Application of the age-period-cohort model in the estimation of income mobility in Brazil

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1. Introduction

The income mobility can be seen by the relationship of causality between an individual's position in the income distribution in the past and the present. It has an important role in analyzes of welfare because of this relation with the long-term income inequality. For a given cross-section inequality, greater upward mobility for poorer individuals and/or descending to those located at the top of the distribution may lead to less inequality in the long run. Mobility can express the change in opportunities of labor market when compared to traditional measures of inequality. High levels of inequality, as observed by the Brazilian economy, can be mitigated if there is evidence of mobility.

However, as noted by Shorrocks (1978), the change in individual income can have a change in income distribution that does not sustain for longer periods. The significant short-term mobility doesn’t reflect a sustained change in the distribution. For example, in a given year, individuals can present lower earnings due to adverse economic events. In this context, mobility does not reveal a systematic change in income inequality in the long run.

Attention has been given in the literature to analyze the possible causes of income inequality, but less interest has been devoted to the analysis of income mobility in Brazil. This article seeks to analyze the relationship between mobility and income distribution in Brazil, considering structural and cyclical effects in the distribution. For that, we consider an age-period-cohort model. We use the microdata from the National Household Sample Survey (PNAD) published by the Brazilian Bureau of Geography and Statistics (IBGE), from 1993 to 2007.

2. Conceptual framework

The ways to measure and interpret the mobility are diverse. Two major areas - sociology and economics - consider this subject from different aspects. But they have a common concern, referenced in how mobility can change the distribution of wealth and power. In economic tradition, the studies of mobility begin with the approach of Becker and Tomes (1979). These authors were the first to discuss the relationship of the intergenerational transmission of income and to consider the role of education. They suggest a theoretical model of intergenerational transmission of family status. They distinguish two forces of intergenerational transmission of income: investment in human capital derived from rational decisions and correlation of skills. Thus, the intergenerational transmission of economic status is identified as an indicator of opportunities in labor market. In addition, it can be related to income inequality over time. Behrman et al (2001) points out that parent’s education and family economic status are frequently used as indicators of access to opportunities in the labor market.

In this context, as in the sociological literature with an emphasis on social hierarchy, research on mobility is based on intergenerational correlations of income and formation of education among parents and children, with reference to the theoretical approach of Becker and Tomes (1979, 1986). Works such as Solon (1999) and Behrman et al (2001) show the role of intergenerational income elasticity between generations. Besides the income mobility, the mobility following the economic vision can be measured by socioeconomic mobility, expressed mainly by occupational mobility, and the mobility of earnings. According to Solon (2001), the increase in inequality over time may be due to a growing gap in earnings among the poorer and richer people. A scenario like this sustains growing inequality in the long run.

Among the factors that justify cross section inequality, the author shows that differences between the individual attributes of the same cohort may lead to a permanent change of income inequality. It can affect positively the long-term inequality. For example, a higher level of education can lead cohort to earn higher earnings. In addition, factors as motivation, intelligence and individual skills may have favorably effects in income over the cycle of life. On the other hand, individuals may have an increase in volatility of their earnings, which does not hold over time. In this case, the long-term inequality may be little affected, although the cross section inequality is influenced.

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As the income mobility does not derive from a problem of individual choice, the literature is focused on methodological aspects of its measurement and empirical application. The income mobility is a reflection of individual decisions taken ex ante in investment in education and independent factors such as macroeconomic conditions, labor market and institutional factors that may contribute to the phenomenon.

Considering these factors, it is important to analyze the mobility from the perspective of the cycle of life. It contributes for understanding the phenomena of declining income inequality between demographic groups.

3. Methodology and Preliminary Results

3.1. Data

The PNAD is a survey characterized by cross-section data. Thus, the information does not allow monitoring of the same individual in a time series. The main advantages of this survey are its temporal and geographical scope. In addition, it considers other income, besides labor income. Thus, it can be inferred about a possible relationship between mobility and income inequality in Brazil. For this, we consider the period between 1993 and 2007. Because of the organization of data, it was necessary to construct homogeneous groups that were monitored every two years, from 1993 to 2007.

The formation of the groups was based on the year of birth, gender, education and race. In addition to the year of birth, the composition of homogeneous groups is formed by gender: men and women; race/color: white and nonwhite, and schooling: 0 years of education, 1-3 years of schooling, 4-7 years of schooling, 8 to 10 years of schooling, 11 years and 12 to 15 years of schooling. For the combination of these variables, we formed 288 homogeneous groups. As an example, it has white men, born between 1932 and 1935, with 0 years of education.

3.2. Age-period-cohort model

The analysis of the age-period-cohort model (APC) allows all factors that influence the rate of occurrence of event can be grouped into age of event, period of occurrence and birth cohort of individuals. As pointed out by Rios Neto and Oliveira (1999), this model incorporates the three relevant dimensions of demographic processes. The analysis of these effects considers all the determinants that affect the behavior of the response variable. In addition, as noted by Wilmoth (1998), the occurrence of influences resulting from interactions or overlaps between the three dimensions have an importance smaller than the main effects associated with each one.

The effects of period or cyclical effect are related to specific events observed at a given time. They depict how changing in economic, social and environmental factors influence the population evenly. Cohort effects are associated with the year of birth of individuals. They are usually connected to changes in fertility and intergenerational behavior. This effect reflects characteristics that differentiate the various generations. They can reflect, for example, cultural change, institutional or political, that has occurred in a certain time, differencing the generations as a whole.

Given that any of the variables is a simple linear combination of the other two, there is a difficulty in estimating the parameters. For the identification of effects, it is necessary to allow some additional hypothesis for seeing the contributions of each of these dimensions (HECKMAN and Robb, 1985).

The methods for dealing with the problem of identification in age-cohort period model can be classified in three types. The first method of identification consists in treating the three effects as dummy variable. In addition, it is necessary impose one or more linear constraints on the coefficients of the model. Authors like Mason and Fienberg (1985) and Mason et al. (1973) suggest arbitrary imposition of one or more linear constraints on the relationship between any independent variable and the dependent variable. In this case, the parameters are estimated based on the assumption that the effects of two cohorts (or ages or periods) are equal. With this restriction, the model can be estimated, but one has to assume that the specific effects are the same for both categories of each variable considered. Still, it is possible to assume that all categories of the same variable to be equal. Thus, the effect of this variable is totally eliminated from the

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2 The other Brazilian survey (Monthly Employment Survey - PME) from IBGE is important because of the longitudinal format. However, in this panel the individuals are followed only for a year. In this way, it is impossible to do long duration analyze.
model. Another type of constraint is proposed by Deaton and Paxson (1993) and Deaton (1997). These authors suggest the use of dummy variable for each of the effects and restrictions related to the period effect.

The second method is done considering dummy variable for cycle of life, period and cohort. It is done by substitution of one or more variables by low order polynomials. Finally, the third method proposes to replace one or more of the sets of dummy variables for direct measurement of the effect (age, period or cohort). For this work, the estimation is performed using two of the methods proposed in the literature. Firstly, we consider dummy variables for the three effects as:

\[ \Delta y_c = f_c + a_{t-c} + d_t + e_{ct} \]  

(1)

Where: \( \Delta y_c \) = difference between average earnings observed in \( t \) and \( t-1 \) for each homogeneous group; \( f_c \) = cohort effect represented by dummy variables; \( a_{t-c} \) = age effect considered by dummy variables; \( d_t \) = period effect given by standard dummy variable and, \( e_{ct} \) = errors of specification. In this case, we consider to the period effect only changes in income mobility of short duration, whereas the effects of age and cohort contain a trend component.

The second form of identification considers direct measurements of the effects of age and period as:

\[ \Delta y_c = f_c + \alpha \exp + \beta \text{gdp} + e_{ct} \]  

(2)

Where: \( \exp \) = experience based on Mincer (1974); \( \text{gdp} \) = growth rate of real gross domestic product.

Regressions are estimated by method of weighted least-squares, wherein the relative number of individuals in each homogeneous group is used as weight. The estimation is done for main work earnings and all sources earnings. The results show higher coefficients for the younger cohorts. The composition effect caused by the improvement of the distribution of education for the younger generation in Brazil may explain in part this result. The coefficients of age dummies reflect an increase in mobility with higher age. The results confirm that the increase of experience is related to higher earnings. The effects of period show a lower response to cyclical variations on mobility. A greater negative effect on mobility is observed until 1999.

The second model used direct measurements of the effects of period and age. To capture possible effects of period, we included the growth rate of real GDP. The effect of age is considered by the experience. Cohort effects are maintained with the inclusion of these variables. The variable of experience as a direct measure of the effects of age confirms the results previously shown. The income mobility increases with the degree of experience of the individual in the labor market. The growth rate of real GDP has a positive effect on income mobility. It reflects possible changes in mobility that is resulting of the performance of the economy rather than an improvement in income distribution. Overall, the combination of the characteristics of age and birth cohort emphasizes the role that education can have in higher income mobility, especially on the younger cohorts in Brazil.

4. References

IBGE. Série histórica da pesquisa nacional por amostra de domicílios. Disponível em <www.ibge.gov.br>


