The geography of social class mobility in France: a multidimensional approach

Abstract

Economic and sociological research have shown that the strength of social mobility substantially varies between regions within countries. The objective of this paper is to shed light on the multidimensionality of subnational variations of mobility. Regions do not only differ because of the strength of their social mobility, but also because of the type of social mobility that prevail within them. We use data from the French Labor Force Survey conducted between 1982 and 2022. Compared with traditional economic and sociological methods, we firstly propose an original approach by using a dimensionality reduction technique (correspondence analysis) and a clustering method to identify specific patterns of absolute mobility corresponding to three main types of territory: rural territories, higher white collar urban territories, and blue-collar urban territories. Secondly, we shed light on the multidimensionality of social fluidity by examining the relation between different dimensions of social fluidity measured at the regional level. Combining log-linear models and principal component analysis, we show that the strengths of the inheritance of the different classes are not well correlated, some even being negatively correlated. Upward fluidity and downward fluidity are also negatively correlated, and both are weakly correlated to inheritance. General measures of absolute mobility and of social fluidity are therefore not well equipped to account for geographical class inequality variations, because of their multidimensional nature.

Introduction

Research on subnational variations in social mobility has become increasingly influential in the recent years (Chetty et al 2014; Zwysen 2016; Ballarino and Panichella 2021; Engzell and Gränstrom 2023; Kenedi and Sirugue 2023; Morris 2023; Breen, In, 2024). Studies have shown the importance of within-country variations of social mobility and those variations have been used to identify mobility factors, i.e., macro-sociological or macro-economic indicators associated with higher or lower rates of social mobility, such as GDP, unemployment, local labor market conditions, or even local social capital.

Those subnational comparisons have so far relied on unidimensional measures, as they usually compare different territories according to their total rate of mobility (i.e. absolute mobility) or according to the strength of the statistical relation between the parents' position and the child's position (i.e. relative mobility or social fluidity). These measures have the advantage of being easy to correlate to diverse characteristics of the environment at the macro level. Such an approach misses, however, the multidimensional nature of social class mobility. Indeed, the same rate of social immobility in a given territory can emerge from very different ways by which life trajectory is constrained by the territory in which someone is born or lives. For example, social mobility can be weak because children of managers become managers, but also because children of blue collars become blue collars or because children of farmers become farmers. Similarly, comparatively strong mobility in a given region can mean very different things: people born in agricultural regions may have different kinds of mobility than those living in urban or industrial regions. Different types of mobility are in general "aggregated" in average measures of the total volume of mobility. Distinguishing those different measures is, however, fundamental for a better understanding of the diverse geographical factors that affect one's life chances.

We shall therefore analyze regional differences in mobility in France using an approach that captures various types of absolute mobility and multiple dimensions of social fluidity, rather than focusing solely on the total volume of absolute mobility or on the overall strength of the origin-destination association (social fluidity). To shed light on those different types of mobility, this paper focuses on class mobility. Classes are groups of occupations that are collapsed because of their proximity on a small number of variables, such as the level of qualification, the fact of being self-employed or of belonging to some specific sectors (such as farming). These variables can be used to define different types of mobility, some of which are vertical (as they imply for example mobility between low skilled and high skilled occupations) while the others are horizontal (such as for example mobility between self-employed and farmers).

To measure class, we use a 6-class version of the European socioeconomic classification, which permits distinguishing 30 different types of mobility and 6 types of immobility. To analyze these different types of absolute mobility and immobility, we develop an original approach by using a dimensionality reduction technique (correspondence analysis) and cluster analysis to identify the main dimensions that structure the flows of mobility between classes.

Then, to obtain a multidimensional description of social fluidity, we estimate a separate topological log-linear model in each department of metropolitan France. This model provides, for each department, a measure of the specific inheritance of each class, as well as of upward and downward fluidity. We define inheritance as the tendency of individuals from a given class to remain in that class more often than expected under the assumption of statistical independence between class origin and class position. Similarly, we define upward and downward fluidity as the tendency for individuals to experience upward or downward mobility more frequently than predicted under the same independence assumption. This produces a substantial set of indicators: eight for each of our 95 departments, totaling 760. To describe the relations between those indicators measuring different dimensions of social fluidity and the socioeconomic factors, we employ a Principal Component Analysis (PCA). The PCA offers intuitive visualizations of these correlations and allows to assess whether they are structured into distinct underlying dimensions.

Our contribution to the literature is threefold. First, we identify the main structural divisions in the French territory: the opposition between rural and urban regions, and the opposition between the relatively affluent white collar urban regions and more disadvantaged blue-collar urban regions. These three types of regions have specific patterns of mobility, and those patterns are correlated to different socioeconomic characteristics of the territory. In this way, we overcome one of the main limits of the more conventional approach that seeks a unique set of factors of mobility, by showing that the relation between socioeconomic factors and mobility depends on the type of mobility that is considered.

Second, we examine the multidimensionality of the variations of social fluidity. We show that the inheritances of the different social classes are not well correlated and that some are negatively correlated. Therefore, regions do not differ only in the strength of inheritance observed within them, but rather in the types of occupational inheritance that prevail within them. Again, the opposition between rural and urban regions appears as central to understanding those variations. The inheritance of the managerial and professional class as well as of the manual class appear as stronger in the most rural regions. On the contrary, the richest regions provide a more equal access to the managerial and professional class. The socioeconomic factors appear as more particularly correlated to some dimensions of social fluidity than others. In line with some recent research (Hertel, Groh-Samberg, 2019; Granström, Engzell, 2023), we also found that class inequality is a better predictor of a lower fluidity than inequality between individuals.

Third, we compare our multidimensional approach to a unidimensional one by examining whether the Unidiff coefficient is correlated to the different types of inheritance and to downward and upward fluidity. The coefficient appears as a good compromise because it is correlated to almost all types of class inheritance, as well as to upward fluidity. We show, however, that it merges some negatively correlated types of inheritance and hides thereby some fundamental geographical oppositions and inequalities.

Literature review

Socioeconomic factors and social mobility

Since the outset of research on social mobility, many studies have focused on temporal and cross-country comparisons (Lipset and Zetterberg 1959; Featherman, Jones, and Hauser 1975; Grusky and Hauser 1984; Erikson and Goldthorpe 1992; Ganzeboom, Luijkx, and Treiman 1989; Breen and Luijkx 2004). Those studies aimed at understanding to what extent social mobility vary and whether those variations could be explained by factors such as industrialization, education, or inequalities. As we shall see, the study of subnational differences in social mobility have permitted to revisit their results.

One of the most classical theory about changes in the level of social mobility is the modernization thesis according to which the direct link between origin and social position should diminish with industrialization. Society should become increasingly meritocratic as industries will require job distribution to rely more on skills acquired through education (Treiman 1970). This last theory, was challenged a lot in the subsequent research. Despite some first negative results (Erikson, Goldthorpe, 1992), research has demonstrated a positive effect of educational expansion and democratization on social mobility in temporal comparison within countries (Breen 2004; Breen, Müller 2020) and more recently in cross-country analysis (Van de Werfhorst 2024).

To revisit the theory of modernization, Knigge *et al.* (2014) used historical data on regional variations of mobility in the Netherlands between 1827 and 1897. They found that indeed the father's effect on social destiny was less important in the most modernized communities. Similarly, Lippényi *et al.* (2015) studied how modernization influenced mobility in Hungarian cities between 1870 and 1950. They found that increasing equality in education reduced the rigidity between manual and non-manual classes.

Berger and Engzell (2022) adopted a regional approach to explore another aspect of modernization theory: the impact of technological progress—particularly task automation—on social mobility. They demonstrate that regional levels of task automation are correlated with a decline in absolute mobility in the USA. By reducing the number of skilled manual jobs, automation has deprived the children of manual occupations of a pathway to skilled positions via occupational mobility, thus confining them to the position of unskilled employee. Modernization appears therefore in this case to increase spatial inequalities in social mobility.

Beside modernization theory, another topic that has attracted attention is the relation between inequality and the level of social mobility, a relation that has been called the "great Gatsby curve". The existence of the great Gatsby curve (GGC) that supposes a negative relation between inequality and mobility is widely accepted in economics that uses income as a measure of social position, whereas its existence is more contested in sociology, results on the subject being less robust (Torche, 2015). Recently however, comparing 39 countries, Hertel and Groh-Samberg (2019) reformulated the GGC thesis to show that social class fluidity is not negatively correlated to the general level of inequality but to inequalities between classes. This result has been confirmed at the regional level by Granström and Engzell (2023) who used data from the European Social Survey to cover all the different regions of Europe.

Finally, studies in sociology used subnational data to emphasize the role of the strength of the local labor market in explaining inequality of opportunity (Zwysen 2016; Lindeman, Gangl, 2019; Morris 2023). They showed that regional labor market conditions have a particularly strong impact on children from less advantaged backgrounds.

These studies showed how socioeconomic factors that have been conceived of as impacting mobility at a national level can have important consequences for understanding regional levels of mobility and for explaining spatial inequality within countries. To summarize those results, we propose to distinguish four types of factors that may explain regional levels of mobility. From the research on modernization theory and its impact on social mobility, we can suppose that mobility will differ between the urban areas of France and between the more rural areas. Urban areas concentrate many aspects of what have been associated to modernization: access to service and industrial jobs rather than farmers' jobs, easier access to geographic mobility and to education. Because of its special importance, the access to education can also be considered as a factor in itself: it is related to the urban/rural division but it is not entirely explained by it. As we've seen the sociological literature insisted on how bad economic conditions could affect the mobility of lower class and therefore reduce inequality of opportunity. Our third factor is therefore the strength of the labor market and this strength corresponds to economic characteristics such as the GDP of the region or its unemployment rate. Finally, from the literature on the GGC, the fourth factor is inequality and it can be decomposed into inequality between individuals and inequality between classes.

From the previous studies, we have therefore identified four factors that may affect social mobility: the urban/rural division, the access to education, the labor market conditions, and the level of inequality. The studies we have referred to for identifying those factors relied on a unidimensional approach, using measures of the strength of absolute or of relative mobility. We argued that such a unidimensional approach may hide some important differences in the type of mobility between territories, as well as in the impact of socioeconomic factors. To develop this thesis, we shall now present a set of findings highlighting the significance of multidimensionality in social mobility. We will then examine the implications of those finding for studying regional mobility levels.

Toward a regional mobility paradox?

A first important result that evidences the multidimensionality of social mobility is the mobility paradox. The mobility paradox arises from the various ways social position is measured in social mobility research. Research in sociology has often used the social class. Literature in economics almost exclusively relies on a measure of income. Many comparisons have been made of the two approaches (Björklund, Jäntti, 1999; Torche, 2015). Those comparisons have uncovered that countries that exhibit a stronger income persistence are not always the same as those that exhibit a stronger class persistence, a result that has been called the mobility paradox (Breen, Mood, Jonsson, 2016).

The literature on the mobility paradox shows that there are different types of social mobility and that they do not need to be perfectly correlated. This is not surprising, because class mobility can in fact correspond to mobility across different dimensions: level of qualification, self-employment to salariat, or from a manual occupation to a non-manual one. Depending on the country or time, barriers within each of these dimensions may vary in strength, and they do not necessarily evolve in the same way as barriers between income categories.

Having the mobility paradox in mind should be important for comparing mobility in different regions, because there may be a corresponding regional mobility paradox, but also a corresponding class mobility paradox. Instead of supposing that regions differ by their general degree of class mobility, we could expect that some regions may be more mobile for some classes and less for other classes. Two regions could have the same general degree of social fluidity, but very different types of fluidity. This would make the ranking between the regions much more complicated. It would also make problematic the research of factors of mobility and fluidity, as some factors could be particularly correlated to some forms of absolute mobility or of fluidity rather than others.

The topological log-linear models: a multidimensional approach

The importance of the multidimensionality of class mobility has actually already been highlighted in cross-country analyses and temporal studies of mobility within countries. This is particularly evident when authors employ topological log-linear models. These models are crucial tools for exploring the multidimensionality of social fluidity.

After having observed that social fluidity varies by countries, Erikson and Goldthorpe (1992) proposed a topological model, the core fluidity model, to account for these differences. The model distinguishes four factors: immobility, hierarchy, affinity, and sector. Those factors can be considered as different dimensions of social fluidity: they correspond to characteristics of social classes that explain the flux of mobility between them. Thus, the model describes the fact that individuals are more likely to move within the same sector, at the same hierarchical level, or between classes that have an affinity (being a non-manual class for example). Erikson and Goldthorpe (1992) showed that this model accurately describes the social mobility tables of all nine countries considered. They demonstrate thus that one general model can account for the variability in social fluidity across countries, with the same mechanisms at work in all countries. Breen and Jonsson (2005) highlighted as one of the most robust findings that the most important factors in social fluidity are indeed heritage, hierarchy, and sector.

More recently, Bukodi and Goldthorpe (2021) have revisited this model to describe social fluidity in 30 European countries. Only the sector factor has disappeared, as it was previously used to identify the particularity of the mobility of farmers, which is no longer relevant given their reduced share in the social structure of most European countries. They showed that this model describes quite well the structure of fluidity in those 30 countries.

Recently, an important work by Zhou and Xie (2019) on social mobility in China used a topological model, a longitudinal version of the core fluidity model, to evidence the importance of the multidimensionality of class mobility. Previous works concluding that modernization had little effect in China have used the Unidiff model which assumes a uniform change of social fluidity over time. If different dimensions have evolved differently, this cannot be seen with such a model. Zhou and Xie (2019) used their topological model to evidence a contradictory trend: a decline in social fluidity in the transition from socialism to a market economy due to an increase of the hierarchical factor, alongside an increase in fluidity between farmers and non-farmers, measured by the sector parameter. By distinguishing those two parameters their model allowed them to evidence this contradictory trend.

Topological models, such as the core fluidity model proposed by Erikson and Goldthorpe, enable, therefore, to account for the common structure of fluidity between countries and for the multidimensionality of social fluidity. They can be used to make cross-country comparisons, but also to understand contradictory trends in temporal evolutions. Similarly, topological models could explain significant regional differences that cannot be reduced solely to variations in the strength of social fluidity. Applied to regional variations, it may show how the strength of mobility along different dimensions do not vary in the same way.

Spatial inequalities and geography of mobility in France

Research on France has shed light on important factors explaining the temporal variations of social mobility and fluidity such as the decrease of farmers, and the expansion and democratization of education (Vallet, 1999, 2017). The impact of those changes should be very unequally distributed within the country, especially because France is a very centralized country and is therefore characterized by important regional inequalities. French GDP is very concentrated around Paris. Farmers are concentrated in rural regions, whereas access to higher education is most common in big cities and more urbanized areas. Some areas, especially the north and the eastern north, are well known for the importance of their traditional industry, and more recently those regions are characterized by their strong unemployment rates.

Some important regional inequalities in social mobility in France have already been documented (Dherbécourt 2015; Kenedi and Sirugue 2023). According to Dherbécourt, "The chances of upward mobility for individuals of working-class origin (...) vary by a factor of two depending on their region of birth." He argues that his results are mainly explained by differences in accessibility to higher education between the regions. Kenedi and Sirugue (2023) have explored the geographical variations of relative income mobility and of absolute upward mobility. Similar to Granström and Engzell (2023) in their study on European regions, they found few factors correlated with relative mobility, but more factors associated with absolute upward mobility. The only robust result they found for relative mobility is the negative impact of unemployment, which is consistent with the conclusion from the sociological literature on the negative effect of bad market conditions for the lower classes (Morris, 2023). They found no evidence of a relation between inequality and relative mobility. They found however and surprisingly a positive correlation between inequality and absolute intergenerational mobility.

Those first studies on France used a unidimensional measure of mobility, a measure of the strength of mobility. They do not describe how the types of mobility differ between French territories. However, we could suppose that mobility in rural France and mobility in Paris are quite different types of mobility and that the factors of mobility do not have the same effect depending on the type of mobility considered. In rural France for example, mobility may often be a mobility from the class of farmers to another class, such as lower self-employed, manual worker, or intermediary occupation. It is a mobility that may not require having an important educational degree. On the contrary, in more urban territories, mobility may more often be an upward mobility to the class of managers and professionals. In that case, having access to a college degree is necessary.

We shall therefore firstly test whether the geographical variations of absolute mobility and social fluidity in France are in fact multidimensional, in the sense that regions would mainly differ by their type of absolute mobility and fluidity rather by the strength of their mobility and fluidity. To test this hypothesis, we shall use technics from multidimensional statistics and topological log-linear models. As we've seen, the latter permits to measure the strength of social fluidity along different dimensions. They shall thus provide a different picture of French inequalities that traditional tools used to measure the volume of absolute mobility or the strength of social fluidity.

Secondly, we will examine how different types of mobility and fluidity are correlated to socioeconomic characteristics of regions. We have distinguished earlier four types of factors: the rural/urban division, the access to education, the labor market conditions, and inequalities. We expect those four types of factors to be correlated to absolute mobility and to social fluidity. We shall however test to what extent their correlations depend on the type of mobility and fluidity considered.

Data & Method

Data

We use the French Labor Force Survey conducted each year from 1982 to 2022. We keep in the sample individuals who were at least 30 years. We thus have a dataset containing 1,497,288 respondents for whom the social class of the father has been measured. The region is the French "department" (NUTS 3 region) in which the person was born. Metropolitan France comprises 96 departments. However, the two departments of Corsica have been merged due to the unavailability of certain socioeconomic data at a separate level. As a result, our analysis considers 95 departments.

We collected data on the socioeconomic characteristics of departments from INSEE, the national statistical office: GDP, unemployment, population density, and urbanization. For departmental GDP, data are available only from the 2000 onwards, for departmental density from the year 1994 onwards. Given these time differences and because we wanted to be able to compare the variables, we decided to use only data measured at the same period. We have chosen a reference period, 2003-2010, and we have calculated the average value of different indicators for each department over this period. This period has the disadvantage of being quite recent, falling in the second part of the temporal range of our survey (from 1982 to 2022). However, this allowed us to have data over the same period for almost all of our indicators. The only exception is for the departmental urbanization rate for which we only have data from 2017. It is therefore less comparable with other measures.

We completed these various indicators on departments provided by INSEE by several additional indicators that we were able to compute directly from the Labor Force Survey: the share of individuals that only attained high school, the share of college undergraduates, of postgraduate degrees, the Gini coefficient on the income, and a class inequality indicator. The class inequality indicator is the R^2 obtained in a regression predicting the income with the class variable as the independent variable. Table 1 shows the correlation between all our socioeconomic indicators.

Table 1 Correlations between departmental socioeconomic indicators.

	GDP	% High School	% Undergraduate	% Postgraduate	Unemployment	Density	Urbanization	Inequality
GDP	1							
% High School	-0.66	1						
% Undergraduate	0.42	-0.77	1	ma				
% Postgraduate	0.69	-0.93	0.59	1				
Unemployment	0.15	0.12	-0.32	-0.09	1			
Density	0.47	-0.61	0.15	0.78	0.04	1		
Urbanization	0.83	-0.64	0.42	0.60	0.30	0.35	1	
Inequality	0.66	-0.69	0.37	0.74	-0.03	0.49	0.62	1
Class inequality	0.06	0.08	0.09	-0.09	-0.06	-0.21	0.02	-0.04

The occupation classification

In the original data, the occupation is coded using a French classification (the PCS classification). We rely on the latter to code the social class using a simplified six-class version of the European Socioeconomic Classification. Table 2 displays our six classes and their relation with the ESeC ten-class schema. Compared to the more detailed version of the ESeC class schema, first, we decide to collapse the classes 2 and 3 of ESeC into one intermediate class. In the French classification, occupations categorized as lower professional (Class 2) are coded as intermediate occupation due to significant differences in qualification levels and official recognition compared to those in Class 1. As a result, they are much more closely aligned with intermediate occupations than with Class 1.

Table 2 Social class classification

Economic hierarchy	Social class	Description	ESeC social class	ESeC description
1 (highest)	Class 1	Professionals, managerial occupations, and large employers	Class 1	Large employers, higher-grade professional, administrative and managerial occupations
2	Class 2	Intermediate Occupations	Class 2	Lower grade professional, administrative and managerial occupations
			Class 3	Intermediate occupations
2	Class 3	Small employers and self-employed in non-professional occupations	Classes 4	Small employer and self-employed occupations (excluding farmers)
2	Class 4	Farmers	Classes 5	Self-employed occupations (agriculture)
	Class 5	Manual workers	Class 6	Lower supervisory and lower technician occupations
			Class 8	Lower technical occupations
3			Class 9	Routine occupations
3 (Lowest)	Class 6	Lower white collars	Class 7	Lower services, sales and clerical occupations

Second, all manual classes that have a labor contract relationship (classes 6, 8 and 9) are collapsed into a single blue-collar class. Despite their differences, skilled and unskilled workers have many common characteristics that distinguish them from non-manual classes. Skilled blue-collar worker is a position that unskilled workers can attain through training and experience: there is therefore an important intragenerational mobility between the two categories. Besides, limiting the number of manual classes allows us to focus on the frontier between manual and non-manual classes, and thereby to consider only the strongest barriers. Finally, we have ranked the social classes according to their position in the economic hierarchy: we created a three points scale that corresponds to the hierarchy in the ESeC classification.

A static analysis

Given the difficulty of obtaining longitudinal data on departmental characteristics, as well as the observed modest change in the degree of geographic inequality over time, our analyses are static in nature. Decomposing our results by cohort yielded fundamentally the same results, only with some difference for the oldest respondents, who represent a much more rural cohort.

Social fluidity and Unidiff model

To measure social fluidity at the regional level, we use the Unidiff model. It is written as follow:

$$\ln(\mu_{ijk}) = \lambda + \lambda_i^O + \lambda_j^P + \lambda_k^D + \lambda_{ik}^{OD} + \lambda_{jk}^{PD} + \varphi_k \psi_{ij}$$

Where μ_{ijk} is the expected frequency in the cell ijk, i being the origin, j the position, and k the department, λ is called the main effect, λ_i^O the marginal effect of origin, λ_j^P the marginal effect of position, λ_k^D to the marginal effect of the department. λ_{ik}^{OD} and λ_{jk}^{PD} account for the regional changes of the marginal distributions from one department to another. ψ_{ij} is a matrix of coefficients describing the association between origin and position. φ_k gives one coefficient for each department (the layer coefficients) to describe the difference of associations between them. Social fluidity will be measured by the layer coefficient associated to each department.

Topological fluidity model

To conduct a multidimensional analysis of social fluidity, we will compute eight indicators: one indicator for the inheritance of each class, one for upward fluidity, and one for downward fluidity. These indicators will be derived from a log-linear model, meaning they correspond to parameters estimated within a model that already includes terms for predicting frequencies based on marginal distributions. Therefore, they represent the additional number of individuals not accounted for by marginal distributions alone. As defined above, inheritance is the tendency for individuals from a certain class to stay in their class more than expected by the marginal distributions of the classes. Upward and downward fluidity are the tendency to be upwardly or downwardly mobile more than expected by the marginal distributions of the classes.

To obtain those indicators, we compute for each department a topological log-linear model similar to the core fluidity model (Erikson, Goldthorpe, 1992). The model is written as follows.

$$ln(\mu_{ij}) = \lambda + \lambda_i^O + \lambda_j^P + \iota_{ij} + \upsilon_{ij}$$

$$i \neq j, \qquad \iota_{ij} = 0$$

$$i = j, \qquad \iota_{ij} = \iota_i$$

$$(i, j) \in U_l, \qquad \upsilon_{ij} = \alpha_l$$
$$\alpha_1 = 0$$

i stands for the father's social class or origin, j for the respondent's social class. μ_{ij} is the expected frequency in the cell ij. λ_i^O, and λ_j^P stand for the effects of father's and respondent's marginal distributions. ι_{ij}measures the inheritance. The inheritance coefficients are null when the respondent's social class is different from the father's social class. There is one inheritance coefficient for each social class. We call ι_i the inheritance coefficient.

υ_{ij} measures Upward and Downward Fluidity: moving in the economic hierarchy more than would be expected by the marginal distributions. Our economic hierarchy scale is a 3 points indicator. Individuals can move therefore from zero, one, or two ladders. To simplify, we do not distinguish between two points and one point difference between the origin and the destiny. The ij cells of the mobility table can be divided into a set of three mutual exclusive levels of association (S_l, $l = 1{,}2{,}3$): a set for hierarchical immobility, upward fluidity, and downward fluidity. α_l is a vector of three coefficients that measure hierarchical immobility, upward and downward fluidity. The coefficient measuring hierarchical immobility, α_1, is set to zero because of identification constraints.

Principal component analysis

In the paper, we will use two main dimensionality reduction techniques, firstly the Correspondence analysis (CA) to analyze absolute social mobility and secondly, the Principal Component analysis (PCA) to analyze the result from the topological models estimated for each region. Given that the CA technique is derived from the PCA, below we first explain the principle of the PCA and then of the CA.

PCA is used to simplify and obtain a summary of a dataset of m quantitative variables observed over n observations, while preserving maximum information. Suppose we have a dataset where each column represents a variable and each row represents an observation. For $j = 1, \dots, m$, we denote the j-th column of X by X^j ; $\overline{X^j}$ stands for its mean and Var(X^j) its variance. To prevent variables with larger ranges from dominating those with smaller ranges, we standardize the dataset X by transforming each variable to have a mean of zero and a standard deviation of one.

We obtain a standardized matrix Z of size $n \times m.$ $\mathrm{Cov}(Z^j, Z^l)$ is the covariance between the variables Z^j and Z^l. The PCA makes a linear transformation on standardized observations $Z_i = (Z_i^1, \dots, Z_i^m)$ for all i to obtain $Y_i = (Y_i^1, \dots, Y_i^m)$ such that $Y = ZL$, where L is an orthogonal matrix of size $m \times m$. In the resulting matrix Y, the variables are not correlated, which means that the covariance matrix of Y is diagonal. Let us call $\lambda_1, \dots, \lambda_m$ these diagonal elements. Skipping the computational details and using that $Y = ZL$, we obtain the following equation: for all j,

$$\mathrm{Cov}(Z)L^j = \lambda_j L^j,$$

where L^j is the j-th column of L. Solving this equation, we obtain that the vectors L^j are the eigenvectors of the covariance matrix $\mathrm{Cov}(Z)$ associated to the eigenvalues λ_j. The eigenvectors L^j represent the principal axes, or in other words directions, and the eigenvalues measure the amount of variance explained by the corresponding principal components Y^j. By ranking the new variables Y^j in the decreasing order of their eigenvalues, such that $\lambda_1 \geq \cdots \lambda_j \geq \cdots \lambda_m$, we get the principal components in the order of significance. The new variable Y^1, associated with the largest eigenvalue λ_1, explains the largest variability in the data while being uncorrelated with each other. The variable Y^2 accounts for the next highest variance while being perpendicular to Y^1, and so on.

PCA reorients the data into a new coordinate system where the principal components are the principal axes, allowing to visualize patterns in multivariate data. The goal is to project the data onto the first two or three principal components to create plots that reveal underlying structures or clusters.

Correspondence analysis and cluster analysis

Correspondence analysis is a statistical method employed to examine the associations between categorical variables. The idea of correspondence analysis is to represent categorical variables as points in a multidimensional space. Let us consider a contingency table X, giving the joint distribution of a pair of categorical variables X_1 with categories $a_1, \dots, a_p$ and X_2 with categories $b_1, \dots, b_q$.

Correspondence analysis involves conducting two separate principal component analyses (PCAs) on the contingency table: one for the conditional distribution in rows and another for the conditional distribution in columns. This approach helps to reveal the relationships and associations between the rows and columns by mapping both into a common low-dimensional space. The distance between two row-profiles i and k is

$$\sum_{j=1}^{q}\left(\frac{f_{ij}}{f_{i\circ}\sqrt{f_{\circ j}}} - \frac{f_{kj}}{f_{k\circ}\sqrt{f_{\circ j}}}\right) = \sum_{j=1}^{q}\frac{\left(\frac{f_{ij}}{f_{i\circ}} - \frac{f_{kj}}{f_{k\circ}}\right)^2}{f_{\circ j}},$$

which is the χ^2-distance weighted by the mean.

CA allows categorical variables to be plotted in a low-dimensional space (2D) where categories that are close together tend to be associated. Categories far apart are weakly related or independent. The origin represents the average profile of the dataset. By examining proximity in the correspondence plot, we can see which row and column categories are related.

In our case, we apply the correspondence analysis to the contingency table crossing the department (in rows) and the 36 cells of the mobility table in columns. Therefore, the analysis takes into account the marginal distribution of the population in the departments and the marginal distribution of individuals in each of the 36 combinations of origin and position. Therefore, the results describe only absolute mobility and not social fluidity, as the analysis does not take into account the specific marginal distributions of origin and position in each department. It will permit us to visualize how some departments are characterized by the importance of some flux between origin and position, but not whether the importance of those fluxes can be explained by the specific marginal distributions of origin and position in those departments or by the statistical association between origin and position in the departments.

To complete the use of the correspondence analysis, we shall use a hierarchical clustering analysis on the results of the CA. The goal will be to group departments together based on their proximity that will be measured by the correspondence analysis.

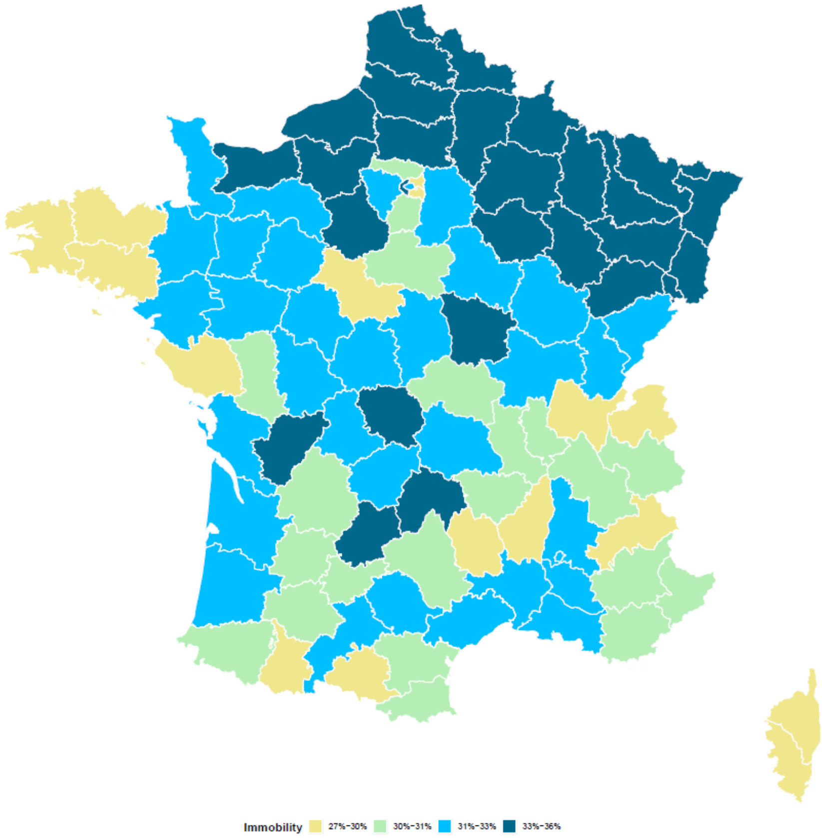
Results

We will start by analyzing geographical variations of absolute mobility and then we will analyze the variations of social fluidity. In each case, we will firstly conduct a unidimensional analysis and secondly, we will proceed with a multidimensional approach. It shall demonstrate how a multidimensional approach uncovers important geographical inequalities that are ignored by a unidimensional approach.

Geography of absolute social mobility: a unidimensional description

Figure 1 presents the departmental variations of absolute immobility: the share of individuals having the same position than their father. The figure shows relatively modest spatial disparities: in some areas, absolute immobility goes up to 36% while it is between 27% and 30% in the most mobile departments. The map reveals an important geographic opposition: the north and north-east being the most immobile regions, whereas departments of the south are often more mobile. The north and the north-east are blue-collar regions that have seen an important rise in unemployment in the last decades, which may explain their stronger social immobility.

Figure 1 Regional variations of absolute immobility



Note: The different colors indicate four groups of departments, defined according to the quartiles of the distribution

Table 3 provides correlation coefficients between the shares of immobility in a department, the share of upward mobility, and our socioeconomic indicators. The correlations between the socioeconomic indicators and immobility are rather weak. The most important one is the negative association between the share of undergraduate and immobility (-0.29) and then the positive association between unemployment and immobility (0.28). The correlations with inequality indicators are almost null. While the former correlation may indicate that regions with a higher share of individuals with some tertiary education are more prone to mobility, the latter may suggest that high economic insecurity limits mobility chances.

Table 3 Immobility, upward mobility and economic factors

	% Immobility	% Upward mobility
% Immobility	1	-0.15
% Upward mobility	-0.15	1
GDP	0.14	0.60
% High School	0.17	-0.57
% Undergraduate	-0.29	0.31
% Postgraduate	-0.05	0.57
Unemployment	0.28	0.29
Density	0.02	0 .44
Urbanization	-0.10	0.75
Inequality	0	0.52
Class inequality	0.09	-0.19

The correlations are stronger between the socioeconomic characteristics and upward mobility. Upward mobility is positively correlated with GDP (0.60), urbanization (0.75), and the share of postgraduates (0.57), while it is negatively correlated to the share of only high school graduates (-0.57). Upward mobility is positively correlated to the level of inequality (0.52), but negatively to class inequality (-0.19). An important part of upward mobility implies moving to the class of managers and professionals, which may explain the positive correlation between the rate of upward mobility in a department with its GDP and with residents' education. Also, in richer departments, there are more inequalities (see table 1 in *Data & Methods*), which should explain the positive association between inequality and upward mobility. On the contrary, class inequality is not correlated with the GDP of the department. The negative correlation seems indeed to show that when barriers between classes are wider, upward mobility is more difficult.

These results provide a unidimensional picture of social mobility in France: immobility is more associated with the north of France and with territories displaying higher rates of unemployment. On the contrary, upward mobility is more frequent when people are born in richer and more urbanized areas, which are more unequal zones on average. We shall show how using multidimensional techniques will provide a more refined picture of France's geographical inequalities in absolute mobility.

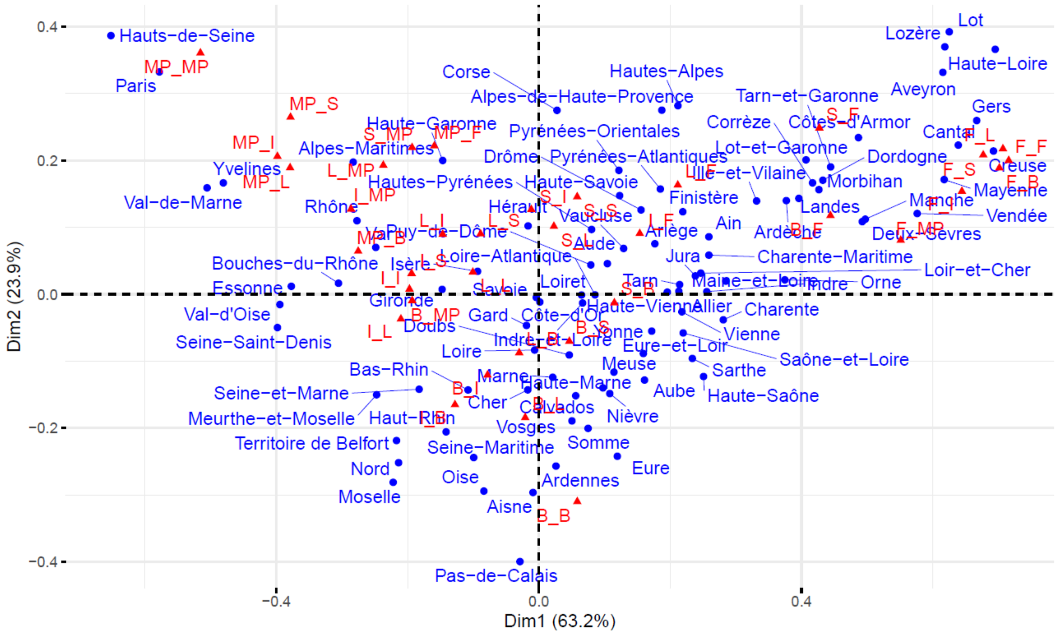
Geography of absolute social mobility: a multidimensional description

To describe all the absolute mobility flows between occupational groups, we performed a correspondence analysis (CA) on the frequency table crossing the department of origin and the 36 variables corresponding to the cells of the mobility table, i.e., the frequency in each origin-destination combination. The CA allows to project the categorical variables into a two-dimensional space, where the distance between points reflects the strength of their association. Categories positioned near each other share similar patterns, while those farther apart indicate little to no relationship (see *Data & Methods* section for more details).

Figure 2 presents the graphical result of the CA. Table 4 provides the correlations between the coordinates on the two first dimensions obtained by the CA and the socioeconomic characteristics of the departments[1]. A large part (87.1%) of the departmental variations in the mobility tables can be explained by only two factors. The first explains 63.2% of the variance and the second 23.9%. This first factor can be interpreted as opposing the rural departments to the richer urban departments, while the second factor opposes those two last types of departments to the urban blue-collar departments.

[1] The appendix also contains the correlation between the axes' coordinate and the distribution of social classes.

Figure 2 First two dimensions of a correspondence analysis on the social mobility table



Note: the letters in red represent the cells of the mobility table. The letter before the "_" is the origin, after it is the destination. L: Lower White Collar; MP: Manager-Professional; F: Farmers; S: Self-employed; B: Blue collar (Manual class); I: Intermediary occupations.

Table 4 Correlations between axes coordinates and socioeconomic characteristics of departments.

	Dimension 1	Dimension 2
GDP	-0.73	-0.17
% High School	0.58	-0.30
% Undergraduates	-0.27	0.23
% Postgraduates	-0.62	0.29
Unemployment	-0.34	-0.35
Density	-0.43	0.23
Urbanization	-0.79	-0.07
Inequality	-0.59	0.15
Class inequality	0.12	-0.11

At the top right of the figure, all variables describing the mobility table correspond to mobility from or toward the class of farmers. These departments are therefore characterized not only by a strong reproduction of farmers, but also by more significant flux into and out of this category compared to other departments. Those departments are rural regions such as Lot, Lozère, Gers, Aveyron, Haute-Loire, or

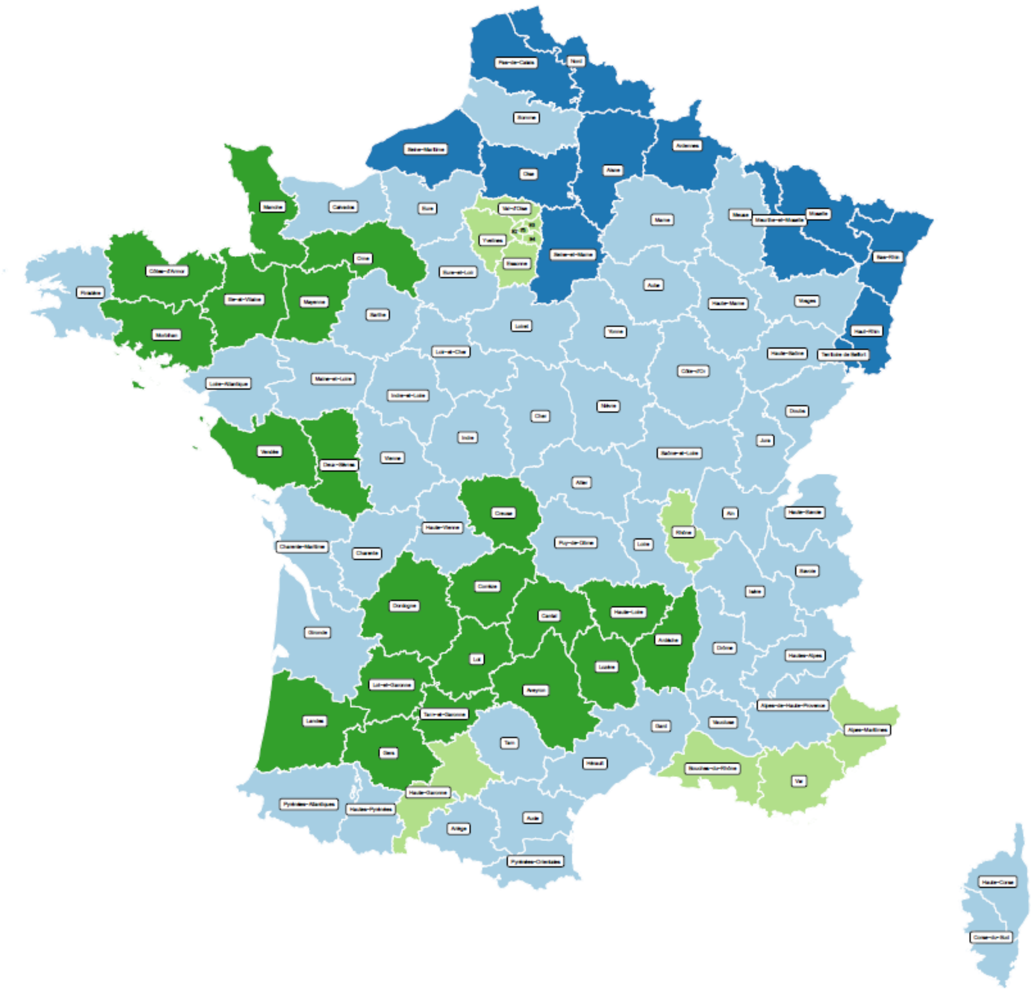
Cantal. In these regions, the importance of the class of farmers implies that children of farmers have more chances to stay in this class, but also that people from different origins can become farmers.

In the left part of the plot and therefore opposed to the farming regions, we find the richest regions of France: Paris and the departments around Paris (Hauts-de-Seine, Yvelines, Val-de-Marne), as well as the departments containing France's main cities: Rhône (Lyon), Haute-Garonne (Toulouse), Alpes-Maritimes (Nice), and Bouches-du-Rhône (Marseille). Those departments are characterized by the importance of the social reproduction of the class of managers and professionals, but also by all the flows from and toward this class. The position of the department on the first axis strongly correlates with its urbanization (-0.79), but also its GDP (-0.73), and to a lesser extent to its density (-0.43). It is also positively correlated to the share of farmers and negatively correlated to the share of all the other classes (*see appendix*).

The vertical axis (from the top of the graphics to the bottom) opposes the farmer departments (top) and the urban richer departments (top) that we already described to the northern and eastern regions (bottom), such as Nord, Moselle, and Pas-de-Calais. The variables that are the most correlated to this second axis are those that describe blue-collars flows and particularly the reproduction of blue-collars. The second dimension identifies therefore urban regions which are characterized by a higher proportion of blue-collars and to a lesser extent of intermediary occupations. Unemployment is this time the most correlated socioeconomic variable (-0.35), whereas GDP is much less correlated than with the first dimension (-0.17). The share of high school graduates is negatively correlated (-0.30), whereas the share of postgraduates (0.29) is positively correlated. Inequality is positively correlated (0.15) whereas class inequality is negatively correlated (-0.11), which means that the blue-collars regions are those with more unemployment and a little more class inequality, but a little less individual inequality.

To provide a geographical representation of the multidimensionality of the variation of absolute mobility, we performed a cluster analysis based on the proximity between the departments on the first five dimensions of the correspondence analysis. We incorporate therefore more information than the previous analysis that was limited to the two most important dimensions. We obtained four clusters, as depicted in Figure 3.

Figure 3 Map of the different clusters



Compared to Figure 1, Figure 3 shows how a multidimensional approach to social mobility gives a different picture than a unidimensional one. It reveals that different types of mobility correspond to different and identifiable geographical areas of France. The first cluster in dark green corresponds to the departments with a greater immobility of farmers and the greater mobility from and towards this class. This corresponds to the center of France and to the west. The second cluster (in light green) corresponds to the richest departments and mobility from and toward the category of Managers and Professionals: Paris, its regions, and regions containing France's big cities: Rhone (Lyon), Haute-Garonne (Toulouse), Bouches-du-Rhône (Marseille), Var (Toulon), and Alpes-Maritimes (Nice). The dark blue cluster reflects the historically industrial regions of the North and East, which have experienced significant deindustrialization in recent decades. The last cluster, in light blue, corresponds to more intermediate situations between those three clusters.

Rather than simply contrasting more and less mobile departments, our analysis identified different types of departments characterized by different mobility tables. We obtained three main department types—Industrial Blue-Collar, Managers and Professionals, and Farmers—which serve as ideal types. This means that most departments fall somewhere along a spectrum relative to these categories, even though most departments exhibit a mix of social classes.

Those results describe absolute mobility and, for a large part, can be explained by the distribution of the social classes in each department and do not necessarily imply a geographical variation of the intrinsic association between origin and destination (social fluidity). It means, for example, that departments with more farmer immobility are departments in which there are, on average, more farmers, but not necessarily that in those departments farmers' children would have more chances to become farmers than children from other social classes. The results describe thus general inequalities between territories, particularly the fact that the distribution of social class in France varies by departments and therefore departments have distinct mobility flows. It means that social destiny strongly depends on the department of birth, but this seems to be true for all social origins. We shall now investigate social fluidity and therefore the inequality between the different classes of origin.

Geography of social fluidity: a unidimensional description

To test whether social fluidity varies by department, Table 5 provides the fit indices for two log-linear models: a common flux model and the Unidiff model. The first one supposes that there is no variation of the association between origin and position between departments, whereas the second one adds one parameter by department to account for those variations. The model assumes that the association varies uniformly.

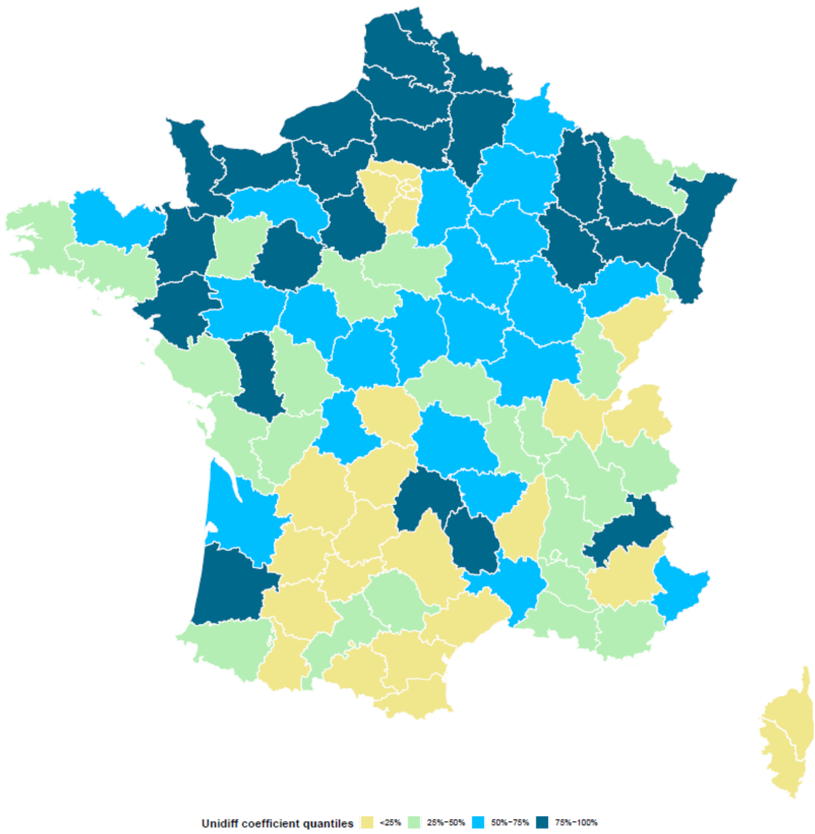
Table 5 Fit indices, models of social fluidity

	Dissimilarity index	LL	BIC
Common flux	2.84	10214	48,938
Unidiff	2.59	9,012	49,125

The Unidiff model provides a slightly better fit. The dissimilarity index reveals that 2.84% of individuals would need to be redistributed to match the observed frequencies when using the predicted frequencies from the common flux model. In contrast, 2.59% would need to be displaced when applying the Unidiff model. The L^2, which quantifies the discrepancy between the observed data and the model's predictions, is reduced by a factor of 12% when using the Unidiff model compared to the common flux model. The number of parameters increases significantly with the Unidiff model, which mechanically leads to a substantial improvement in fit. However, the Bayesian Information Criterion (BIC), which accounts for the number of parameters and favors more parsimonious models, very slightly increases. This indicates that the Unidiff model has almost the same balance between model fit and complexity than the common flux model.

The layer coefficient from the Unidiff model is the most common measure of the statistical association between the father's social class and the child's one. It is generally used to compare different countries or different generations. To inspect the Unidiff coefficients associated with each department, Figure 4 provides a map of the geographical variations of the Unidiff coefficient.

Figure 4 Regional variations of Unidiff coefficient



Note: The different colors indicate four groups of departments, defined according to the quartiles of the distribution

The map shows that, compared to the geographical distribution of absolute mobility, departments seem to be less geographically clustered in terms of their propensity to social fluidity. That said, the main result remains the same: northern and eastern regions are among the most unequal territories. However, Paris and very close regions around Paris are among the most fluid, which was not the case for absolute mobility.

Table 6 provides the correlation coefficients between the Unidiff coefficient and the two previous measures of social mobility (absolute immobility rate and upward mobility rate). Geographical variations of social fluidity and social mobility are somewhat similar, the correlation coefficient between the two indicators being 0.62, indicates that the higher the class immobility in absolute terms in a given department, the higher the strength of the association between Origin and Destiny. The correlation between the Unidiff and the upward mobility rate is weaker but non-negligible (-0.33), suggesting that departments that display lower social fluidity are also less upwardly mobile.

Table 6 Social fluidity and absolute mobility

	Immobility	Upward mobility
Immobility	1	
Upward mobility	-0.15	1
Unidiff	0.62	-0.33

Correlation coefficients between indicators measured at the department's level.

Table 7 presents the correlation coefficients between the Unidiff coefficients and the socioeconomic characteristics of the departments. The correlations are rather weak, but they suggest a trend: postgraduate education rate is associated with lower Unidiff values and therefore more fluidity. This aligns with the idea that access to higher education serves as a great equalizer in society. When it comes to testing the Great Gatsby curve, our findings differ according to the measure of inequalities. When inequality is defined by the Gini coefficient, the Great Gatsby curve does not hold in geographical terms, as more unequal departments appear to be also more socially fluid. However, when inequality is defined in terms of the social distance between class, we observe that the higher the class inequalities, the lower is the level of fluidity in a given department. Though this last result is not very strong, it goes in the same direction as previous research (Hertel, Groh-Samberg, 2019; Granström, Engzell, 2023).

Table 7 Correlation between economic characteristics and social fluidity

	Unidiff
GDP	0.07
High school	0.19
Undergraduate (%)	-0.07
Postgraduate (%)	-0.21
Unemployment	0
Urbanization	-0.17
Density	-0.25
Inequality (Gini)	-0.15
Class inequality	0.20

The good fit of the common flux model suggested that there is a similar fluidity between departments. Even though the Unidiff model somewhat improves the results compared to the simpler common flux model, the improvement does not seem substantial. This may be interpreted in two ways. We may be tempted to conclude that there are no strong differences between departments in terms of social fluidity.

Another possibility is that the differences between the departments are not well represented by the Unidiff model that assumes uniform differences and therefore describes only differences between the overall degree of fluidity. Significant differences may exist between departments, even when the overall degree of social fluidity remains similar. For example, if the inheritance of the farmer class is particularly strong in a given department, while the inheritance of the managerial and professional class is weaker than average, the overall level of inheritance may not differ significantly from that of other departments. More generally, multidimensional differences can offset each other, making them less visible when measured on a single-dimensional scale. We will explore this hypothesis in the following section.

Geography of social fluidity: a multidimensional description

As described in the *Data & Method*s section, we have estimated for each department a topological model similar to the core fluidity model. We obtained for each department a set of parameters describing the strength of each class inheritance and of the two types of fluidity, upward and downward. We will examine the extent to which the inheritance of each class and the two different types of fluidity are correlated to one another: for example, when the inheritance of one class is strong in one department, does it tend to be the same for the inheritance in other classes?

To conduct such an analysis, we have performed a Principal Component Analysis (PCA) on the 8 variables describing the inheritance of each social class, the two different types of social fluidity, and the socioeconomic factors. The PCA allows us to visualize and summarize the correlations between our 17 variables (see appendix for the correlation matrix). It summarizes the information into a limited number of dimensions or components that are linear combinations of the original variables. It also allows for convenient visualization by producing a figure in which the angle between two variables (represented by arrows) corresponds to their correlation. The more acute the angle, the stronger the positive correlation, the more obtuse, the stronger the negative correlation.

Figure 5 represents the graph produced by the PCA using the first two components. Variables measuring the socioeconomic characteristics of the departments are introduced as supplementary variables. It means that they do not contribute to the construction of the components but are only projected on the graph. Table 8 provides the correlations between the position of the department on each component and the socioeconomic characteristics of the departments.

Figure 5 PCA on the dimensions of social fluidity (Components 1 & 2)

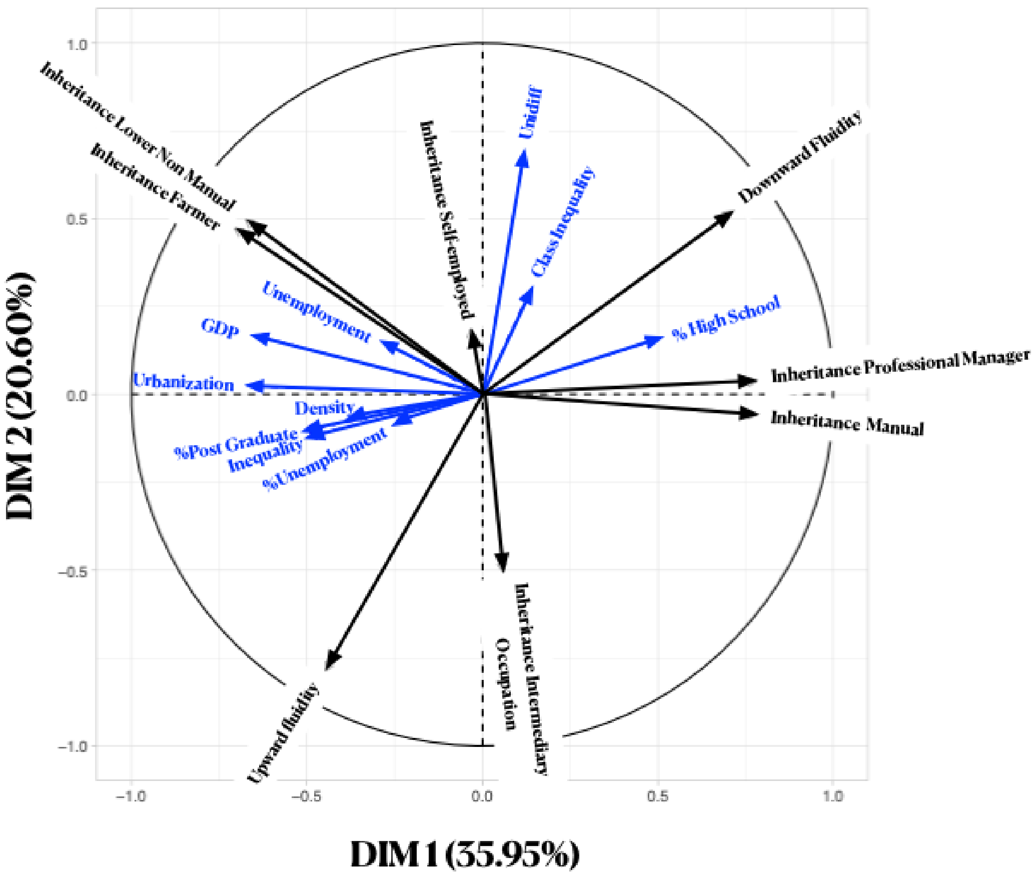


Table 8 Correlation between socioeconomic variables and components' coordinates.

	Dim.1	Dim.2	Dim.3	Dim.4
GDP	-0.59	0.04	0.08	0.24
Postgraduate degree (%)	-0.37	-0.12	0.17	0.09
Undergraduate degree (%)	-0.09	-0.07	0.32	0.19
Less than High school	0.32	0.17	-0.26	-0.12
Unemployment	-0.34	0.07	-0.09	0.06
Urbanization	-0.56	-0.08	0.17	0.08
Density	-0.29	-0.08	0.11	-0.02
Inequality (Gini)	-0.38	-0.21	0.11	0.02
Class inequality	0.06	0.31	-0.08	0.13

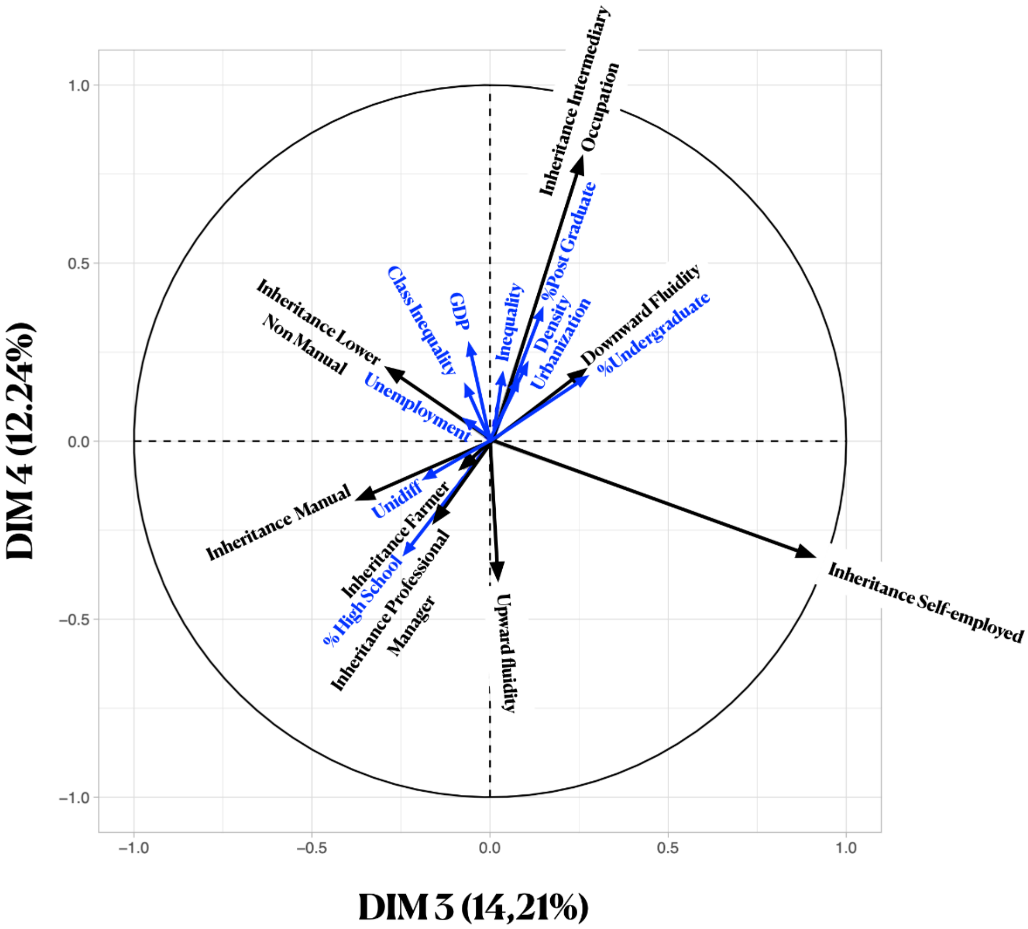
The first dimension or component that we obtain explains 36% of the variance between the indicators of social fluidity across departments. This first component (horizontal axis) synthesizes the positive association between the inheritance of managers and professionals and the inheritance of blue collars. This inheritance is opposed to the inheritance of the lower non-manual class and the farmers, showing that there is a negative association between these latter variables and the two first ones. The variables measuring the inheritance of the intermediary occupation and of self-employed occupations are almost orthogonal to the first factor, meaning that there is only little correlation between them and the other inheritances.

The position of the department on this first axis is negatively correlated to the GDP, the urbanization, and the density (see table 8). The axis opposes, therefore, rural areas on the right to richer urban areas on the left. The strength of the inheritance of the position of blue-collar and of manager and professional are therefore correlated to a lower GDP and to a lower urbanization. This is partly counter-intuitive and opposed to the results with absolute mobility, in which the reproduction of managers and professionals was stronger in richer areas. It suggests that more positions of managers and professionals in richer areas give more opportunity for everyone to attain those positions and not only to the children of managers and professionals, thus reducing the inequality of opportunity when it comes to accessing these positions. Conversely, poor and less urban regions seem to lead to more inheritance of the position of managers and professionals, but also of blue-collars.

The plot also reveals that the inheritance of farming occupations is more pronounced in regions with higher GDP and higher population density. This somewhat unexpected result may be due to the fact that in the departments that are mostly non-rural, individuals without farming origins have a very low chance of becoming farmers, contrary to more rural regions in which becoming a farmer is more frequent even without farming origins.

The second component (vertical) is made of the negative association between upward and downward fluidity. The inheritance of intermediary occupations is correlated to upward fluidity. Socioeconomic variables are much less correlated to this component. Figure 6 draws the third and fourth components of the PCA. The third dimension isolates the inheritance of self-employed, while the fourth one isolates the inheritance of intermediate occupations. The correlations with socioeconomic variables are also weaker here. The position on those axes is more correlated to the share of undergraduate degree than to the share of postgraduate degree (see table 8), which shows that they isolate more intermediary socioeconomic departments.

Figure 6 PCA on the dimensions of social fluidity (Components 3 & 4)



These two graphs reveal several key insights. Firstly, class inheritance is not a unidimensional phenomenon; otherwise, all the inheritance variables would have been pointing in the same direction. On the contrary, there are different kinds of inheritance, some being negatively correlated, others being orthogonal to one another. It means that the departments in which one has more chances to inherit a manager position are not the same as the departments in which one has more chances to inherit a lower white-collar position or an intermediary position, or, more obviously, a farmer position. Territories differ, therefore, not only in the strength of their social fluidity but also in the type of fluidity that prevails within them.

Secondly, downward and upward fluidity are not opposed to inheritance; their relation varies depending on the type of inheritance. One might have expected inheritance to conflict with fluidity overall, but the data reveal that departments with higher levels of inheritance are not necessarily less fluid on average. Additionally, downward and upward fluidity are negatively correlated, challenging the possibility of merging them into a single measure of general fluidity.

Thirdly, the socioeconomic indicators are more correlated to some dimensions than others. It shows that they are not associated with more or less fluidity, but with some particular kinds of fluidity and inheritance. In particular, the opposition between rural and richer areas is still the most important to understand geographical inequalities. Whereas the analysis of social mobility showed that there were more chances to be a manager in richer urban areas, the analysis of social fluidity showed less inequality to access to this position in richer areas.

Finally, the Unidiff coefficient is orthogonal to the first axis, which corresponds to the main opposition between the different types of inheritance. This reflects the synthetic character of the coefficient: because it is moderately correlated to the most opposed types of inheritance, it appears as orthogonal to this opposition. The second component shows that the Unidiff coefficient is also positively correlated to downward fluidity but negatively correlated to upward fluidity, and to the inheritance of intermediary occupation. It captures therefore quite well the most important dimensions of social fluidity. It remains however limited, because of the multidimensional nature of social fluidity: a similar degree of fluidity can correspond to quite different situations: a particular strength of the inheritance of the position of manager and professional, or on the contrary the strength of the inheritance of a lower non manual position, two phenomena that are negatively correlated.

Conclusion

The paper has provided an original way to analyze the geography of social mobility and of social fluidity in France. Instead of reducing them to a unidimensional measure to inspect the variations of their strength, we have proposed to shed light on their different types using a multidimensional approach. This is possible because we started from a class approach, which enabled us to distinguish different types of mobility and to assess whether the prevalence of these different types of mobility varies across departments.

We have identified an important heterogeneity between departments which is usually ignored when one focuses at the national level on the amount of absolute mobility or on the strength of the association between origin and destiny (relative mobility or social fluidity). The most important differences between absolute mobilities that emerged are between the rural territories, the urban blue-collar territories, and the higher white-collar territories. Those territories partly correspond to some localized geographical oppositions: higher white-collar territories correspond to France's biggest and richest cities, and blue-collar areas correspond mainly to northern and eastern France, even though there are also some blue-collar territories scattered through the country. Finally, the most rural parts of France correspond to a particular area between the center and the south-west and to a small part of the west in Brittany.

These results on absolute mobility shed light on the importance of the overall distribution of class positions in a birth region to account for variations in social destinies. They show that an individual's social destiny reflects the economic structure of her/his birth region. From a more technical point of view, they show that France's mobility tables vary depending on the region considered. That said, the analyses based on absolute mobility measures do not inform us on the variation of inequality of opportunity by departments since they strongly depend on the marginal distributions.

The analysis of social fluidity provided a slightly different picture of France, but which again emphasized the importance of multidimensionality. The literature on the mobility paradox has already shown that there are different types of fluidity, depending on the indicator of social position used. Our approach evidenced some shortcomings of looking for a general fluidity even within a class-based approach. We have shown that the different components of social class fluidity were far from correlated. When inheritance is weak for a particular class in a department, it is not necessarily the case for all classes, and, on the contrary, it can be particularly strong for some classes. Moreover, downward and upward fluidity were negatively correlated. A strong or weak general fluidity in a department can therefore hide very different situations: the particular strength of inheritance of some particular classes, a strong downward fluidity, or a strong upward fluidity.

Once we distinguish the different dimensions of social fluidity, we no longer expect these to display homogeneous relations with different socioeconomic factors. The role of the Urban/Rural division appeared as quite important, both in terms of social fluidity and absolute mobility. Being born in urban territories with a higher GDP and a higher access to postgraduate studies is positively correlated with a lower inequality of access to the class of managers and professionals, but it is negatively correlated with a higher inheritance of the lower non manual class and the farmer class. On the contrary, more rural and less rich territories are characterized by a stronger inheritance of the manual class and the class of managers and rofessionals, as well as a stronger downward fluidity. The strength of the inheritance of an intermediary occupation on a territory is not correlated with this Urban/Rural distinction or with the GDP.

Our results also confirmed that the relation between inequality and mobility is more complex than the one predicted by the Great Gatsby Curve. Like Granström and Engzell (2023), we found a regional confirmation of the thesis that Hertel and Groh-Samberg (2019) formulated at the national level: there is negative correlation between social class fluidity and class inequalities (rather than individual inequalities). We also found that class inequalities were positively correlated with downward fluidity, whereas they were negatively correlated with upward fluidity. Finally, we found that there was a positive correlation between individual inequalities and social fluidity. This last result can be explained by the fact that there are more individual inequalities in richer departments, which are also departments with more social fluidity and more upward mobility.

Our results highlight the importance of geographical variations of both social mobility and fluidity. Those variations can appear as modest, when one focuses on the total strength of social fluidity or unidimensional measures of social mobility. However, our results show that the prevalence of different types of mobility and fluidity varies by departments. It means that behind the aggregated national level of social fluidity, there is a heterogeneity of inequalities. Understanding the importance and specificity of the regimes of mobility and fluidity at a more fine-grained geographical level allows one to better understand a given society, its internal fractures and oppositions.

References

Ballarino, G., & Panichella, N. (2021). Social origins, geographical mobility and occupational attainment in contemporary Italy. *Genus*, 77(1), 3.

Berger, T., & Engzell, P. (2022). Industrial automation and intergenerational income mobility in the United States. *Social Science Research*, 104, 102686.

Björklund, A., & Jäntti, M. (1999). Intergenerational mobility of socio-economic status in comparative perspective. Social Policy Research Centre, University of New South Wales.

Breen, R. (Ed.), 2004. *Social mobility in Europe*. Oxford University Press, Oxford.

Breen, R., In, J. (2024). Does it matter where you're from? Geographical variation in social mobility in Britain. *European Sociological Review*, jcae046.

Breen, R., Jonsson, J. O. (2005). Inequality of opportunity in comparative perspective: Recent research on educational attainment and social mobility. *Annu. Rev. Sociol.*, 31(1), 223-243.

Breen, R., Luijkx R., 2004. "Social mobility in Europe between 1070 and 2000", in Breen, R. (Ed.), 2004. *Social mobility in Europe*. Oxford University Press, Oxford.

Breen, R., Mood, C., & Jonsson, J. O. (2016). How much scope for a mobility paradox? The relationship between social and income mobility in Sweden. *Sociological Science*, 3, 39.

Breen, R., & Müller, W. (2020). Education and intergenerational social mobility in Europe and the United States. Stanford University Press.

Bukodi, E., & Goldthorpe, J. H. (2021). 'Primary' factors in intergenerational class mobility in Europe: results from the application of a topological model. *European Sociological Review*, 37(1), 1-17.

Chetty R., Hendren N., Kline P., Saez E., 2014. "Where is the land of opportunity? The geography of intergenerational mobility in the United States." *The Quarterly Journal of Economics*, 129(4), 1553-1623.

Dherbécourt C., 2015, "La géographie de l'ascenseur social français", *Document de travail France Stratégie*, Vol. 6.

Erikson R., Goldthorpe, J. H., 1992. *The constant flux: A study of class mobility in industrial societies*. Oxford University Press.

Featherman, D. L., Jones, F. L., & Hauser, R. M. (1975). Assumptions of social mobility research in the US: The case of occupational status. *Social science research*, 4(4), 329-360.

Granström, O., & Engzell, P. (2023). The geography of intergenerational mobility in Europe. SocArXiv Papers. Ithaca, NY.

Grusky, D. B., & Hauser, R. M. (1984). Comparative social mobility revisited: models of convergence and divergence in 16 countries. *American Sociological Review*, 19-38.

Hertel, F. R., & Groh-Samberg, O. (2019). The relation between inequality and intergenerational class mobility in 39 countries. *American Sociological Review*, 84(6), 1099-1133.

Kenedi, G., & Sirugue, L. (2023). Intergenerational income mobility in France: A comparative and geographic analysis. *Journal of Public Economics*, 226, 104974.

Knigge, A., Maas, I., Van Leeuwen, M. H., & Mandemakers, K. (2014). Status attainment of siblings during modernization. *American sociological review*, 79(3), 549-574.

Ganzeboom, H. B., Luijkx, R., Treiman D. (1989). Intergenerational Class Mobility In Comparative Perspective. *Research in social Stratification and Mobility*, 8, 3-84.

Lindemann K., Gangl M., 2019. "Parental unemployment and the transition to vocational training in Germany: interaction of household and regional sources of disadvantage." *European Sociological Review*, 35(5), 684-700.

Lippényi, Z., Maas, I., & Van Leeuwen, M. H. (2015). Modernization and social fluidity in Hungary, 1870–1950. *European Sociological Review*, 31(1), 103-114.

Lipset, S. M., & Zetterberg, H. L. (1959). *Social mobility in industrial societies*. Berkeley: University of California Press.

Morris, K. (2023). Where DESO Disappears: Spatial inequality and social stratification at labour market entry. *European Sociological Review*, 39(1), 85-103.

Torche, F. (2015). Intergenerational mobility and equality of opportunity. *European Journal of Sociology/Archives Européennes de Sociologie*, 56(3), 343-371.

Treiman, D. J. (1970). Industrialization and social stratification. *Sociological inquiry*, 40(2), 207-234.

Vallet, L. A. (1999). Quarante annees de mobilite sociale en France: L'evolution de la fluidite sociale a la lumiere de modeles recents. *Revue française de sociologie*, 5-64.

Vallet, L. A. (2017). Mobilité entre générations et fluidité sociale en France: Le rôle de l'éducation 1. *Revue de l'OFCE*, (1), 27-67.

van de Werfhorst, H. G. (2024). Is Meritocracy Not So Bad After All? Educational Expansion and Intergenerational Mobility in 40 Countries. *American Sociological Review*, 00031224241292352.

Zhou, X., & Xie, Y. (2019). Market transition, industrialization, and social mobility trends in postrevolution China. *American Journal of Sociology*, 124(6), 1810-1847.

Zwysen, W., 2016. "Crowding out of disadvantaged young adults in Germany: background matters depending on local labour market." *European Sociological Review*, 32(5), 662-674.

Appendix

Table A1 Correlations between axes coordinates and class distribution in the department.

	Dimension 1	Dimension 2
% Farmers	0.59	0.08
% Managers and Professionals	-0.68	0.11
% Lower white collar	-0.71	-0.23
% Self employed	-0.61	-0.09
% Blue collar	-0.53	-0.50
% Intermediary class	-0.73	-0.19

Table A2 Correlation coefficients between class inheritances, downward and upward fluidity

	Farmer	**Self-employed**	**Manager, Professional**	**Intermediate**	**Lower Non manual**	**Manual**	**Upward fluid.**	**Downward fluid.**
Farmer	1.00							
Self-employed	0.07	1.00						
Managers, Professionals	-0.47	-0.04	1.00					
Intermediate	-0.28	-0.06	-0.09	1.00				
Lower non-manual	0.60	-0.09	-0.44	-0.18	1.00			
Manual	-0.47	-0.22	0.65	-0.06	-0.44	1.00		
Upward fluid.	0	-0.02	-0.28	0.10	-0.16	-0.28	1.00	
Downward fluid.	-0.31	0.16	0.40	-0.07	-0.33	0.38	-0.74	1.00
Unidiff	0.38	0.07	0.32	-0.37	0.34	0.22	-0.54	0.29

Table A3 Correlation coefficients between indicators of social fluidity and socioeconomic factors.

	GDP	Postgraduate degree (%)	Undergraduate degree (%)	Less than High school	Unemployment	Urbanization	Density	Inequality (Gini)	Class inequality
Farmer	0.61	0.26	0.19	-0.25	0.18	0.48	0.18	0.30	0.05
Self-employed	-0.15	-0.04	0.11	-0.03	0.03	-0.05	-0.01	-0.09	0.05
Managers, Professionals	-0.49	-0.46	-0.32	0.48	-0.21	-0.62	-0.33	-0.34	0.10
Intermediate	0.07	0.31	0.23	-0.32	-0.05	0.05	0.17	0.17	-0.07
Lower non-manual	0.49	0.28	-0.07	-0.17	0.38	0.36	0.22	0.26	0.03
Manual	-0.62	-0.60	-0.41	0.61	-0.15	-0.66	-0.42	-0.55	-0.02
Upward fluidity	0.11	0.19	0.12	-0.23	-0.06	0.24	0.14	0.26	-0.32
Downward fluidity	-0.25	-0.27	-0.01	0.26	-0.22	-0.31	-0.21	-0.34	0.32