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# The dynamics of school-to-work transition processes of university graduates: an analysis of French data

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ABSTRACT *Understanding the dynamics of school-to-work transition processes is of major interest for individuals involved in these processes, for guidance and counselling institutions, and for education policy. This knowledge is particularly important in order to assess the relevance of education inequality correction policies implemented in most countries of the European Union. On the basis of surveys of the school-to-work transition of university graduates conducted in France, this article demonstrates that transitional processes are governed by various dynamics (chaotic, determinist and stochastic). The article concludes that individual strategy and public policy as well as guidance and counselling should be adapted according to the nature of the transitional processes in which individuals are involved.*

## Introduction

The dynamics of school-to-work transition processes are of major interest for individuals involved in transitional processes, for guidance institutions, and for education policy making. First of all, for young people starting to think about their school-to-work transition, the question is knowing whether there is a need to devise a strategy or not. In other words, is defining and implementing a coherent action plan towards a precise vocational goal a necessary and sufficient condition to perform one's transitional process successfully? Obviously, all depends on the nature of the dynamics of the transitional process. If the process is *determinist*, initial conditions (for example, social origin, gender, educational institution, qualification obtained) determine precisely the vocational position: given initial conditions, an individual will necessarily reach a precise vocational position, and carry out certain type of functions associated with a certain wage level and a certain status. Therefore, an individual A, wishing to reach the same vocational position as an individual B, will be entitled to be a strategist, i.e. to seek to place himself/herself in the same initial education and training conditions (qualification, institution, etc.) as individual B. On the contrary, if school-to-work transition processes are *chaotic*, strategy becomes of no use: there is no guarantee that the same causes will produce the same effects. In this case, despite

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the similarity of their initial conditions, two individuals may well experience divergent trajectories.

The question is important for institutions of guidance and counselling too. Counselling individuals involved in transitional processes implies having an idea of which processes are determinist, and which are chaotic; where chance plays and where it does not; in which curricula strategy makes sense; and which qualifications allow us to anticipate, with some certainty, the end of the transitional process. *A priori*, there is no reason for all school-to-work transition processes to obey the same uniform dynamics. It seems more realistic to expect the dynamics of transitional processes to differ, for example, according to educational institution attended, to training level, to educational and vocational speciality, or according to the conditions of the labour market. Therefore, knowing the *cartography of dynamics*, their respective influence zones, and their intensity, is of the greatest interest for school and vocational guidance and counselling.

Knowledge of the nature of the dynamics of school-to-work transition processes is important for education policy too. In the European Union, different countries, such as Denmark, Sweden, Finland, Italy, Spain, Greece or Portugal, give major importance, in their education policies, to the objective of harmonising the conditions in which young people receive education and training. In France particularly, several reforms have, for a long time, organised the harmonisation of education conditions. From primary school to higher education, the functioning of institutions, the recruitment and assessment of teachers, the programme contents, the assessment of pupils and student knowledge, and the granting of degrees obey rules centrally defined for the whole national territory. When geographic or social disparities appear, corrective policies are implemented, particularly through positive discrimination policies. For example, in 1981 priority education zones (*Zones d'éducation prioritaires*) were created. These zones are geographic areas where the concentration of economically and culturally disadvantaged people justifies the award of additional material and human educational means. Even in the United Kingdom, where the education system is traditionally far more decentralised, education policy comprises elements of harmonisation (for instance, the national curriculum or comprehensive schools) and measures of inequality correction (Education Action Zones, analysed for example, by Gewirtz & Power, 2001).

All these policies are founded on one common idea, namely, that as soon as young people are in the same education and training conditions, they have the same chances to reach the same set of vocational positions. Of course, the intention of these policies is not that all young people have identical jobs. Their objective is that young people have equal opportunity to reach positions which, though various, belong to the *set of jobs generally considered as worthwhile in the society*. In these policies, identical conditions are supposed to generate equal probability. However that may be, the important thing is that actually, identical conditions and equal probability can lead to the same set of positions only if transitional processes are *determinist* or *stochastic*. It is no longer the case if transitional processes are structurally *chaotic*.

Of course, the issue of determinism in the field of school-to-work transition has already been studied. Authors such as Bourdieu and Passeron (1977, 1979), and

Boudon (1981, 1982), have shown how factors such as social origin, gender, and qualifications, influence educational and vocational trajectories. But the systematic analysis of the dynamics within transitional processes has not yet been studied. This is the objective of this article.

The first part of the article presents a general method for the systematic analysis of the dynamics within school-to-work transition processes. In the second part, this method is applied to data from a survey. This application is intended to illustrate how the method works. The third part is devoted to a comparison between the results of this first application and the results of the analysis of two other surveys. Some general observations can thus be drawn. Next, some methodological guidelines for using the technique and interpreting its results are discussed. Finally, in conclusion, some limitations of the approach and its significance are discussed.

## Method

School-to-work transition processes are dynamic processes. Dynamic processes themselves may be split into four classes, according to two criteria: the *degree of chance* and the *degree of divergence* (Table 1).

The degree of chance is a criterion on the basis of which stochastic and determinist processes can be distinguished. Let us consider a variable $w$ (for example, wage). The process followed by this variable is *stochastic* when the relationship between the value of the variable at time $t$ (represented by $w_t$) and the value of the variable at time $t+1$ (represented by $w_{t+1}$) is defined only in probability, i.e. with some uncertainty, implying a risk of error [1, 2]. The process is *determinist* in the opposite case, i.e. when the relationship between $w_t$ and $w_{t+1}$ is defined by an exact law, without uncertainty [3].

The degree of divergence allows us to distinguish between chaotic and non-chaotic processes. A process is *chaotic* when a slight modification of initial conditions results in a considerable modification at the end of the process [4] (Stewart, 1997). In the opposite case, the process is not chaotic and can then be either *non-chaotic convergent* or *non-chaotic stable*. There is *non-chaotic convergence* if the perturbation created by the initial modification declines throughout the process [5]. There is *non-chaotic stability* if this perturbation remains exactly the same all along the process, without amplifying or decreasing. The degree of divergence between the reference path and the erroneous path (path with initial perturbation) can be measured using

TABLE 1. Dynamic processes

| | | *Degree of divergence* | |
|---|---|---|---|
| | | Chaotic processes | Non-chaotic processes |
| *Degree of chance* | Stochastic processes | Chaos-stochastic processes | Stochastic convergent and stochastic stable processes |
| | Determinist processes | Chaos-determinist processes | Purely determinist processes |

Lyapunov exponents (for example, Kiel & Elliott, 1996; McCaffrey *et al*., 1992; Peitgen *et al*., 1992). A Lyapunov exponent is a growth rate of the perturbation between the reference path and the erroneous path. This approach had not yet been applied to the field of school-to-work transition analysis. In this article, we compute the Lyapunov exponents on the basis of the gaps between individuals with regard to different variables of vocational inclusion.

The first stage consists of dividing the population of individuals involved in school-to-work transition processes into homogeneous groups. A group is homogeneous if all its members are in the *same initial conditions* at the beginning of the transitional process. For example, we can consider that a group is homogeneous if its members are of the same gender and have the same nationality, the same social origin, and the same qualifications, obtained at the same age in the same institution in the same year.

The second stage consists of identifying variables that will allow us to characterise the personal situations of the individuals in terms of vocational inclusion. For instance, these variables can be the wage, the term of the work contract, or the annual duration of work. We only take account of quantitative variables.

The third stage consists of characterising the situation of each individual in terms of each variable of vocational inclusion. Individuals' situations are observed and characterised during a period defined as the *transitional period*. For instance, the transitional period can be defined as the 3 years following obtaining the qualification and during which the individual makes his or her first steps in the labour market. Within this framework, gaps between individuals and consequently Lyapunov exponents can be computed. The technical appendix provides further details. Five main types of processes can be obtained.

The first type is the purely determinist process. In this type, with regard to the variable considered, all members of a group which are in identical situations at the beginning of the process will also be in identical situations at the end of the process. For example, all members of a group are recruited immediately after obtaining their qualification, and earn annual wages of equivalent amounts.

The second type is the stochastic convergent process. In this type, with regard to the variable considered, members of a group are in different situations at the beginning as well as at the end of the process, but the gap between situations tends to decrease. For example, some members first experience unemployment before being recruited. But once they are recruited, they earn the same wages as other members.

In the third type—the stochastic stable process—with regard to the variable considered, the members of a group are in different situations at the beginning as well as at the end of the process, and the gap between situations remains the same all along the process. For example, while the unemployed take different and less well-paid jobs, other members who were previously employed receive a pay rise.

The fourth type is the chaos-determinist process, in which, with regard to the variable considered, perfect identity within a group at the beginning and at each stage of the process ensures that members will be in identical or equivalent situations at the following stage. But the slightest difference at an early stage will result in a

considerable gap between individuals at the end of the process. For example, differences in hobbies or in marital status result in considerable gaps between the individuals' professional situations.

In the fifth type—the chaos-stochastic process—with regard to the variable considered, chance excludes any certainty that members will achieve equivalent outcomes, even if their situations at the beginning of the process were perfectly identical.

The application of this method to data from a survey will allow us to illustrate how it works.

## Application

Data used for this application came from a survey carried out in France by OURIP, the Rhône-Alpes District University Observatory of School-to-Work Transition.

The survey (Di Vito, 2002) was conducted from March to July 2000. A total of 6489 individuals were interviewed. These had to have been registered as students at least at Bachelor's degree level in economics or management in 1996–1997 in one of the following Rhône-Alpes District University: University of Grenoble 2, University of Lyon 2, University of Lyon 3, University of Savoy, or University of Saint-Étienne. From this population, we only retained the 430 French nationality respondents who were effectively in initial education (which excludes re-entry students) in 1996–1997, and who were effectively involved in a transitional process towards work during the observation period (which excludes individuals who remained economically inactive, particularly those who remained students). We excluded re-entry students in order to avoid any bias due to the influence of earlier work experience on vocational inclusion performance. The observation period was from July 1997 to March 2000.

In this population of 430 respondents, we distinguished 45 homogeneous groups, which constituted together a set of 110 individuals (25.58% of the studied population). These groups are small (two to five individuals) and their members have identical profiles. The survey provides information on about 15 criteria that characterise the initial profile of the individuals: year and speciality of secondary school-leaving certificate; date, level, speciality and institution of first registration in higher education and of first qualification obtained; nature of, number of and preparation conditions for any civil service examinations to which the respondent had been an applicant; study periods abroad; parents' professions; etc. Given the size of the studied population, to take into account all the criteria would lead to distinguishing as many initial situations as there are individuals, which would make it impossible to constitute groups and, *a fortiori*, to analyse the gaps within these groups. Therefore, we kept only six criteria of homogeneity for this analysis: gender; level and speciality of the highest qualification obtained; and institution, year and age at which the highest qualification was obtained. These conditions were sufficiently few to allow us to constitute groups. At the same time, they belonged to the set of

criteria most generally admitted as discriminating in school-to-work transition analysis (Stoeffler-Kern & Martinelli, 1998, pp. 74–75).

Concerning the situations at different dates, the survey provides information on the characteristics of the first job and of the job at the end of the observation period, but provides above all qualitative data: job title, socio-professional group, sector of economic activity of the firm, etc. Only two quantitative variables characterising the jobs are available: the net monthly wage and the duration of the work week. However, these two variables are sufficient to allow us to illustrate how the dynamics of school-to-work transition processes can be analysed using Lyapunov exponents. One can, for each of these two quantitative variables, compute the coefficient of variation within each homogeneous group during the first year and during the last year of the observation period. One can also compute the mean variation index of the coefficients of variation (the square root of the global variation index) and the Lyapunov exponent. Nevertheless, since the survey provides information only on situations at the beginning and at the end of the observation period, it does not allow us to exclude *pseudo-determinist processes*, i.e. processes in which the individuals' situations, though identical at the beginning as well as at the end of the process, may be different at intermediate dates. Table 2 presents the main results.

The Lyapunov exponents computed for the whole population of 430 persons indicated that the school-to-work transition processes of the Rhône-Alpes District University graduates in economics and management, involved in their first transitional process towards work from July 1997 to March 2000, are globally convergent. This convergence is observed in terms of net monthly wage ($\lambda = -0.172$) as well as in terms of duration of the work week ($\lambda = -0.84$). The fact that the Lyapunov exponents are negative means that the gaps between individuals' situations in terms of wage and duration of the work week have been globally decreasing all along the transitional process.

Considering more precisely the homogeneous groups, we first observe some chaos. Twelve among the 45 groups are characterised by a chaotic process in terms of wages. Chaos seems to affect especially groups of doctorate holders and groups of Master's degree graduates, which are involved in five of the six most chaotic processes. But, on the whole, the influence zone of chaos is confined: most of the processes are non-chaotic.

As for the non-chaotic processes, the dynamics differed according to the variable that is considered. In terms of wages, all non-chaotic processes suggest a stochastic dynamics: as small as the groups may be, there is no case of individuals being in identical situations not only at the beginning but also at the end of the period. Therefore, though the survey does not provide information on the situations at intermediate dates, we can reject any hypothesis of pure determinism. Furthermore, it appears that, in terms of wages, nearly all these non-chaotic transitional processes of the homogeneous population observed are *stochastic convergent*. In other words, these processes are not purely determinist but, in each group, the wage situations of the graduates are closer at the end of the transition than they were 3 years earlier.

On the contrary, in terms of duration of the work week, *pure determinism* predominates. First, we observe no chaotic process. Second, among the processes for

TABLE 2. Dynamics of school-to-work transition processes of economics and management students from Rhône-Alpes District Universities, July 1997–March 2000

| Groups | Homogeneity criteria | | | | | Size of groups | Lyapunov exponents | |
|---|---|---|---|---|---|---|---|---|
| | Sex | Age | Highest degree (speciality and level) | University | Year | | Net monthly wage ($\lambda_1$) | Duration of the work week ($\lambda_2$) |
| G1 | F | 27 | Doctorate in Economics | Grenoble 2 | 1997 | 2 | 1.851 | UD |
| G2 | F | 28 | Doctorate in Economics | Lyon 2 | 1997 | 2 | − 0.28 | Determinism |
| G3 | F | 23 | Master of Management | Grenoble 2 | 1997 | 4 | 0.092 | Determinism |
| G4 | F | 24 | Master of Management | Grenoble 2 | 1997 | 3 | − 0.37 | Determinism |
| G5 | F | 24 | Pre-doctoral Master of Management | Lyon 3 | 1997 | 2 | − 1.15 | UD |
| G6 | F | 23 | Specialised Master of Transport | Lyon 2 | 1997 | 2 | 0.65 | Determinism |
| G7 | F | 23 | Specialised Master of Economic Statistics | Lyon 2 | 1997 | 3 | − 0.05 | UD |
| G8 | F | 23 | Specialised Master of Marketing | Lyon 3 | 1997 | 2 | − 0.17 | Determinism |
| G9 | F | 23 | Specialised Master of Management | Grenoble 2 | 1997 | 5 | − 0.91 | − 1.38 |
| G10 | F | 23 | Specialised Master of Expertise[a] | Lyon 2 | 1997 | 2 | − 2.5 | UD |
| G11 | F | 23 | Specialised Master of Financial Audit | Grenoble 2 | 1997 | 2 | − 0.8 | Determinism |
| G12 | F | 24 | Specialised Master of Business Adm. | Lyon 3 | 1997 | 2 | UD | Determinism |
| G13 | F | 24 | Specialised Master of Asset Management | Lyon 3 | 1997 | 2 | − 0.11 | Determinism |
| G14 | F | 24 | Specialised Master of Economic Informatics | Lyon 2 | 1997 | 2 | − 0.35 | 0 |
| G15 | F | 24 | Specialised Master of Management | Grenoble 2 | 1997 | 2 | − 0.23 | Determinism |
| G16 | F | 24 | Specialised Master of Finance[b] | Lyon 2 | 1997 | 2 | 0.449 | Determinism |
| G17 | F | 24 | Specialised Master of Information Systems | Lyon 2 | 1997 | 3 | − 0.01 | Determinism |
| G18 | F | 25 | Specialised Master of Social Protection | Grenoble 2 | 1997 | 2 | 0.952 | Determinism |
| G19 | F | 22 | Short Master of Accounting | St-Étienne | 1997 | 2 | − 0.01 | UD |
| G20 | F | 22 | Short Master of Commerce | Chambéry | 1997 | 3 | 0.405 | UD |
| G21 | F | 22 | Short Master of Management | Lyon 3 | 1997 | 3 | − 0.53 | UD |
| G22 | F | 22 | Short Master of Economics | Grenoble 2 | 1997 | 3 | − 0.06 | Determinism |
| G23 | F | 22 | Short Master of Economics | Lyon 2 | 1997 | 2 | UD | Determinism |
| G24 | F | 23 | Short Master of Economics | Lyon 2 | 1997 | 3 | − 0.59 | UD |
| G25 | F | 23 | Short Master of Economics | Grenoble 2 | 1997 | 4 | 0.222 | 0 |
| G26 | F | 23 | Short Master of Management | St-Étienne | 1997 | 2 | 0.342 | Determinism |
| G27 | F | 23 | Short Master of Administration | Lyon 3 | 1996 | 2 | 0 | Determinism |
| G28 | F | 24 | Short Master of Commerce | Chambéry | 1997 | 2 | − 0.53 | UD |
| G29 | F | 24 | Short Master of Economics | Grenoble 2 | 1997 | 5 | − 0.59 | − 1.52 |
| G30 | F | 24 | Short Master of Economics | St-Étienne | 1997 | 3 | − 0.17 | Determinism |
| G31 | F | 25 | Bachelor of Economics | Grenoble 2 | 1996 | 2 | 0.16 | Determinism |

TABLE 2 (*Continued*)

| Groups | Homogeneity criteria | | | | | Size of groups | Lyapunov exponents | |
|---|---|---|---|---|---|---|---|---|
| | Sex | Age | Highest degree (speciality and level) | University | Year | | Net monthly wage ($\lambda_1$) | Duration of the work week ($\lambda_2$) |
| G32 | M | 31 | Doctorate in Economics | Grenoble 2 | 1997 | 2 | − 0.48 | 0 |
| G33 | M | 23 | Master of Management | Grenoble 2 | 1997 | 2 | − 0.48 | Determinism |
| G34 | M | 23 | Specialised Master of Business Adm. | Lyon 3 | 1997 | 3 | − 1.36 | UD |
| G35 | M | 24 | Specialised Master of Finance[b] | Lyon 2 | 1997 | 2 | UD | Determinism |
| G36 | M | 24 | Specialised Master of Management | Grenoble 2 | 1997 | 2 | − 1.35 | Determinism |
| G37 | M | 24 | Specialised Master of Management Control | Lyon 2 | 1997 | 2 | − 1.11 | UD |
| G38 | M | 24 | Specialised Master of International Trade | Grenoble 2 | 1997 | 2 | − 0.05 | Determinism |
| G39 | M | 24 | Specialised Master of Financial Audit | Grenoble 2 | 1997 | 2 | UD | Determinism |
| G40 | M | 26 | Specialised Master of Management | Lyon 3 | 1997 | 2 | 0.638 | Determinism |
| G41 | M | 22 | Short Master of Economics | Grenoble 2 | 1997 | 2 | − 0.08 | UD |
| G42 | M | 24 | Short Master of Commerce | Chambéry | 1997 | 3 | − 0.37 | 0 |
| G43 | M | 24 | Short Master of Economics | Lyon 2 | 1997 | 2 | 1.366 | Determinism |
| G44 | M | 25 | Short Master of Economics | Grenoble 2 | 1997 | 2 | UD | Determinism |
| G45 | M | 25 | Short Master of Commerce | Chambéry | 1997 | 2 | 0.297 | Determinism |
| Total of 45 groups | | | | | | 110 | − 0.193 | − 0.60 |
| Total of persons outside groups | | | | | | 320 | − 0.170 | − 0.88 |
| Total population in first transitional process | | | | | | 430 | − 0.172 | − 0.84 |

UD: Unavailable data.
Determinism: including possible *pseudo-determinist* processes.
Short Master: one year after bachelor's degree.
Specialised Master: for a career in business or administration.
Pre-doctoral Master: for an academic career.
[a]In employment and school-to-work transition analysis.
[b]Financial markets organisation and control.

which data are available, in more than four cases out of five, individuals' situations are identical both at the beginning and at the end of the observation period. We observe only five *stochastic convergent* processes. However, the determinism thus observed is not linked to the academic specialities of the studied population. This determinism results from the fact that in the labour market, firms as well as labour suppliers generally prefer full-time contracts. In France, up to the year 2000, the legal duration of the work week for full-time wage-earners was 39 hours. For this reason, the positions occupied by the population in this survey are generally associated with a 39-hour work week, at the beginning as well as at the end of the observation period.

A particular situation is that in which the gap between individuals is exactly the same at the beginning and at the end of the observation period. In these cases, the Lyapunov exponent equals zero. It is the case for variable wage for group 27, and for variable duration of the work week for groups 14, 25, 32 and 42. In these five cases, the processes are non-chaotic and *stochastic stable*.

## Observations

These results can be compared with those from the analysis of two other surveys conducted in France: the Biology Survey published by OURIP in 2000; and the Survey of 1994–1995 Graduates from University of Lille 1. The latter was published in 2001 by the Observatory for Training and Professional Integration (OFIP).

The Biology Survey of OURIP (Dizin, 2000) allowed us to analyse, with the same method, the dynamics of school-to-work transition processes of 235 graduates who obtained a degree in biology (from bachelor level up to doctorate level) in 1994 and 1995 in three Rhône-Alpes District Universities: University of Lyon 1, University of Grenoble 1 and University of Saint-Étienne. These 235 graduates can be split into 61 homogeneous groups: six groups of doctorate holders, 34 of Master's degree graduates, and 21 of Bachelor's degree graduates. Lyapunov exponents can be calculated for the monthly net wage and for the duration of the work week.

Here too, the analysis shows that the area of chaos is confined: only seven groups have a chaotic process in terms of at least one variable. Among the non-chaotic processes, *stochastic convergence* predominates: 14 groups have a purely determinist process in terms of at least one variable; seven groups have a stochastic stable process in terms of at least one variable; and 35 groups have a stochastic convergent process in terms of at least one variable (20 groups have a stochastic convergent process for both variables).

In this survey too, chaos affects mainly the processes of doctorate holders groups: five of the seven groups having a chaotic process are composed of those with doctorates. On the contrary, we observe no chaotic process in the groups of Bachelor's degree graduates. Thus, it appears that in this mono-disciplinary population, the degree level provides a clear division line between chaos and non-chaos. This situation can be explained by the fact that, on the one hand, there is

much heterogeneity in the geographical and intellectual origins of students registered in doctoral studies. There is much heterogeneity in their doctorate specialities too. This heterogeneity may be a factor of trajectory divergence. On the other hand, students involved in Bachelor's degree studies generally come from the same neighbouring schools, apply for the same public teacher recruitment examinations, and become in most cases biology teachers, which is of course a factor of trajectory convergence.

The OFIP survey (Grivillers, 2001) allowed us to analyse the transitional process of 974 graduates who obtained their highest qualification at University of Lille 1 in 1994 and 1995. In this population, all degree levels from Bachelor's degree up to doctorate as well as engineers' degrees were represented. Most disciplines (mathematics, physics, chemistry, life sciences, human and social sciences) were represented too. A total of 330 of these 974 graduates can be distributed in homogeneous groups. We identified 109 homogeneous groups. Only one quantitative variable, the annual gross wage, is available. The Lyapunov exponent for the whole population of 974 graduates is positive ($\lambda = 0.0951$), which corresponds to intuition, given the heterogeneity of specialities and levels represented. However, convergence appears as soon as we take account of initial conditions: the exponent for the population distributed in homogeneous groups is negative ($\lambda = -0.0332$). Thus, we observe that, here too, as soon as we take into account initial conditions, the influence zone of chaos appears confined. Chaos was more frequent in some degrees (for example, Master's degree in international trade), and non-chaos in others (for example, Master's degree in mathematics or in computer science for management). In this pluri-disciplinary population, the dividing line between chaos and non-chaos seems to be determined by the speciality. Lastly, all non-chaotic processes observed were *stochastic convergent*: no purely determinist process and no stochastic stable process could be observed.

## Some methodological guidelines for using the technique and interpreting its results

Three issues will be addressed in this part of this article: the choice of grouping variables, the choice of dependent variables, and the timescale for observation.

### *The choice of grouping variables*

Groups are not made up of strictly identical individuals. In the field of transition dynamics analysis, the objective is not to make an exhaustive inventory of all possible criteria which could be used to differentiate individuals. On the contrary, we try to select and use a small set of criteria which we consider as essential to account for major differences between individuals with regard to school-to-work transition. Homogeneity means that members of a group are identical with regard to all these essential criteria simultaneously.

These criteria are not chosen arbitrarily. They are the main factors generally considered to influence school-to-work transition trajectories. In France, the interesting methodological research edited by Stoeffler-Kern and Martinelli, and published by the French Centre for Research on Education, Training and Employment (Céreq) in 1998, surveyed 130 studies of school-to-work transition in higher education at local and national levels. This research has shown that seven factors are generally recognised to be major determinants of school-to-work transition trajectories, and therefore are systematically taken into account in surveys and analyses. These factors are: gender, age, degree course, and the date, speciality, level and place of the highest qualification (pp. 74–75).

It is on the basis of these criteria that dynamics analysis must be conducted. On this basis, concluding that determinism (chaos) has been observed means that we observe identical (divergent) trajectories within a group of individuals who can be considered as similar from the viewpoint of the criteria generally admitted to be major determinants of differences in school-to-work transition trajectories.

This means that the choice of grouping variables must be consistent with what we know about transitional processes. For instance, it might be possible to find similarity in the standard of life, and determinism in the youth transition processes, among regular customers of a same holiday resort. Yet, holiday resort has not been so far generally recognised as a significant determinant of differences in school-to-work trajectories. Furthermore, a concept of determinism based on holiday resort homogeneity would not make sense from the viewpoint of what we know about school-to-work transition processes. Therefore, such 'dustbowl empiricism' should be avoided.

Of course, this is a relative conception of chaos and determinism, different from the absolute conception used in physics and mathematics. But this relative conception is more suitable for analysis in the social sciences. This implies that the set of homogeneity criteria used must be explicitly specified so that the precise meaning of the observed convergence and divergence can be understood. Then, given the set of homogeneity criteria adopted, and given the methodology defined, the results of analyses of a same set of data should not vary according to the researcher.

### *The choice of dependent variables*

With regard to dependent variables, all quantitative job dimensions that make sense for an individual involved in a transitional process should be surveyed. In this article, because of the lack of relevant variables in the available surveys, working time is used, but this is simply as an example, rather than being important in itself. In fact, it is clear that in France, working time is largely prescribed by law. Therefore, this variable is probably not the most suitable in this case. Working time would be more suitable in national contexts in which it is a matter for negotiation between employers and employees rather than a matter for law. In this sense, generally speaking, working time can be an adequate variable in this kind of analysis. Ideally, specific surveys

should be designed in order to collect data on adequate variables such as, for example, annual earned income including unemployment benefits, income support, as well as the term of the work contract (to measure the lack of job security). All these dimensions should be analysed as dependent variables. Because there is no reason for all dimensions having the same characteristics in terms of chaos or determinism, each dimension should be specifically characterised. This information should be given on demand, in career advice and in education policy. Thus, it appears that there is no choice of dependent variables to be analysed.

*The timescale for observing divergence or convergence*

The period of school-to-work transition is relatively short. Generally, it lasts 5 or 6 years at the most. Therefore, a 3-year observation period is enough to detect divergence, if it exists. Of course, ideally, surveys should gather data relating to a longer period, for instance, 5 years after the end of studies. However, the longer the observation period, the higher the risk that the individuals interviewed forget precise details about what their situation actually was throughout their transitional process. To avoid this, it is possible to re-interview individuals every year, but this is costly. Moreover, the longer the observation period, the higher the risk of attrition of the panel.

In addition, it should be stressed that one important objective of analysing the school-to-work transition processes of graduates is to contribute to career advice for current students. This presupposes that educational and economic conditions have not significantly changed since the graduates who were analysed were themselves studying. If this is so, the results obtained can be relevant and useful for current students. It is obvious that the longer the observation period, the higher the risk that significant changes occur in the education system and on the labour market. Therefore, excessively long observation periods (more than 5 or 6 years) would probably be irrelevant and should be avoided.

## Conclusion

This analysis is undoubtedly too partial to reach final conclusions. It needs to be continued and completed. Moreover, the small size of the populations on which the analysis is based restricts its scope to description, without any attempt to generalise for all populations involved in transitional processes. A more thorough analysis of dynamics will demand larger and more specific surveys, gathering all necessary information, especially information on individuals' situations at intermediate dates, information on all incomes (not only on wages), and information on all quantitative characteristics of jobs.

Another weakness of the method presented here is that it can be applied only to certain dimensions of jobs. Though salary or insecurity give information on important aspects of jobs, it would be interesting to know more about qualitative aspects of jobs. For example, are transition processes determinist, chaotic or

stochastic in terms of socio-professional group, signs of social success and social recognition in the working place, or employment quality? Because such variables are qualitative, they cannot easily be processed with the technique proposed here.

However, at this stage, the method which applies Lyapunov exponents to the analysis of school-to-work transition processes seems interesting in that it allows us to distinguish the influence zone of chaos and, outside this zone, the respective shares of pure determinism and of chance. Thus, we are able to observe that part of transition processes can be chaotic, part of them determinist, and another part at the same time neither chaotic nor determinist but stochastic.

Besides, this analysis suggests that, behind the generally considerable diversity in the positions occupied by university graduates—which sometimes creates an impression of trajectory indeterminacy—there can lie a lot of convergence. This convergence appears as soon as account is taken of initial conditions. The analysis suggests that even when no pure determinism is observed, school-to-work transition processes seem to bring individuals to work positions that become closer as time goes on.

In terms of guidance, counselling and career planning, purely determinist processes and stochastic convergent processes are particularly interesting. First, they would mean that individual strategies consisting of placing oneself in favourable initial conditions (to register in the 'good' institution, to obtain the 'good' qualification at the 'good' age, etc.) can be efficient. Secondly, they would also mean that public policies consisting of harmonising education and training conditions can be efficient. However, the efficiency of such individual strategies and public policies would become doubtful outside the field of pure determinism and stochastic convergence. Public policies especially would probably be inefficient and of no use if they are applied to specialities and levels that belong to the influence zone of chaos.

The approach presented here suggests that more attention should be paid to initial conditions in empirical analysis of school-to-work transition trajectories. This approach can be useful especially in career analysis. Moreover, since the results obtained here come from the French experience, it would be interesting to compare them with results obtained by applying the same method in other national contexts.

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## Notes

[1] The following notes as well as the technical appendix are not strictly necessary to understand the paper.

[2] For example:

$$w_{t+1} = \alpha_{p_i} w_t, \quad i \in \{1, 2, \cdots, n\}, \quad \alpha_{p_i} \geq 0, \quad 0 \leq p_i \leq 1, \quad \sum_{i=1}^{n} p_i = 1$$

where $\alpha_{p_i}$ is the index of wage variation between $t$ and $t+1$ if event $i$ happens, probability of event $i$ being $p_i$.

[3] For example: $w_{t+1} = 1,01 w_t$.

[4] For example, in: $w_{t+1} = 4w_t(1 - w_t), 0 < w_t < 1$.

[5] For example, in: $w_{t+1} = 3w_t(1 - w_t), 0 < w_t < 1$.

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## Appendix

Let us consider an homogeneous group of individuals involved in the school-to-work transition process. We characterise the situation of the individuals along the process in terms of variables describing *dimensions* of vocational inclusion, for example, wage, term of the work contract, duration of the work week, and so forth. Thus, at each date, the situation of an individual can be represented by a vector of the values taken by the variables for this individual at this date. For example, the situation of individual $A$ at date $t$ can be represented by a vector $\vec{v}_t^A$ such as:

$$\vec{v}_t^A = (y_{t1}^A, y_{t2}^A, \cdots, y_{tM}^A) \tag{1}$$

where $y_{tm}^{A}$ represents the value of dimension m for individual $A$ at date $t$, and $M$ the total number of dimensions considered.

In the same way, the situation of the $\mathcal{J}$ group members at date $t$ is represented by a matrix $y_t$ such as:

$$y_t = \begin{pmatrix} y_{t1}^{A} & y_{t2}^{A} & \cdots & y_{tM}^{A} \\ y_{t1}^{B} & y_{t2}^{B} & \cdots & y_{tM}^{B} \\ \vdots & \vdots & \vdots & \vdots \\ y_{t1}^{J} & y_{t2}^{J} & \cdots & y_{tM}^{J} \end{pmatrix} \tag{2}$$

For each dimension $m$, the gap between individuals at date $t$ is represented by the coefficient of variation of the values of dimension $m$ for the whole group. The coefficient of variation is defined as the standard deviation divided by the arithmetic mean. The use of the coefficient of variation makes it possible to compare distributions that do not have the same mean. In school-to-work transition processes, since the variables used (wages, duration of the contract, etc.) cannot be negative, and since standard deviation is always positive by definition, the coefficients of variation cannot subsequently be negative. The gaps between individuals for all dimensions at date $t$ are represented by a vector $\vec{c}_t$ such as:

$$\vec{c}_t = (c_{t1}, c_{t2}, \cdots, c_{tM}) \tag{3}$$

where $c_{tm}$ represents the coefficient of variation of the values of dimension $m$ for the whole group at date $t$.

We compute vector $\vec{c}_t$ for each date of the transition process. Thus, for the whole observation period, matrix $C$ synthesises the coefficients of variation of all dimensions:

$$C = \begin{pmatrix} \vec{c}_1 \\ \vec{c}_2 \\ \vdots \\ \vec{c}_T \end{pmatrix} = \begin{pmatrix} c_{11} & c_{12} & \cdots & c_{1M} \\ c_{21} & c_{22} & \cdots & c_{2M} \\ \vdots & \vdots & \vdots & \vdots \\ c_{T1} & c_{T2} & \cdots & c_{TM} \end{pmatrix} \tag{4}$$

Then, for each dimension, the average growth index of the coefficients of variation, and therefore the Lyapunov exponent, can be computed. For each dimension $m$, the Lyapunov exponent $\lambda_m$ is given by:

$$\lambda_m = \ln \left| \sqrt[T-1]{\frac{c_{Tm}}{c_{1m}}} \right| \tag{5}$$

The vector of Lyapunov exponents, $\vec{\lambda}$ such as:

$$\vec{\lambda} = (\lambda_1, \lambda_2, \cdots, \lambda_M) \tag{6}$$

summarises the results.

Lyapunov exponents are strictly positive when the gaps between individuals are growing all along the process, and strictly negative when the gaps are decreasing. An exponent equals zero when the gap is stable.

Therefore, in terms of a variable $m$, the school-to-work transition process is *chaotic* if the Lyapunov exponent is strictly positive, since the gap between individuals in terms of this variable is growing all along the process. In the opposite case, the process is not chaotic. Consequently, a process can be chaotic in terms of some variables, and not chaotic in terms of other variables. A chaotic process is *chaos-determinist* if it is governed by an exact law, and *chaos-stochastic* otherwise.

When a process is not chaotic, the question is to know whether this process is purely determinist or stochastic.

A non-chaotic process is *purely determinist* in terms of a variable if the standard deviation systematically equals zero for this variable whatever the date. In other words, at each date, all individuals are in identical situations as regards the variable considered. Since the standard deviation equals zero at the first date as well as at the last date, the Lyapunov exponent cannot be calculated. Therefore, if a non-chaotic process is purely determinist, the Lyapunov exponent cannot be calculated. The converse is not true: the fact that an exponent cannot be calculated is not sufficient to conclude that the process is purely determinist. Indeed, although there may be perfect identity between the individuals' situations at the first and at the last dates (which explains why the exponent may be not calculable), differences between the individuals' situations may exist at intermediate dates, and this cannot be called pure determinism. We describe as *pseudo-determinist* processes in which the individuals' situations are similar at the beginning and at the end, but not at intermediate dates. In this sense, the fact that an exponent is not calculable can reveal purely determinist processes as well as pseudo-determinist processes.

When the exponent is calculable, a non-chaotic process is *stochastic*, and can be either *stochastic stable* (the exponent equals zero) or *stochastic convergent* (the exponent is negative).

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