.384	0.395	0.383
$CI_{0.25}$	0.270	0.362	0.370	0.367
$CI_{0.95}$	0.286	0.412	0.427	0.401
		Theil		
Index	0.139	0.298	0.337	0.265
$CI_{0.25}$	0.125	0.239	0.250	0.228
$CI_{0.95}$	0.156	0.362	0.434	0.307

[a] Percentile method, 200 replications.
[b] Symbols $CI_{0.25}$ i $CI_{0.95}$ depict lower and upper bound of the interval.

Keeping in mind that Theil and Gini indexes have different value ranges we can observe similar trends: a steep increase between 1988 and 1993 and then a relative stabilizing after 1993. The period between 1988 and 1993 corresponds to the most turbulent times of Polish transformation. The market reforms introduced in 1990 and 1991, the so-called Balcerowicz plan, freed the private sector from all restrictions of the socialist era.

Inequalities and Size of Residence

We now turn to answering the question of relations between the increase in global level of inequality and the dynamics of inequality among urban and rural households. The values of inequality indexes for urban and rural households are presented in Table 10.3.

In contrast to other communist countries in the region, Polish agriculture was largely within the private sector. According to Milanovic's model we expect that during the first years of the reforms rural households will be characterized by higher levels of inequality than their urban counterparts.

Table 10.3. Gini and Theil Indexes of Income Inequalities for Rural and Urban Households (1988–2003)

Rural/urban	1988	1993	1998	2003
		Gini		
Rural	0.315	0.369	0.354	0.377
Urban	0.247	0.358	0.382	0.352
		Theil		
Rural	0.194	0.254	0.224	0.274
Urban	0.105	0.272	0.332	0.224

The structure of inequality may be demonstrated using an additive decomposition of the Theil index. According to that property, the total amount of inequality[2] may be decomposed, similarly to variance, into a sum of between-group and average within-group inequality. The relation between those components may be stated formally:

$$T = \underbrace{\sum_{g \in S_g} Q_g \log \frac{Q_g}{P_g}}_{\text{within-group}} + \underbrace{\sum_{g \in S_g} Q_g \overbrace{\sum_{i=1}^{N_g} q_i/Q_g \log \frac{q_i/Q_g}{p_i/P_g}}^{\text{within group } g}}_{\text{avg. within-group}} \qquad (2)$$

Here, g corresponds to a generic group, P_g and Q_g are population and income shares of the group g, and p_i and q_i are population and income share of ith household within group g.

Table 10.4 shows urban and rural income shares that are necessary to calculate the above decomposition.

Table 10.5 shows that in the period under study the value of the between-group component is very low as compared with the within-group component. This means that the variation of group means is very low. The share of the between-group component in the total amount of inequality varies from 3 percent in 1988 and 11 percent in 1993 to approximately 9 percent in 1998 and 2003.

[2] As measured by the Theil index on the global level.

Table 10.4. Income Shares of Rural and Urban Households (1988–2003)

Rural/Urban	1988	1993	1998	2003
		Proportions		
Rural	0.324	0.22	0.253	0.295
Urban	0.676	0.78	0.747	0.705

Table 10.5. Decomposition of the Theil Index into Within- and Between-Group Components (1988–2003)

Decomposition	1988	1993	1998	2003
Total	0.139	0.298	0.337	0.265
Between-group	0.005	0.033	0.033	0.025
Average within-group	0.134	0.265	0.304	0.240

Income Mobility: Types and Measures

Numerous authors have demonstrated that income mobility is not a homogeneous concept (see, e.g., Fields and Ok 1999) Among the notions, definitions, or types of mobility are included:

- Relative vs. absolute mobility (Fields and Ok 1999)
- Structural vs. exchange mobility
- Mobility as origin independence (Fields and Ok 1999)
- Mobility as positional change (Fields 2000)
- Mobility as a share movement (Fields 2000)

Below we present an analysis of income mobility in Poland from the *relative* perspective and as a *share movement*. In our context, relative mobility is related to the relative position (and relative movement) of households along the income scale. Consequently we abstract from:

- Economic growth / contraction (global changes in income levels)
- Inflation and similar economic factors

We propose a new measure of relative income mobility that is based on notions similar to the Theil inequality index: notions taken from the mathematical theory of information. The Theil index may be stated as:

$$T = \Sigma_{i=1}{}^{N} q_i \log q_i / p_i \tag{3}$$

where q_i is an ith person income share and p_i is his share in the population, that is, frequency (Theil 1972). The functional form of (3) is inspired by the definition of the amount of mutual information in the mathematical theory of communication. If we redefine p_i and q_i as (subjective) probabilities over some set of events before (p's) and after (q's) receiving the message, then the value of (3) measures the informational value of this message in bits.

However, if we define p_i and q_i as income shares at time points t_0 and t_1, then (3) becomes a measure of income mobility. It takes the value of 0 in the case of strict stability (that is, when $p_i = q_i$ for every i) and the maximum value for the maximal mobility. The maximal value depends on the vector of incomes for time t_0.

Figures 10.1 and 10.2 show the relationship between the structure of changes in the income distribution and the values of the index in a simulated two-person population. Points on the horizontal axis represents various income distributions for time t_0. The income share of the first person is the distance to zero, the income of the second person is the distance to 1.

Figure 10.1. Values of the Proposed Measure of Mobility for Artificial Two-Person Population if the Initial Income Shares Are Equal to 0.33 and 0.67

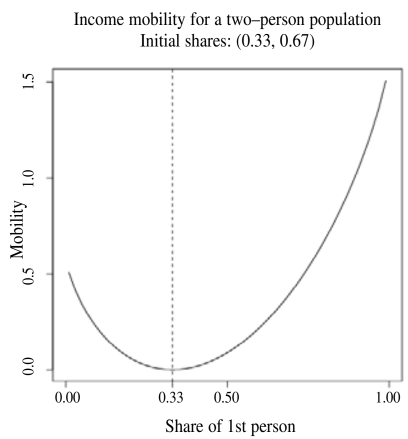
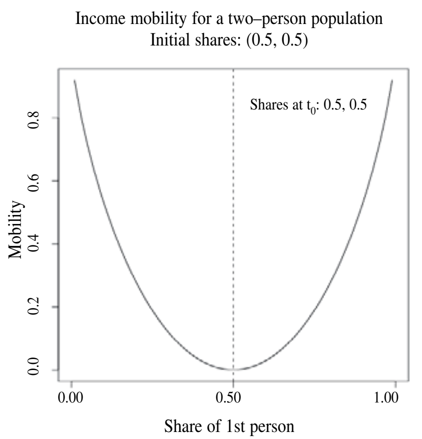


Figure 10.2. Values of the Proposed Measure of Mobility for Artificial Two-Person Population if the Initial Income Shares Are Equal to 0.50 and 0.50



For example, in Figure 10.1 the emphasized point 0.33 corresponds to an income distribution at t_0 in which the first person has 0.33 of the total income and the second person has the remaining 0.67. On the other hand, Figure 10.2 represents a situation in which the initial distribution is fifty-fifty.

The curves show the values of the index for different income distributions at t_1. Let us take Figure 10.1 with the initial distribution of [0.33, 0.67]. Notice the asymmetry: the maximal value of the index (approaching 1 or 2) depends on the "direction" of changes. The height of the curve over the 0 point, far left, corresponds to the level of the mobility index if the final income vector at t_1 is [0, 1]. The index measures this change with a value of approximately 0.5. On the other hand, with Figure 10.2, for the change from initial incomes [0.5, 0.5] to final incomes [0, 1] the measured level of mobility is approximately 0.7. This reflects the fact that the former transformation requires more drastic change in income shares than the latter.

The proposed measure also has reasonable theoretical grounds. It belongs to the class of measures of distributional change defined axiomatically by Cowell (1985; see *normalized decomposable class*). The set of key defining properties contains the following:

Symmetry: The measure is invariant under any permutation of individual income receivers.

Continuity: The measure is continuous over the set of all bivariate income distributions that define any income mobility process.

Monotonicity in distance: The measure should "reasonably" react to the direction of income transfer between times t_0 and t_1.

Decomposability: The measure should be decomposable into group components.

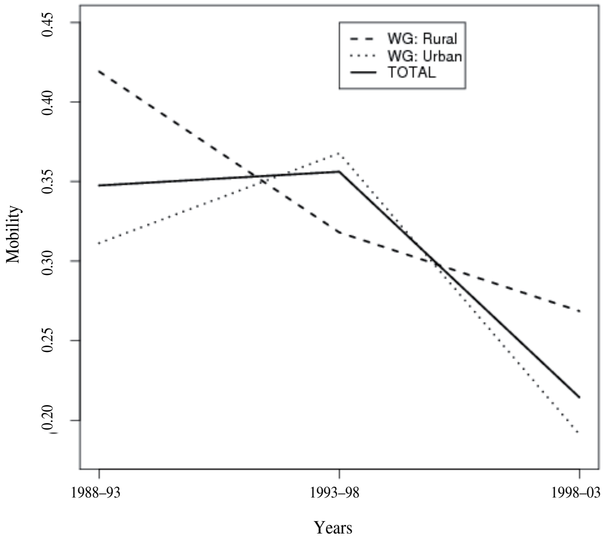
Smoothness: The measure should not involve steady and bumpy change in its value.

For detailed definitions, theorems and proofs, see Cowell (1985).

Relative Income Mobility in Poland

Figure 10.3 and Table 10.6 show the results of applying the proposed measure to the POLPAN data. As may be seen, the increase in income inequality among urban households (see Table 10.2) was accompanied by a rather mild level of mobility (as compared with rural households). On the other hand, a smaller increase in inequality among rural households took place with a relatively high level of mobility. It is worth noting that in the periods 1988–93 and 1993–98 the level of total mobility was rather stable; this is in contrast to the level of within-group mobility, which shows fairly different dynamics. In the period 1998–2003 we observe an increase in mobility with respect to both the total and the groups. One cause of this phenomenon may be the aging of panel respondents.

Figure 10.3. Income Mobility of Urban and Rural Households: Values of the Measure Proposed



Source: POLPAN

Table 10.6. Household Income Mobility. Values of the Proposed Measure

	Periods		
Inequality	1988–1993	1993–1998	1998–2003
Total	0.348	0.356	0.214
Rural	0.419	0.318	0.269
Urban	0.311	0.368	0.191

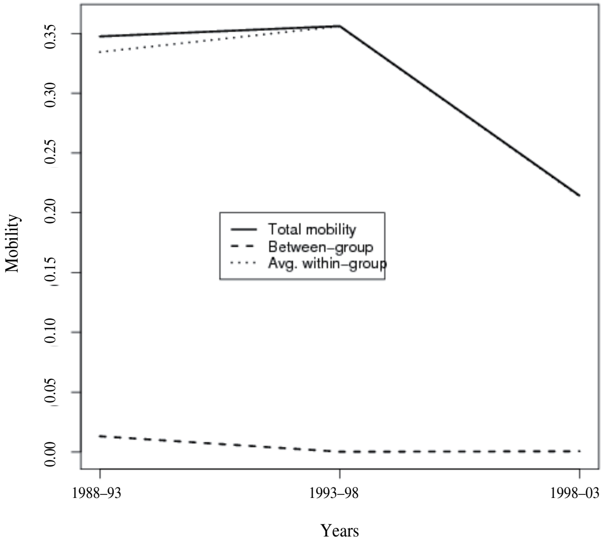
Because our "informational" measure of mobility is additively decomposable (similarly to the Theil index), we can represent the total amount of mobility in every period as the sum of two components:

• Average within-group mobility, which represents changes in household incomes relative to the group.

• Between-group mobility, which represents changes in mean group incomes, that is, if we treat groups as the units of analysis.

The results of such decomposition are presented in Figure 10.4, which shows that the changes in group shares (between-group mobility) have taken place only in the period between 1988 and 1993. Numerical values of indexes are also shown in Table 10.7.

Figure 10.4. Decomposition of Income Mobility



Source: POLPAN

Table 10.7. Decomposition of Income Mobility

	Periods		
Decomposition	1988–1993	1993–1998	1998–2003
Total	0.348	0.356	0.214
Between-group	0.013	0.000	0.001
Average within-group	0.334	0.356	0.214

Dynamics of Income Trajectories of Individual Households

In the previous part of this chapter we analyzed the dynamics of incomes with macro characteristics such as "the level of income inequality" and "the level of income mobility." Those analyses show aggregate changes in the variation of incomes as well as the extent of changes in the given periods. They do not tell us much, however, about the changes in incomes of individual households. In this part of the chapter, we bridge this gap with analyses of individual income trajectories of households. We take advantage of the approach described by Jenkins (2000), which may be viewed as an application of statistical models proposed by Laird and Ware (1982). Those models are a variation of multilevel models that are extensively described in the literature. Because of space restrictions, we limit ourselves to only a brief characterization and focus on application to the panel data. The reader is advised to consult fairly complete treatments of multilevel models, for example, Snijders and Bosker (1999), Goldstein (1995), and Bryk and Raudenbush (1992).

Multilevel models are models for analyzing data with *hierarchical* structure. The hierarchy can result primarily from two sources. First, it can be a consequence of the multilevel nature of the problem being addressed, thus resulting from theory. Second, it can be a consequence of the multilevel (multistage) sampling scheme that was employed to collect the data.

Classic examples of multilevel problems reside in the field of educational testing, in which researchers study patterns of association between properties of schools and the quality of education of the pupils within them. In this context we can separate levels of the analysis. The first level corresponds to individuals: individual pupils are the unit of analysis. We expect that pupils who belong to the same classes will have similar test outcomes just because they attend the same courses and are taught by the same teachers. The latter is the second level, in which the class is the unit of analysis. Therefore, we can say that, the individual level (first level) is *nested* within the school class level (second level). Similarly, we could have defined a third level corresponding to schools, and so on. The hierarchical structure would look like this: schools > school classes > pupils.

Panel data also have a hierarchical structure. Let us assume that we are interested in some variable, say X, and that we have panel data from two respondents ($i = 1, 2$) from three waves ($t = 1, 2, 3$). The structure of such data can be represented like this:

respondent [i]	time [t]	measurement [X_{it}]
1	1	X_{11}
1	2	X_{12}
1	3	X_{13}
2	1	X_{21}
2	2	X_{22}
2	3	X_{23}

We can distinguish two levels of analysis. The first level corresponds to individuals. On this level we have two units of analysis. The second level, which is *nested* within the first, consists of three observations and corresponds to three waves of the panel. From the hierarchical nature of the data we expect that measurements of the same respondents will be more similar to each other than to measurements for others. Multilevel models make possible the estimation of regression-like models that take this phenomenon into account.

In the context of income mobility, the multilevel models allow the analysis of changes in individual incomes of households. Below we present the model, in which we compare individual income trajectories of households according to the size of residence (urban/rural) and the year of birth of the head of the household. The model structure is presented in Table 10.8:

Table 10.8. Mulitilevel Model of Household Income Trajectories

Variable	Coefficient (B)	Standard error (SE)	Degrees of freedom (df)	*t*-test (*t*)	Sig. (*p*)
Constant	*28,367.485*	*35,40.634*	*3,142*	*8.012*	*0.000*
Time					
Time	–28.427	3.549	3,142	–8.011	0.000
Time-squared	0.007	0.001	3,142	8.011	0.000
Type of residence					
Urban	–19,015.401	3,050.443	1,044	–6.234	0.000
Birth cohorts					
cohort (1937, 1951)	–10,019.791	3,925.361	1,044	–2.553	0.011
cohort (1951, 1966)	–4,610.838	3,852.327	1,044	–1.197	0.232
Time × size of residence					
Time * urban	19.043	3.057	3,142	6.228	0.000
Time × cohort					
time * cohort (1937, 1951)	10.031	3.934	3,142	2.550	0.011
time * cohort (1951, 1966)	4.631	3.861	3,142	1.199	0.230
Size of residence × birth cohort					
urban * cohort (1937, 1951)	0.078	0.111	1,044	0.702	0.483
urban * cohort (1951, 1966)	–0.192	0.107	1,044	–1.790	0.074
Time-squared × size of residence					
time-squared * urban	–0.005	0.001	3,142	–6.223	0.000
Time-squared × cohort					
time-squared × cohort (1937, 1951)	–0.003	0.001	3,142	–2.547	0.011
time-squared × cohort (1951, 1966)	–0.001	0.001	3,142	–1.202	0.229

Model fitting statistics: AIC = 9,306.137; BIC = 9,426.65; Log likelihood = –4,634.068.
Observations: 4,200. Number of respondents: 1,050.
Autocorrelation coefficient: 0.721.

The data provide us with information for 1,050 households at four time points (1988, 1993, 1999, and 2003). We model each income "profile" using a quadratic curve. Initial analyses (not presented here) show that the simple linear trend is insufficient to explain individual income changes. The use of a quadratic curve enables us to capture the variability in growth/decline rates. The between-subject variability of parameters describing income dynamics according to the size of residence allows for the description of different "income histories" in the period under study (1988–2003). Multilevel models enable simultaneous estimation. The estimated parameters are presented in Table 10.8.

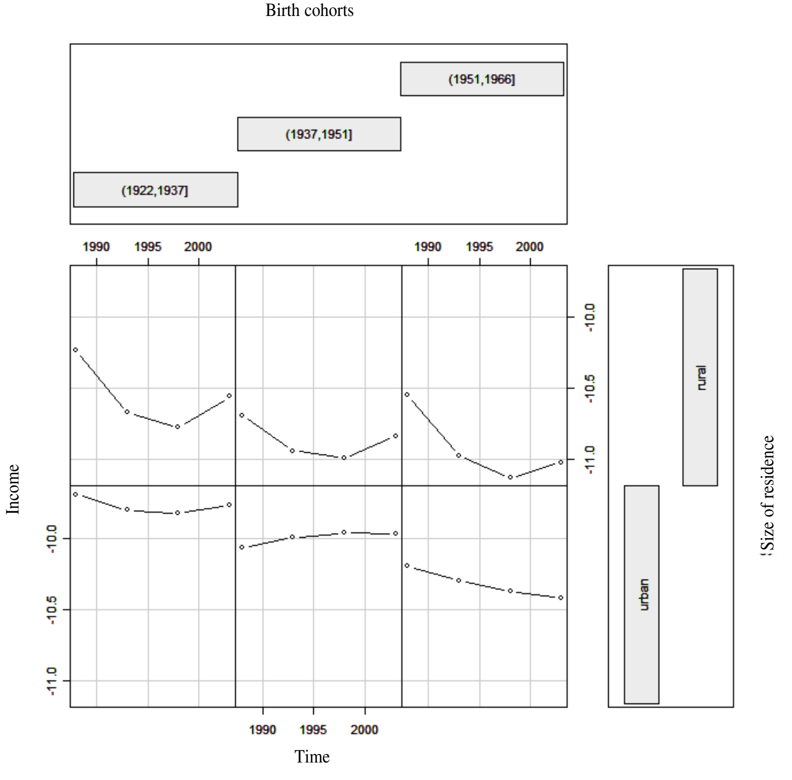
First, let us describe the variables. The dependent variable is the household income measured as a fraction of the mean income in a given year corrected with an equivalency scale. For independent variables we have, first, time corresponding to the waves of the panel: 1988, 1993, 1998, and 2003. It is modeled using both linear and quadratic effects. The second variable is the size of residence introduced as a dummy variable (urban = 1). The third variable is "cohort." For the sake of our analyses, we distinguish three generation cohorts: respondents born in (1) 1922–37, (2) 1937–51, and (3) 1951–66. The other rows in Table 10.8 correspond to interaction effects between those variables.

The model structure is fairly complicated because of the number of interaction effects. Therefore, for interpretation we will use a figure. Figure 10.5 presents fitted income levels under the model estimated from Table 10.8. The figure consists of six panels organized in two rows and three columns. Every panel presents the relation between the income (vertical axis) and time (horizontal axis) for a different combination of the size of residence (rows) and birth cohorts (columns).

Intergenerational differences. The first thing to note is the difference in the income dynamics between depicted groups. The incomes of rural households decreased at the beginning of the 1990s, were stable between 1993 and 1998, and then increased from 1998 to 2003. Among urban households we observe a linear increasing trend. We also observe differences in the levels of incomes. Older cohorts are characterized, on average, by higher income levels than younger cohorts. The variation in income levels comes from the significant interaction effect between size of residence and birth cohort.

Size of residence. While rural households can be characterized by the nonlinear trend that was already mentioned, among urban households we observe a constant increase. This difference in shapes is confirmed by the significant interaction effect of residence size and time.

Figure 10.5. Graphical Interpretation of the Multilevel Model: Predicted Household Incomes in Years 1988–2003 Dependent on Size of Residence and Birth Cohort



Discussion

In this chapter we presented analyses of household income dynamics using two approaches: (1) an analysis of distributional changes using indexes of inequality and mobility, and (2) an analysis of individual income trajectories using a two-level regression model with random effects. On theoretical grounds using both approaches enabled us to approach the posed problem from two different perspectives.

The first approach, "distributional," made it possible to answer the macro question concerning changes in income inequality levels and changes in income mobility rates. The measures that were used also provide good interpretations from the perspective of welfare economics. With this approach we observed an initial increase and later stabilization in income inequalities and a systematic decrease in the levels of income mobility.

The second approach using individual income trajectories, or careers, provided a micro-level analysis. It made it possible to dissect significant individual and group effects on the shape of dynamics of household incomes. The analyses presented restated the differences in incomes between urban and rural households. They also unraveled differences in the shapes of income careers: the linear trend for urban households and a decrease followed by later increase for rural households.

The question that arises is whether it is possible to integrate both analytical strategies. Integration could be accomplished by incorporating the inequality and mobility measures as parameters of the multilevel models. However, this would require the construction of parametric links between the values of these measures and the shapes of the analyzed income distribution and its changes. Considerations of this kind were presented in Figure 10.5. Unfortunately, to the author's knowledge, significant results in this respect are yet to be achieved.

Appendix:
Additional Details on the Estimated Two-Level Model

The estimated model is a two-level model in which time is modeled as a random effect. In this respect, it is a random coefficient model. All three parameters describing individual changes in incomes, that is, constant, linear effect, and quadratic effect, are treated as random variables. The income data on the level of the individual household (first level) are in principle a four-point time series. Therefore, we introduced an autocorrelation component—the correlation of an income with its value in the previous period. To be exact, we fitted a first-order autocorrelation function to regression residuals. This corresponds to an AR (1) process according to the time series analysis framework formulated by Box and Jenkins (1970). The coefficient of autocorrelation is 0.723.

The model and other calculations in this article were performed with "R," an environment for statistical computing (R Development Core Team 2006).