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Modelling Educational Choice

An Explanation of Change in French Secondary Education

Nathalie Bulle

The Bardwell Press, Oxford

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Foreword

This book springs from the idea that the changes that affect educational systems are produced by two categories of actors: decision-makers on one hand, and students and their families on the other. Despite its simplicity, this idea is at one and the same time sound, innovatory, powerful and praiseworthy. Sound, because it is incontestable that the changes in question are due to the actors involved. Innovatory, because there has been a tendency within the sociology of education in recent decades to attribute the outcome of educational systems to conflicts between social wholes that are loosely defined but described as dominant and dominated. Powerful, because it makes it possible to explain a great quantity of factual data, and far better than any of the studies inspired by the thesis that the development of the educational system is the result of conflict between social groups. Praiseworthy, because all research that aims to explain macroscopic data on the basis of the individual behaviour that is undoubtedly its cause, must face up to the awkward problems posed by the identification of the mechanisms through which individual behaviour engenders collective phenomena. This difficult question is usually referred to as that of the transition from the micro to the macro level. Nathalie Bulle manages brilliantly to escape from this exercise by conceiving a simulation model which not only has real explanatory value, but can also inspire other research on different topics.

It is clear that within the French education system that is her subject, pupils and their parents seek to take best advantage of the choices offered to them by the educational system at any given moment. The choice of curricular streams involving study of Latin have long been dictated in the minds of students and their families not so much by the love of the language, of Roman history or of that of Caesar and Cicero, than by a concern to follow a course of study that was socially advantageous. This role has been played at other times by German, a language considered to be difficult, and mathematics, a discipline that has the reputation of being unrewarding. The choices made by political decision makers about the distinctions between the streams, syllabuses and timetables devoted to a given discipline constitute the multiple parameters that structure the range of options available to pupils and their families. As far as the policy-makers are concerned, they are responding to some degree to the effects that result from the individual choices of pupils and their families.

A recent example of this was apparent in 2006 when political decision-makers were confronted with a difficult problem. It had become evident that the scientific stream in the second cursus at the *lycée* (the final period of education leading to the *baccalauréat*) had become so attractive that it had led to a devaluation of the literary stream, and they wished to find a remedy for this situation. The difference in prestige between the two streams that had gradually emerged was in fact the result of an aggregation of choices made over time by pupils and their families, as the model developed by Nathalie Bulle has shown. Confronted with this situation, political decision-makers wished to relieve the scientific stream of the role it had acquired as most prestigious, and thought up the idea of getting rid of the courses in history and geography that came at the end of the second cursus. As Nathalie Bulle makes clear these decision-makers also had their own objectives, strategies, values and, more generally, their beliefs. The means to be used in the hope of attaining these objectives were put forward not merely by « experts » but also by interest groups who do not always lose sight of their own interests. In this case the interest groups were right to protest against the idea of giving future citizens the hope of an easy and rapid route into the job market, but at a high price, that of a narrowly scientific education. In other cases, these interest groups have played a more negative role.

I would like to extend Nathalie Bulle's analysis of this point in a general fashion, rather than try to summarise a book whose argument is clear. Experts in educational science are one of these interest groups, alongside in particular the teachers unions and the associations that represent the parents of school pupils. It was the experts in educational science who previously, for example, had convinced decision makers that the whole word method of learning to read was better than the traditional phonics method. They were the same people who had recommended a structuralist approach to grammar and who had imposed this or that programme within one discipline or another. There is nothing surprising about such a phenomenon and it happens in every country. But political decision-makers in France seem more ready to be influenced by these groups than in neighbouring democracies. However, because there are conflicts between the corporate and general interest over many subjects, there are undesirable consequences which result from such cases. But why do these groups have greater political influence than in neighbouring democracies, this difference explaining why France finds particular difficulties in reforming its educational system ?

Roberto Michels, a student of Max Weber, coined the term *iron law of oligarchy* to describe the tendency for the governments of democratic nations to be influenced by the opinions of interest groups rather than public opinion itself. But he was not able to explain this phenomenon. It was the American economist and sociologist Mancur Olson who succeeded in identifying the basic mechanism that was responsible for this tendency towards oligarchy amongst democracies. He demonstrated that when a small *organised* (or « lobby ») group tries to impose its interests, its will or its ideas on a large but *unorganised* group, it has a good chance of succeeding because as the members of the large group are unorganised they are likely to adopt the *free-rider* strategy, that is to assume that *the others* will try to exercise the pressure needed to oppose the interests of the small organised group, with all of the costs that it involves. Every person thus hopes to benefit from the collective action that he wishes for, but without having to be responsible for its costs. But since everyone tends to use the same reasoning, the large unorganised group that forms the public does not in most cases take any action in the end to oppose the small organised group. This mechanism is an explanation of why many governments are so sensitive to the demands of interest groups, and so often impose on the public views that they do not share.

But what is most important to note here is that the mechanism in question acquires an excessive power in a centralised state where, as in France, the executive enjoys dominant power. It is because within this type of configuration of political power, political decisions tend to take the form of a compromise between the executive and the interest groups or lobbies.

This mechanism explains many features of educational policy. It explains why France appears to be less capable than other democracies of renewing its educational system and why it has such a low ranking in international classifications of educational training. It explains why it was possible to impose the whole word method of learning to read on French schoolchildren, even when it could quickly be seen to be counterproductive. It explains why the role of assessment and ranking of pupils may have been strongly watered down, contrary to the expressed will of the political authorities, or why the setting up of occupational training designed to fulfil the needs of the firm has been neglected, that is one of the main causes of youth unemployment in France.

Not only does Nathalie Bulle's book demonstrate an original approach which can inspire research in the sociology of education and be a role-model through the pertinence and effectiveness of its methodology, it also opens up important questions in other domains such as comparative political sociology.

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Introduction

CURRICULUM CHANGES: THE NEED FOR EXPLANATION

The changes in status of academic disciplines in France over the course of the 20th century have been particularly surprising. Mathematics, for example, followed Latin and played a role, over a certain period of time, of comparable importance in selection processes and choices of area of study in France. The new educational orthodoxy today defends a diversification of academic courses offered and an equalization of their value as well. Old prejudices seem to be breaking up, and the educational system aims at responding to new needs in terms of general training, without any ranking of areas of knowledge and levels of academic achievement. Over the course of a long process of transformation of the educational system, which gradually merged schools and broke down the barriers between streams of study, and which has tried to level inequalities among students, each program of reform has been presented as a rationalization of the educational system, addressing at one and the same time both economic and social demands.

In opposition to this portrayal of an educational system adapting itself to social and economic needs, educational change has been presented as determined by social conflicts, along the lines of movements of thought that characterized the 1960s. At that time it was observed that there was no theoretical approach that could explain the manner in which curricula appeared, continued and changed; this observation turned out to be fruitless, since the existing educational culture was perceived as a mere instrument of power relationships within a social structure. The sociology of conflict, especially in its neo-Marxist form, had no doubt the greatest influence, during the second half of the 20th century, on the way we perceive the role played by the values that dominate school culture, affecting processes of school selection. This sociology fostered a belief that such values participate in a process of reproduction of the social structure. But changes in the educational system affected these very values without fundamentally changing the role of the school in selection processes. These changes lead us today to reject in large measure the diagnosis of the sociology of conflict. One might even ask oneself if the neo-Marxist episode in the sociology of education did not in the long run add strength to a functionalist, quasi-evolutionary model which in reality still dominates the interpretation of changes in modern educational systems. The reforms inspired by neo-Marxism were carried out as a means of addressing economic and social needs, including the need for progress and equality. A belief in the fundamental tendency of educational systems to adapt to social evolution is thus reinforced.

We propose here to show that the changes in education occurring within educational systems in a period of expansion really follow their own logic. The evolution of curricula, programs of study and methods of secondary education constitutes a response to the development of the school population itself and to the overturning of the supposed purpose of the school, namely, to train a social elite. Membership in this social elite in France has long depended upon one's obtaining a baccalaureate qualification.[1] Since, however, the economic abilities of families varied widely, opportunities to study were subject to a high degree of inequality. An increase on average in the standard of living changed this state of affairs. Meanwhile, the number of young people entering secondary school and higher education was growing, and the institution of the school was continually involved in transformation, re-evaluating its objectives, its organization and the subjects taught in school. But this transformation, which the school undergoes, is not a simple process because it depends on what educational decisions make of it, quite as much as it affects those decisions. The generative mechanisms that underlie these changes show us that their effects actually create original institutional forms. Each school reform that was undertaken created new conditions that functioned as constraints upon systems of action; each inspired new choices, and created new situations that in general were neither foreseen nor desired. Nothing allows us to believe that an overall rationality controlled these changes, such as expectations for individual development, efficiency, equity and, more generally, social progress.

SOCIOLOGICAL PERSPECTIVES CONCERNING THE EVOLUTION OF EDUCATIONAL SYSTEMS

The most natural explanations of the evolution of educational systems are of the functionalist type and always address the most widely shared observations and understandings. Longer school careers, an equalization of opportunities for education and the transformation undergone by curricula—all of these are assumed to be part of a global process of adaptation on the part of schools, responding to the needs of a society that is becoming more complex and whose economy calls for specific skills. Attitudes and values, like the cognitive and intellectual dispositions that are promoted by the school, are thought to be linked to improvement in performance on the job. Analyses that account for processes of the "modernisation" of industrial societies put forward the training of specialists as a new function performed by the educational system, more precisely by higher education. The transformations of the system of secondary education are in general justified in a manner more social than cognitive. The dominant function of secondary education is perceived as changing from the training of an economic and social elite, to the integration of all young people in an economic and social system.[2] The importance of this integration is considered to be correlated with changes that themselves mark intergenerational processes of the transmission of social statuses. These statuses, increasingly assigned in a more meritocratic fashion, come to depend less on *ascription status* (individual inherited attributes) and more on results that emerge from structures of competitive action, or *achievement status*.[3]

By contrast with the latent functionalism that inspires spontaneously adopted positions on education, the theories of conflict do little more than substitute another overall rationality, based upon action taken by dominant groups in order to ensure a control that serves their own interests. But these theories tend to minimize the cognitive value of instruction. The macro-social logics that claim to determine the role played by the school cannot guarantee that curricula will meet social needs all by themselves. Most occupations require few specific skills or abilities. The school, it is claimed, is first of all responsible for maintaining or even accentuating social inequality. The school is thought to induce acceptance of these inequalities, making those whom inequality harms believe that the system is fair. The following examples are offered in support of this position.

According to Samuel Bowles and Herbert Gintis (1976) educational structures in a capitalist economy are not so much intended to prepare a new generation for its future specific tasks, but rather aimed at perpetuating the social organisation of labour. The demand in terms of knowledge coming from the job market is thought to be weak; correlatively, cognitive abilities are not rare, and the gap between cognitive abilities and productive opportunities is large. The links between school and the economy are not primarily based on the production or recognition of skills, but rather on forms of consciousness, behaviour and personality that schools foster and reinforce in students. The structure of relations of production in a capitalist system is thus held to determine a "hidden curriculum", the structure of social relations within the educational system.

The "new sociology of education" that arose in Anglo-Saxon literature in the wake of Michael Young's (1971) book *Knowledge and control* (a work that gathers together diverse contributions, such as those of Basil Bernstein and Pierre Bourdieu) sees the educational system as an accompaniment to relations of interest and power that exist within society itself. This current of thought, which also draws inspiration from the symbolic interactionism developed by American scholars and from the phenomenology of Alfred Schutz, does not form a doctrinal unity and sometimes fails to keep sight of the connections between individual actions and social and institutional structures. Still, it maintains the distinction, along with the French theory of social reproduction, of denouncing the socio-centrism that presides over the elaboration and transmission of school knowledge.[4] The school is seen as selecting individuals by valuing specific types of skills and their modalities of transmission, while ignoring the social constructions that govern the processes involved. These conceptions are systematised in the French case: supposedly a transmutation has taken place within the institution of the school, which exchanges differences in cultural heritage for a meritocratic hierarchy that insures, in an almost functionalist sense, the legitimation and perpetuation of the social order in advanced industrial societies.

Because of various social divisions considered by neo-Weberian theoreticians of conflict, more interest groups become involved in the debate, and the changes the institution undergoes become part of an endogenous dynamic, as is the case with Randal Collins (1979). Demand for educational opportunity, competitive by nature, coming from individuals and groups looking for a social positioning as well as from occupational organisations, appears to lead to an unjustified increasing of requirements to qualify for jobs and careers. Like Bowles and Gintis, Collins attacks the technocratic myth that explains the developments in curricula with reference to the need for vocational skills. Competition for social status is interpreted as widespread, and brings into opposition the "producers" of culture, the institutions that offer instruction, professional corporations and social groups, as well as school "consumers". Collins attributes to cultural markets an essential role in the definition of what is involved in schooling; that which is exchanged in return for a socio-professional status is not the productivity of individuals, but their ability to impose a given frame on reality. By reducing human capital to a symbolic good, and by removing any objective basis for the notion of educational success, Collins' interpretation loses all explanatory force. He does not consider the rationality (in a broad sense) of the decisions that underlie the emergence of educational values. Thus, his interpretation is unable to take into account the fundamental role played by educational structures with regard to these very values, structures that define the individual situations that are the basis of students' educational decisions.

Approaches that can account for the rationality of individual actors lead to the most solid arguments. These approaches tend to give a place to the symbolic dimension of school culture, but this place does not explain either the formation of educational inequalities, or the evolution of educational values. In the formal model developed by Raymond Boudon (1973) the inequality of educational opportunities is progressively brought about by the different meanings that educational decisions have, depending on the social positions of the persons involved, where success in school is held constant. Boudon's model also allows us to show that the interdependence of individual decisions supports the notion of a strong inertia in processes of social mobility, despite the expansion of the educational system as a whole. Thus we can sweep aside ad hoc hypotheses that invoke the action of dominant social groups in order to explain this inertia.

The work of Mohamed Cherkaoui (1982) on the transformation of the hierarchy of educational values after 1945 embodied an approach that sanctions neither the presuppositions of theories of modernisation nor the culturalist presuppositions of the sociology of conflict. Cherkaoui was primarily interested in the phenomenon of the increasing dominance of mathematics relative to literary studies, and showed that even more than the value assigned to knowledge or skills to be learned, the issues represented by various curricula (linked to selection of groups of students, to the predominance of a gender, etc.) explained changes in educational strategies. Cherkaoui analysed in particular the dynamic of change in the demand for education, and showed that this demand had an endogenous character similar to that of the diffusion of a cultural good.

THE ANALYSIS OF THE EVOLUTION OF EDUCATIONAL VALUES IN FRANCE

The present research continues this line of investigation into the evolution of values with regard to intellectual training in France. This work supports, as do analyses such as Boudon's and Cherkaoui's, the thesis of the relative autonomy of educational systems, a thesis that was at the centre of the account Émile Durkheim (1938) made of changes in educational thought in France. Durkheim showed that social changes give rise to new educational needs, and in response more or less contingent solutions are provided, solutions that emerge from a struggle for the power to dominate education. These solutions, progressively made part of the institutional framework, constitute the background of the cognitive resources of people in the process of historical change

The responsibility for defining such solutions weighs heavily on the shoulders of reformers, who by making changes in the structure of opportunities offered to individuals, influence, sometimes in an unexpected and even unwanted way, the development of educational systems toward a definite state, in a manner which eventually could be predicted. When educational systems appear to respond at the macro-social level to definite needs and interests, the role of public authorities hardly merits study, except by historians; issues regarding schools are supposed to be fought over in another arena. As soon as we highlight the relatively autonomous character of the evolution of educational systems, a study of processes that cause them to be restructured appears important. Through such restructuring actions governments try to exercise control in a more or less indirect manner over students' training, orientation and success. Interpretations of the mission of the school, the influence of nebulous ideologies and knowledge with regard to pedagogical, social and epistemological questions, and the quite sketchy style of the analyses carried out, all contribute to our understanding of the solutions adopted in response to new educational needs.

The analysis of changes in educational values leads us to distinguish two major groups of protagonists. The first group is made up of all those who affect by some action the transformations of the educational system in terms of its structures and its teaching. Whatever the differences of opinion and interest that might divide this group, a dominant interpretation of the needs and interests of the school population emerges from it. The transformation of the formal structures and instructional activity of the school is more or less accomplished according to this interpretation.

The second group of protagonists is constituted by the school population, which intervenes mainly through the choices students make. Such choices may be understood in the light of situations with which social actors are faced. School values depend on processes in which the dominant interpretation of the needs and interests of the school population interacts with individual school decisions, working through structures of the educational system. What is expressed in the work of Cherkaoui as increasing rationality as regards the choice of a stream of study, taking into account a more competitive educational context, may be explainable with reference to relatively similar motivations over the entire course of the 20th century. The very structure of the system of streams of study leads to the concretisation of these motives, in different ways during different time periods. Phenomena of interdependence between individual decisions lend credence to the notion of a *sui generis* evolution of educational systems.

Observation of the French system of secondary and higher education over time reveals that most of its changes have since the end of the 19th century been justified with reference to changes in the school population, and this is what has given rise to transformations of instructional curricula and teaching. The educational system does not primarily change as a function of exogenous needs, but in relation to the way in which internal tensions linked to changes in the school population are resolved. While expressing needs that have made themselves felt and while setting up a movement that precedes it,[5] public action defines the rules, the constraints, the limits of freedom and the uncertainty that make possible a certain form of objectification of demand for education rather than some other kind, and in all these ways strongly influences the development of educational systems. In the course of this process the dominant interpretation of the needs and interests of the school population and school decisions themselves interact, and in this interplay the school is being constructed, with its structures and values. We propose in order to demonstrate this dynamic of formation of educational values, a model that simulates the choice between the different classic streams of study in French secondary education between the reforms of 1902 and those of 1965.

The proposed analysis requires an understanding of the reasons that underlie school reform movements, an understanding of the way that individuals make choices, decide, react to conditions that are offered to them so they can realise their educational and occupational aspirations, an understanding, finally, of the effects of the interdependence of educational decisions. These decisions are not the immediate expression of individual aspirations; at best they express them in the framework of particular situations. Situations of this kind are not only modified by the structure of curricula but also by the effects of the aggregation of decisions.

The developed model tends to show that the culture most highly valued within the educational system depends strongly on the overall level of students' achievement in streams of study in which that culture is dominant. The valuation of that culture is the result of a process that involves the structure of educational opportunities and choices actually made, and which therefore cannot be considered as exogenous to the institution. Educational systems, relatively autonomous with regard to other social sub-systems, produce their own impact, which can be very important, upon social development in the most general sense. It may be assumed that that, as a result of these processes, the school excersises its own educational action independently of an macro-social forces, that is with a certain degree of autonomy for which it is solely accountable, and that this is not only during periods of revolutionary change.

NOTES

1. The "bac", as it is popularly known, is the school leaving examination taken in the final year at the *lycée*.
2. Cf. D. Bell (1973); T. Parsons (1971); C. Kerr (1964); B.R. Clark (1961); A.H. Halsey (1960).
3. Cf. P.M. Blau & O.D. Duncan (1967); T. Parsons (1970).

4. This socio-centrism takes different forms in the writings of different authors. According to Young: "the new sociology of education" starts by rejecting the assumption of any superiority of educational or 'academic' knowledge over the everyday common sense knowledge available to people as being in the world. (cf. M. Young, "Taking sides against the probable, problems of relativism and commitment in teaching and the sociology of education", 1973: 214).
5. Cherkaoui (1982: chap. 6) shows for example that a fall in the percentage of students gaining a philosophy baccalaureate occurs about a decade before the reform of medical education, the Debré reform of 1958, which particularly emphasized new programs centred on basic sciences.

1
Changes in the Secondary Education System: 1902–1965[1]

The evolution of the education system in France as described by Durkheim (1938) shows that the historically prevalent modes of schooling owe their status as much to the needs and values of society as to the contingencies defined by the circumstances influencing individual decision-makers. These modes corresponded to a demand for education in a form that was not defined by this demand but which instead channelled the potential for investing in education that it sparked. *The Evolution of Educational Thought*, which stems from a course given by Durkheim designed to prepare candidates for the French *agrégation*[2] examination following a reform in 1902, allows us to follow several major stages in this development.

In the Middle Ages, the aristotelian dialectics was presented as the way *par excellence* of conducting thought in a world where verisimilitude and likelihood characterized the organization of things. True demonstrative reasoning was confined to the restricted domain of mathematics. Because the demonstrative method does not apply directly to empirical reality, the rational understanding of the world was amenable to the dialectical method. Yet these teaching principles, based on logic and its forms of discourse, were not a complete and satisfactory model of education justified by the knowledge and mind set of a given time. The Renaissance rejected them, looking to other formulas for the means to satisfy its taste for intellectual refinement. Many paths could have been taken that, following Rabelais, would have valorized scientific erudition or, following Erasmus, would have privileged literary culture and linguistic art. These potential alternatives show that the forms which are momentarily crystallized by teaching methods are not totally imposed from outside. The taste for erudition and classical letters had rubbed off on secondary teaching, but the mastery of the solution adopted, Durkheim tells us, fell less to the University than to a new corporation of teachers that would shortly become all powerful. By favouring the advance of Protestantism, the sixteenth-century Reformation had aroused enough disquiet in the Catholic Church for it to respond by creating the Jesuit order. In effect, the Church saw individuals evading its influence. To recoup in the face of the threat it saw in Calvin's or Luther's doctrines, it introduced into lay society a priest who was also a member of a religious order. As an integrated member of the secular world, the Jesuit priest could hope to gain better control. For such control to be operational, the Jesuits took charge of secondary education; and indeed their teaching methods were much appreciated. Jesuit education was founded on the intensive transmission of Greek and Latin culture, and strongly encouraged emulation. The Jesuits proposed a humanist education in the classics, ultimately channelling and dominating this time-honoured culture.

Humanism dominated secondary education in France via Greco-Latin culture to the point of excluding the sciences from the dominant pedagogical model. The 19th century inherited the unresolved problem of what place to give to the sciences in education, with, as proof of the crisis, some fifteen successive plans for reform. Different disciplines were included in the curriculum—French, sciences, history, modern languages—without questioning the priority of classical culture. But the old order was plagued from within and without; from within because the need for scientific culture introduced a duality that had not yet been surmounted; from without because classical culture did not seem suited to the needs of the new student populations. The value of the modern subjects was defended against that of the classical ones, while the modern subject matter was itself split by the demands of the sciences versus those of the literary disciplines. As the 20th century was about to dawn, classical and modern disciplines, as well as literary and scientific ones, coexisted in the absence of an educational project that would truly unify them. On the eve of the new reform, the modern and classical streams of study were unequally valued and did not offer the same access to higher education. The classical curriculum, which lasted a year longer, proposed a *baccalauréat* of which the first part was common to all students and the second divided into philosophy and mathematics.

The school system was in a shaky state at the start of the 1902 reform. By putting all disciplines on an equal footing through the creation of parallel streams offering various combinations, the reform merely reflected the indecisive character of this pedagogical crisis. Durkheim's analysis corresponded in particular to a search for the necessary balance between literary and scientific disciplines. According to Durkheim, as long as the antinomy was not resolved, as long as it was not understood that they did not represent two orders of values, both incommensurable and opposed and therefore necessitating a choice, it was inevitable that minds would follow their penchant and incline wholly in one direction or the other.

1) THE 1902 REFORM: INTRODUCTION OF SCIENTIFIC, CLASSICAL AND MODERN CURRICULA

At the turn of the century, the debate over the future of secondary schooling testified to the intense preoccupation with the quality of education and its evolution. The public authorities chimed in with sweeping studies and surveys. The conceptions of education that appear in the different studies show a shift toward the exercise of the intelligence and critical analysis. The educational value of the different disciplines was thereby called into question. The concern was to infuse students with a taste for study, inculcate good working habits and develop their capacity to understand. It was not how much they learned that mattered but the ability to learn more. Here the study of the sciences could be of help. Classical studies, indispensable to the careers of those who would later occupy elite positions, were perceived as serving primarily to educate the mind, to form judgment. With the intellectual discipline to which these teaching programs were supposed to contribute was associated a moral dimension translated by the words uprightness, sincerity, willpower. But it was not a matter of inculcating knowledge and values directly. School was supposed to teach children to learn, to develop their ability to think and use their judgment thanks to the teaching of disciplines. The future elites of the country and those destined for professional careers, were endowed more specially with a social mission that went beyond the exercise of their particular occupations, for which their education in the humanities was charged with preparing them.

The 1902 reform attempted to find a compromise between the competing intentions to reinforce the modern kind of teaching (without classical Greek and Latin), the scientific and the classical ones, all at the same time. The new system had two *cycles*. The first (corresponding to the middle school) was divided into a modern stream and a classical stream (in which Latin was required and Greek was optional). The *second cycle* (corresponding to high school) covered two years. The *seconde* and the *première*[3] (formerly known as *Rhétoric*) offered two divisions with two *sections* each. Unlike the practice in most other education systems, the various school years in France are numbered on a decreasing scale. The modern curriculum was elevated to the same status as the classical tradition with the creation of a *section* without Latin. *Section D* (foreign languages and sciences) was designed in particular to preserve the classical path of students who did not have a true calling for Latin. Creation of *section C* (Latin and sciences) was supposed to consolidate the scientific path, which was losing steam, while allowing future candidates to the *grandes écoles*[4] to continue the classical curriculum. Creation of *section B* (Latin and foreign languages), alongside *A* (Latin and ancient Greek), established a symmetry between the literary and scientific curricula. Each had two *sections*: one with a classical orientation, which prevailed over the second by the teaching of an ancient language, and the other with a modern orientation, which substituted for this classical trend the teaching of an additional modern language. In the final class (*terminale*), there was a choice in all *sections* between philosophy and mathematics.[5]

As they were conceived, the curricula almost inevitably gave rise to disappointments with regard to the hopes for each of the *sections*. Recruitment in the classical literary *section A* stagnated in the wake of the reform, while *B* and *D* continued to grow, as did—though more slowly—*C*, which rivalled the quality of *A*.

The new *A section* was in a weak position because it offered a more specialized program with respect to the curriculum offer of *C*, a program that was also threatened by the more modern character of the subjects that dominated the curricula of the other *sections*—modern languages and the sciences

During the 1920s, the prevailing opinion was that the system established in 1902 had been a mistake and ultimately resulted in a decline in the "cultural level". *Section A* stagnated and diminished, and "Latin and foreign languages" grew, whereas its curriculum was held in low esteem and its students were judged to perform less well than those in *D*. The plan had been to set up *sections* that would run in parallel and suit the needs of a "modern" society, but it turned out that the demand for these *sections* did not fit with the needs of the job market. The Greek and Latin humanities were supposed to train the student elites, but *C* competed with *A*. Engineers and "practitioners" were wanted, but *B* competed with *C* and *D*. There was fear for the future of *section A*, supposed to represent the prestige of the French secondary school system; furthermore, *B* attracted too many students. In 1902, the classical humanities were regarded as far too important to imagine them being overshadowed by other disciplines, but the impact on the choice of the changes in the whole school system shows that this value depended more than was realised on a process of increasing prestige that has still to be explained. Competition from *section B* seems to have prompted fewer fears than that from *C*, which called into question the training of the national elites. Instead of striving to ensure harmonious development of the intellectual faculties, there was concern about shared competences. The curricula proposed at the beginning of the 20th century were, in effect, relatively differentiated. *Section C* offered a slightly better balance between literary and scientific subjects, which was likely to meet with more favour than the fairly specifically literary *section A*. These choices did not run counter to the classical image of culture. All theories of the time tended to make room in the baggage of the *honnête homme* for the sciences, even if they remained subordinated, in the highest idea of this culture, to the humanities.

The experience of the 1902 reform shows the importance of different underlying factors in students' decisions. First, changing the choice structure affects the individual preferences for each of the alternatives proposed. The choice of a *section* does not seem to be guided directly either by a value recognized as intrinsic to their dominant disciplines or by the occupational prospects theoretically offered by these curricula. These choices appear in particular to be influenced by the relative position occupied by each of the *sections* and underlie a comparison of the different alternatives. This comparison seems sensitive to the overall structure of the *section* system. Choices are also incontestably influenced by the requirements connected with preparation for the competitive entrance examinations to the *grandes écoles*. This influence was probably increased by the structure of the 1902 system, which allowed combining a scientific curriculum with classical culture. These competitive examinations, were, in their great majority, preparations for entry to scientific *grandes écoles*. Last, the proposed curricula obviously had a great effect of their own on educational demand. The quantitative success of the Latin-foreign languages *section* suggests that for many the challenge was neither gaining membership of the academic elite, nor improving job prospects—in this case a classical secondary curriculum would satisfy, to a certain extent, both ambitions—but obtaining a diploma on the cheap.

2) THE 1925 REFORM AND INTRODUCTION OF A CORE SCIENCE CURRICULUM

By the early 20th century, the problem of the split between the humanities and the sciences, which marked the debates on the educational system throughout the 19th century, was beginning to give way more specifically to the problem of the divide between classical and modern culture, owing to the importance given to "modern" disciplines in the new *sections* system. In 1923, in order to defend the humanities, which the best students—future candidates for admission to the *grandes écoles*—had deserted for the science *sections*, the Minister of Public Instruction, Léon Berard, suggested doing away with the modern *section* of the *first cycle* and creating a "scientific equality" between all *second cycle sections*, which would have the same programs and devote the same number of hours to mathematics and the physical sciences up to the first part of the *baccalauréat*. The reform project rested on an intention to raise all secondary school curricula to an equally high level. With science being placed on the same level in the three *sections*, *section* choice would be based uniquely on the advantages attributed to either Greco-Latin culture or to Latin culture alone or to modern culture. This experiment was to be decisive, since the importance given to the sciences would no longer sway students. If, following this experiment, students preferred *section A*, it could be concluded that families did not forsake the Greco-Latin curriculum providing it was completed by an equivalent scientific cursus. The same reasoning could be applied to an exclusively modern education since, in the hypothesis of an equal number of scientific courses in all *sections*, it would be chosen for its literary content and not for its scientific content/courses.[6]

The project was rejected out of hand by a large number of academic or intellectual organizations, which feared in particular its impact on teaching and its selective approach to students. Suppression of the modern *section* in the first cycle, which would imply a late integration of the best pupils of the *Primaire Supérieur* curriculum[7] into secondary education (in *seconde*), aroused concerns about its effect on the academic level. In addition, the existence of a modern *section* covering the whole secondary cursus was regarded as necessary to "preserve the social democratic role and vitality of secondary education".

At the beginning of the 1924/25 school year, the Minister of Public Instruction, François Albert, reinstated the modern *section* in the first cycle. The classical "core curriculum" imagined by Léon Berard was presented as not being adapted to the evolution of the school population and more likely to be a vehicle of exclusion than of equal opportunity. The Minister brought in another reform that did away with *section B* in the second cycle, an option that had proved to be "a fairly ill-advised combination, of middling pedagogical value, a refuge for students equally frightened of Greek and the sciences",[8] but retained the idea of a core science curriculum.

The 1925 reform gave its blessing to the rise of scientific culture through its expected participation in general intellectual culture and, at the same time, revitalized classical culture by allying it with the sciences.

> *If the* honnête homme *of the 17th century was the product of a wholly Latin education, the cultivated man of the 20th century can only be the result of a close collaboration between the literary and the scientific disciplines. This general culture (ensured by the twin action of the humanities and the sciences), by means of which the proper balance of necessary qualities is maintained, must therefore be continued as long as possible, until the time when the mind is fully formed, in other words until the end of the* première*).*[9]

Those who studied ancient Greek were no longer foreordained to teach the humanities, which was not the case in 1902. Students studying ancient Greek began thronging to the *math-élém section*, i.e. what was known as *terminale scientifique*. And, too, most of the largest *lycées*[10] organized complementary extra-curricular courses in philosophy—which even became official in a few *lycées*—for the many students in the *terminale scientifique* class (*math-élem*) wishing to prepare *baccalauréats* in both mathematics and philosophy.

Section C, in which candidates for the *baccalauréat* had grown a mere 6% between 1927 and 1928, saw their numbers explode between 1928 and 1929, after the implementation of the new reform in the première classes, as can be seen in Table 1.1. Furthermore, this *section*,

Table 1.1: *Distribution of students taking the first part of the baccalauréat in 1927, 1928 and 1929*

Section	1926–1927	1927–1928	1928–1929
A (Latin-Greek)	2474	2821	3121
B (Latin-Foreign languages)	5225	5719	
A' ex-C (Latin-Sciences)	3706	3951	9569
D (Sciences-Foreign languages)	3890	3937	4332

Source: Ministère de l'Education Nationale

which would be the largest from 1928 to 1941, would see a steady decline in its enrolment figures during the period that coincided with the existence of a core science curriculum. During the same interval, *section A* relentlessly gained on *C*.

When *section B* was cut in 1925, it was, significantly enough, *C* (renamed *A*') that inherited the students that would have chosen *B* had it still existed, and not the modern *section* or *section A*. The choice of *B* was therefore not motivated by the predominance of foreign languages in the curriculum: there were 4 hours of courses in *A*' (ex-*C*) as compared to 8 hours in the modern *section*. Selection by the presence of Latin was still widespread at this level of schooling, but one would surely be wrong to see this choice as merely being dictated by the reputation Latin lent to those *sections* that taught it. These students had intensive training in Latin, they had taken an average of more than 5 hours a week in the first *cycle*, as compared to 2.5 hours of mathematics; it was therefore natural enough for them to continue studying it. So why not choose *A*? Might not the elimination of *section B* have favoured the demand for ancient Greek? This was unlikely. Adding Greek to Latin and the science program was too heavy a load for students, of whom it was said that they feared Greek and the sciences equally.

The number of students in *A* grew slowly but surely. Those who would have chosen *C* in the past did not now immediately opt for this *section*. For them, the principal solution lay in the choice between Greek—in the event they had chosen this option in middle school—and spending more time on French and their optional modern language. There must have been some *section* switching. Some who would have chosen *A* might have turned to *C* because the workload in *A* was becoming too heavy; and some who would have chosen *C* for its scientific content and who would have regretted not taking Greek might have chosen the new courses in *A* which allowed them to do it all. Nevertheless, if the *A* and *C* students were to balance out according to these criteria, why did it not happen immediately and why was the growth of the *A sections* so gradual? Were the students entering secondary education in the post-reform years harder working and better prepared to tackle the sciences and the humanities at the same time? There is nothing to suggest this. Did the pared-down curriculum of 1931 make the *section* more accessible than before? That is unlikely. If neither the students nor the plans and syllabi explain the new uptake of Greek, the most plausible hypothesis is that it is due to the reputation of *section A*. This reputation apparently improved following the 1925 reform and outdistanced *section C*, whose overall level likely fell after taking in the student populations formerly destined for *B*. More specifically, it can be posited that, in turning to *section A*, because of the dynamics of the *sections* system induced by the reform, the students contributed to enhancing its reputation and therefore its appeal.

The secondary school *sections* in the 1930s and 1940s were not deemed to be harmoniously balanced. The modern *sections* stuck out, and the level of their recruitment was constantly deplored. And then there was the problem of selection on the basis of Latin. By steering the "bad Latin students" toward the modern *section*, the selection was accused of dooming "modern" culture to a lower status. Yet there was a desire to promote a "modern humanism", not only because of the plurality of needs, tastes and aptitudes but also, it was argued, because the work in the *sections* in question was supposed to prepare students for the scientific and technical careers that were to be developed. It was explicitly supposed at the time that the relative value attached to a *section* strongly depended on the students recruited, hence the harm done to the modern *section* by selection on the basis of Latin.

The opposition between *secondary* and *Primaire Supérieure* school[11] now appeared detrimental to the harmony of the system, a situation that was exacerbated by the rapid development of the latter. A series of important changes were therefore implemented. The *classes élémentaires* in the *lycées* and *collèges*[12] were brought under the auspices of the *Direction du premier degré*[13], and the *Ecoles Primaires Supérieures* (EPS) transferred to the secondary system, becoming *second degré.*

3) THE VICHY REFORMS AND ELIMINATION OF THE CORE SCIENCE CURRICULUM

Under the Vichy government, the *Ecoles Primaires Supérieures* were fully integrated in the second *cycle* and turned into modern collèges. The resulting greater organic unity of the *second degré*[14] was supposed to be designed to put a stop to the ongoing competition from the EPS and to serve as a means of repression of the secular and republican spirit thought to permeate these establishments that trained future primary-school teachers.

The secondary school *sections* underwent several other major transformations under Vichy: re-establishment of *section B* "Latin and foreign languages", creation of a new *section* for the terminale classes, *philo-sciences* (subsequently renamed *Experimental sciences*), and elimination, in 1941, of the core science curriculum, which remained optional. The syllabi were deemed too heavy, given the increased number of students and the growing heterogeneity of the student body.

When *section B* (Latin-foreign languages) was reinstated in 1941, it manifestly regained the students it had ceded to *C* some fifteen years earlier, as Table 1.5 shows. These were Latin students, some of whom may have dropped Latin to join the modern stream, but for most of them, the choice was the following: ancient Greek, sciences or modern languages. *Section A*, relieved of the mandatory "core science curriculum, could now appear less difficult, but it had the best reputation and, ten years later the *baccalauréat A* was still considered to be the hardest. Apparently these students who, in the absence of *section B*, would have chosen *C*, chose *B* once it was reestablished for the same reasons they had at the beginning of the century: *sections B* and *C*, one because of the sciences and the other because of modern languages, had a modern character; but the sciences demand additional effort and only those

Table 1.2: *Distribution of students taking the first part of the baccalauréat in 1940, 1941 and 1942* [15]

Section	1940–1941	1941–1942	1942–1943
A	7558	8359	8030
B			6822
C (ex-A')	11032	11448	6889
D	7357	13088	13027

students ready to furnish this investment chose "*C*". The others, who now had a choice, went into *B*. The proportion of *section C* students going into *math-élém* was to rise, for a large portion of those without a scientific calling could now choose "*B*" before choosing philosophy.

Faced with this new choice structure, *section A* did not immediately lose students; it did not undergo the sharp loss of candidates experienced by *C*. The loss of *section A* candidates was in fact very gradual, just as the increase had been after 1928.

4) EDUCATIONAL CHOICES OF APPLICANTS BEFORE ENTERING ONE *GRANDE ÉCOLE*

The future candidates of the scientific *grandes écoles* progressively made *section A* their preferred choice when the core science curriculum was brought in. This can be seen from the example of students recruited by *Centrale Paris*, a *grande école* with an established reputation and large graduating classes. These students increasingly chose *section A* before going into *math-élém*. Figure 1.1 shows the evolution of the educational backgrounds of those who passed the competitive examina-

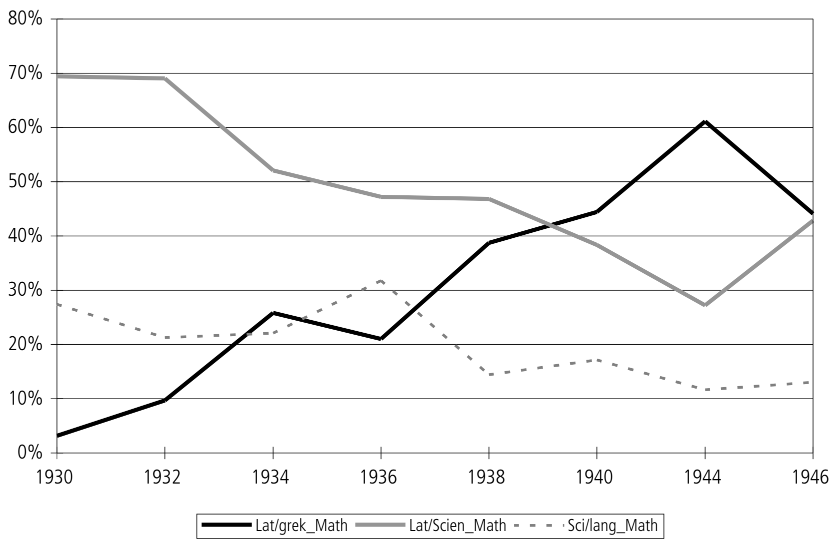


Figure 1.1: *Baccalauréats taken by graduates of Centrale Paris between 1930 and 1946*

Source: Archives Centrales Paris.

Y-axis: Year of the first part of the *baccalauréat* (3 or 4 years before admission) tion. Of those who took the entrance examination in 1930, some three to four years after having passed the first part of the *baccalauréat*, 3% had completed *A* before *math-élém*, 74% *section C* and 27% the modern *section*. In the 1944 entrance exam, 61% came from *A*, 27% came from *C* (hitherto *A*') and 11% came from the modern *section*. By contrast, in the 1946 exam, only 44% came from *A*, compared to 42% from *C* and 13% from the modern *section*. One third of them had a philosophy *baccalauréat* in addition to the mathematics *baccalauréat* in the 1930s, while this was the case for over two thirds at the beginning of the 1940s.[16]

Having made part of the mathematics curriculum optional for the literary classes did not directly compromise mathematics teaching in these classes but aimed to lessen its selective character. Furthermore, mathematics were no longer a requirement in the written part of the *baccalauréat* for *sections A* and *B*. The effect of these measures was gradual, and it would be several years before the large majority of those preparing the competitive science exams dropped Greek. The complete elimination of the core science curriculum in 1945 would definitively hasten the tendency.

A look at the evolution of entrance requirements for the Ecole des Hautes Etudes Commerciales (HEC) and at the educational background of the students opens the way for further analysis of the evolution of the status of the academic streams and disciplines.

In the 1930s, business schools did not yet attract the elite coming out of the lycées, and HEC was only beginning its career as a *grande école*.[17] By the end of the 1950s, many things had already been decided, and the competitive entrance examination was on its way to its present-day format. For the period under consideration, the share of candidates from each *section* of *première* and *terminale* changed considerably and depended—in addition to the modifications in the examination and in the upward trajectory of the Ecole—on the evolution of the *sections* themselves. From 1935 to the early 1940s, the modern stream and the mathematics *baccalauréat* were to provide the best preparation[18] for the examination—taking into account the subjects and their weightings coefficients—which was at the time not highly selective. Yet, during this period it was *section C* that was best represented among those having passed the examination, while the philosophy and mathematics *baccalauréats* were on a fairly comparable footing.[19] The presence of students from *section A*, who furthermore had a mathematics *baccalauréat*, increased from the mid-1930s, while the modern stream lost ground. At the beginning of the 1940s, while the respective curricula of the various *sections* of première were of almost equivalent interest for the entrance exam, admissions were

Figure 1.2: *Evolution of the relative presence of* première *sections among HEC admissions*[20]

Figure 1.3: *Second part of the* baccalauréat *taken by HEC admissions from section A between 1935 and 1957 (from section A)*[21]

Source: Archives HEC

Figure 1.4: *Second part of the* baccalauréat *taken by HEC admissions from section C between 1935 and 1957 (from section C)*[22]

Source: Archives HEC

divided fairly evenly between the two classical *sections*. The majority of these candidates had a mathematics *baccalauréat*. In 1943 and 1944, the number of graduates from the *A section* was slightly greater than from *C*. From 1945, in tandem with the changes in the 1944 and 1945 *curricula* and the shifting of *section A* in the direction of the philosophy *baccalauréat*, the proportion of students from *A* among those having passed the competitive exam, and notably the *A section* students with a mathematics *baccalauréat*, fell. Alternatively, from 1954, the proportion of *section C* students among those having passed the HEC examination was three times higher than the proportion of holders of a "Latin-sciences" *baccalauréat* among *bacheliers* (holders of a *baccalauréat*). At the end of the 1950s, they accounted for some 60% of admissions, and more than 95% in the 1960s. Despite the increase in the literary subjects at the HEC entrance examination and the elimination of the physical science test, the reduction of the time given to mathematics in the curricula of the literary *sections* made *C* the preferred choice for those preparing for the entrance examinations of the major business schools and more generally of most of the *grandes écoles*.

5) *SECTION* CHOICES AFTER THE *LIBÉRATION*, AND THE LACK OF ENGINEERS AND TECHNICIANS

In the immediate post-war period, what was known as the "educational explosion" brought out a major concern: specialization. The volume and social composition of the student population evolved rapidly. The school system attempted to respond to the demand for education, while economic growth allowed and even obliged youngsters to delay entering occupational life. The rise in family living standards, the fall in unqualified jobs and the parallel intensification of the economy's need for technicians and managers at various levels stimulated the general tendency to prolong schooling, which was further fed and amplified by families. This trend was first marked by the surge in the first *cycles*—after elementary school—as well as in the *cours complémentaires* offering an additional course of study supplementing that provided by elementary school. The *cours complémentaires* stopped at the *troisième*;[23] they offered a solid curriculum, comparable to the courses of the first *cycles* of secondary school, though they did not teach Latin and only one modern language .

Post-war secondary education still had relatively few children from the working classes, who instead attended *cours complémentaires*, or other sources of technical or practical training. Enrolment in these *sections* soared. From the end of the 1930s to the beginning of the 1950s, the *cours complémentaires* gained nearly 100,000 students, while the technical streams added over 175,000. In secondary education streams, change in the student population called for an overhaul of the whole curriculum. The call for recognition of cultural pluralism was a response to the dawning awareness that it was impossible for the future secondary school student to fully assimilate all of the disciplines formerly taught in the best *sections*. The core science curriculum, which was perfectly conceivable as adequate for adolescents in 1925, was no longer so for those after 1945. The Jean Zay reform, which in 1939 annexed *enseignement primaire supérieur* to *enseignement secondaire*, resulted in a rapid rise in the number of students, but the opening up of secondary and higher education did not maintain educational outcomes nor to an increase in occupational recruitment.

After the Liberation, principles of differentiated curricula were adopted, which were thought to be adapted to the diversity of the student body, based on the argument of the equal dignity of all branches of knowledge; Zay therefore took measures aimed at accentuating the specificity of the curricula proposed by the different *sections*. First, he did not consider the possibility for students in *sections A* and *B* to follow a science curriculum the equivalent of that proposed by *C* and the modern *sections*[24]; and second, he asserted his desire to reserve Latin for the "*Latinistes*", that is, those specializing in that language.

Beginning in 1945, the population of students enrolled in *section A* fell practically without interruption until 1965. The absence of a core science curriculum doomed *A* to desertion by a certain number of students, who could not transfer from there into *math-élém*.

In 1952, new experimental *sections* were planned to satisfy the diversity of tastes and aptitudes of a constantly evolving student population; at the same time, a new *section A*', demanded by the defenders of the humanities and which revived the pre-war formula of a high-level literary and scientific syllabus, was created in some lycées.[25] *Section C* gradually moved into a position of strength, which can be explained in part by the creation of a new *B section* in 1941.

The situation in France nevertheless proved alarming, owing to the choices actually made by the students in higher education. In 1954, the number of engineers trained per million inhabitants was: 236 in the USSR; 237 in England; 214 in Canada; 195 in the United States; 155 in Switzerland; 114 in Italy; and 90 in France. Furthermore, the USA had 4,700 working engineers and researchers per million inhabitants; the USSR, 2600; and France 2000. It became imperative to recruit a maximum of engineers and technicians. *Sections A* and *B*, having become more specifically literary, could not provide them, even though remedial courses were set up to allow students to take the mathematics *baccalauréat*. Because of the difficulty involved in combining Latin and the sciences, the *sections* in *C* were not big classes. It was thought that students in the modern *section* could, if they chose more massively the mathematics *baccalauréat*, go on to become the needed engineers and technicians. Comparisons with other countries show that the syllabi of the *second degré* in the OECD countries display fairly stark differences. Generally speaking, the classical literary *sections* spent less than one quarter of teaching time[26] on science and mathematics, with inter-country differences ranging from less than one fifth of the time to nearly one third. The science *sections* devoted some one third of their time to science and maths, with national differences ranging from one quarter to nearly half of weekly class time. France, where the classical literary *sections* devoted around 18% of class time to the sciences and the modern *sections*, 30%, is one of the countries most faithful to literary culture. Should this lack of engineers be due to the core science curriculum, which raised the prestige of the classical literary *section*?

The changes in the *terminale sections* chosen between 1902 and 1945 show that the number of students taking the mathematics *baccalauréat* had been falling before 1928 and had actually stabilized between 1928 and 1941. The core science curriculum had oriented students who, before 1929, would have gone into the philosophy *section*, toward *math-élém*, a choice that was facilitated by the fact that some lycées offered their *math-élém* students a preparation for the philosophy *baccalauréat* as well.

The lasting consequences of an institutional measure are so hard to determine that the same reform can either satisfy one side and the other side as well or be rejected by both sides for opposite reasons. What one side approves or disapproves on principle, the other side accepts or rejects because they have a better idea of what the concrete consequences will be. A core science curriculum was set in place because it satisfied both sides, though for different reasons. Implemented in 1923, this project was to support the teaching of the humanities by opening Greek courses to future science candidates. It protected the literary *sections* from competition from the sciences in the classical *sections* and, surreptitiously, ensured the future national elites of getting a serious background in literature even if they were to opt for a scientific career path. The idea of making science programmes the same for all secondary school *sections* served to continue the 1902 reform, in other words the integration and diffusion of new forms of knowledge in academic education. It was this “inadmissible privilege” granted the sciences that prompted making the core science curriculum optional in 1944, in the interest of defending the humanities. But the 1945 reform was also aiming at the privilege enjoyed by the literary classes when it definitively did away with the same core science curriculum. In the 1950s, the most ardent defenders of the humanities were the first to regret the disappearance of the core science curriculum, while those science specialists most committed to their discipline regarded this experiment as an aberration. The 1920s had learned the lesson of 1902, warded off the unintended perverse effects of the system and won over nearly everyone; but the student body continued to change, and soon the new system seemed even more unsuitable than the old one, and even more “perverse”. It was believed that a growing number of students required more a homogeneous preparation in order to succeed and to pursue a scientific career.

Figure 1.5: *Evolution of the distribution of students taking the first part of the baccalauréat, 1914–1964*

Source: Ministère de l'Education Nationale

Figure 1.6: *Evolution of the distribution of students taking the second part of the baccalauréat, 1915–1966*

Source: Ministère de l'Education Nationale

Different measures were adopted in the hope of attracting a majority of students to the sciences. In particular, the time allotted to mathematics in the first cycle[27] was revised and raised to 4 hours in *sixième* at the beginning of the 1957–58 school year, in October.

Was the replacement of the "Latin psychosis" by a "mathematics psychosis" the consequence of government measures designed to reconcile student demands with the needs of the job market? We will see that this change in academic values, which was such a specific mark of French secondary schooling at the turn of the 1970s, turned out to be the indirect consequence of a broader structural reform.

6) THE 1965 REFORM AND ITS EFFECTS ON STUDENT ORIENTATION

The decree issued by De Gaulle on 6 January 1959 provided for "investing with maximum accuracy" by encouraging the large post-war generations to seize the opportunities provided by economic development and choose careers in scientific or technical fields. To achieve these aims, the decree made school attendance mandatory until the age of

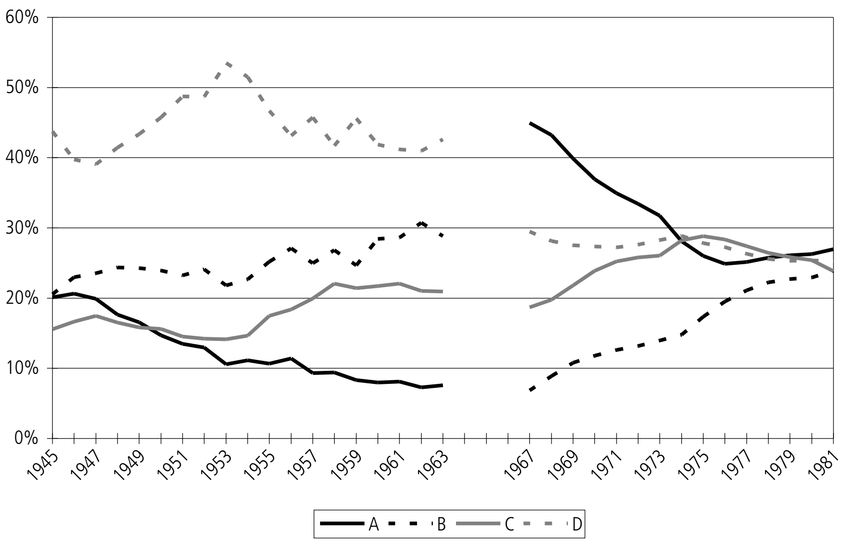


Figure 1.7: *Evolution of the distribution of students in premières A, B, C and D, 1945–1981*

Source: Ministère de l'Education Nationale

Note: No figures were published between 1964 and 1966.

sixteen (instead of fourteen) for pupils having celebrated their sixth birthday after first of January 1959 and improved the structural unity of the first *cycle* of studies. The *cours complémentaires* became *collèges d'enseignement général* (CEG) and the apprenticeship centres became *collèges d'etnseignement technique* (CET). The decree proposed setting up a *cycle d'observation* that would ensure the students were followed more closely in the first two years of secondary school. This cycle of observation began with a semester-long common curriculum; changing streams was possible and facilitated during the entire cycle; *conseils d'orientation* were set up. But the observation years were too dependent on the individual establishments, and the pathways between *sections* could not function as intended. This was one of the reasons for the creation, in 1963, of the *Collèges d'Enseignement Secondaires* (CES), which would soon, through their generalization and autonomous status, be required to include all collège students in the same framework. The lycées thus lost their first cycles, while the CEG theoretically continued but only temporarily. The period between 1962 and 1972 was characterized by a multiplication of establishments, as expressed by the slogan "one CES a day, one CET a week, one lycée a month". Nevertheless, the old divisions continued in the form of streaming in the first cycles.[28] In 1968, the streams (classical and modern) of the beginning of the first cycle were combined into a 2-year core curriculum, definitively seating side by side in the same classrooms—by the elimination of Latin in the beginning of secondary school (*sixième* and *cinquième*)—the "classics" and the "moderns".

Expansion of the *second degré*, in part linked to population growth, to the endogenous dynamics of the prolongation of schooling and the extension of its mandatory period, gave rise in 1965 to a broad renovation of the school system aimed at adapting the lycée, technical streams and higher education to the evolution of the school population. The hope was to rationalize choices of educational paths and improve students' chances of success by gradual selective orientation and by greater homogeneity in the curricula of the new secondary school *sections*, which would be defined by "a few major cultural axes", in view of ensuring the positive character of the orientations toward forms of culture "adapted to the various capacities of the students". The second-*cycle* reform was connected to the reform of higher education, which aimed to obtain a better "performance" from the students by developing specialized vocational training alongside classical university courses.

The 1965 reform accentuated the differentiation of the main subjects taught in the various second-cycle *sections* and revised the orientation mechanisms based, in large part, on the choice of Latin. Greek and Latin were made optional in all *sections*, including the literary ones. As a result, the former organization was completely overhauled. The old "Latin-modern languages" *section* became an option in *section A*, which added the possibility of an initiation to economics starting in seconde that opened access to the new *premières* and *terminales B*,[29] and options in modern languages for students not taking Latin. *Section C* added 3 obligatory hours of mathematics, thus reinforcing its scientific curriculum, and like *section A*, opened access to students not taking Latin by offering more modern languages.

The hopes the reform had kept alive of a more rational orientation for students, one that would be more adapted to both their aptitudes and the openings in the job market, were soon dashed.

Soon after the school restructuring, students that in the former system would have opted for *section* M modern actually opted massively for the literary *sections* rather for the scientific *sections*, as Table 1.4 and Figure 1.6 show. Students not taking Latin naturally opted for *math-élém*, or for the experimental sciences before the reform, but this was no longer the case when the choice between science and humanities was made upon entering *seconde* and independently of whether or not they took Latin or Greek. Furthermore, French teaching careers, which had recently dropped the classical literature requirement, offered new occupational opportunities to those who did not learn Latin or Greek.

Table 1.3: *Comparison of the number of students in* première *in classical, modern and technical public* lycées *in 1967–1968 and 1965–1966*

	1965–1966	1967–1968	Difference
Sections: A + ex B	3,994 + 22,378	55,069	+28,697
B (eco)		7,825	+7,825
C – A'	14,876 + 2,414	22,799	+5,509
D (ex M')	32,702	34,055	+1,353
M	42,734		–42,734
Premières T – T' and Technical	63,611	66,709	+3,098
Total	182,709	186,457	+3,748

Source: Ministère de l'Education Nationale

Table 1.4: *Comparison of the number of students in première sections in public schools in 1980–1981 and 1968–1969*

Sections	1968–1969	1980–1981	Difference
A	54,708	41,813	–12,895
B	11,245	36,511	+25,266
C	25,046	40,461	+15,415
D	35,601	40,402	+4,801
E	8,112	7,861	–251
F	18,592	34,168	+15,576
G	24,435	53,284	+28,849
H	66	872	+806
Long vocational	9,968	15,632	+5,664
Total	187,773	271,004	+83,231

Source: Ministère de l'Education Nationale

In the end, the choices following the changes in the secondary *sections* after 1965 gave rise to a bigger gap between the social aspirations prompted by the school paths and the opportunities provided by the job market. The "explosions" in 1968 were not unrelated to the discrepancy perceived by the large post-war generations between the school level achieved and occupational prospects; this was further aggravated by the fact that increased specialization in the university-bound streams only rigidified the path followed by a large portion of the student population without specific career plans.

The much-talked about idea of a "global" crisis in education, at the time, rested on the lack of fit between educational choice and the job market, a gap that was both quantitative and qualitative. Population growth and the endogenous increase in the demand for education meant that professional hopes grew more quickly than the economic system. These educational choices were directed more massively toward the literary disciplines, a trend that was reinforced in France by the fact that classical languages were no longer a barrier. This was the interpretation advanced at the time by certain analyses of the crisis in the school system, which identified the preferences of a student population dictated by a job hierarchy based on the prestige conferred by these jobs, and which did not correspond to with the new hierarchy of specialisations demanded by the growing economy (Coombs 1968: 16–21).

In the 1970s, pressure from the demand for education increased greatly on *section C*, while *section A* lost students to *B*, *C* and *D*, as can be seen in Figure 1.11. The reputation of *section A* was linked in part to the selectivity of its curriculum. However in the wake of the 1965 reform, the barrier of the classical language requirement was lifted. Furthermore there was an influx of girls into this *section*, in particular because of its fusion with the former *section B*.[30] This feminisation helps explain boys' desertion of the philosophy classes (Cherkaoui 1982: 230), which, as it increased yearly, had a negative impact on the image of the *section*. Gradually the reputations of the second cycle *sections* became differentiated, creating a new hierarchy that went from literary dominance to scientific primacy and would soon have a strong influence on student orientation in virtue of their academic level: doing "*C*" became almost a rule for the best students; in passing from *troisième* (usually classical) into *seconde C* they were merely going into the next class up. Some students forsook the literary *section* for the scientific *section* for reasons that recall those that prompted the abandonment of Greek and Latin by the best students bound for the *grandes écoles* following the 1902 reform. The context here was very different and favoured strategies of this type. The *grandes écoles* were protected from the effects of mass education and therefore increasingly attractive, especially since their increase in number and their diversification in the 1960s made

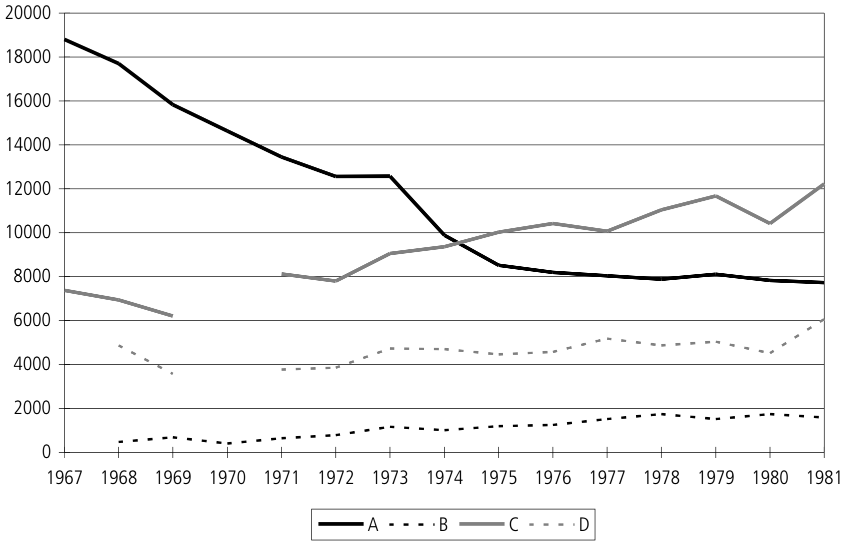


Figure 1.8: *Evolution of the number of students taking at least one classical language in the public* premières *between 1967 and 1981*

Source: Ministère de l'Education Nationale

it possible to ensure success to those who could avail themselves of preparatory classes. In 1966, over 40% of the boys who passed their baccalauréat coming out of *math-élém* went directly into the first year of preparatory classes for the *grandes écoles*, as compared with 9% of those coming out of philosophy. In 1992, 37% of *section C* students (both boys and girls) would go into "*prépa*"[31], as opposed to 5% of *section A* students. Alternatively, the use of the mathematics *section* as an access path to preparatory classes for the major competitive exams led to it developing strong programmes, which helped to maintain the selective character of the teaching. Once the scientific *sections*, and *C* in particular, become the only paths of access to the majority of these schools, they attracted the majority of the best students. Comparison of the number of students choosing the Latin option in the two *sections* presented in Figure 1.8 shows that, while these numbers decline in *section A*, they gradually rise in *C*, but in a smaller proportion.

These changes, which run counter to the logic of the curricula direction of the *sections*, show that certain of the best students formerly destined for the *A section* have chosen *C*. In addition, *section B* gains those students from *section A* who are not planning in general to go into purely literary studies. It became the preferred stream for future law students. In the early 1970s, fewer than 20% of students entering law school were new holders of a *section B* baccalauréat and nearly two thirds the new holders of a *baccalauréat A*. At the beginning of the 1990s, more than 40% had a *baccalauréat B* and only a quarter a literary baccalauréat.

The main goals of the 1965 reform, equalization of opportunities, the positive character of the academic choices and the massive re-direction of students toward scientific and technical *sections* led to measures that ran counter to the hoped-for changes. The desire to create a more democratic school system, by making classical letters optional, was detrimental to the expected development of the scientific curricula. Instead of growing and becoming more democratic, as they would have done if they had accepted a broader selection of students from the former modern *sections*, the scientific *sections* developed only gradually and for reasons that were not a primary outcome of the reform, but a secondary one. In 1965, in effect, students first turned massively toward *section A*, which had been combined de facto with the *B section* and still enjoyed prestige, and then gradually opted for the scientific *sections*. Academic choices reinforced the new hierarchy of the *sections* but also the differentiation by social background of their students. If

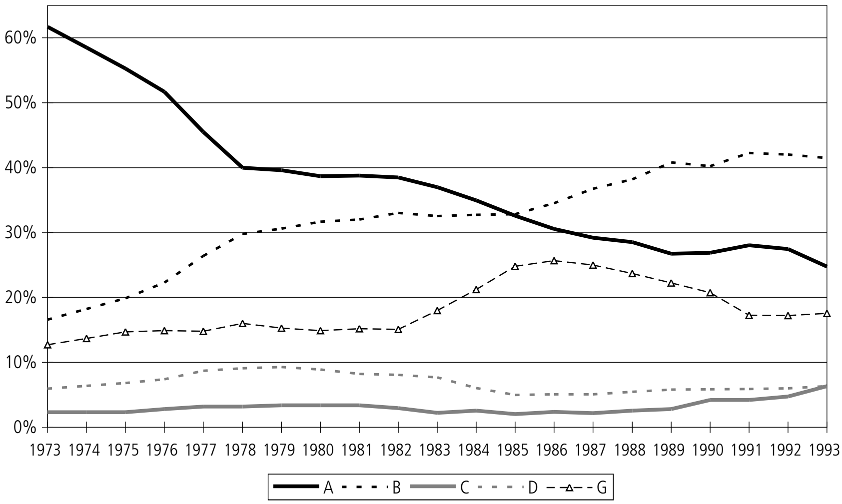


Figure 1.9: *Changes in the proportion of students obtaining the* baccalauréat *from 1900 to 1995, by section*

Source: Ministère de l'Education Nationale

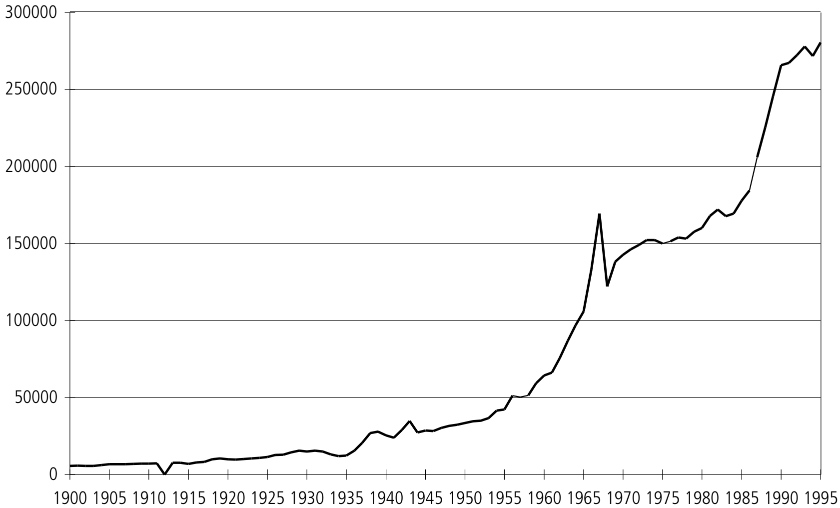


Figure 1.10: *Changes in the number of students obtaining an academic* baccalauréat *from 1900 to 1995*

Source: Ministère de l'Education Nationale

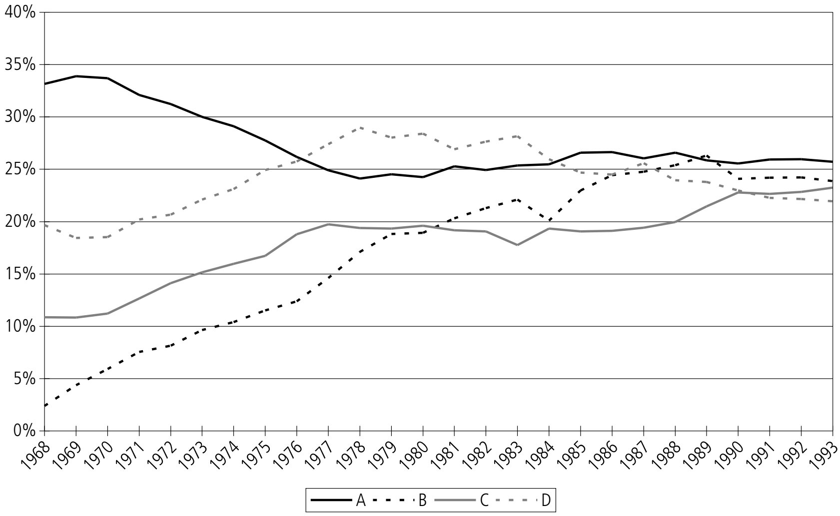


Figure 1.11: *Changes in the proportion of students obtaining an academic baccalauréat from 1968 to 1993, by section*

Source: Ministère de l'Education Nationale

the hierarchy of the streams corresponded well enough to the average academic level of the students, the statistical dispersion of such levels may be more or less large. Students who turned away from prestigious streams when they were admissible were most often girls or children from lower social backgrounds. On the contrary, the more privileged milieus were more insistent on getting their children in. The evolution of the numbers of students in the *sections* shows that more boys than girls favoured the scientific *sections* and that girls from less-advantaged backgrounds tended to prefer these *sections* less. The apparently sub-optimal character of the orientations of children from modest social backgrounds, like the orientations of girls in general, can be explained in particular by a shared element in their respective situations, namely the fact of being upwardly mobile (Cherkaoui 1982: 225). The lower risks for these categories of students of becoming downwardly mobile is reflected in academic choices by less sensitivity to the "reputation" of the *sections*.

Table 1.5: *Curricula of* première *and* terminale *sections of the secondary school from 1902 to 1965 reforms*

YEAR	LEVEL	SECTION	WEEKLY HRS	MAJOR SUBJECTS								
				French	Latin-Greek	Language 1	Language 2	Philosophy	History-Geography	Maths	Phys.-Chem.	Biology
1902	*Première*	A (Lat–Greek)	23h + 4 optional	14h (with latin–greek)		2h	X	X	5h	2 + 2 optional	3.5h	X
		B (Lat–Lg)	21h + 6 optional	7h + 2 optional		7h		X	5h	2 + 2 optional	3.5h	X
		C (Lat–Sc)	26h	7h (with latin)		2h	X	X	3h	Eh	4.5h	5h
		Modern	28h	4h	X	7h		X	3h	5h	4.5h	5h
	Terminale	Philo	19.5h + 10 optional	X	4 optional	2 optional	1 optional	8.5h	4.5h	2 optional	5h	2h
		Math	26.5h + 2 optional	X	X	2h	1 optional	3h	4.5h	8h	7h	2h
1925	*Première*	A (Lat-Gk-Sc)	24.5h + 1 optional	3h	8h	2h	X	X	3.5h	4h	4.5h	X
		C (Lat-Sc: A')	24.5h +1 optional	4.5h	4h	4h	X	X	3.5h	4h	4.5h	X
		Modern (B)	25h	4.5h	X	4h	4h	X	3.5h	4h	4.5h	X
	Terminale	Philo	23h + 2 optional	2h	X	2h	2 optional	8.5h	4h	2h	3h	2h
		Math	24.5h + 2 optional	X	X	2h	2 optional	3h	4h	8.5h	4.5h	2h
1931	*Première*	A (Lat-Gk-Sc)	23.5h	3.5h	7.5h	1.5h	X	X	3.5h	3.5h	4h	X
		C (Lat-Sc: A')	23.5h	3.5h	5h	3.5h	X	X	3.5h	3.5h	4h	X
		Modern (B)	23.5h	4.5h	X	3.5h	4h	X	3.5h	3.5h	4h	X
	Terminale	Philo	24h + 2 optional	2h	X	2h	2 optional	8.5h	3.5h	1.5h	4h	2.5h
		Math	25h + 2 optional	X	X	2h	2 optional	3h	4h	8h	5.5h	2.5h

Table 1.5: *Continued*

YEAR	LEVEL	SECTION	WEEKLY HRS	MAJOR SUBJECTS								
				French	Latin-Greek	Language 1	Language 2	Philosophy	History-Geography	Maths	Phys.-Chem.	Biology
1941	*Première*	A (Lat-Gk-Sc)	24h + 4 optional	3h	6h	2h + 1 optional	X	X	2.5h	2h + 1 optional	2.5h	X
		B (Lat-Lg: A'')	25h + 2 optional	3h	3h	3h	2h	X	2.5h	3h	2.5h	
		C (Lat-Sc: A')	25h + 2 optional	4h	4h	3h	X	X	2.5h	3h	2.5h	X
		D Modern	25h + 2 optional	4h	+	3h	3.5h	X	2.5h	3h	3h	X
	Terminale	Philo	22h + 7 optional	1h	X	1h	1 optional	8.5h	2.5h	lb	2h	3.5h
		Math	22h + 8 optional	X	X	1h	1 optional	3h	25h	8.5h	8.5h	2.5h
1945	*Première*	A	23.5h + 4.5 optional	4h	7h	3h	X	X	4h	1.5 optional	3.5h	X
		B	23.5h + 4.5 optional	4h	3h	3h	4h	X	4h	1.5 optional	3.5h	X
		C	23.5h + 4.5 optional	4h	3h	2h + 1 optional	2 optional	X	4h	4h	4.5h	X
		Modern	24.5h + 3 optional	4h	X	3h	3h	X	4h	4h	4.5h	X
	Terminale	Philo	23h + 3.5 optional	1h	1.5 optional	1.5h	1.5 optional	8h	4h	1.5h	2h	2h
		Sc.exp.	25.5h + 4.5 optional	1 optional	1.5 optional	1.5h	1.5 optional	5h	4h	4h	5h	4h
		Math	27h + 3.5 optional	X	1.5 optional	1.5h	1.5 optional	3h	4h	8h	5.5h	2h
1952	*Première*	A	24h + 4 optional	4h	7h	3h	X	X	4h	1.5h	2.5h	X
		B	24h + 5 optional	4h	3h	3h	4h	X	4h	1.5h +1.5 optional	2.5h	X
		C	24.5h +6 optional	4h	3h	3h	2 optional	X	4h	4h	4.5h	X
		Modern	24h	4h	X	3h	4h	X	4h	4h	4.5h	X
	Terminale	Philo	23h + 3.5 optional	1h	1.5 optional	1.5h	1.5 optional	8h	4h	1.5h	2h	2h
		Sc.exp.	25.5h + 4.5 optional	1 optional	1.5 optional	1.5h	1.5 optional	5h	4h	4h	5h	4h
		Math	27h + 3.5 optional	+X	1.5 optional	1.5h	1.5 optional	3h	4h	8h	5.5h	2h

Table 1.5: *Continued*

YEAR	LEVEL	SECTION	WEEKLY HRS	MAJOR SUBJECTS								
				French	Latin-Greek	Language 1	Language 2	Philosophy	History-Geography	Maths	Phys.-Chem.	Biology
1965	*Première*	A	25h	4h	3h or L2	3h	3h or L	X	4h	2h	2h	2h
		B	27.5h (4h: econ.)	3h	3h or L2	3h	3h or L	X	4h	4.5h	2h	2h
		C	27h + 3 optional	3h	3h or L2	3h	3h or L + 3 opt.	X	4h	7h	5h	X
		D	27h	3h	3h or L2	3h	3h or L	X	4h	5h	4h	3h
		T	32h	3h	X	3h	X	X	2h	6h	4h	X
	Terminale	A	26h	3h	3h, L2 or L3	3h	3h or L	8h	4h	2h, L2, L3, Gk	X	X
		B	27.5h (4h: econ.)	2h	3h or L2	3h	3h or L	5h	4h	4.5h	X	X
		C	27h + 3 optional	2h	X	2h	3 optional	3h	3h	8h	5h	2h
		D	26h	2h	X	2h	X	3h	3h	6h	4h	4h
		T	32h	2h	X	2h	X	3h	X	7h	5h	X

NOTES

1. Most of the data that served as a basis for this study stem from research carried out in the French National Archives.
2. High-level competitive examination for recruiting teachers.
3. These levels of study correspond to students in the first two years of the *lycée* which lasts three years; they are theoretically 15–16 (sophomores in the US system) and 16–17 years old.
4. There is a large number of higher educational institutions in France. Among these institutions, "*grandes écoles*" (business schools, engineering schools, Institute of Political Studies …) are the most prestigious. Normale Supérieure (ULM), Polytechnique, Centrale, les Mines, are among the most famous of engineering schools (Normale Sup., is also an extremely selective school for literary candidates); HEC and ESSEC are among the most famous of business schools. To be admitted to engineering school or business school, students must usually pass an entrance exam. The preparation takes two years (previously one year in the case of business schools) in "*classe préparatoire*"**.** Studies last three years after the two years of "prépa".
5. The curricula for the *première* and *terminale* classes are shown in Table 5 at the end of the chapter.
6. Conseil Supérieur de l'Instruction Publique, Monday 15 January 1923, Archives Nationales.
7. This secondary level program was followed by students after leaving primary school, but was overseen by the primary-school sector and not by the secondary-education sector. *Enseignement primaire supérieure* (EPS) existed in France between 1888 and 1941. This program was taught either in primary schools in the form of complementary courses or in specifically designed schools called *écoles primaires supérieures.*
8. F. Vial (1936: 259).
9. Instructions of 1925.
10. The "lycée" corresponds to the (senior) high school and lasts three years.
11. The complementary courses continued to prosper even after the EPS were brought into secondary education.
12. The "collège" corresponds to the junior high school in France and lasts four years.
13. Relative to primary education.
14. Relative to secondary education.
15. In 1940, not including the Academy (administrative area) of Strasbourg; in 1941 and 1942, not including the Academies of Strasbourg and Algiers.
16. A study of the applications of those admitted to the Ecole Nationale des Ponts et Chaussées confirms, in spite of the feeble numerical size of the classes, the gain of *section A* on *section C* between 1930 and 1941, and its abandonment by those bound for the competitive entrance examinations to the *grandes écoles* in the mid-1940s.
17. Since 1939 the HEC has lasted three years. The preparatory classes, of which there were only some ten in 1936, multiplied in the *lycées* until the end of the 1980s.

The teaching programs, formerly dominated by law, were revised and oriented in the 1950s toward the disciplines of economics and business management.

18. Modern languages always held an important place and between 1932 and 1963, accounted for nearly a third of the coefficients.
19. The evolution of the school background of the winners of the competitive examinations is shown on graphs 2–4.
20. The parity rates are calculated with respect to the *sections* represented in the school system in the previous two years.
21. The second "*philo-science*" or "experimental sciences" *baccalauréats* are not shown on the graph because of the small number of students students (4 on average from *section A* between 1944 and 1957).
22. The second "*philo-science*" or "experimental sciences" *baccalauréats* are not shown on the graph because of the small number of students (4 on average from *section C* between 1944 and 1957).
23. Last year of the *collège* (pupils are theoretically 14–15 years old).
24. With respect to the 1931 curricula, *section C* gained an additional hour of sciences and lost two hours of Latin, while *section A* gained an hour and a half of modern languages and lost two and a half hours of sciences.
25. The *A*' *sections*, very similar to the 1931 *A sections*, had a Greek program almost comparable with that taught in *A* (3 hrs as compared with 4 hrs) and a science program very close to that of *C* (equivalent in mathematics, and 3¼ hrs of physics compared to 4½ hrs in *C*).
26. These calculations were made on the basis of a whole cursus, going from the *sixième* to *terminale* (OECD 1966)
27. Cf. Circulaire of 14 November 1958.
28. The first cycles have 3 groups of *sections*: 'Classical and modern *sections* of the long general curriculum (path I); modern *sections* of the short general curriculum (path II); the classes of the transitional cycle and the practical *terminal* cycle (path III)" (Cf. Décret no. 63-794 of 3 August 1963).
29. *Section B* was revised in this sense in 1959.
30. The divisions of *section A* are not obligatorily separate classes, especially since fewer and fewer students take Latin and Greek.
31. To be admitted to a *grande école*, students prepare the entrance in "*classe préparatoire*" ("*prépas*").

2
Some Elements of Educational Choice Models

1) ASYMMETRY OF INFORMATION AND THE ROLE OF SCHOOL CERTIFICATIONS: AKERLOF'S MODEL

The model of George Akerlof (1970) is based on the example of the market for used cars (in America bad quality used cars are called "lemons"). This model shows why markets can be reduced in size or disappear because of problems related to uncertainty about the quality of cars, even though there are potential buyers and sellers that could otherwise reach agreement.

We assume that used cars are assessed according to an idea of average quality that corresponds to an average quality of cars offered for sale by the entire group of sellers of such cars. Thus it is in sellers' interest to place goods of mediocre quality on the market, but the average quality of goods on the market is lowered as a result, and the total size of the market as well. Formally, the model is presented as follows:

Let S be the function of supply, a function of price p; let D be the function of demand, a function of price p and estimated quality $y(p)$. At equilibrium, supply is equal to demand for a given average level of quality:

$$S(p) = D(p, y(p))$$

We assume that there are two groups of individuals, the *sellers*, whose function of utility is represented by:

$$U_1 = M + \sum_{i=1}^{n} x_i$$

and the *buyers*, whose function of utility is represented by:

$$U_2 = M + \frac{3}{2}\sum_{i=1}^{k} x_i$$

M is the consumption of goods other than cars; x_i is the quality of the ith car, and quality is uniformly distributed from zero quality to maximum quality; n and k are the numbers of cars owned by the group of sellers and the group of buyers, respectively.

The satisfaction ("utility") of sellers is increased by the sale of a car x_i at price p if:

$$M + p + \sum_{i=1}^{n-1} x_i > M + \sum_{i=1}^{n} x_i$$

that is, if $x_i < p$.

This is why sellers sell cars whose quality is inferior at price p of market equilibrium (good and bad cars are sold at the same price because it is impossible for a buyer to determine a priori the difference between them).

The satisfaction of buyers increases through the purchase of a car x_i at price p if:

$$M - p + \frac{3}{2}\sum_{i=1}^{k+1} x_i > M + \frac{3}{2}\sum_{i=1}^{k} x_i$$

that is, if $\frac{3}{2}x_i > p$.

Now, since cars placed on the market have a level of quality that is uniformly distributed from 0 to p (we have already seen that sellers keep cars whose quality is superior to p), the average quality of these cars that can be estimated by buyers is $\frac{p}{2}$. Since buyers do not know x_i but estimate it to be $\frac{p}{2}$, the market equilibrium price has to satisfy $\frac{3}{2} \times \frac{p}{2} > p$, that is, $\frac{3}{4}p > p$, which is of course impossible. Therefore no transaction takes place.

The paradox illustrated by this model is that there are cars of quality q for which buyers are ready to pay $\frac{3}{2}q$ and sellers ready to sell for *q*, but there are externalities between the sellers of good quality cars and sellers of bad quality cars. In fact, the sale of bad quality cars lowers the estimation buyers make of the likely quality of cars, and thus lowers the price they are ready to pay. And cars of good quality cannot be put on the market without costing the seller part of the advantage that should come from selling a good quality car. If quality was observable, each car of quality q would be sold at price p, which price would be located between q and $\frac{3}{2}q$. In a situation of uncertainty, and taking account of the greater interest that owners of bad cars have in selling their cars, relative to other owners, the market could completely disappear. Nonetheless there are ways in which sellers of good cars can get around this impasse, for example by obtaining from a third party (an expert) a guarantee of some kind that allows the uncertainty of potential buyers to be reduced. This "signal" of quality has nonetheless a cost and it corresponds to a kind of wastage since it has no other utility than to certify the quality of a good offered for sale; however, the necessity of such guarantees is at the origin of many economic institutions.

The value of this model certainly goes beyond the realm of exchange situations of the economic sort. Many social relations are condemned because expectations, that are based on more or less subjectively evaluated characters at the level of a group of social actors, harm a whole segment of the membership of that group. Akerlof emphasizes the importance of the school institution as a provider of support for employment of minorities. In fact, the economist explains, employers can refuse to hire members of minority groups for certain types of jobs. Their decision is not necessarily based on segregationist motives, but rather on a desire to maximize profit in a situation of uncertainty; in the absence of a dependable educational qualification, the skills of a job seeker can be rationally evaluated, under certain conditions, in accordance with the average skills observed in the community the job seeker belongs to. In this way good quality education serves as a substitute for this statistic. By grading students, education reduces employers' margin of uncertainty. The certifying establishment, as Akerlof says (1970: 494) must be credible. Greater or lesser reliability of educational quality influences the economic opportunities of students.

2) SCHOOL STRUCTURES, INDIVIDUAL PERFORMANCES AND DECISIONS: SPENCE'S MODEL

Faced with a job seeker, an employer considers a set of personal data (school courses taken, work experience, race, gender, etc.), some of which can be altered (signals) and some of which cannot be (indices). The employer trusts his or her own experience, and so, in evaluating job applicants, will intuitively calculate the conditional probabilities based on various combinations of signals and indices. Signals can be manipulated, according to Michael Spence (1973), by individuals, and the condition that enables them to have a discriminant value is that their "cost" must be negatively correlated with individual productive capabilities. Thus there is a semi-circular relationship between the choice of a signal for individuals and the adjustment, or the self-confirmation, of the beliefs of the employer, as illustrated in Figure 2.1. If we assume that the job market is competitive, hoped-for productivity on the part of an applicant is assumed to be the basis on which his or her salary is to be evaluated.

Formally, the model presents itself as follows. Two groups of individuals are looking for jobs. They are distinguished by different average productivity levels. The cost of reaching a given level of education (y) for an individual is negatively correlated with his or her productive capabilities. Therefore the cost of a higher level of education is greater to the extent that the individual is less "productive".

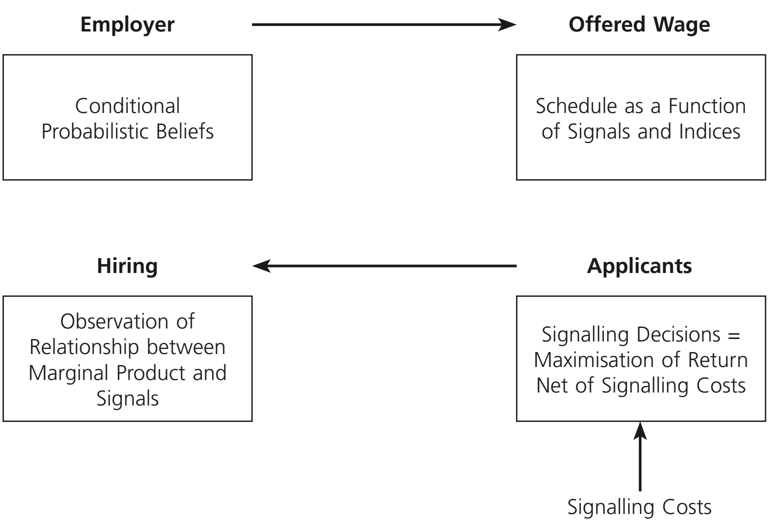


Figure 2.1: *Informational feedback in the job market*

Characteristics of groups as a function of their level of performance in the model of Spence

Group	Marginal product	Proportion of population	Cost of educational level (y)
I	1	q	y
II	2	$1-q$	$y/2$

Let us assume that, in accordance with the beliefs of an employer, there is a level of education y^* such that:

if $y < y^*$, the productivity of the individual is at level 1
if $y > y^*$, the productivity of the individual is at level 2

We may observe here that there will not be any level of education chosen other than y^*. In fact, education here has only the value of a signal; an individual who cannot attain y^* should rationally choose $y = 0$ in order not to invest in a signal that a priori has no interest. On another hand, individuals who choose to reach education level y^* have no a priori interest, for the same reasons, in going beyond that.

Group I will choose not to invest in education if the investment is not cost-effective. Since we know that the pay rates these individuals are likely to be offered correspond to the expectation of productivity attached to a level of education equal to 0 or 1, it follows necessarily that:

$1 > 2 - y^*$ assuming that $y^* > 1$

In the same way group II will choose to invest in education if the investment is cost-effective, if for example:

$2 - y^*/2 > 1$ so that $y^* < 2$

Thus the employer's beliefs will be confirmed if:

$1 < y^* < 2$

We can find an infinite number of possible values for y^* and an infinite number of equilibria. These equilibria, Spence notes, are not equivalent from the point of view of welfare. To the extent that y^* increases past 1, group II is investing at a complete loss while group I remains unaffected. In return, group I is worse off than it would be if there were no signalling at all. In fact, if no signalling takes place, each individual would be paid in accordance with his or her unconditional expected marginal product which is just (since we know that the two groups represent the proportions q et $(1-q)$, respectively, in the population):

$$q + 2 \times (1 - q) = 2 - q$$

Even if $y<2$, the individuals in group II may be worse off than it was with no signalling, unless the following condition is operating:

$$2 - y^*/2 > 2 - q \text{ so that } y^* < 2q$$

If the proportion of non-productive (Group I) people in the population is small (here $q > \frac{1}{2}$), the chances are good that an investment in education will not be very cost-effective. The associated costs are likely to exceed the losses caused by the presence of non-productive people making the level of performance expected by the employer go down a little. On the other hand, the more productive individuals (Group II) are a minority, the more it is to their advantage to identify themselves to employers.

Also, the economist adds, the requirement that unknown productivity be negatively correlated with the signalling costs is a necessary condition, but not sufficient for signalling to take place. There must also be a sufficient number of possible signals associated with appropriate costs. For example, if group I only has a choice between a level 1 education (too low) and a level 3 (too high), it will not make any use of these potential signals.

The proposed model thus allows us to look for the conditions under which a signal might be of interest to groups of individuals distinguishable in terms of their productive capabilities. It gives us an idea of the different types of equilibrium that might come to be established in a given market as a function of employers' beliefs and the likely reinforcement of those beliefs. Such reinforcement is due to adaptation on the part of job seekers to conditions placed on employment. For a world in which uncertainty is total, a world with greater certainty is substituted, but in that surer world, the play of subjectivities leads to the creation of arbitrary rules of identification, and in fact to systematic overinvestment in education. Spence explains that there are a number of possible equilibria. When beliefs are self-confirming, there may be stable prerequisites for jobs that do not produce any information by their existence, and which have no function. Sometimes everyone in the world loses because of the existence of signalling; sometimes some people win and some lose. The model can be made more complex without its conclusions being invalidated. Thus, we can use multidimensional variables for signals (years of education, institution attended, grades, subjects of particular value, etc.). There can be many groups, some suited for one kind of work, others for other kinds. Spence made a particular study of the role of indices (gender, race, etc.) in the formation and the reinforcement of beliefs on the part of employers. He showed that if employers consider conditional probabilities for whatever reason, also based on these indices, the equilibria to which these beliefs lead will be discrete and the prerequisites demanded from individuals belonging to distinct groups of reference may be arbitrarily different.

For example, if y^*_w is the level of signalling required from a group of women and y^*_8 that required from a group of men, the conditions that would lead to the self-confirmation of the employer's beliefs are: $1 < y^*_w < 2$ and $1 < y^*_m < 2$. There is no reason, at least under the hypotheses of this model, why y^*_w would equal y^*_m.

The consideration of productive effects from education is compatible with this model. The very idea of productive capabilities in Spence's model can appeal not only to general individual dispositions that serve economic productivity, but as easily to cognitive dispositions acquired in school that have a long-term effect.

The level of performance "signalled" by school performance is very likely to be linked to selective effects and to the productive effects of particular types of schooling. But schools do not, for all that, insure a primary "function" of filtering vis-à-vis the job market, and educational performance only furnishes an indicator (an important, but not a unique one) of productivity in the economic sense.[1] Approaches in terms of "screening" are opposed to approaches in terms of human capital at the level of the importance assigned to structural variables in the explanation of social and occupational trajectories, but the two types of approach are in many respects complementary. According to Gary Becker (1964), the function of "screening" in school is real in a world where information is imperfect, but on the other hand is of little weight in the determination of differences in pay due to training. The theory of human capital begins with the idea that variations in income earned through work are due to differences in the quality of work linked to the "human capital" acquired by individuals, that is, cognitive skills that are economically useful. Analyses, however, have generally up to now been unable to determine, without a large margin of uncertainty, the portion of these differences in income that are attributable to educational investments in themselves. They failed to establish the existence of univocal links between skills acquired in school, individual dispositions, and careers in occupations. The approach offered by the theory of screening, an example of which is given by Spence's model, is less interested in the general economic impact of the level of education reached by school-attending populations, than in mechanisms that explain their distribution in the economic and social system. A consideration of the role of signalling played by school-related "certification" has the advantage of allowing us to grasp the functioning of real social processes by taking account of structural variables, thus exhibiting "dysfunctions" arising between the educational system and the social or economic systems. The cognitive impact of education is not at all denied, but it tends to take on a more problematic character, if we consider, for example, the fact that the expansion of the school system did not lead to a lessening of inequality of income distribution. The role of filter played by educational levels is shown in the endogenous character of the expansion, in which the absolute value associated with diplomas diminished, while employers raised their standards in recruiting (Blaug 1985).

3) THE DIFFUSION OF CULTURAL PREFERENCES: THE LOGISTICAL MODEL

One model of social influence was used by James Coleman, Elihu Katz and Herbert Menzel (1957) in their analysis of the adoption of a new medicine by a group of doctors. They observed that at first, the influence of social networks operated among the doctors through ties of a professional nature, and then it spread through networks of friends. The more isolated doctors were slower to adopt the new drug, but did so independently of their colleagues' own reactions. These observations led Coleman *et al.* to set in opposition two models of the diffusion of an innovation, based on differential equations. The first refers to a process that does not include intervention by interactions between decision-makers, and the second is a logistics model translating a "snowballing" process. This model allows us to account for initial slow growth that becomes faster, then slower again, tending to flatten out.

(1) Individual innovation model—the number of individuals adopting the innovation at each interval of time remains a constant percentage of those who have not already adopted it:

$$\frac{dy}{dt} = k(1-y)$$

(2) "Chain-reaction" innovation model—the number of individuals adopting the innovation at each interval of time increases in proportion to those who have already been converted:

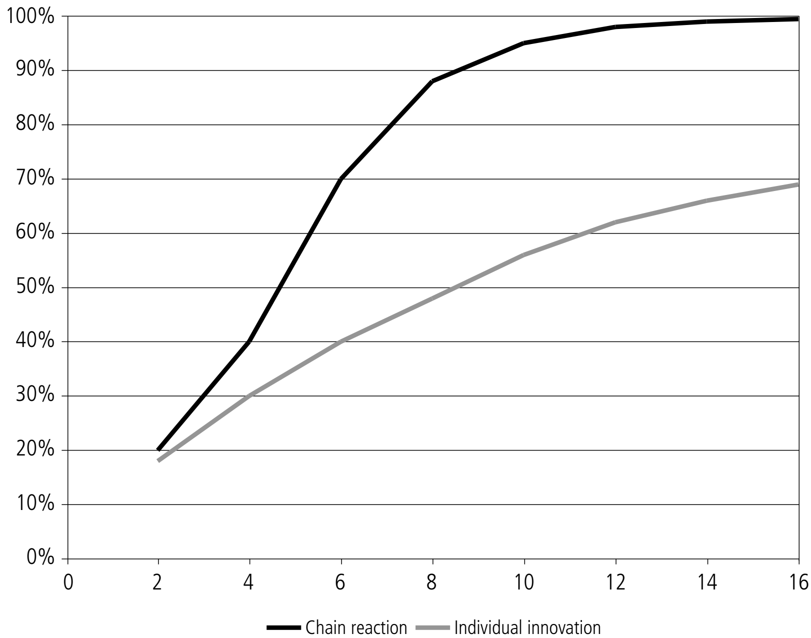


Figure 2.2: *Comparison of the "chain-reaction" innovation model with individual innovation model: change in cumulative proportion of individuals who have introduced the innovation*

Source: Coleman, Katz & Menzel (1957) fig. 4, p. 261.
Y-axis: months after start of process

$$\frac{dy}{dt} = ky(1-y)$$

Logistic diffusion models were used by Mohamed Cherkaoui (1983: 39–4)[2] who showed that education can be identified with a cultural commodity, since the change in the number of *baccalauréat* candidates conformed to that of many diffusion phenomena over time. Cherkaoui translates the propositions governing the construction of the mathematical function as follows:

Let a be the saturation level. This level represents the maximum size of the population of baccalauréat candidates, lower than that of the age-group of young people between the ages of 17 years 6 months and 18 years.

Let x be the number of candidates at time t; $(a-x)$ is equal to the distance separating x, the increased level attained, from a, the saturation level. The rate of increase of x per time unit is proportional to x and to $(a-x)$. This relation can be represented formally by the following equation:

$$\frac{dx}{dt} = k \times x \times (a-x)$$

where $k > 0$ designates a coefficient of proportionality.

x, which increases with time, is a factor of acceleration; $(a-x)$ is a restraining factor. When saturation level a is approached, $(a-x)$ tends towards zero, and the rate of increase, $\frac{dx}{dt}$ also tends towards zero.

The speed at which the phenomenon develops $\frac{dx}{dt}$ is proportional to the number x of individuals who are factors of propagation of change and to the number $(a-x)$ of individuals who constitute the number of individuals still likely to follow the changing trend in educational behaviour.

Figure 2.3 shows that the change in the percentage of an age-group of high-school graduates, between the end of the nineteenth century and the end of the twentieth century, takes the overall shape of a sigmoid (S-shaped) curve, which can be associated with a diffusion phenomenon such as that formalized above. In Figure 2.2 the change in the proportion of French students in a generation having obtained the baccalauréat degree reflects the intertwining of several sigmoid curves connected with specific political reforms, in particular the conversion

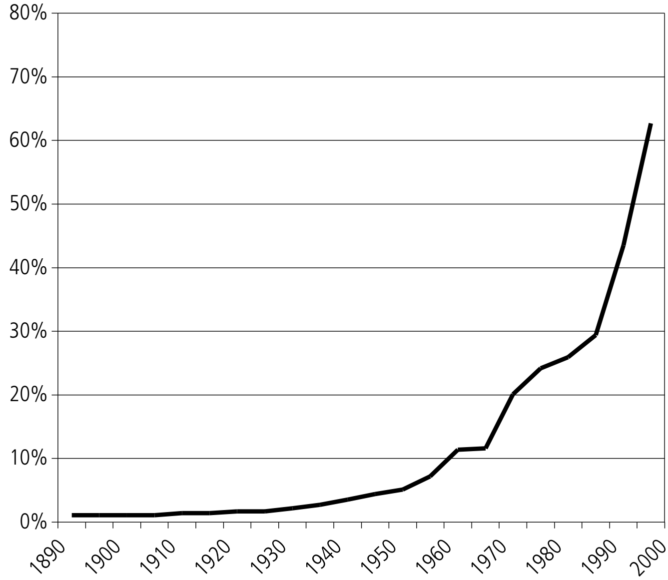


Figure 2.3: *Change in the proportion of baccalauréat holders in a generation*

Source: French Ministry of Education.

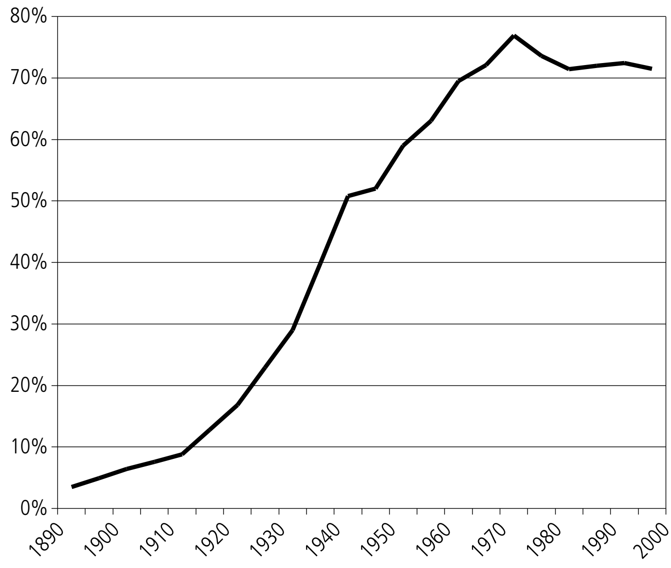


Figure 2.4: *Change in the proportion of high-school graduates in a generation, between 1890 and 1995*

Source: US Department of Education and US Department of Commerce.

of *brevets* into technical *baccalauréats* at the end of the 1960s and the creation of vocational *baccalauréats* at the end of the 1980s.[3]

4) THE INTERDEPENDENCE OF THE CHOICE OF A STREAM OF STUDY: SCHELLING'S MODEL

The description given by Thomas Schelling (1971) of processes that underlie certain phenomena of segregation proves pertinent to the understanding of the dynamic of change in the distribution of a population of students in different parts of the educational system. The separation of social groups into segregated groupings can take place in a number of ways; it may occur in a more or less organized way, or it may be the result of actions that are more or less intentional. The kinds of segregation Schelling was interested in stem from individual behaviours caused by sensitivity to certain characters that differentiate individuals from the overall population under consideration. He shows that it is difficult to evaluate the degree of this sensitivity based on the sharpness of the separation between groups. In fact, the processes that were the object of Schelling's dynamic models amplify the effects of individual motivations that are the origin of the segregation patterns observed at the social level.

Let us assume that individuals dislike, with regard to some social or ethnic group that they belong to, finding themselves to be a minority, for example in an urban neighbourhood. The explanatory hypothesis of the phenomenon of segregation developed by Schelling is based on the interdependence of individual decisions, where individuals are decision-makers for themselves and are part of the environment of their neighbours. This hypothesis underlies a phenomenon of amplification that opposes individual preferences and the aggregate results of decisions. Schelling proposes a simulation of the process of segregation at work with the help of an example, based on the movement of chess pieces on a chessboard. The pieces are of two kinds, underlying the stable and identifiable character of belonging to a determinate group. The individuals are assumed to be sensitive to the groups their neighbours belong to. At every moment they are able to move if they are not happy. The possibility of moving is represented on the chessboard by the existence of empty spaces. The variables here are the number of individuals in each group, the degree of sensitivity that is the origin of discriminatory behaviour, the definition of neighbourhood and the rules that determine the order and the locations involved in moving.

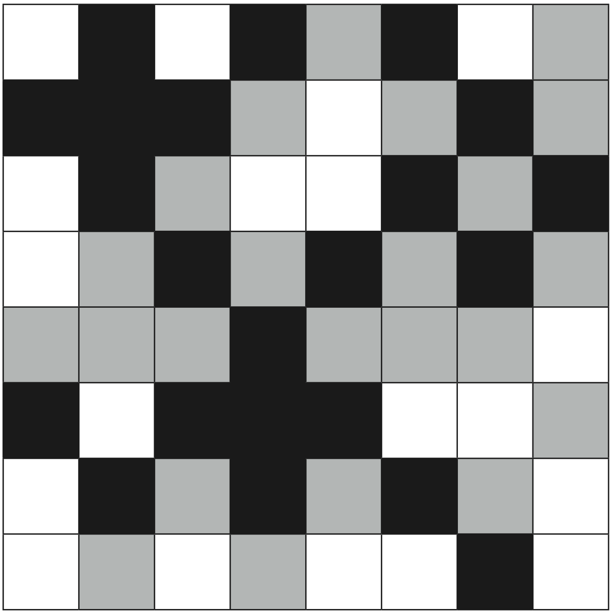


Figure 2.5: *Simulation of the movement of individuals on a chessboard: Step 1*

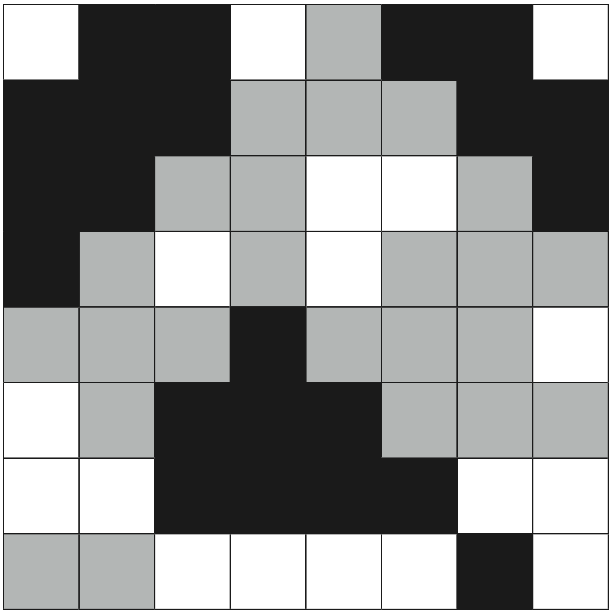


Figure 2.6: *Simulation of the movement of individuals on a chessboard: Step 2*

In the following example neighbourhood is defined as the eight squares that encircle any given square. Let us assume for example that a piece moves toward an open square whenever two-thirds of the pieces around it are of a different colour. The order of movement is only determined by the position of the pieces on the chessboard, precedence being given to movement from left-to-right and to movement up instead of down. This order affects the particular form of results but not their overall character.

Figure 2.6 is a result that can be obtained based on the distribution of chess pieces present in Figure 2.5, using the rule stated above, after several iterations. In the present case the average proportion of neighbours of the same colour, relative to neighbours of a different colour, is 2.3 to 1, that is, twice the original proportion and about three times that required by any given individual. “The underlying motivation,” notes Schelling, “can be much less extreme than the visible models of segregation.” The indigenisation of the process brings about states of strong segregation. A chain reaction is produced, in which every individual that chooses a new environment affects the environment of those he leaves behind and those he goes to join.

In the context of schools, individual productive capabilities or performances, can play the role of discriminating factors. It is likely that the highest performing individuals dislike situations in which they are a minority if they are evaluated in accordance with the average level of the group in which they find themselves (Spence’s model offers an illustration of this). On another hand, for the least productive individuals, it is rational a priori to prefer to be a minority. But just as the first group did not find it advantageous to be in a too-strong majority position, since groupings that are too elitist can have negative consequences, the second group will not wish to be in a too-acute minority position, since the presence of a majority of individuals who are more productive makes work more difficult for them. One could thus imagine that theoretically there exist for each type of students certain thresholds below which and above which their presence in a given group is disadvantageous. Thus the situation is a little different from that described by Schelling.

We note that while the social and economic repercussions of a particular grouping are comparable for the two groups of students, psychological costs are not of the same order. In general, if external expectations (from teachers, family and friends, employers, etc.) are higher than the level of performance of an individual, his or her level of performance will tend to increase. Inversely, his or her level will tend to fall if external expectations are lower than the initial level. If these expectations are based on the average level of performance linked with a group of students, we can then formulate a hypothesis concerning the existence of a phenomenon of "regression to the mean" (whose causes can be quite diverse) that justifies individual preferences for access to groups at the highest levels of success. Rosenthal and Jacobson (1968), carried out an experiment in an elementary school in San Francisco, that showed the influence of teachers' prejudices on the success of their students.[4] These prejudices contributed to the creation of a subjective representation on the part of students with regard to their own abilities, and this affected their performance results. Such influence is all the greater when students are in a more "anomic" situation, either because of being very young, lacking a clear idea of their level of performance in school, or because they may be experiencing a new environment, etc. Students may also, as a function of teachers' expectations, retain their surplus energy for activities from which they derive other advantages.

Nonetheless the phenomenon of regression to the mean that is being considered here must not be held to be a general one, since other factors come into play. For example, raising the mean does not automatically lead to an elevation of all individual performance levels. Too great a gap between an individual's level of performance and the average (higher) level of a group to which that individual belongs, and the effect will be to discourage the student and make him or her feel less involved in school. Systems that are too elitist are thus not necessarily effective, since they do not allow an optimal rise in overall performance levels. One can add a second hypothesis (a complement to the first) which says that all departure from the mean has a specific cost; this tends to justify general individual preferences for groupings whose levels are relatively homogeneous.

Thus a choice of course causes a process of segregation which is to some extent comparable to that described by Schelling's model of residential choice. This is so because of the performance levels associated with school curricula. If we assume that there is a form of competition for access to curricula, individuals' course choices following a meritocratic rule would tend to reinforce the grouping of students into homogenous levels. Another factor can produce a similar result: preferences for different disciplines, if we assume that these are correlated with individual performance levels. Thus the process we are describing resembles the process of amplification described by Schelling, to the extent that successive cohorts make their choices. The course choices of an individual in a stream of study (or in a particular school or some other specific type of institution, etc.) marginally affects the reputation of the stream at step *t*. This course choice also causes the student not to choose some other stream that he or she might have chosen in a previous stage, and thus it affects the reputation of that other stream marginally, and so on. The situation that results from processes of educational decisions not only can offer a caricature of the motivations that brought it about, but can also harm everyone involved, since it acts as a constraint on orientation decisions.

NOTES

1. Cf. for example Blaug (1972), Wise (1965), Lazear (1977), Stiglitz (1975).
2. Dichotomizing exogenous and endogenous theories of social change is ideal-typical, no theory is ever totally exogenous or totally endogenous. Nevertheless this division indicates which class of independent variables is given priority, since, in the event, endogenous theories give precedence to the internal determinants of the observed changes.
3. A *brevet* is a certificate of education delivered upon completion of a course of studies shorter than that for the *baccalauréat*, usually in technical, agricultural or other specialized domains. The *baccalauréat* is the certificate awarded at the end of seven years of secondary education if the student passes the final examinations. The "bac", as it is known, is organized into broad series: currently L (literary), ES (economics and social sciences), S (scientific), a second group covering technological subjects and a third covering vocational courses).
4. The conditions of the experiment were questioned afterward, but not its overall results. For an overview of recent experiments on this question cf. Cooper and Good (1980).

3

Simulation of Choice of Stream of Study[1]

In order to explain changes in the status of disciplines within the French educational system, and the varying values given to different streams of study, we propose to model educational choice decisions. The model will be implemented in order to simulate the course choices in different *sections* of the academic education system, and to analyse the operation of the particular system of actions involved.

Transformations undergone by the system of streams of study in the second cycle of secondary education allow us to distinguish between several major periods in the transformation of the educational system. We note that the curricula of *seconde* and *première* were virtually identical between 1902 and 1964.

The first period was that of structural unification, along with a differentiation of the scientific and literary curricula, and it extended from 1902 to 1927. Data concerning the results of examinations for the first *baccalauréat*, which we have beginning with the 1915 examination period, show that within the classic streams of study *section C* was the best represented until 1922–23, at which time *section B* took the lead in numbers. During this time *section A* counted, at best, a little more than a fifth of Latin-school students.

The second period was marked by "scientific equality", mandated by the 1925 reform, and this equality came into force from 1928 to 1944. *Section B* (Latin and languages) disappeared, and the *sections* had the same programs and schedules with regard to mathematics and the physical sciences up to the first part of the *baccalauréat*. During this time *section A* added steadily to its numbers relative to *section C*, reaching stable equilibrium at the beginning of the 1940s. At that time, *section A* numbered two-fifths of Latin-stream students, while *section C* accounted for the remaining three-fifths.

The third period we consider saw the reintroduction of the *section B* stream (Latin-languages), as well as a return to greater pedagogical differentiation (comparable to what was available in 1902), and this situation held from 1945 to 1965. We also note the creation (in 1941) of a terminal *section* that led into *baccalauréat* studies in experimental sciences. Numbers of students in *section A* declined during almost all of this period, while numbers in *section B* increased in almost all years. The numbers for *section C* also increased, but only from the mid-1950s on, and to a lesser degree.

One could call the following period (after 1965) the period of linguistic equality, in the sense that this equality was brought about, in particular, by the possibility of students' being exempted from studying classical languages in all streams, not by their being obliged to study them. The new *section A*, which took in a portion of the students who would have been headed for the previous *section B*, saw its numbers rise rapidly following the reform, and then decline steadily until the end of the 1970s. On the other hand, this decline was accompanied by increases for *section C* and the new *section B*, which introduced students to economics.

The model as developed allows us to describe the changes in the classic *sections* of the second cycle of classic secondary education between 1915 and 1964. The model demonstrates the effect of the curricular structure available in educational choice. It also demonstrates the related effect of the interdependence of individual decisions on the prestige given to *sections* and disciplines. Use of simulation techniques also allows us to set up various possible scenarios, and in so doing to make guesses about developments that might have occurred within the system of action, as a result of decisions by the government.

1) GENERAL HYPOTHESES

(1) Two important aspects of streams of study within the general education system are capable of influencing the choices of *lycée* students: their levels of "esteem" and student interest in the curricula offered.

(2) We are assuming that the "esteem" of a stream of study depends essentially upon the level of academic achievement of individuals who had previously followed that curriculum.

The reasons that individuals have for attributing importance to the academic level of their predecessors are illustrated by the Spence model in particular. Such an esteem will serve as a rational base of evaluation for many people with whom students will interact, including future employers. This is what explains the importance alumni associations (for example those connected to *grandes écoles*) assign to maintaining the performance level of the students recruited to attend their institutions, or to raising it.

For the purposes of the model it is supposed that the level of academic achievement of individuals can be expressed by a linear scale. The esteem of a stream of study will be functionally linked to an average performance level with regard to individuals who followed a given curriculum in previous years. Such an esteem is more sensitive to the value placed on streams of study in previous years, in proportion as these previous years are more recent.

(3) We have adopted the following principle for calculating the relative importance of periods: at moment t, the evaluation of a stream is fixed by taking account of the esteem of that stream at moment $(t-1)$, letting K_{t-1} stand for this esteem, and also the average level of performance for individuals who chose that stream at moment $(t-1)$, letting P_{t-1} stand for this level. For this evaluation we assign a relative weight of $(1-r)$ to the esteem and a relative weight of r to the average level of observed performance during the previous period. The esteem index is thus calculated as follows:

$$K_t = [(1-r) \times K_{t-1} + r \times P_{t-1}]$$

Let us take a case in which $r = 1/3$.

We will assume that $P_0 = K_0$, since the beginning of the simulation is an equilibrium point. The average level of performance of individuals who choose a given stream corresponds exactly, at moment $t = 0$, to the esteem of the stream. It is the transformation of the system of streams of study that will end up causing a disequilibrium that generates movement towards a new state of the system.

Thus we arrive at $K_1 = K_0$.

By recurrence we deduce the relative "weight" of average observed levels of productivity for prior stages in the evaluation of K_t:

$$K_t = \frac{2^t}{3^t} \times K_0 + \frac{1}{3} \times \left[\sum_{k=1}^{t} \frac{2^{t-k}}{3^{t-k}} \times P_{k-1} \right]^2$$

The importance given to the average level of performance for those who chose their stream at the stage immediately preceding, that is, its "weight" in the model, is always one third, and the weight given to the next-to-last stage is always two-ninths, and so on. On the other hand, as we move forward in time, the relative importance of the stages decreases as a function of their "distance" from the present stage. This function of waning importance is determined by the coefficient:

$$\frac{1}{3} \times \frac{2^{t-k}}{3^{t-k}}.$$

We note that the esteem model offered here assumes that individuals change their opinions as a result of the qualities of individuals who follow different streams of study, to the extent that the qualities identified as belonging to such individuals do in fact change with every new school year. According to the "weight" assigned to the last school year, and by recurrence to the years immediately preceding, these beliefs are corrected to a greater or lesser degree.

A number of reasons militate in the direction of a moderated value for this coefficient. The opinions of social actors cannot change radically from one year to the next, in relation to the academic cohorts that come and go. The relative inertia of the esteem of a stream of study is also related to the manner in which an actor takes account of the subjectivity of other actors. It is largely on the basis of a past esteem that programmes are judged, and the authors of these evaluations are not necessarily in direct contact with the actual state of school reality.

Another group of reasons points in the direction of a relatively high value for coefficients related to recent school years. Individuals who have attended school and their families are sensitive to what they see and what they know. *Lycées* are places in which small networks of people who exchange information are formed, and these extend over several consecutive school years. One might suppose that an individual is surer about his or her beliefs, to the extent that his or her relations with members of particular school cohorts are extensive and direct.

The coefficient of "waning" referred to above expresses not only the decreasing relevance of information, but also the distance that exists between an individual and reality, and the multiplication of intermediaries that might render the latter less credible.

(4) We are assuming that levels of individual performance are distributed over the populations considered according to a normal distribution. Independent factors that are in fact capable of affecting performance levels are sufficiently numerous; if we consider that each of these factors has a negligible effect compared to that of the group, and that these effects are additive[3], this form of distribution of the performance levels can be assumed.

We may assign performance levels a merely ordinal significance, and not a cardinal one (an individual's performance level equal to twice that of another individual would not mean that one individual had performed "twice as well", but would only allow him or her to be located in relation to other levels of performance). In this case, the choice of a given standard deviation in order to characterize the distribution selected would be in this regard unimportant. But this determination is nonetheless indispensable because the dispersion of levels of performance is capable of affecting the differences between the average levels attributed to students in streams of study, and thus capable of affecting the differences in "esteem". Thus we are led to form implicitly the hypothesis that this determination has a meaning, and that while it may not make sense to say that one student is twice as good as another, it is significant to say that the difference of "level" between two given students is greater than that which exists between two others. The differences between individual levels of performance must allow us to account, within the model of choice of streams of study, for the importance given to their esteem relative to their curricula.

(5) We also assume that curricula offered by the streams are adequately characterized by their course offerings. The evaluation of the potential interest of such offerings by individuals depends on considerations of a utilitarian type (possibility of making particular forms of training received count when looking for a job, etc.), cultural preferences (particular interest in knowledge for its own sake), and purely personal preferences (taking into consideration individual temperaments, inclinations, individual education trajectories, etc.)

The model applies to streams of study in academic education; even if choices take future ambitions into account, and even if orientations are limited because of such ambitions, we would not assume that someone's interest in certain studies could be measured by a strict evaluation of their immediate utility. Introducing utilitarian-type hypotheses at this point would tend to over-value their dependence on an overall socio-economic context. The streams of study in higher education that can conform to this context adapt themselves to individual profiles coming from the second degree in order to make selections if necessary.

It is also important to grasp the distance that separates preferences from actual choices, and the possibility that such preferences precede the choices. Programme features and lists of courses for streams of study only function in a very imperfect way as responses to the more or less nebulous expectations of individuals. They are a means of objectifying these expectations, and of reacting, in good years and bad, to the entire set of general purposes that give rise to these expectations. In order to express individual preferences, we simply make use of the idea of a sort of ideal programme of instruction, which would correspond to the programme that each individual would design, if he or she had the opportunity.

To sum up, it appears that the group of reasons for preferring one stream leads the individual implicitly to situate himself in a space possessing (n – 1) dimensions, n being the number of disciplines that motivate the individual's choice, and the preferred time of study is related to a particular overall schedule. The individual's inclinations, dispositions, success in school, constraints, and the more or less vague group of occupations capable of drawing his interest all determine this position. We must add that this position remains virtual, and it is not certain that a survey would allow it to be further determined. This position allows us to work up a representation of the student population. We only assume that it is sufficiently pertinent to account for observed choices.

For a given individual the levels of preference relative to different subjects of study are expressed by the optimal portions of school time devoted to those subjects. Functions of the Cobb-Douglas type express this relation. They also express a decreasing "marginal utility" of the time devoted to each discipline, which agrees well with what we observe in reality. Let U be the function that evaluates the level of satisfaction of the individual, in the case of two disciplines, for example:

$$U = l \times \text{Log L} + m \times \text{Log M}$$

where L designates the time devoted, for example, to literary disciplines; M is the time devoted to scientific disciplines; 1 refers to the coefficient of preference for literary disciplines; m is the coefficient of preference for scientific disciplines.

U is a maximum for[4]:

$$\text{L} = l \times \text{H} \textit{ and } \text{M} = m \times \text{H}$$
$$\text{with H} = \text{L} + \text{M and } l + m = 1$$

(6) As regards the distribution of preferences among the population of *lycée* students we are studying, every possible arrangement can be imagined. The choice of a distribution model, however, is not for all crucial at this point. What counts here is a desire more or less shared by all to study the disciplines indicated. This does not exclude the possibility that certain disciplines could weigh more heavily in choices than others, or that they could have negative weights. Still, we assume that in general we can assign a positive coefficient to these preferences. This hypothesis is completely plausible in psychological terms, and even necessary: these preferences satisfy the idea of culture and general instruction and training, the fact that the majority of individuals have predispositions concerning different areas of study, not just one specific area. Finally, this hypothesis satisfies strategies of the management of uncertainty.

We assume that the levels of preferences for the disciplines considered are distributed among the population of *lycée* students according to a normal distribution for the same reasons that the distribution of levels of performance was assumed to be a normal one.

(7) Regarding the choice of a stream of study, all individuals weigh and balance in like manner the esteem of the stream of study (which they evaluate in an identical way) and the curricula offered (summed up by the different amounts of time to be spent upon each of the disciplines taken into account). We assume that the attractiveness of a stream increases in a linear manner as its esteem increases. We could choose other types of relationships, for example exponential or logarithmic, according to whether we wished to express that when a stream's esteem grows its attractiveness grows even more, or that the marginal "utility" of esteem decreases under such a condition, but the linear hypothesis appears to be the best one.

To begin with, we assume that all individuals are equally affected by the esteem of streams of study. The general model suggested for measuring the level of preference for a stream is in this form:

$$Uf = \mathrm{K} + l \times \mathrm{Log\ L} + m \times \mathrm{Log\ M}$$

where K is the level of esteem of the stream.

We assume that each *lycée* student chooses an initial stream by comparing the respective advantages of streams that are offered to him or her, and that everything happens just as if this comparison was made with the help of the function described above.

Of course, individuals who are attracted to such and such a type of studies do not know in the beginning the exact list of courses of the streams they choose from. We are not attempting here to simulate the way in which decisions are actually made, but to find a heuristic model that allows us to simulate adequately the overall results of decisions. Programme curricula express the general course content of streams, and this is a relatively objective basis for comparison. Even if students do not have exact knowledge of these course offerings, this inexactness of individuals' information is assumed not to have any systematic effect on the results of choices.

The choice of a stream results from a comparison, which may or may not be explicit, of several possible choices, not an a priori choice made without consideration of a group of possibilities. The place of each curriculum and each stream of study in the group of all streams considered, and more broadly, within the whole educational system, must be considered. Every choice expresses at one and the same time a selection and a rejection, Choosing Latin when you have a choice between Latin and Greek is not the same thing as choosing Latin when the choice is between Latin, Greek and sports. The introduction of a new *section* or the termination of an old one modifies the decision space individuals make use of. All else being equal, a change in the course offerings of a *section* or the introduction of a new *section* changes the places of each element within the entire system, and changes the way each links up with the whole group of types of higher education.

We may suppose that a *lycée* student compares his or her preferences for the study of particular disciplines with what is offered by the various streams of study, and weighs the reasons for preferring particular curricula against the levels of esteem of various streams of study under consideration. The student is able to rank all the streams of study in a preferential order, taking account of previous comparisons that taken together are assumed to constitute all the reasons that may motivate the student's choice.

In order to illustrate the formal procedure for choosing, we note that the results of the comparison of two streams F1 and F2, distinguished according to the amount of time each respectively devotes (for example) to literary disciplines or to scientific disciplines, are expressed through the following calculation:

F1 is preferable to F2 if
$K1 + (l \times \text{Log}(L1)) + (m \times \text{Log}(M1)) > K2 + l \times \text{Log}(L2) + m \times \text{Log}(M2)$
With $l = 1 - m$
$(1 - m) \times \text{Log}(L1/L2) + m \times \text{Log}(M1/M2) > -(K1 - K2)$
Si $M1 > M2$ (thus $L1 < L2$)

$$m > (K1 - K2) \times \frac{-1}{Log(M1/M2) + Log(L2/L1)} - \frac{Log(L2/L1)}{Log(M1/M2) + Log(L2/L1)}$$

Assuming $x = K1 - K2$; $a_T = \dfrac{1}{Log(M1/M2) + Log(L2/L1)}$

and $b_T = \dfrac{Log(L2/L1)}{Log(M1/M2) + Log(L2/L1)}$

we get: $m > -a_T \times x + b_T$. avec $a_T \geqslant 0$ and $b_T \geqslant 0$.

If $M1 < M2$ (and so $L1 > L2$) the condition becomes:

$m < a_T \times x + b_T$ where $a_T \geqslant 0$ and $b_T \geqslant 0$.

In the period T during which particular curricula are offered, the parameter m denoting preference for the sciences is compared to a value that varies linearly with $(K2 - K1)$. When $M1 > M2$, the condition affecting m is more flexible, to the extent that the stream F1 has a better esteem than the stream F2, and it disappears if $-a_T \times x + b_T \geqslant 0$. Inversely (when $x \leqslant 0$), the better the esteem of F2 is in comparison to that of F1, the more marked the candidate's preferences for the sciences must be, in order for him or her to choose F1.

If the class schedules of stream F1 are filled with courses that lean toward instruction of the literary type, the condition on preferences for the study of disciplines of the literary type (or a corresponding aversion to scientific disciplines) becomes more marked as x diminishes, and thus to the extent that the esteem of stream F1 is bettered by that of stream F2. It loses all meaning if $a_T \times x + b_T \leqslant 0$. Inversely, if stream F1 has a better esteem than stream F2 (when $x \geqslant 0$), the condition on m becomes more flexible, disappearing if $a_T \times x + b_T \geqslant 1$.

(8) If we assume that students are not all equally affected by the levels of esteem of streams, two cases arise. Either this differential sensitivity is independent of the variables that we are using to characterize individuals, or it is correlated with those variables. In the first case, it cannot affect the overall results unless it changes on average. In the second case, we may hypothesize that this sensitivity is stronger when individuals are at high performance levels, and inversely that students who are not so talented lose less if they opt for streams with lesser esteem, or are daunted by the level demanded by the streams with the highest levels of esteem. It is not certain that the highest performing students should give less weight to their preferences, and more to the esteem of particular streams; one could argue in favour of the opposite hypothesis. Students whose performance is not as high also have an interest in entering the best streams, since it is on the basis of the esteem level of these streams that they will be judged later on. Nonetheless, the existence of a correlation between sensitivity to the esteem of a stream and levels of performance is quite plausible. That is why we will consider the consequences of taking a differential sensitivity to esteem into account based on this variation of the model:

$$U_f = s \times \mathrm{K} + l \times \mathrm{Log\ L} + m \times \mathrm{Log\ M}$$

Where s stands for sensitivity to the esteem of streams of study. We shall assume that it is distributed over the populations under consideration following a normal distribution, and that it can be correlated with individual performance levels.

(9) Individuals have a tendency to have a level of preference for disciplines that are reputed to be difficult or selective, and this preference

gets stronger as their level of performance gets higher; the investment required by these disciplines is assumed to "cost" them less.

The potential correlation between levels of performance for a discipline and the levels of performance achieved by students can be expressed in the following manner: let us assume for example lat_i and mat_i to be levels of preference, respectively, for classical languages and for the sciences, and we also assume $prod_i$ to be a level of performance for student *i*:

$$prod_i = idum \times Eprod + Mprod$$
$$mat_i = \frac{Emat}{\sqrt{1+\alpha_2^2}} \times (idum + idum_2 \times \alpha_2) + Mmat$$
$$lat_i = \frac{Elat}{\sqrt{1+\alpha_2^2}} \times (idum + idum_3 \times \alpha_3) + Mlat$$

Idum, $idum_2$ and $idum_3$ are independent random variables distributed according to standard normal random variables; *Eprod* is the standard deviation of levels of performance; *Mprod*, *Mmat* and *Mlat* are averages of these distributions; α_2 and α_3 are coefficients that vary as a function of the importance of the random factor in the determination of preferences; *Emat* and *Elat* stand for the standard deviations of preferences for (respectively) mathematics and Latin.

(10) The assignment of individuals to streams depends on constraints that control entry to the streams (open streams, number of places determined, relative flexibility, etc.). We assume that there may be a process of selection that controls admission to the streams. In this process, and following a rule of meritocratic precedence, all applications are accepted until the particular candidates applying appear likely to make the average performance level of the stream's recruits go down, and thus to cause its esteem to go down, below a certain threshold (linked, for example, to the previous year's recruitment).

We propose the following algorithm:

> Let J_f be the average level of students that have already entered stream F, and let it be the case that students are ranked in decreasing order according to their performance levels; let Cn_f be the number of these students; let $Prod_f$ be the average level in school of students who entered F during the previous stage; let $prod_i$ be the school level of the student *i* in question; let w be the permitted

flexibility of the selection process. The student will be accepted into stream F if:

$$\frac{J_{fi} + prod}{Cn_f + 1} > (1 - w) \times Prod_f$$

The flexibility of the selection process, and thus the value of w, may also depend on the number of students the stream can accept, and on the possibility of this number being exceeded by the acceptance of a particular student's request for admission, etc.

We assume that no student's request for admission is rejected by the system. With regard to the case in which all a student's applications are rejected, we place that student into the stream with the least favourable esteem.

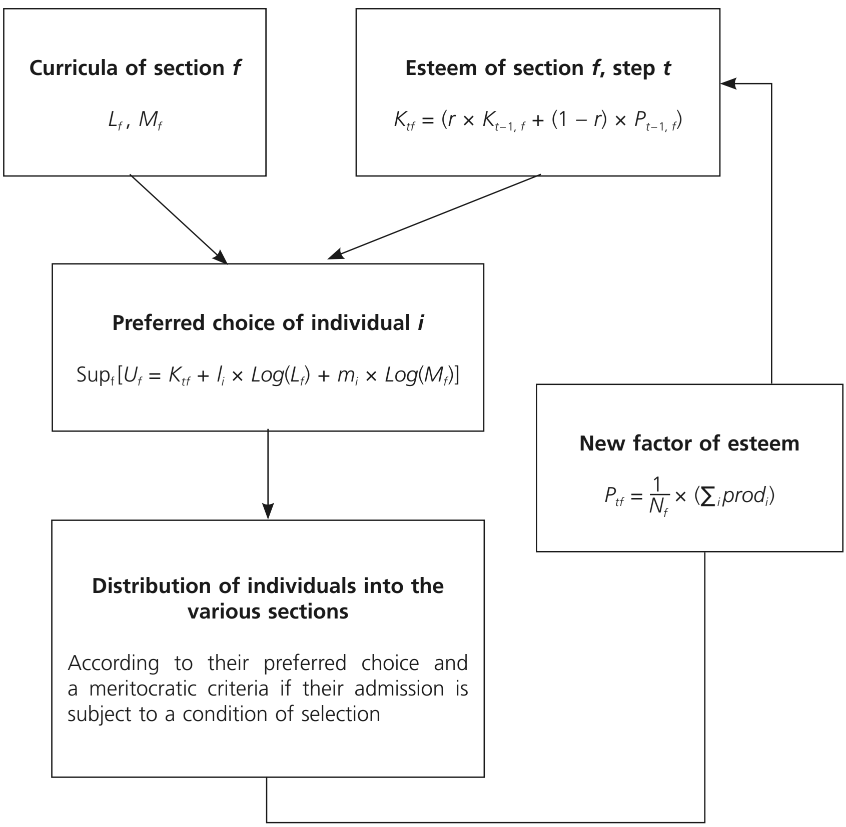


Figure 3.1: *Iterative process of division of candidates among streams—General schema—Case of two disciplines*

The model we have proposed allows us to simulate changes in imaginary streams of study and to gauge the impact of modifications in the structure of choices on student preferences and on the course of development of the streams. An examination of observed data should allow us to judge the potential pertinence of the model, a synthesis of which is offered in Figure 3.1. We will attempt in what follows to simulate developments in second cycle *sections* in classical secondary education since 1915.

2) COMPLEMENTARY HYPOTHESES

With regard to a simulation of the process of choosing between streams of *première* since 1915, we suggest the following complementary hypotheses.

(1) For simplicity's sake and because the groupings employed appear to be pertinent with regard to the period under consideration, we will assume that streams of study can be distinguished from one another with regard to the time per week devoted to classical languages, to the sciences, and to other important disciplines (modern literature, modern languages, history and geography).

Table 3.1: *Curricula for streams used in the simulation (%)*

1902	**A**	**B**	**C**
Classical Languages	40	20	22.5
Sciences	16	16	45.5
Other disciplines	44	64	32

1928	**A**	**C**
Classical Languages	32	22
Sciences	32	32.5
Other Disciplines	36	45.5

1945	**A**	**B**	**C**
Classical Languages	30.5	13.5	12.5
Sciences	21.5	21.5	34.5
Other disciplines	48	65	53

1966	**A**	**B**	**C**	**D**
Sciences	17.5	26.5	43	32
Other disciplines	82.5	73.5	57	68

The curricula of particular streams of study are devoted in the following proportions[5] to classical languages, sciences, and other disciplines (we assume that these parts can be represented in terms of a number of hours per week, adding up to a total of 20), with regard to the following years: 1902, 1928 (calculations are made based on class schedules from 1933), 1945 and 1966 (Table 3.1).

(2) In order to take account of the development of the school-attending population, during the period between the two World Wars, and especially after the Second World War, we have expressed the increase in the population of *lycée* students through a continuous variation of the parameters used to characterize that population.

The general model used to express these changes is a logistical model of the following form:

$$x_t = x_{t-1} - t \times (\mathrm{T} - t) \times k$$

where x_t is the value of the parameter in question at stage t (one stage equals one year here); k is a coefficient of proportionality whose sign and value can vary according to parameters and time periods; T is the date of saturation for these changes (calculated according to the number of stages or years beginning with stage 1).

We note that the proposed model only has a descriptive value; it allows us to give changes in parameters a logistical appearance over the period under consideration. This kind of development is comparable to that undergone in the case of the diffusion of an innovation or a cultural good, as illustrated in the analyses of Coleman *et al* (1957), and Cherkaoui (1982), previously mentioned. The model expresses a rate of change that is maximal at the end of $t = \mathrm{T}/2$. A slow rate of change at the beginning accelerates and then slows down again; coefficient k ("coefficient of imitation" or "coefficient of proportionality") can eventually break the symmetry of the process, since the population involved changes a great deal during the period.

(3) We also hypothesize that preferences are fairly coherent over time. The choice of a *section* of seconde or première supposes that streams previously followed were compatible with these choices. In fact the model is based on the choice of a *section* of première, but these choices are partially conditioned by earlier curricula, especially (as concerns the period up to 1965) by the study of classical and modern languages.

(4) The model of choices suggested here allows us essentially to simulate choices between *sections* leading to similar types of studies. It does

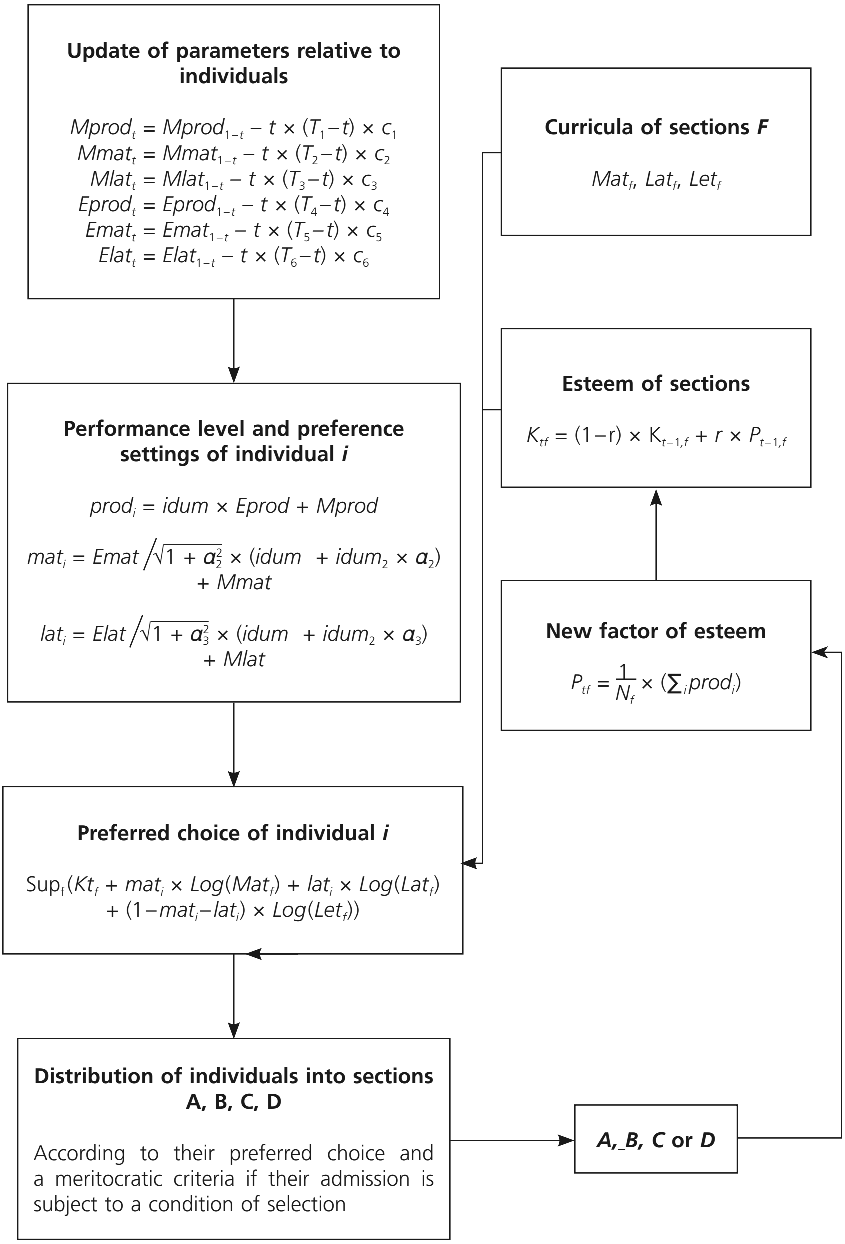


Figure 3.2: *Iterative process of distribution of candidates within streams of study from 1902 to 1965—Stage t*

not allow us to simulate the choice between classical and modern *sections* that cannot be placed on the same level with regard to the populations concerned. On one hand, the fact of not studying Latin leads to studies that will not take as long; on the other hand, schools that offer only modern teaching are more likely to be geographically close to lower income residential areas. The choice of a modern stream is thus largely socially determined. The development of the characteristics of populations in modern streams is also very sensitive to factors that are exogenous to the model during the period under consideration, especially as regards the transformations undergone by the *Ecoles Primaires Supérieure*. We will only pay attention here to the orientation of students coming from classical *sections* of the first cycle, retaining the possibility of students' passing from classical into modern *sections*.

(5) We assume that postulated correlations between levels of preference for sciences and levels of performance on one hand, and between levels of preference for classical languages and levels of performance on the other hand, are the same and constant over the period under consideration.

3) STUDY OF INTERACTIONS BETWEEN PARAMETERS

The Set of Parameters

The whole set of parameters used in the application of the model includes the following sub-groups.

(1) Parameters that describe the limit-conditions of the problem. These are means and standard deviations that characterize distributions (assumed to be normal) of performance levels and preferences for (respectively) sciences and classical languages, for the student population in 1915; for the value of the esteem of streams in 1915 and the value of the esteem of the *B* stream when it was re-established in 1942.

(2) Parameters that characterize changes over time in means and standard deviations of the distributions of levels of performance and preferences. These are dates of saturation for changes in means and standard deviations, as well as coefficients of proportionality. The latter may be modified for each time period (corresponding here to the periods during which particular curricula are in operation). This set also contains parameters that characterize the correlations between

levels of performance and preferences for different disciplines.

(3) Parameters that characterize changes in the levels of esteem of streams of study. This is essentially a matter of the relative importance of different cohorts of students in the evaluation of an average "level" of performance for a given stream.

(4) Parameters that characterize the rigorousness of the selection process at various times.

Interactions Between Parameters

In the proposed model of choice of stream two groups of parameters are identified—those that apply to preferences for the curricula of streams and those that apply to their esteem. The preferences relative to the proportion of teaching time devoted to particular disciplines are characterized by the means and standard deviations of their distributions. The standard deviations increase the effect of the means when they are small, and they diminish them when they are large.

Among the parameters that affect the levels of esteem of streams, we must account for those that define the correlation between preferences for disciplines that are offered and performance levels, the standard deviations between levels of performance, and the coefficient that allows the actualization of the esteem of streams as a function of the average level of students in the most recent cohort *r*. If we consider the possibility that there is a differential sensitivity to the levels of esteem of streams, then the average sensitivity and the eventual correlation between this sensitivity and individual performance levels will also affect the results. The average of performance levels does not play a role a priori, at least as long as we do not apply a specific selection algorithm. Let us assume for the moment that this average is fixed, once and for all. The standard deviation between performance levels, therefore, would play a crucial role. It would determine, apart from differences between curricula, the "weight" of the esteem of streams relative to their pedagogical contents. The larger the standard deviation, the greater the tendency of streams to have levels of esteem that rank them hierarchically. Three other types of conditions affect these changes; first, the speed at which levels of esteem change as a function of changes in the level of students; second, correlations between preferences for the various disciplines and performance levels; finally, the rules that govern the distribution of individuals in streams. The effects of the amplitude of standard deviations between performance levels are limited by a lower speed for change in esteem. We can also obtain similar results if the correlation between performance levels and preferences is stronger and the standard deviation between performance levels is smaller, or if this standard deviation is greater and the correlation in question less strong. In fact, the esteem of a given stream increases all the more, to the extent that the preference for its curricula assumes a higher performance level, but it increases less to the extent that performance levels are less differentiated. The effect of standard deviations between performance levels is also more or less marked depending on whether the distribution of individuals in streams is affected by selection conditions that are more or less stringent. The effect upon esteem of standard deviations between performance levels may also vary as a function of changes in the average sensitivity to the esteem of streams. For example, a drop in the average sensitivity to the esteem of streams can, if not taken into account, lead to an underestimation of the increase in standard deviations between performance levels. The existence of a correlation between this sensitivity and individual performance levels

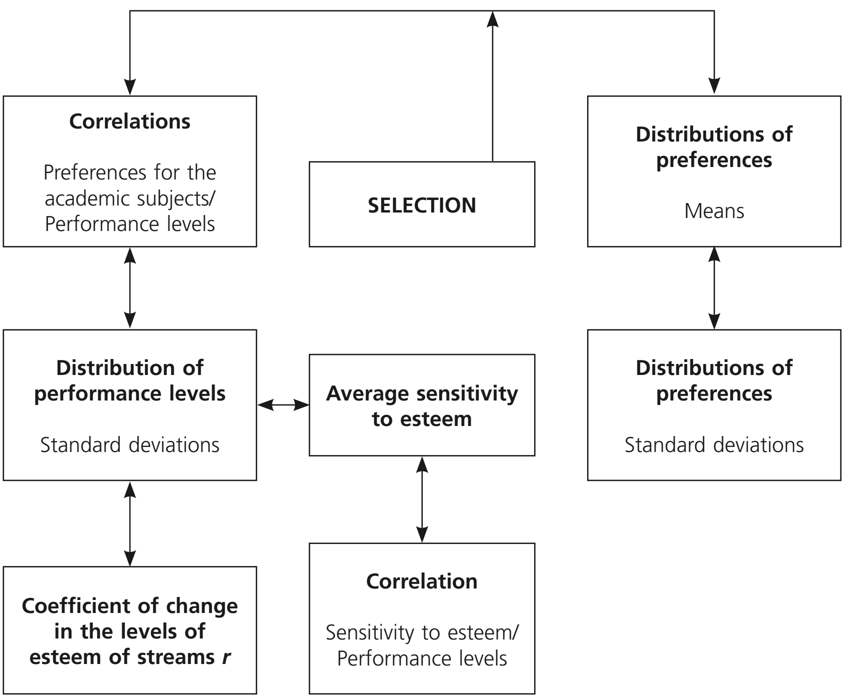


Figure 3.3: *Interactions between parameters—Synthetic schema*

leads, in return, all other things being equal, and if this sensitivity is not taken into account, to an overestimation of this standard deviation which has an effect upon the variable "esteem", etc.

The two groups of parameters oppose each other, giving more "weight" to the esteem of streams or more "weight" to their curricula, as shown in Figure 3.3.

3) THE RANGE OF SOLUTIONS

The Existence of Solutions

The model of choices previously defined is only pertinent if the respective amplitudes of the intervals of variation of the values attributed to the esteem of streams and the values assigned to preferences for curricula are on a comparable scale. If, for example, individual choices of stream turn out to be practically identical, the differences in value of esteem should be much higher than the differences in value associated with preferences for curricula. On the other hand, in the case where individual preferences strongly depend on differences between curricula, differences in esteem should have a negligible value. The relative comparability of amplitudes of intervals of variation that is in question here is a hypothesis that we make a priori. We have only taken into account those streams that satisfy this criterion. Nonetheless, in *concrete* terms the problem does not present itself in this manner. In practice, we are looking for deviations between performance levels that are large enough so that the effect of levels of esteem on choices allows us to simulate real changes. At the point at which the distribution of performance levels becomes fixed, the course of changes escapes our control. The conformity of the results of simulations to real changes allows us to confirm the likelihood of links established between the different variables and strengthens the hypothesis upon which the model is based, namely, that that which counts in terms of educational choice, over and above the curricula offered by streams, is a function of the average "level" of recruiting done by each stream.

The main quantity that remains undetermined is that of the relative "weight" of the esteem of streams and preferences for curricula. These "weights" are as we have seen determined by the distributions of preferences and by the importance of differences in prestige in *sections*. If the evolution of choices between the various streams (each presenting specific characteristics with regard to the disciplines that they value most highly and with regard to their esteem) leaves something undetermined, then the experience of a change in curriculum must allow this undetermined part to be cleared up. In fact, immediately after changes in curricula, esteem and distributions of preferences appear to be very similar to the state they were in just prior to the changes. The immediate changes of orientation brought about by reform thus give us new information about the structure of preferences. Later changes in the representations of streams reveal the role played by the esteem of streams. Overall preferences may change at the same time, but eventually they will change in a direction that runs counter to the values reinforced by levels of esteem themselves.

In definitive terms, despite the degrees of freedom allowed by the model, reality largely overdetermines the parameters in operation. If a solution to the problem before us exists, it seems likely that it will appear in the form of a domain of variation of parameters. This domain will give rise to a group of possible solutions when interactions between parameters are taken into account.

New Unknowns Introduced by the Reform of 1965

The new unknowns introduced by the reform of 1965 are of two types: there are changes in the school population and changes in the system of *sections*.

Up to 1965 modern and classical streams changed in ways that were subordinated to choices made according to differing rationales, even if passing from one to the other was possible, at least as regards the passage from Latin *sections* to non-Latin *sections*. The *A* and *C* streams were dominant, as to esteem, over the *B* and *D* (MM') streams. On the other hand the *B* and MM' streams were dominant over the *A* and *C* streams in terms of number of students. The modern streams essentially took on either students judged to be weak, or good and sometimes excellent students from families of modest means. When in 1965 the students in classical *sections* and modern *sections* were regrouped together, the general characteristics of the student population whose choices are simulated by the model changed perceptibly. Not only can the standard deviation between performance levels be modified as a result, but one should observe a discontinuity at the level of overall preferences relative to curricula. Otherwise, the sensitivity of students and their families to the esteem of *sections* are probably more differentiated since the population in question includes individuals from more heterogeneous social origins. Finally, after this, the population that rejoins the *lycée*, during the 1970s, contains a majority of women and represents a non-negligible part of the overall student population. For example in 1980 more than 26% of the student population is made up of females who came to the *lycée* for the first time between 1969 and 1980, as opposed to 8% of males in the same case. The new population integrated into general secondary education is capable of having different requirements as regards schooling. The differential feminisation of streams can also have an effect on their levels of esteem, independently of their degree of selectivity.

The structure of schooling is marked as well by the suppression of the separation of streams of première and terminale. The new *A* and *C* streams would suggest in the first place the respective preparations for classes of philosophy, mathematics, and the *D section* of première, that of experimental sciences. The new *B section* would still have an uncertain status (which would be confirmed by its numerical weakness in 1966).[6] Otherwise, from 1902 to 1966 the curricula for streams of *seconde* and *première* are almost identical, but this is no longer true in 1966. In particular, the *secondes C* and *D* are not differentiated. Thus the reform introduced important discontinuities into the structure of educational choice.

The logic of educational choice proposed by the model, on the other hand, is in conformity with the changes undergone by streams between 1965 and 1980. The esteem of the *A* stream declined during the 1970s, while the *C section* became more strongly marked off from it and attracted, because of the difference in the levels of esteem of the streams, more students. The new *section B* (social sciences) was not well developed in 1966. This is a stream that was formerly part of technical education. It has every chance of seeing its esteem improve and its population increase. The *D section* accepts students that do not continue in the *C section* just as the class for experimental science took in students who in general would not enter math-elem. Thus it maintains a status that is subordinate to that of *section C*.

According to the model, preferences between streams must be in accordance with conditions that follow. Let us study for example the case of the *B* stream. We have already seen, taking account of the curricula of *sections*: that:

the *B* stream is preferred to the *A* stream if:
$\text{mat} > 0.22 - 1.88 \times (KB - KA)$;
that the *B* stream is preferred to the *C* stream if:
$\text{mat} < 0.34 + 1.35 \times (KB - KC)$;

that the *B* stream is preferred to the *D* stream if:
mat < 0.29 + 3.75 × (*KB* – *KD*).

We see that if the levels of esteem of the streams are very close to one another, the *B* stream is chosen, in general, if the level of preference for mathematics falls in the range 0.22 to 0.29. Let us assume that the difference between esteem for the A and *B* streams is higher than 0.037, where *KA* > *KB*; the choice of *B* assumes mat > 0.29. If on the other hand *KD* > *KB* the choice of *B* means mat < 0.29; no student prefers *B* to A and to *D* at the same time. Let us see more exactly what happens to the conditions for the choice of *D*. In general:

the *D* stream is preferred to the *A* stream if:
mat > 0.24 – 1.25 × (*KD* – *KA*);
the *D* stream is preferred to the *B* stream if:
mat > 0.29 – 3.75 × (*KD* – *KB*);
the *D* stream is preferred to the *C* stream if:
mat < 0.37 + 2.11 × (*KD* – *KC*).

If the levels of esteem of the streams are close to each other, the *D* stream is chosen, in general, as long as the level of preference for mathematics is kept within the range 0.29 to 0.37. Let us assume that the difference in esteem between the *D* and *C* streams is higher than 0.038, where *KC* > *KD*; the choice of *D* means that mat < 0.29. If *KD* = *KB*, the choice of *D* means that mat > 0.29. No student prefers *D* to *C* and to *B* at the same time. But again, if the esteem of the *A* stream is close to 0.04 units higher than that of *section D*, no student prefers *D* to *C* and to *A* at the same time.

The reduction of the problem to one dimension makes it difficult to maintain four streams in the model other than by a control on the student population that is rigid enough so that no stream ends up absorbing another stream that is subordinate to it. If this is assumed to be the case, there is an explanation for the strict hierarchy of streams after the 1965 reform. One would still want to study more closely the circumstances that contributed to the rise of the *B* stream, which was at the beginning under a handicap. The feminisation of the *A* stream probably contributed, through a factor not taken into account in the model, to a reduction in the difference between their esteem.

5) CHANGES IN THE PROFILE OF STUDENTS IN CLASSICAL STREAMS

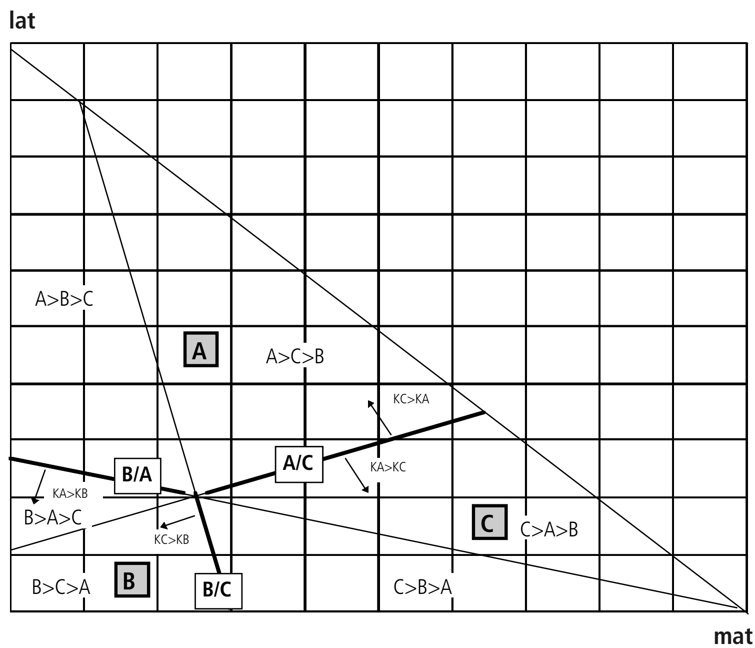
In order to give an account of the changes in the profiles of the preferences of students with regard to streams between 1902 and 1965, and therefore to give an account of the changes implicit in the orientation of streams as a function of the relations between their respective curricula, we can use the model already proposed. In order to simplify, and because the groupings made appear to be relevant for the period considered, we will still assume that streams are distinguished from one another with regard to the proportion of courses devoted to classical languages, the proportion devoted to the sciences, and the proportion reserved for other main disciplines (modern literature, modern languages, history and geography). These three variables are certainly connected; added together, their sum is equal to one. Otherwise we continue to assume that streams are distinguished from one another by their esteem, as represented in the model by a numerical value that is supposed to represent an average "level of performance" attained by a stream's students in previous years.

Let us assume that individuals are situated upon an orthonormal Euclidean plane. The axis of abscissas allows us to measure a "preference" on the part of individuals for sciences (mathematics and physics-chemistry) and the ordinate axis their "preference" for classical languages. The sum of values of these two variables is less than or equal to unity, that is, 100% (we recall that preferences are expressed by an ideal proportion of courses in the school timetable), and individual profiles occupy a triangle whose hypotenuse is the straight line segment situated on the straight line defined by the equation $x + y = 1$. Comparison of streams two by two comes down in each case to dividing the triangle with a straight line segment that delimits the preferred stream as a function of individual profiles. Finally, the esteem of streams, which may vary from one year to another, increase or decrease fields of preference for these streams. This increase or decrease is expressed through a translation of each straight line segment previously defined which is proportional to the difference in levels of esteem of the streams being compared.

We refer to the parts that curricula devote to classical languages, sciences and other disciplines after the reforms of 1902, 1925 (calculations based on curricula of 1933), 1945 and 1965.

Let mat be the index of preference for mathematics, and lat the index of preference for classical languages; let *KA*, *KB*, *KC* respectively be the indices of esteem for the corresponding streams. Figures 3.4–3.6 allow us to visualize the profiles of student preference for streams such as they have been defined, and taking into account the hypotheses put forward in the exposition of the model of choice. If we consider that the *A* and *C* streams distinguish students as "literary" or "scientific" during a given period, we are then in position to represent in graphic form the evidence that being "literary" or "scientific" from one period to another does not have the same meaning.

Between 1902 and 1928 (then 1932), we see clearly how stream *C* absorbs the former stream *B* and also bequeaths a portion of its students



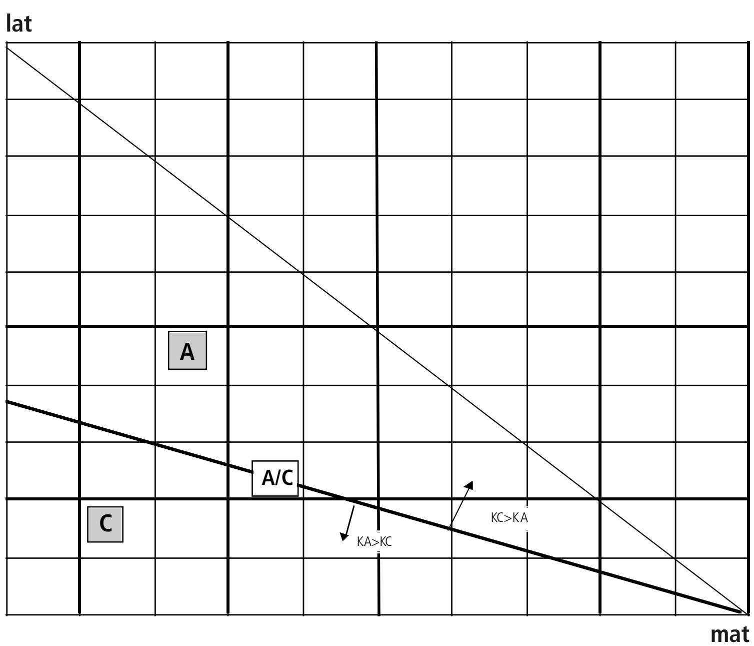
Stream B is preferred over stream A if:
$(1 - \text{mat} - \text{lat}) \times \log(12.8/8.8) + \text{mat} \times \log(3.2/3.2) + \text{lat} \times \log(4/8) > KA - KB$
So that $0.37 \times \text{mat} + 1.06 \times \text{lat} < 0.37 - (KA - KB)$

StreamC is preferred over stream A if:
$(1 - \text{mat} - \text{lat}) \times \log(6.4/8.3) + \text{mat} \times \log(9.1/3.4) + \text{lat} \times \log(4.5/8.3) > KA - KC$
So that $1.37 \times \text{mat} - 0.26 \times \text{lat} > (KA - KC) + 0.32$

Stream B is preferred over stream C if:
$(1 - \text{mat} - \text{lat}) \times \log(12.8/6.4) + \text{mat} \times \log(3.2/9.1) + \text{lat} \times \log(4/4.5) > KC - KB$
So that $1.73 \times \text{mat} + 0.81 \times \text{lat} < 0.69 - (KC - KB)$

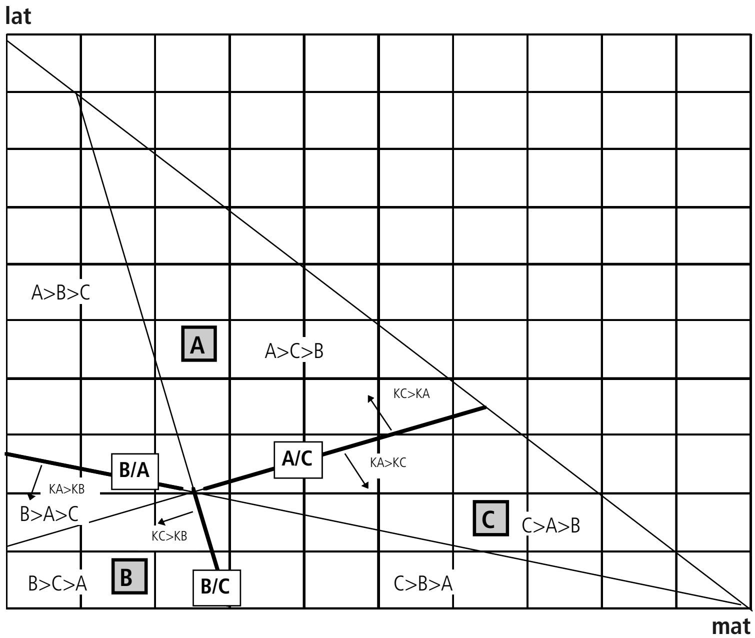
Figure 3.4: *Profile of student preferences for A, B or C streams – Curricula of 1902*

to stream *A*. The quantitative importance of exchanges depends on the distribution of the population according to the variables retained. Very likely its "centre of gravity" is situated in the lower part of the diagram, toward the left, if one accepts the fairly strong attraction *section B* had for students before 1928. In 1928, *section C* accepted students who, under the old system, would have chosen *section B*. The fact that stream *A* did not increase numerically at that moment could have various explanations, particularly a "esteem" close to that of *section C*, or lower. Nonetheless it appears clearly that the relative and gradual increase of the number of students in *section A* up until 1940 can be explained by an increase in its esteem, relative to *section C*. In 1945 the configuration of classical streams recalled that of 1902, were it not for the fact that *section A* remained quite open to the sciences, *section C* being much less open to classical languages. The drop in number of students for *section A* despite the place it still occupied at the beginning of the 1940s suggests an accelerating fall in students' attraction to classical languages.



Stream C is preferred over stream A if:
(1 – mat – lat) × log (9.1/7.2) + mat × log (6.5/6.4) + lat × log (4.4/6.4) > KA – KC
So that 0,23 × mat + 0.6 × lat < 0.23 – (KA – KC)

Figure 3.5: *Profile of student preferences as between streams A, C (A') – Curricula of 1925*



Stream B is preferred over stream A if:
(1–mat–lat) × log (13/9.6) + mat × log (4.3/4.3) + lat × log (2.7/6.1) > KA – KB
So that 0.3 × mat + 1.11 × lat < 0.3 – (KA – KB)

Stream C is preferred over stream A if:
(1–mat–lat) × log (10.6/9.6) + mat × log (6.9/4.3) + lat × log (2.5/6.1) > KA – KB
So that 0.37 × mat – 0.99 × lat > (KA – KC) – 0.1

Stream B is preferred over stream C if:
(1–mat–lat) × log (13/10.6) + mat × log (4.3/6.9) + lat × log (2.7/2.5) > KC – KB
So that 0.67 × mat + 0.12 × lat < 0.2 – (KC – KB)

Figure 3.6: *Profile of student preferences for streams A, B, C – Curricula of 1945*

In 1966, it is no longer possible to distinguish the streams according to the proportions of their curricula devoted respectively to sciences or to classical literature because Latin and Greek are available as options in both streams. Streams *A* and *C* offer the possibility of learning three languages, including (eventually) two classical languages (however, only in *A* can students choose three modern languages, and in *C* the choice of a supplementary language forced students into a much heavier weekly timetable, 30 hours as against 25 in *A*). If we set aside the natural sciences (not taught in première in *section C*) and economics (only taught in *B*), for all other disciplines, except for mathematical and physical sciences, the same time of teaching is devoted across all *sections*. If the choice of a stream is not primarily motivated, for the great majority of students, by the desire to learn a third modern language, or biology or economic sciences, then the problem has approximately only one dimension: the part of study time devoted to mathematical and physical sciences differentiates the student preference profiles for students in each *section*. However, the reduction of the problem to one dimension remains a simplification.

6) RESULTS OF THE MODEL

The graphic representations of student preference profiles during the periods when different reforms were in force allows us to arrive by induction at a cloud of points representing the school population whose preferences are measured along the axes (Lat, Mat). The knowledge of a solution and that of the interactions between parameters allows us to grasp the whole set of solutions in an intensive form. We are not looking for precise values of the latter, which as we have emphasized do not describe reality as such but as it appears in the framework of the proposed model.

The population of students is recreated randomly at each step. The trials are carried out on populations of 800 individuals, and the results are presented based on the cumulative result of three different trials.[7]

Values of parameters at the beginning of the simulation:

— the esteem of streams are $KA = 1.5$; $KC = 1.51$, $KB = 1.38$, $KD = 1.38$;
— the means for levels of performance is Mprod = 1.5; means for preferences for disciplines are Mmat = 0.205 and Mlat = 0.21;
— standard deviations between performance levels and between preferences for disciplines are Eprod = 0.06; Emat = $[0.12 \times \sqrt{2}] = 0.17$; Elat = $[0.08 \times \sqrt{2}] = 0.11$;
— the dates for saturation of changes are Tprod = 1985 (step 70 of the simulation); Tmat = 1985 (step 70 of the simulation); Tlat = 1975 (step 60 of the simulation).
— the coefficient of actualization of the esteem of streams is $r = 0.17$;
— the coefficient that characterizes selection beginning in 1945 is $w = 0.0005$;

— the coefficient of correlation between, respectively, preferences for mathematics, for classical languages, and levels of performance is equal to 0.7;
— the coefficients of proportionality relative to changes in different parameters are defined by Cmprod, Ceprod, Cmmat, Cemat, Cmlat, Celat.

A decrease in the average of levels of performance only has an effect on the selection algorithm; as regards the standard deviation its variation is practically non-existent in the solution retained here.

The model is not very sensitive to modifications of certain coefficients of proportionality, when those coefficients describe variations of basic parameters that are weak and which could still be augmented (or even diminished) considerably. If instead of lowering students' "appetite" for science we increase it by the same amplitude, the representation of *section C* in 1964 is 10% too strong, to the detriment of *section B* (taking 7%) and *section A* (from which it takes 3%). If we had increased the standard deviation that marks the distribution of preferences for the sciences, instead of diminishing it, by the same amount and all other things remaining equal, stream *C* in 1965 would have attracted 5% more students, the amount being subtracted from stream *A*.

In 1915 a tenth of the population created preferred to devote more than 41% of total teaching time to sciences, and a quarter of the population, more than 31%; in 1965 a tenth of the population prefer to devote more than 37% of this time to sciences, and a quarter prefer to devote more than 28%. By contrast the "taste" for classical literature saw its average fall considerably during this period. In 1915 a tenth of the modelled population prefer to devote more than 34% of their school time to classical literature, and a quarter of the population, more than

Table 3.2: *Coefficients of proportionality used in the simulation*

	1915	1929	1945
Cmprod	$+0.2 \times 10^{-7}$	$+0.2 \times 10^{-7}$	$+10 \times 10^{-7}$
Ceprod	-0.2×10^{-7}	-0.2×10^{-7}	-0.2×10^{-7}
Cmmat	$+1 \times 10^{-7}$	$+3.3 \times 10^{-7}$	$+6.6 \times 10^{-7}$
Cemat	-1×10^{-7}	$+3.3 \times 10^{-7}$	$+3.3 \times 10^{-7}$
Cmlat	$+1 \times 10^{-7}$	$+40 \times 10^{-7}$	$+50 \times 10^{-7}$
Celat	-1×10^{-7}	$+6.6 \times 10^{-7}$	$+10 \times 10^{-7}$

27%; in 1965 a tenth would prefer more than 18% and a quarter more than 12%.

In definite terms, in 1965, in the example retained, parameter values are as follows: Mprod = 1,476; Eprod = 0,061; Mmat = 0,183; Emat = 0,15; Mlat = 0,081; Elat = 0,08.

To simplify things we made coincide the overall changes of coefficients of proportionality with the extended periods of applicability of various large-scale reforms we have considered. The dates of "saturation" of changes and coefficients of proportionality, empirically determined for the proposed solution, indicate rhythms of change that are consonant with the major phases of change in the number of students in classical streams.

The changes in the *A*, *B*, and *C* streams over the period under consideration are illustrated by Figures 3.7 and 3.8. The simulation of the changes in the relative representation of these streams, based on the proposed model of choice and empirically determined parameters is illustrated by Simulation 3.2; comparisons between the simulated and real values of the representation of streams is shown in Table 3.3.

On average the difference between the real values and the simulated values of the representations of streams *A*, *B* and *C* are 2.32%. The averages of algebraic values for these differences are, respectively,

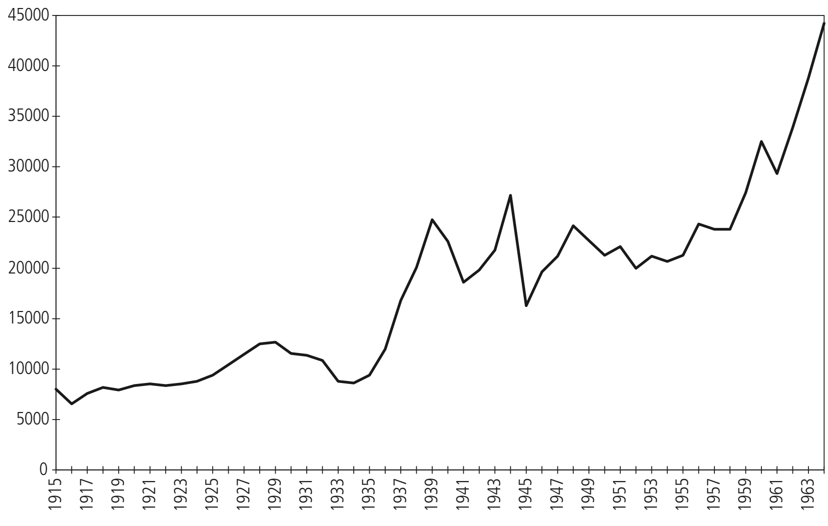
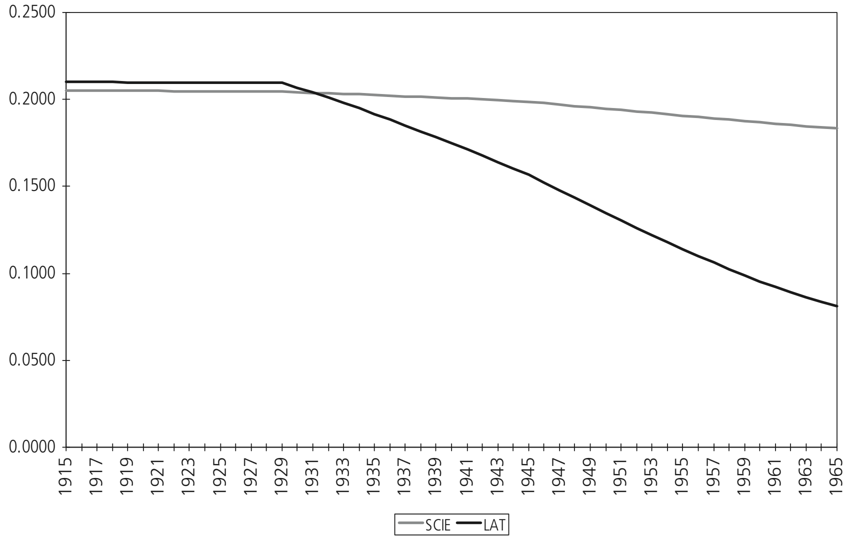


Figure 3.7: *Change in the overall number of* baccalauréat *students in sections A, B, C from 1915 to 1964*

Source: Ministère de l'Education Nationale



Simulation 3.1: *Simulation of the change in average preferences for sciences and classical languages from 1915 to 1964*

–0.2 %, 0.7%, and –0.3%. The formal factors at work give an account of the changes in the representation of streams in a quite satisfactory manner.

According to the distributions of students in the simulated streams at each step, the proposed simulation permits us to infer changes in the levels of esteem of streams as defined (represented by Simulation 3.3) and changes in the heterogeneity of students in streams based on the standard deviations between levels of performance (represented by Simulation 3.4).

We see that in conformity with what we know, *sections A* and *C* are relatively close to one another in terms of esteem over the period in question, while *section B* is situated at a perceptibly lower level. *Section C* surpasses *section A* by a small amount at the beginning of the century, but the latter regains the advantage following the reform that instituted "scientific equality". Gaps in relative esteem increase until 1942 (the dates in abscissas of the graphs correspond to *baccalauréat* sessions). The recreation of *section B* allows *section C* to experience an increase in esteem.

Until 1945, the assignment of individuals to streams can be modelled, within the framework of the hypotheses put forward, without a specific rule of selection having to intervene. Between 1928 and 1944, a

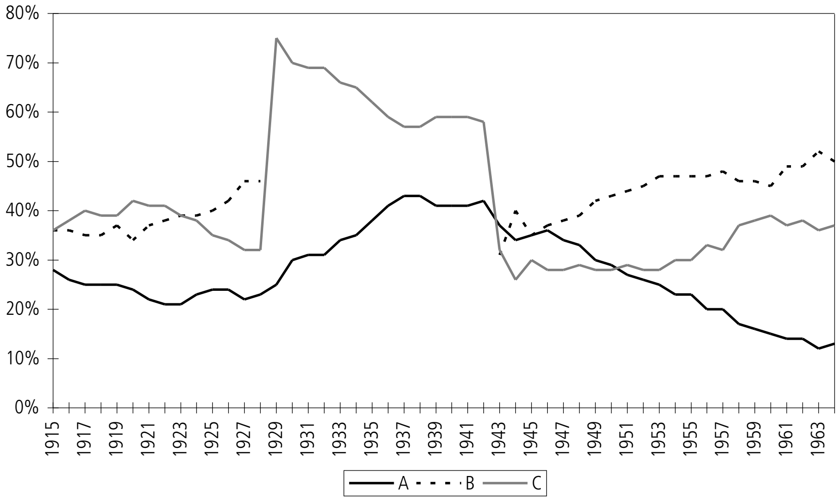
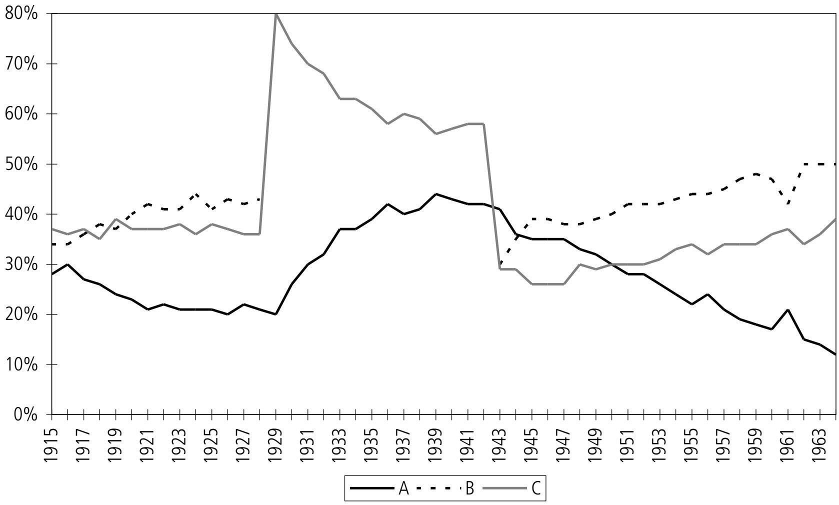


Figure 3.8: *Changes in the representation of streams A, B, C from 1915 to 1964*

Source: Ministère de l'Education Nationale



Simulation 3.2: *Simulation of the changes in the representation of streams A, B, C (graduation year) from 1915 to 1964*

larger and increasing number of students appear to have been directed toward the modern stream, particularly because of a relative drop in

Simulation 3.3: *Simulation of changes in the esteem of streams A, B, C from 1915 to 1964*

Note: K = level of esteem, see pp. 66 & 85.

Simulation 3.4: *Simulation of the changes in the heterogeneity of students in streams A, B, C from 1915 to 1964*

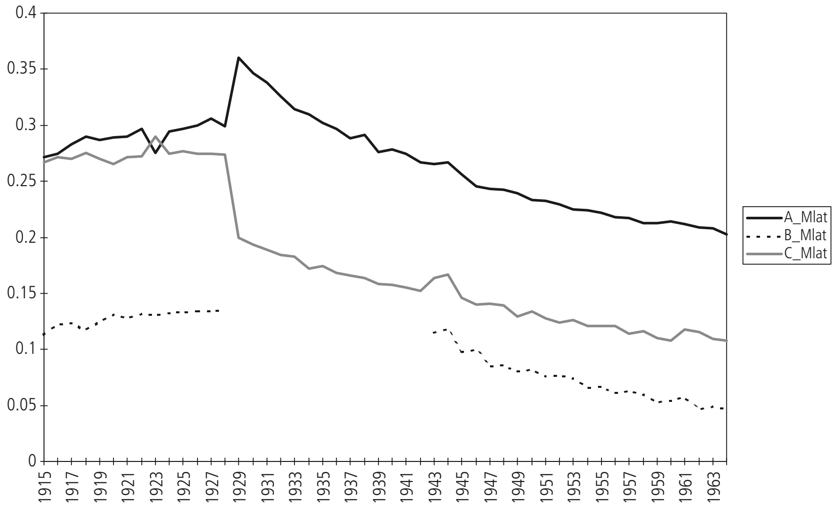
Note: E = Eprod = the standard deviation of levels of performance, see pp. 69 & 85.

the esteem of *section C.* That number would exceed an average of 10% of the number of students during the period if the esteem of the modern

Table 3.3: *Comparison of representation of real and simulated sections*

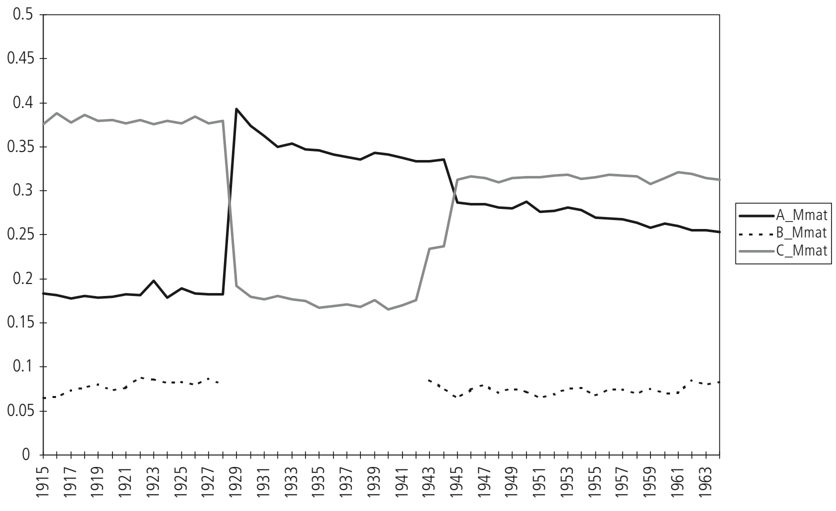
%	A actual	A simulated	B actual	B simulated	C actual	C simulated
1915	28	28	36	34	36	37
1916	26	30	36	34	38	36
1917	25	27	35	36	40	37
1918	25	26	35	38	39	35
1919	25	24	37	37	39	39
1920	24	23	34	40	42	37
1921	22	21	37	42	41	37
1922	21	22	38	41	41	37
1923	21	21	39	41	39	38
1924	23	21	39	44	38	36
1925	24	21	40	41	35	38
1926	24	20	42	43	34	37
1927	22	22	46	42	32	36
1928	23	21	46	43	32	36
1929	25	20			75	80
1930	30	26			70	74
1931	31	30			69	70
1932	31	33			69	67
1933	34	37			66	63
1934	35	38			65	62
1935	38	40			62	60
1936	41	42			59	58
1937	43	40			57	60
1938	43	42			57	58
1939	41	44			59	56
1940	41	43			59	57
1941	41	43			59	57
1942	42	43			58	57
1943	37	41	31	30	32	28
1944	34	36	40	35	26	29
1945	35	34	35	40	30	25
1946	36	34	37	39	28	27
1947	34	35	38	37	28	28
1948	33	32	39	37	29	31
1949	30	31	42	39	28	30
1950	29	30	43	39	28	31
1951	27	28	44	42	29	31
1952	26	27	45	41	28	31
1953	25	25	47	41	28	34
1954	23	23	47	44	30	33
1955	23	21	47	43	30	36
1956	20	22	47	44	33	34
1957	20	20	48	44	32	36
1958	17	17	46	47	37	36
1959	16	17	46	48	38	36
1960	15	16	45	46	39	39
1961	14	19	49	42	37	39
1962	14	13	49	51	38	36
1963	12	12	52	49	36	39
1964	13	10	50	49	37	41

section had been equal to 1.3, which already corresponds to a very low esteem, inferior without doubt to the average "level of performance"



Simulation 3.5: *Simulation of changes in average preferences for classical languages in A, B, C from 1915 to 1964*

Note: Mlat see pp 69 & 85.



Simulation 3.6: *Simulation of the change in average preferences for scientific disciplines in A, B, C from 1915 to 1964*

Note: Mmat see pp 69 & 85.

of the students of this *section*. This esteem was maintained constant because it was only important to observe the eventual variations in the flow of students from the classical *sections* to the modern *section*. It thus appears that the modern *section* is in fact not considered to be on the same footing as the other *sections* by students in classical *sections* when they make their choice of stream.

After 1945, the significant growth of *section B* can only be explained, in the context of the hypotheses we have put forward, by the existence of increased selectivity for students entering *sections*. This kind of selection would have affected more than 15% of students at the very beginning of the period, and 5% toward 1964. Practically all the students who did not get their first choice were admitted to the stream corresponding to their second choice. We could also observe that *section A* includes students of a more homogeneous level than *section C*, except during the period when *section B* is suppressed. Its heterogeneity also increases along with its esteem. This heterogeneity drops fairly strongly after 1943, on one hand because the *section* offers curricula that do not match up well with average preferences, and on another hand because the creation of *section B* and the hypothesis of selectivity, even weak selectivity, is influential in the direction of greater homogeneity of its students.

According to the simulated distributions of students among the streams, it is possible to infer the changes in the average levels of preference, by stream, for classical languages and for sciences, respectively, represented by Simulations 3.5 and 3.6.

We may observe here that while *section B* includes students who on average don't like sciences or classical languages very much, *sections A* and *C* exhibit contrasting profiles over the three periods. Between 1915 and 1928, *section C* tracks close to *section A* in terms of preference for classical languages but the students *C* attracts are much more motivated to study the sciences than *section A* students. Between 1928 and 1944, students from *sections A* and *C* are not very similar; students in *section A* have a marked preference for both sciences and classical languages. Paradoxically, students in *section C* are not very enthusiastic about the sciences. Between 1945 and 1964, *section C* students once more show a taste for the sciences; the preferences of *section A* students for the sciences are then quite similar to the preferences of *section C* students, who still do not share the level of preference for classical languages of *section A* students.

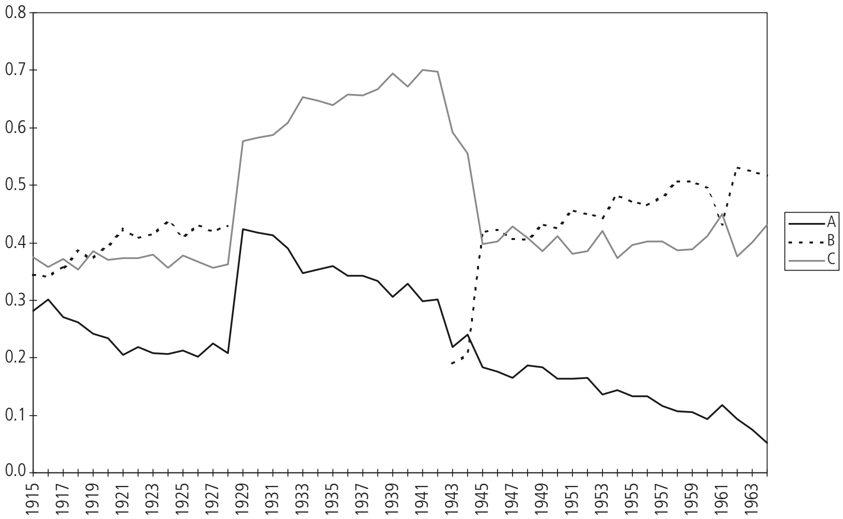
These results agree with what we know about the orientations of students who were admitted to Centrale Paris or to HEC (*Hautes Etudes*

Commerciales) during the time period under consideration. Between 1928 in 1944 more and more of these students chose stream *A* and then continued on to enter math-elem.[9] More students exited from *section C* and entered HEC in the mid-1930s with a *baccalauréat* in philosophy than exited with a *baccalauréat* in mathematics (although the *baccalauréat* in mathematics was thought to be better preparation for the "*concours*".[10]

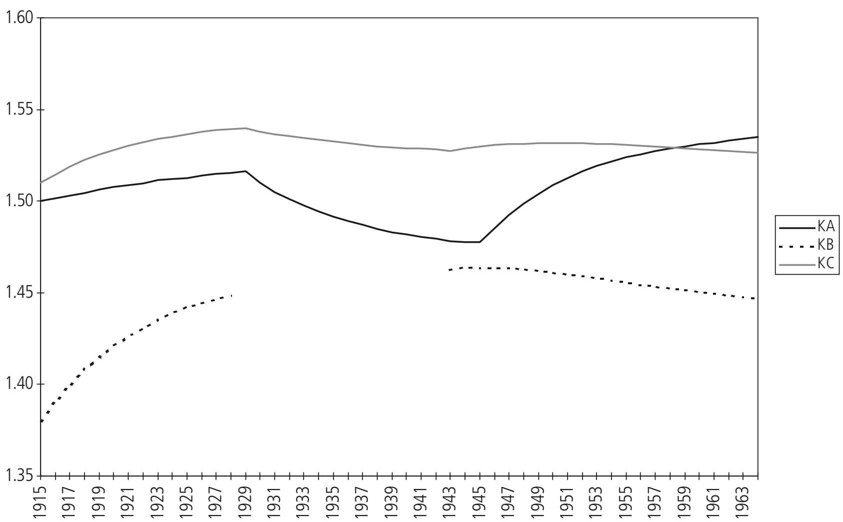
One can attempt to simulate the changes undergone by *sections*, all else being equal, if things had turned out differently. We observe that if *section A* had not been altered in 1928, despite the elimination of *section B*, *A* would nonetheless have lost students gradually. If *sections A* and *C* had retained the curricula from 1928 after 1945, *section A* would have continued to lose students and *section C* would have experienced no new increase; *section B* would have taken in three quarters of students in 1965. Continuing the same hypothetical line, if *section B* had not been revived in 1945, *section A*, while remaining the most prestigious of the *sections*, would have undergone a slow decrease, and *section C* would have included a little less than 90% of the school population in question. *Sections A* and *C* would have divided the group of Latin students in the proportion of one quarter to three quarters 20 years later. Still in the same line, if *section A*' (Latin-Greek-sciences) had been represented as a separate *section* in the majority of *lycées*, *sections A*', *A* and *C*, in actual order of prestige, would in 1965 have attracted, respectively, one-fifth, one-fifth, and three-fifths of Latin students. Finally, the simulation permits us to think that in the case where *section B* is revived, *sections A*', *A*, *B*, and *C* would have included approximately 15%, 5%, 50% and 30% of the students in classic *sections*; but in 1963–64 their respective totals were 5%, 12%, 48% and 35%.

Simulations 3.7 and 3.8 illustrate the changes in numbers of students and levels of esteem of *sections* if, instead of increasing the part devoted to sciences in *section A* in 1928, it had been proposed (for example) that a second modern language be included in the curriculum.

In this scenario, taking account of all the hypotheses we have formulated, *section A* would have attracted more students in 1928 than it actually did attract in reality, but it would have seen its esteem go down. *Section C* would in that case have attracted more and more students, and the gap in esteem between the *sections* would have increased up until 1944. Between 1928 in 1944, *section C* would have included students with a scientific profile that was fairly high on average, although



Simulation 3.7: *Simulation of the changes in number of students in streams A, B, C from 1915 to 1964 without "scientific equality"*



Simulation 3.8: *Simulation of the changes in the esteem of streams A, B, C from 1915 to 1964 without "scientific equality"*

Note: K = level of esteem, see pp. 66 & 85.

a little lower than that in the period just preceding, and a taste for classical languages a little higher than the average level of preferences of students in *section A*. These changes can be compared with those undergone by the same *sections* after 1965.

7) DISCUSSION OF RESULTS

The results obtained with the help of the model of choice of stream are in conformity with all the information that texts and numerical data concerning the changes affecting streams of study since the beginning of the century. These results allow us to confirm the likelihood of the general hypotheses we have put forward, and they allow us to make the following observations as well.

(1) The dynamic of change within the system, during the periods of application of school reforms, is in general terms endogenous.

(2) The structure of choices strongly conditions the distribution of students in all streams. So, the structure of preferences does not by itself allow us to predict this distribution in terms of the dominant disciplines in each stream. If the choice of the stream affects choices in the future, particularly professional choices, then the structure of the curricula available to students has an important induced effect on individual outcomes.

(3) Inversely, characteristics of the population of candidates have a rapid and direct effect on the development of the streams. Thus there is a return shock by the structure of demand upon the significance of curricula. If, for example, two streams offer curricula that are fairly similar, the more selective stream which accepts candidates with higher average levels of performance, and which in fact has a superior esteem, will keep the other stream in a subordinate position. Over the long term this situation, which assumes that orientations among students in the subordinate stream are mostly chosen by default, can explain why the streams end up merging. This is what has been observed in France, where in an effort to equalize the prestige of academic *baccalauréats*, the program of the "pedagogical renovation of *lycées*" mandated by the "law of orientation in education" of 1989 merged streams *C* and *D* in 1992 to form a single scientific stream S. Stream S, despite the measures taken to ensure an equalization of *baccalauréats*, employing for this purpose primarily a greater specialization of curricula, has remained at the top of the educational hierarchy. The model of choice explains

the situation with reference to the variable "performance levels" which we have assumed to be at the basis of the esteem of streams.

A stream that offers a curriculum close to the average of preferences is not necessarily in a strong position. Qualitatively or quantitatively it could undergo a rise or fall, according to whether the distribution of levels of performance places it more or less directly in competition with more selective streams.

(4) The position held by streams depends less on the dominant disciplines in their curricula, and thus upon values which would be intrinsic to these disciplines, than upon the whole group of students the streams admit. Indirectly these disciplines' position is related to the profiles of admitted students.

(5) The average level of performance of students in streams is, under the hypothesis that no stream suffers from a particular prejudice, a consequence of the academic level of the curricula, and of the structure of the system of streams.

(6) The hierarchy of streams appears here as a virtually ineluctable phenomenon whose intensity depends on the heterogeneity of the school-attending population, and on the number and relative importance of selective disciplines in the curricula. If the heterogeneity of the school-attending population grows, a drop in the selective character of streams' admission policies may leave the differential between streams' levels of esteem unchanged.

Let us assume that we have two streams that are distinguished by the amount of time their curricula devote to a selected discipline *D*. Let us further assume an individual I whose preferences, in terms of number of hours devoted weekly to *D* and to other disciplines are expressed by (a, H – a). If a stream F1 offers such a timetable, individual I will prefer it, all else remaining equal. One can calculate the minimum differential in terms of esteem that another stream F2 would have to offer in order for this individual to prefer it. The courses in F2 offer a weekly schedule of $a+x$ devoted to discipline *D*. The esteem differential we are looking for is equal to:

$$\mathrm{K2} - \mathrm{K1} = \frac{a}{H} \times \log\left(\frac{a}{a+x}\right) + \frac{H-a}{H} \times \log\left(\frac{H-a}{H-a-x}\right)$$

In cases where $\frac{a}{H}$ = 30% and where $\frac{x}{H}$ = 20%, giving respectively a = 6h and x = 4h over a weekly schedule of 20 hours for example, K2 – K1 must be higher than 0.082. The levels of esteem of the two streams may be little differentiated at the beginning, or tilted to the advantage of the F1 stream, but the surplus x of time that stream F2 devotes to discipline D will cause it to be chosen by individuals whose levels of performance are on average a little higher than the levels for individuals who choose F1, because we have assumed the existence of a correlation between interest in discipline D and levels of performance. This surplus x thus causes a modification in the differential for esteem of streams that is to the advantage of stream F2. This change causes a process of amplification that can be compared to that described by Schelling for several reasons. First, we are seeing an endogenous transformation in the levels of esteem of streams. At each subsequent step, the choices induced by the surplus x confirm the level of recruitment for stream F2 relative to that of stream F1. Since we have assumed that the evaluation of the esteem of a stream is based on that of levels of performance by students recruited during previous steps, the esteem of stream F2 has a tendency to increase while that of F1 has a tendency to decrease, and so on. In the equation above, the second component expresses differences in levels of performance relative to curricula that are comparable from one step to the other, assuming that neither the characteristics of the population nor the curricula changed in an abrupt manner. The first component of the equation expresses differences in esteem that tend to increase, on the other hand, and to gradually generate a new hierarchy between the streams. Otherwise, the first individuals concerned by the increase in the esteem of stream F2 have on average a slightly higher level of performance than the average level of students in stream F1. The progressive change of esteem of streams causes individuals at the head of stream F1 to leave and go to stream F2, a phenomenon that is accentuated if we assume that sensitivity to the esteem of streams is correlated with individual performance levels. It is nonetheless appropriate to note that the level of recruitment of students to stream F2 tends to fall on average to the extent that its esteem increases, since the reasons for choosing this stream no longer are based so much on its programme of studies, but more on its esteem.

(7) The drop in the selective character of the education offered in streams that are most desired brings about a drop in their esteem,

the most likely consequences of which, all other things remaining unchanged, are either a maintenance of the relative gap in esteem or a decrease of their numbers of students with a reduction in the relative gap in esteem.

In fact, the opening up of a highly-rated stream F allows for the acceptance of students who, in the most likely case, would be situated above the average level of the stream toward which they would have been oriented without the opening up. Since they are situated below the average level of stream F, since the previous selection would not have allowed them this orientation, the streams will see their average level drop without their relative gaps in esteem being perceptibly changed. We observe for example that after the largest opening up of stream *C* in the middle of the 1980s, the best students that would have chosen *D* apparently chose *C*: the increase in the number of students entering medicine since 1985 is almost exclusively due to stream *C*.

More rarely, students situated below the level of a stream toward which they might be oriented find themselves close to the average level of stream F, or below it. If despite everything else the changes in orientation generated by the opening up of stream F causes a diminution of gaps in esteem between streams, some students who would have chosen F at the previous step will turn to another stream. In the most probable case these students will be situated below the average level of stream F and they will be situated above the average level of their original stream. In this hypothetical case their new orientation leaves the relative gaps in esteem between the streams practically unchanged.

If despite everything else the opening up of stream F is great enough so that the relative gaps in esteem between streams disappear, supposing that the disciplines are taught in such a way that they lose their intrinsically selective character, then only preferences will govern orientations. Over time stream F may lose a more or less significant group of students, if the overall population and preferences remain constant.

(8) The multiplicity of selective disciplines can allow the esteem of certain streams to become closer, if the curricula are differentiated, and are comparable in difficulty. If the system of streams includes streams of a less selective character, these can only play the role of subordinate streams. If all the streams have a comparable selectivity, only the preferences of the school-attending population can affect the numbers they attract. But since their levels of esteem are getting closer to the aver-

age in this case, which means that they are attracting a heterogeneous group of students, it may be that they are not able to maintain their level of instruction. If no stream is selective, again, only the preferences of students can affect the numbers they attract.

The particular results of the simulation of educational choice between 1915 and 1964 allow us to make the following supplementary observations.

(9) Streams followed a dynamic of change that was in large part endogenous. These results confirm those of Cherkaoui (1982).

(10) The drop in average preference for classical literature, even within the population of students in classical education, is correlated with the increase in the democratization of secondary education.

(11) The job market plays a role in the distributions of preferences of students for curricula that is less important than the changes in educational choices makes it appear. Its role is important enough to maintain the “taste” for the sciences in relative terms, but not enough to make it increase, at least during the period considered. The modelling took into account only the population headed for classical streams. Taking into account the population headed for modern streams would have slightly raised the average level of preference for the sciences. Nonetheless the main orientations of students in the modern streams toward classes in philosophy before the reforms tends to show that the mixing of the two populations should not raise in a singular way this average rate of preference, such as it appears as a consequence of the hypotheses put forward.

The drop in the preference for classical literature may express preoccupations of a utilitarian nature. But it is likely that it is due to other kinds of factors, such as the change in the way these subjects were taught under the effect of a demand stimulated by the effects of the interdependence of decisions. The effect of the job market on demand for education in this regard mainly affects the importance given to the esteem of streams in the model of choice.

(12) The offer, by certain streams, of curricula that closely coincide with the average preferences of the school-attending population has had rather negative effects on the changes in the esteem of those streams, and thus on the changes in the position of those streams in the hierar-

chy of choices. The esteem effect, when it goes against the preferences of students to a greater or lesser extent, has the consequence of directing choices in favour of the curriculum that is more demanding than is preferred in this case. If we hypothesize that selective disciplines provide the best training, then the esteem effect appears to stimulate demand for education, not only in quantitative terms, but also in qualitative terms.

(13) Reforms adopted have often constituted a response to and a shaping of demand from students. Despite significant counter-intuitive or "perverse" effects, reforms have demonstrated a certain pertinence in giving more weight to the esteem factor than to student preferences when playing on the demand for education.

8) ELEMENTS OF A CONCLUSION ON THE EDUCATIONAL CHOICE SIMULATION

Let us recall the principal hypotheses of the model of educational choice proposed. First, individuals take a partially analytic approach to the curricula of streams. It may be that they have an intuitive ability to imagine a preferred curriculum. They may have many reasons for preferring one style of organisation of a curriculum to another, depending on their tastes, their dispositions, their previous coursework, etc. Independent factors that affect the distribution of preferences may be sufficiently numerous to "normalize" this distribution. For all individuals, the marginal utility of study time devoted to each discipline is assumed to be decreasing. All students intuitively know that each extra hour of study time is less "useful" than the previous one; in addition, everyone has a preference for combinations.

The changes affecting streams of study followed by candidates before entering HEC, tend to corroborate the hypotheses we have put forward concerning the mathematical form given to the function of the utility of course offerings. The coefficients assigned to literary subjects reveals the rise of their importance; these coefficients represent in all 57% of the whole set of coefficients between 1938 and 1959, and they represent 72% after 1968. If we calculate the "utility" of each curricula based on the coefficients assigned to each discipline in the *concours* with the help of the function of choice that was proposed in the general model, it appears that these coefficients in fact are disadvantageous to the literary streams after 1944. We can make the same observation in comparing the relative utility of *baccalauréats* in philosophy and *math-elem*.

The educational preferences of individuals are counterbalanced by the esteem of streams, whose marginal utility is considered by all as constant. This esteem is calculated based on the average performance levels of students who have been successively admitted to a particular stream. The effect of teaching on overall student performance is not explicitly taken into account, but it is quite compatible with the hypotheses put forward.

The esteem effect is an important endogenous factor in the changes that the educational system undergoes. We assume that there is a connection between individual levels of performance and their preferences for certain disciplines that are reputed to be selective, such as sciences or classical languages. This hypothesis allows us to explain the changes in streams following reforms that modify the relative difficulty of the curricula.

Individuals end up choosing the stream that best satisfies them, in terms of its esteem and the curriculum it offers, according to the model of choice we have developed.

The processes identified can be summed up as follows: let the potential that a cohort of students represents be characterized by a fictional distribution of individual "levels of performance". The average increase or decrease of this potential by cohorts does not have a great interest for us here. What influences the dynamic of the system is the distribution of this potential among the streams of study. Thus the structure of the available educational choices plays a large role. The internal changes that affect the system of streams, the suppression of a stream, the addition of a new one or a substantial transformation of the curricula can lead to a modification of the distribution of the student population among the streams, and thus to a disturbance of the equilibrium of the entire system. The demand for admission to streams that offer curricula that are relatively the most difficult increases because their levels of "esteem", as these have been defined, increase, and this happens because of students they attract and also because of the effects of the training offered by their curricula. This demand mainly concerns students who are the best performers in other streams.

The study of the educational background of students entering Centrale Paris between 1930 and 1946 confirms the influence of esteem, which is indirectly due to an increase in the relative level of the difficulty of the curriculum of a stream. After the 1902 reform, future students preparing for the competition continued into streams *C* or *D*, with rare exceptions. During the period of "scientific equality", the "utility" for purposes of competition of curricula in streams *C* and *A* were almost equivalent; the time devoted to learning Greek might harm candidates (although they would gain a small number of points to their benefit). These students preparing for the examination still gradually came to prefer the "literary" *section* for choice. The increase in the representation of candidates coming from stream *A* among candidates reveals a phenomenon of "wearing down" of the "top" of stream *C*. This is a phenomenon similar to that which was observed after 1965. Stream *A* lost good students that stream *C* gained. That is shown by the increased number of Latin students in the streams. The number of Latin students dropped in "*A*" while it increased in "*C*" during the 1970s. At this point it is the general level of academic difficulty of curricula, more than the "subjects" themselves, which is influencing the educational values that dominate the educational system.

In order to be able to simulate the changes in the numbers of students in classical streams of study between 1915 and 1965, supplementary hypotheses have been made. The value of this experiment is not only that it may confirm the validity of the model, but in addition it allows us to develop further the hypotheses that underlie it. It is through comparing the results of simulations with real changes that the general model has been perfected, and that the hypotheses related to changes in preferences have been defined. The main change concerns the "taste" for classical languages. The rapid decline in the esteem of stream *A* after 1945 shows that this preference had been declining for some time, taking account of the apparent S-form of this change. This decline was nonetheless not strong enough to reverse the increase in stream *A* between 1929 and 1945. The speed of the decline was determined empirically, but it appeared to be well correlated with the overall increase of the number of students in classical education. This result would tend to confirm the idea that a decrease in the popularity of classical languages even within the populations preferring classical *sections* is a consequence of the expansion of the educational system.

In all, the model of choice proposed allows us to account for the way in which overall equilibria between streams were able to establish themselves, or be upset. It accounts for the importance taken on by *section C* at the beginning of the century, for the new rise in prestige of *section A* between 1929 and 1945 and for its loss of students after 1945, and also allows us to explain its loss of esteem after 1965. It shows that the hierarchy of streams depends on the academic demand of the curricula and the very structure of the system of streams.

The interpretation of the changes in school-related values that is corroborated by the implementation of the model can also account for changes in other educational systems. Consider for example the hierarchy of different streams of study in secondary education in Italy. These streams did not undergo structural changes comparable to those undergone in France. In the middle of the 1980s, the organisation of secondary education was in fact very similar to that which had existed during the 1960s. Obligatory schooling finished at age 14, in general following three years of secondary studies in *scuola media*, which provided general education for all students. After finishing this middle school, most students continued in school and chose a higher secondary education stream from among these choices: the classical *lycée* education in which humanities have a large part; the scientific *lycées* in which students study more science than in the classical *lycées*, but in which they also study Latin; the institutes that train future teachers for primary education; technical institutes and vocational training institutes. At the end of the 1980s, the classical *lycées*, the scientific *lycées*, the teacher training institutes, the technical institutes and the professional institutes comprised, respectively, 8%, 17%, 7%, 46% and 19%[11] of the school population concerned, and the hierarchy of values to which the families espoused agreed with this order of popularity of streams. The explanation that was given for this division that cited an increasing interest in economic matters and greater acceptance of this trend among the Italian population is less plausible than an explanation which like that proposed for the French case refers to the structure of the system of streams, to proposed curricula, and to the preferences of students as a function of their level in school. One could thus show that comparable distributions of preferences could have led, taking account of the differences in organisation of the system of *sections*, to the number of students in streams, a valuation of educational content and a demand from students that would have been quite different. The situation of the classical literature stream at the top of the school hierarchy, explained by the attachment of the Italian public to literary culture, would have according to our analyses been due primarily to an esteem effect itself dependent on the overall structure of the types of education made available to students.

The recourse to modeling has allowed us to simulate the effects of an aggregation of decisions that are the more difficult to perceive intuitively, insofar as they depend more heavily on the statistical characteristics of the populations concerned. The use of the same model of choice for a period covering half a century may seem audacious, and so may the lessons that we draw, which we expect to furnish indications that are valid for the future. Our results demonstrate the importance of the consideration of situations of choice—here in particular the structure of the educational choices available and the interdependence of decisions—in accounting for the changes in aggregated decisions observed.

It is likely that the role played by the academic level of curricula does not depend very much on the nature of the disciplines involved, as long as the degree of maturity of these disciplines, or simply their didactic quality, is high enough to make them appear to be good training for young minds, and as long as the intellectual effort and the amount of work required from students end up being expressed in "performance levels" that are differentiated. Classical languages and mathematics are such disciplines. This implicit selection however causes certain problems. It is too unilateral, it neglects the diversity of actual talents, and it contains a certain prejudice against other disciplines. Educational choices amplify its influence on the relative valuation of streams and types of teaching, so much so that it generates a demand from students that is not related to the needs of the social system. The demand for Latin appears excessive in 1945, as was the demand for mathematics in the 1970s and 1980s, when it reached the level of a "psychosis". Nonetheless we can see that streams that held the highest rank during this century have always attracted students that have tastes and predispositions in favour of both sciences and classical literature. The "*C*'s" of the 1902 reform that competed at nearly the same level as the "*A*'s", exhibited an average level of preference for Latin not much below that of the students of stream *A*, Latin-Greek. The "*A*'s" were better prepared in science and classical literature than the "*C*'s" after 1928, and continue to present a general profile both scientific and literary after 1945. Finally, we observe that after 1965 "*C*'s" also attract students that have an overall profile that is both literary and scientific. The results of the model thus cohere quite satisfactorily with the evidence that we have been able to gather.

Finally, in order to counter the domination of a discipline or a curriculum within the educational system, while at the same time adapting levels of difficulty in various studies to the diverse characteristics of students and to their particular rhythms for acquisition, the model tends to demonstrate the pertinence of an educational structure organized around disciplines and levels of instruction instead of curricula.

NOTES

1. A version of this section was published in Bulle (1996).
2. Assumed to be:

   (1) $X = \sum_{k=1}^{t} \frac{2^{t-k}}{3^{t-k}}$

   $2/3 \times X = \sum_{k=1}^{t} \frac{2^{t-k+1}}{3^{t-k+1}}$ by subtracting: from (1):

   $1/3 \times X = 1 - 2^t/3^t$

   The sum of the "weights" of different terms that figure in the calculation of K_t have a value of 1.
3. If they are capable of being multiplicative effects, a distribution of the log-normal type would be more likely.
4. Take *n* disciplines *i* whose timetable component is H_i, and set h_i as the parameter that indicates the level of preference of the individual under consideration, and the maximum satisfaction for that individual is obtained by maximizing the function:

   $\Sigma i\ h_i \times \text{Log}\ (Hi)$ under the constraint $\Sigma i Hi = H$.

   The Lagrangian L of the program is written like this: $L = \Sigma i\ hi \times \text{Log}\ (Hi) + \lambda \times (H - \Sigma i Hi)$. Deriving with regard to *Hi* and carrying over to timetabling constraints, we obtain

   (1) $Hi = hi/\lambda$ and (2) $\Sigma i Hi = H$; summing (1) over *i* and with $\Sigma i hi = 1$ we have $\lambda = 1/H$; whence the result: $\text{Hi(optimal)} = hi \times H$.

5. Optional hours are treated as obligatory here. In 1952 the number of hours devoted to mathematics in *Section A*, which had been optional since 1945, became obligatory once again. We have not taken up again here the course curricula of 1928, which are too close to those of 1933, or, again, those of 1952, which are too close to those of 1945. Despite all this we may observe that in 1952 *Section B* offered more sustained instruction in mathematics.
6. It was conceived originally as a technical studies *section* and was not offered in all the *lycées*.
7. Technical constraints make it necessary for us to work with a population of less than 1000 individuals, because of the random function being used.
8. The modern *section* has a low esteem, and is all the more subject to a prejudice on the part of student populations having received a classical education. We assume that this esteem has not changed. It is introduced here only in order to allow the simulation of changes in the orientations of students receiving a classical education switching for a modern education.
9. In Centrale Paris they are 44% coming from *A* in 1940 (year of the "concours", against 38% coming from *C* and 61% in 1944 against 27% coming from *C*.

10. They are respectively 33% coming from *A* against 16% coming from *C* in 1936 (year of the concours) in HEC but 23% against 27% in 1939, with 8% with a first *baccalauréat C*, and two second *baccalauréats*, mathematics and philosophy.
11. Cf. OECD (1969, 1985). Data on school population in 1988 are from *Aggiornamenti sociali* (1990).

4

Formal Thought and the Real World

The formal modelling of social action allows us to implement and test the details of logical links between macro situations, interactions between agents, aggregation processes and emergent social properties. By "emergent" we mean that such social properties are the result of the interdependence of individuals' actions and therefore cannot be deduced from individual units' properties. The modelling of mechanisms that generate a social phenomenon is intended to account for the specific combination of factors that genuinely brings about the phenomenon.

A mathematical model puts into play purely formal factors. It not only presupposes that factors assumed to operate in reality have been selected, but also that the effects of these factors are reproduced in abstract form by means of a formally constructed structure. The latter cannot be based on the actual nature of real factors. The question which then arises in a general way concerns the extent to which one may claim to give a true account by means of the model. For as Nancy Cartwright emphasises (1983: 12), one does not give a causal story and then give another one. In order to clarify the problem involved here, we turn first to the nature of scientific explanation, referring to the conceptions developed by the American epistemologist Filmer Northrop and the physicist Henry Margenau. We will deduce from such views the impossibility of accounting simultaneously in a realistic fashion for both the causes and the effects of complex social processes. These analyses will lead us to characterize the nature of models in social science and to define the conditions of acceptability for the explanatory hypotheses the models represent. Finally we will discuss the meaning and significance of the explanation proposed by the developed model of educational choice.

1) CAUSALITY AND CONCEPTUAL CONSTRUCTION

Depending on the types of objects they deal with, chains of reasoning can be differentiated along a continuum, going from natural reasoning to formal reasoning. The more a theory is "naive", the more specific the objects it handles, since not just any object lends itself to classification. Spontaneous thought does not manage to produce definitions for the objects it deals with. The meanings of everyday or spontaneous concepts are founded on the experience of the objects these notions denote. By contrast, formal thought easily produces definitions for the abstract objects it deals with. The very movement that carries us toward formalism tends to proceed in linear fashion. Scientific concepts are defined with reference to "parameters" that are detached from objects, that is, they are conceived for their own sake. Consumers, for example, are identified as utility functions and the colour blue is identified as a wave length.

Thus the specific feature of scientific concepts, as opposed to common, everyday or spontaneous notions, is that they are defined by their relations to other concepts. Scientific concepts are an integral part of a system of concepts in which they exist independently of real objects. The existence of such a system allows us to establish supra-empirical relationships between abstract elements. The central fact that determines the nature of differences between everyday concepts and scientific concepts is the absence or existence of a system. With the system, relationships between concepts are established, and these make it possible to construct causal relations and to follow out chains of deductive reasoning. [1]

Discussing the meaning of causality in scientific analysis, Margenau (1950: chap.19) makes an important distinction between partial and total causes. In ordinary language we tend to employ the concept of cause by speaking of partial causes. For example, pneumonia (state C) is the cause of death (state B) of a person. No systematic link connects the disease to death. Here the logical connection is in reality the following: If (not C) then (not B); if the person had not caught pneumonia, the person would not be dead. No affirmation supports an invariable sequence of the form, "If A, then B". The principle of causality "asserts that a given state is invariably followed, in time, by another specifiable state." Such a sequence assumes that we have examined the sum total of pertinent events preceding the set of given events represented by state B. In other words, the principle of causality requires for its application completely closed and finished systems of events. Such systems do not exist in nature. The impossibility of establishing a necessary relation between facts of experience was highlighted by David Hume. The form, "If A, then B" cannot apply to the world of experience, because causality is not a property of data. Causality is a relation between constructs, more particularly between states of a theoretical system. The systems that lend themselves to being developed according to logical analysis are therefore intellectual constructions. We prefer to speak of generative mechanisms rather than of causality in social science, but in formal terms the problem of explanation amounts to establishing causal relations (which can be characterized by the relation, "If A, then B") between states of a theoretical system, that is, a model.[2]

The possibility of "manipulating" a model in order to deduce mechanically from it some group of consequences in the phenomenon under study depends on this relative closure of the set of concepts and relations from which the model is constructed. But its capacity to account for this phenomenon in terms of the mechanisms or processes that genuinely produce it is problematic. The operations of abstraction and formalization involved in the model-making process introduce an irreducible distance between the phenomenon and its representation. The explanatory factors used by the model only take into account certain aspects of the phenomenon under consideration. And the model is formally autonomous in relation to the real. The elements it brings into play are operationally defined by the relations it focuses on, and only by these relations, that is, by the whole set of relations maintained between the other elements of the model. Their variations do not correspond directly to variations in real things, but to their relations with various factors contained in the model. They are therefore not simply abstracted from the whole set of factors that are operative in reality, but are literally reconstructed.

Are we not forced to accept the possibility of alternative models that are different but just as valid, thus to take into consideration the conventionalist thesis, according to which we should only speak about properties of logical systems constructed in order to represent the world ? The constructed nature of the formal principles that make scientific activity possible, their irreducibility to the world of experience and the existence of alternative representations, do not for all that evacuate the question of causality. Thus we arrive at the problem of the nature of the relations between the formal world and the real world, and the problem of the meaning of scientific explanations.

2) THE NATURE OF SCIENTIFIC EXPLANATION ACCORDING TO FILMER NORTHROP AND HENRY MARGENAU

A social phenomenon described by a set of facts and data is related to reality in a way that might be likened metaphorically to the relation between real objects and their shadows, projected onto a screen. Observations and data represent the shadows of reality projected onto the screen. The logic of the shapes of the shadows is the object of scientific explanation. Theoretical models connect the projected shadows to formal constructs. They represent autonomous systems, which can develop according to successive hypotheses that may be formulated, and their behaviour can be compared to the shadows projected by reality, the data of experience. These two successive steps, the projection of shadows of reality upon a screen and their subsequent formal representation, together lead to the loss of the infinite richness of reality, but lead as well to the construction of a causal structure; and what we want to know is what it can teach us about the real world.

Cartwright (1983: 17) compares explanation to a simulacrum. This term designates an appearance that does not refer us to an underlying reality, but claims to be that reality itself. Explaining a phenomenon for Cartwright is to construct a model that accounts for it via a theory. Established relations (fundamental laws in Cartwright's terms) under the theory are "true of" objects constructed by the model, and they are employed to produce a specific account of the behaviour of those objects. But the objects of the model only possess the form or appearance of things, and crucially lack (in a strong sense of that word) the substance or proper qualities of things. Laws are true of the objects of the model because the models have been set up that way. Margenau (1950, 242) says as much when he writes that the difficulty in understanding why nature obeys formal laws disappears when you grasp the fact that these formal laws do not apply to immediate experience. There are parameters that enable an adjustment to take place, between the real world and its formal representation. This adjustment is accomplished by means of relations that Northrop calls "epistemic". A freedom to choose among these relations gives science the flexibility it needs to produce an account of experience. Such relations are not part of the nature of things. Scientific concepts ("concepts by postulation" in Northrop's words) have no denotation. We have seen that their meaning is defined by properties and relations that connect together the elements of the model. They can't be directly matched with observable elements in reality. By contrast, the meaning of spontaneous concepts carries us back toward elements of the experience that they denote.[3] The bridge between the model and the phenomenon represented within it has to do with the "epistemic correlations" between formal and real factors. More precisely, epistemic correlations allow scientific concepts to have empirical meaning by linking the entities postulated via scientific concepts to "concepts by intuition or by inspection" that denote real entities or factors (Northrop 1947: 143–44). The term "epistemic" expresses the fact that such correlations link together two worlds each with a different nature. These correlations should not be confused with the ones normally referred to in the sciences. These correlations link factors that belong to a single horizon of knowledge, factors in a formal, constructed world, or factors in a real, observed world. The question of the validity of an explanation proposed by the model thus turns into a question about the validity of epistemic correlations that connect explanatory factors in the model and factors in the real world with which they are supposed to be correlated.

We will now examine a diagram offered by Margenau (see Figure 4.1) concerning relations between scientific constructs and observable or experiential reality. "Nature", representing the totality of the immediate data of experience, is represented by a limit area, in this diagram a vertical line marked N. Formal relations are indicated by single lines and epistemic correlations by double lines. All constructs are labelled C or C'. Scientific constructs are mutually connected in multiple ways, including possible passages toward empirical reality, enabled by epistemic correlations. They do not necessarily all have an empirical entity corresponding to them. If constructs (C') do not have multiple relations, they don't play any part in the theory (for example the colour of an electron). Other constructs (included in the dotted-line circle) may constitute an isolated group, which is coherent but without any known connection to the empirical world.

If we assume that scientific concepts are close to what we would call inventions, and if the certainty found in scientific experience is

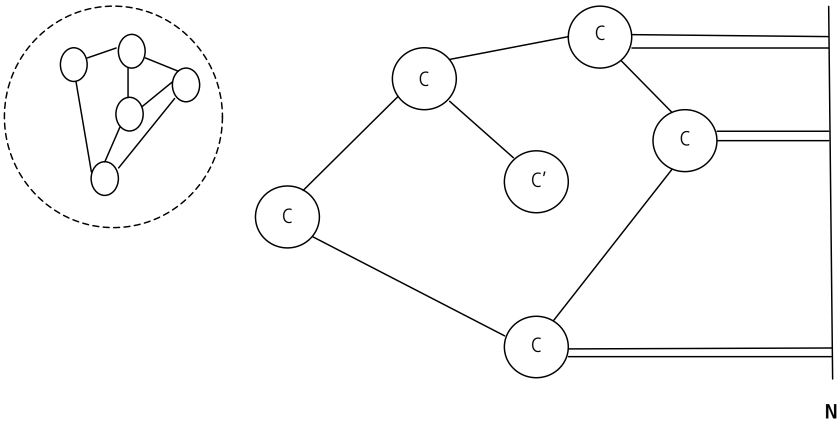


Figure 4.1: *Theoretical constructs and experience*
Source: Margenau (1950), based on figure 5.1 p. 85

constructed, then the question, asked by Margenau (1950: 98) is to know how science can have the stability that it evidently does have. Constructs, he answered, are not purely ideal; they are related to experience in a definite way. But these relations, which ensure the stability of scientific theories, still do not completely resolve the problem of explanation. They cannot assure us that a causal story, produced by means of the model, is actually pertinent. This was the object of the question that Northrop asked (1947: 142). The epistemologist asks how theories, based on formal constructions and built out of postulated concepts which refer us intrinsically to things that are not observable, can be empirically confirmed or refuted.

3) PREDICTION VERSUS LOGICAL REALISM

We can define the theoretical aim of explanation as based upon the accuracy of the roles played by explanatory factors in the framework of models - i.e. on the attribution, via the model, of the right effect to the right real factor involved. In this sense explanation and description each take on a relative status. Explanation points to specific combinations of factors involved in generative mechanisms, whereas description just sums up the joint effects of these factors. Theoretical analysis may attempt to involve factors of a greater generality. The greatest generality refers back to a trans-situational truth, in the sense of the concept of capacity in Cartwright (Bulle 2009: 50).

Explanation can never be considered as absolute, and undoubtedly this is what has caused much confusion, concerning the distinction between an explanation and a mere description. It is correct to view models as representing different phases of a symbolic description of reality, as the positivists did. It is no less pertinent to maintain a distinction between description and explanation, with regard to their nature (Margenau 1950: 170). From description to explanation, the transition is infinitely gradual. An example given by Margenau, when asking whether science describes or explains, concerns Mendel's laws of genetics which were deductively fertile but of a purely descriptive nature. In contrast to Mendel's descriptive laws, Margenau explains, the modern theory which locates the genes within material carriers (the chromosomes) is looked upon as an explanation. It tells us why hereditary traits are transmitted in certain ways, whereas Mendel's laws merely show how this happens. As Margenau puts it, the "why" is nothing more than a disguised "how". Nevertheless, a logical hierarchy distinguishes the two theories; the "why" is here logically prior to the "how": Mendel's laws can be deduced from the theory of genes. We can say, still following Margenau, that a descriptive hypothesis involves constructs closer to the phenomenal world as it is perceived or experienced, while an explanatory hypothesis supposes a further progression into the constructional domain.

Formal constructs are the tools we use for the logical comprehension of the real world. There is no contradiction between advances in the way of a formal construction and advances in the comprehension of mechanisms that operate in reality. The truth of explanation in this sense never has an ultimate character. An explanation attempts to establish the most accurate possible connections between factors that are supposed to operate in the real world. But that explanation cannot represent these factors as they themselves are; it is applied to their operation within a definite space of projection, symbolically represented within the framework of a formal construction.

To the extent that we move further away from observable reality, and abstract from it more fundamental relations, we advance along the path of explanation. But when we do this, we move further away from the truth of phenomenal reality. This is a thesis that was developed by Cartwright (1983) in *How the Laws of Physics Lie*. The explanatory power of the theory varies inversely with its descriptive pertinence. Descriptive models (Cartwright calls them phenomenological) represent observable phenomena but do not explain anything; theories explain but they do not represent. Descriptive models can account for example for the manner in which bodies move when they are placed in a certain context; explanations treat this movement in terms of forces. The observational consequences of an explanatory theory correspond only roughly with what is observable. If our goal is to arrive at predictions rather than explanations, it may be possible to develop descriptive models that are better than anything theory can provide (Cartwright 1983: 160).

We shall now take up an example given by Milton Friedman (1953), who makes the argument that *predictive power has nothing to do with logical realism*. The example concerns the possibility of modelling the shots made by an expert billiard player. We could say that this player acts as if he or she knew the complex mathematical formulas of the billiard shots. This hypothesis is unreal, but it leads us to workable predictions. In this specific example, the model is predictive but it does not allow us to explain the processes that in reality underlie the shots made by the player.

In his 1953 text, Friedman explains that a test by prediction, that is, the realism of effects, can only have value in the evaluation of a model if the field of application of hypotheses is specified. Thus, when a model fulfils our cognitive objectives and allows us to attain an acceptable degree of approximation to reality, it may be preferable to another model, not because its hypotheses are more realistic in the empirical sense (descriptive precision), but because its field of application turns out to be greater in size (analytic pertinence - i.e. logical or explanatory realism). We can see that although logical realism has no direct role to play in making economic models according to Friedman, its indirect role, related to the field of application of a theory, is potentially very important. Friedman bases himself on the example of a model of the density of leaves on a tree. The economist offers the following hypothesis. Each of the leaves is positioned, given the position of all neighbouring leaves, "as if" it sought deliberately to maximize the quantity of light it receives, doing so in conformity with physical laws that permit it to optimise its position. The economist remarks that the results obtained through passive adaptation to external circumstances (the effect of the action of sunlight on the leaves) is practically the same as that which would have been obtained through deliberate adaptation to the same circumstances. Now, if the alternate hypothesis of passive adaptation is more attractive than the hypothesis of deliberate adaptation, Friedman says that it is not because it is more "realistic", but because it is part of a more general theory that is applicable to a greater variety of phenomena. [4]

Let us note that Friedrich Hayek (1952: 74) does differentiate two kinds of hypotheses in the sciences - one kind based on principles that underlie the production of a phenomenon, and the other making precise predictions possible. He holds this distinction to be important with regard to the understanding of theoretical methods in social science and the difficulty of producing predictions on the basis of explanatory principles used to deal with complex social phenomena. Karl Popper (1956: 134-7) returns to Hayek's arguments to defend the idea of a relative unity of method in the physical and social sciences, which often makes it necessary to create an artificial experimental environment in order to be able to predict even physical events; scientists are far from able to predict the exact course of development of a concrete situation, such as a storm or a fire.

The sum total of these observations adds up to saying that depending on whether we want to describe or explain, we will employ different types of realism. For description and prediction, realism bears on effects; realism of explanations bears upon "causes", that is, generative mechanisms. In the first case, the necessary simplifications affect the mechanisms, while in the case of explanations it is facts and data that are simplified. Scientific practice de facto distinguishes descriptive or phenomenological theories from explanatory or causal ones even if there is no intrinsic difference between them. As we saw above, we can maintain that all the models are intrinsically descriptive to the extent that they base themselves upon formal constructs that account for more or less complex effects in the combination of real factors. Still, they can claim to be explanatory if they make use of hypotheses that concern the actual role played by factors that are involved in the production of the observed phenomenon. Explanation and description have actually a relative status. The explanatory power of a hypothesis in comparison to another depends on its capacity to account for the combination of real factors, the effects of which are represented by the latter.

4) THE HYBRID NATURE OF EXPLANATORY MODELS

All models of social action include essentially descriptive hypotheses, which are intended to sum up complex real processes, and explanatory hypotheses that are intended to account for the effects of explanatory factors that operate in reality. The same hypotheses can play a descriptive role in one model and an explanatory role in another, as compared to other assumptions of weaker generality. This association of descriptive and explanatory hypotheses underlies the simulation of real processes, no matter how simplified the reality is.

In models that try to account for the dynamic of the aggregation of individual actions, the modelling of the decisions of social actors tends to reproduce the results of decision-making processes, but these processes are not objects of the simulation; thus they are not explained by the model. Individual behaviours are interpreted by an analyst and described by the model. In this case, formal explanation, properly so called, has to do with the dynamic of a particular social phenomenon. What counts from an explanatory point of view is the role played by decisions in the dynamic of the phenomenon being explained.

For example, the model proposed by Boudon (1973) in *L'inégalité des chances* is based on the effects of interaction, empirically observed, that exist in the relation between educational achievement, social origin and the decision to choose a stream of study. The model allows us to account for the differentiation of levels attained within the school stratification as a function of social origin: the differences in decisions made, which recur at every level of an individual's progress, have multiplicative effects on social inequality of educational attainment (as measured in terms of rates of access to a given educational level).

In general, social actors' decision-making processes can be described in the same way that the billiard shots of a master billiard player were described in Friedman's example. Hypotheses that are related to the function of individuals' satisfaction in the developed model of educational choice have the function of describing the results of a choice, not of accounting, even in a simplified form, for the processes that underlie it. In particular, the calculus for optimization does not express a "strong" rationality attributed to the actors. It is associated with distributions of preferences across a population, and this expresses the interplay of multiple factors.

Let's take an example related to the basis for evaluation of curricula that might be chosen: the relative time of study of major disciplines. We have said that the distribution of preferences in the population does not correspond to a reality in itself, which might be revealed through a survey, but to a set of individual situations that are pertinent with regard to the proposed model of choice. This distribution, like the model to which it is linked, is intended to account for student preferences outside of any consideration in terms of credentials. It constitutes a purely abstract characterization of the school population. Its function is to account for idiosyncratic variations in choice, as opposed to the evaluation of the average level of achievement associated with various curricula, that operate in a more consensual manner. But in order for this procedure to be valid, and so that the simulation covering a certain space of time should be possible, it's necessary that the entire group of real latent factors, to which the abstract distribution of preferences in the model of educational choice refers, should remain more or less stable.

One hypothesis underlying the process of choice supposes that individuals are in a state of uncertainty. They do not evaluate their interest in various alternatives available to them by means of definite strategies, but they do this in a partially analytic manner, by breaking down each alternative in terms of aspects they judge essential. This analytic process is eventually carried on in an intuitive manner. Everything happens as if, as a function of the diversity of the contexts of individual decisions, and independently of all consideration in terms of the reputation of *sections*, it were possible to establish a distance between each individual profile and the progamme schedules offered by different *sections*. As regards school decisions: the choice of optional classes, one's personal work management regime, etc., are means used by individuals to make otherwise rigid curricula more flexible, in order to satisfy various objectives. If individuals have a precise idea concerning the higher education progamme they want to pursue and if this idea motivates their choice, then it must determine their preferences for different disciplines. Nonetheless, if all individuals act in this way, preferences will be dictated by the structure of higher education. Distributions of preferences will be very sensitive to changes that affect the structure or the job market. The distribution chosen for the simulation is justified by the very nature of secondary studies and by the level of maturity of individual identities at this level of progress in school. Preferences, such as the sensitivity of individuals to the reputation of a curriculum or progamme, are connected to the biography of each individual. They depend on facts, on circumstances, on individuals that they have met, on persons counselling them, on perspectives they may adopt, on inclinations, on values they may subscribe to, etc. The plurality of goals, their more or less generic character, the role of values, all these tend to multiply the factors that justify preferences and "normalize" their distribution. Appealing to the notion of subjective or cognitive rationality at this point is unavoidable, not only because the actors are in a situation of uncertainty, but also because the choices they make are not univocal. The very multiplicity of their possible goals and the range of their choices with regard to institutional alternatives are possible driving forces behind social change.

5) EXPLANATION VS. ARGUMENTATION

The explanatory power of theoretical models is associated with an argumentative point of view in the recent literature, especially concerned with multi-agent modelling.[5] The relations between formal explanatory factors and factors that operate in reality are said to be analogical in Nature.[6]

For instance, according to Roger Sugden, the model of inductive inference for explanation is:

(E1) In the model world, *R* is caused by *F*
(E2) *F* operates in the real world
(E3) *R* occurs in the real world

Therefore, there is reason to believe:

(E4) In the real world, *R* is caused by *F*.

According to Sugden (2002), the worlds in which the actors mentioned by Akerlof or Schelling act are imaginary worlds from which all particularity has disappeared except that which serves to account for the causal relations under consideration. The authors of these models make no effort to compare their results with reality. They propose no hypotheses that might be testable in this regard. They only identify in an informal way some cases in which observable social phenomena or factors that they identify may operate. Their models are supposed to transpose certain aspects of the real world into a "possible" world, possible in the sense that the generative mechanisms are real but not the situations. The complex social phenomena on which such causal relations may shed some light would thus be explained qualitatively, in analogical fashion with reference to the model.

This representation of formal explanation introduces a difference of nature where there were only differences of degree between explanatory models and descriptive ones, for want of an explanation of more general relations between scientific models and the real. It is not methodologically fruitful to consider certain formal worlds as counterfactuals, no more than it would be to consider them as simplified versions of the real world. It is preferable to refer to the idea of epistemic correlations which rests upon the different natures of the formal and the real in order to express the relations that can be established between them. Thus we are led to consider as problematic the affirmation according to which force F, mentioned by Sugden, is present in the model and in reality, whereas the formal factors do not refer to the data of experience. The notion of analogy does not express the relationship between the two worlds we are talking about.

Formal automatons simulate the shadows of reality projected upon a given projection plane. The shadows refer to the world, while the automatons are only formal constructs. There is no sense in maintaining that such an automaton participates in a counterfactual reality. The explanation supposes that the connections between various factors of the model, defined by constructed concepts, and various real factors, that is, factors abstracted from the world of experience and denoted by concepts by intuition, are epistemically valid. These connections are much stronger than analogical connections that would place in opposition two worlds that potentially have the same nature. The theoretical model is supposed to represent the internal logic of different situations that are subsumed under the phenomenon that is explained.

We have seen that the Akerlof model explains, on the basis of a simple formalization, why economic transactions do not take place owing to problems of asymmetry of information. Epistemic correlations between versions of the model and real situations could potentially be established under the following circumstances. The attempts of social actors “Y” concerning an element “E”, which is evaluated more or less subjectively at the level of another group of social actors, “X”, affects the exchanges, in a broad sense, between the social actors “Y”' and “X”, following a process of rational anticipations. The social actors “Y” anticipate that the individuals in group “X” who have an interest in being candidates for exchanges are also those who will benefit from the exchange. Now, the benefit that the “Y” group is ready to allow the “X” group to realize is not necessarily sufficient to make the exchange possible, in view of their margin of uncertainty as to the real value of the object to be exchanged “E” as a function of the candidates involved in “X”. The model, in its potential developments, allows us on the other hand to explain the importance given to that which fulfils the role of guarantee or certificate distinguishing the quality of a particular good from the average quality of goods on the market. In educational matters, the reputations of higher education institutions or curricula of secondary education schools play a role in the reduction of the uncertainty experienced by professors, future employers, etc.

Epistemic correlations between versions of the Schelling model and real situations can potentially be established when individuals choose a group to belong to, spatial or social, by taking into consideration the composition of different groups: people are decision-makers for themselves and components of the environment for others. The emergent effects of decisions tend then to differ from the individual intentions that determine the choice of groups.

6) THE QUESTION OF EMPIRICAL ADEQUACY

The degree of proximity to observational data that we have managed to attain in the model of choice developed was possible because of the existence of interactions between parameters. These interactions increase the number of possible connections between the model and empirical reality. It was important to identify a satisfactory solution so that this solution would be able to act as a reference point. The analysis of the interplay between parameters allows us to see, on the basis of this solution, the existence of other sets of parameters that could provide other solutions to the problem. Thus the adequacy between simulated and observational data has been made possible thanks to a slight flexibility in the meaning of parameters, which is due to the mutual relations between parameters. If the adequacy to observable data was not satisfactory, it would have revealed non-random differences between the model and reality. The generative mechanism as defined would stand invalidated, not because precise adequacy between the results of the defined model and observational data had been shown to be impossible, but because despite fluctuations in the meaning of parameters permitted by their interactions, no adequacy had been attainable.

In the model of educational choice, the amplification or "snowball" effect is due to a progressive updating of the reputations of progamme *sections* as a function of the performance levels of their students. This effect is attenuated by the attraction of these reputations upon the group of students, whatever their level of performance. This hypothesis is different from the one found in the Schelling model in which only those who are similar tend to group themselves together. Nonetheless we could have obtained comparable results by reducing the correlations between preferences for disciplines and levels of productivity, and by introducing a sensitivity factor for the reputations of *sections*, correlating reputations and individual performance levels. Changes in preferences due to changes in curricula would have been less differentiated as a function of levels of individual productivity and the reputations of *sections* would have varied less depending on choices. However, differential sensitivity to reputations, correlated with levels of individual productivity, would to the contrary have affected the process of amplification. We would thus have obtained a phenomenon of progressive amplification closer to that found in Schelling. A parsimony condition has led us to suppress one of the two parameters: the differential sensitivity to reputation, which nonetheless plays a role in reality. The data we possess does not lead us to differentiate the reasons for the preferences of the best students with regard to the *sections* that have the best reputations. The statistical connection between relative levels of performance and relative levels of preference for selective disciplines is based, as in the model of Spence, on the lower cost that studying selective disciplines represents for the best performing students. But an aversion to minority situations may also play a role, whatever may be the rational justifications for such an aversion, which is distinct from academic preferences strictly speaking. We may observe that differential sensitivity to reputation is also linked to gender as well as to social origin. It involves an aversion to the risk of social failure.

Certain relations, more or less functionally equivalent, thus enlarge the possible field of interpretation for the results of the model. In other words, the connections between the real processes represented and the formal factors can vary to some extent as a function of the populations involved and by means of these functional equivalencies, without the results of the model being affected. It is also important to underline the inherent limits of this kind of experimental procedure. Simulation is like an experiment carried out under laboratory conditions, in which we control as far as possible the group of parameters that we are going to operate with, and whose impact upon the phenomenon being studied we are going to measure. Simulation even constitutes an archetype of controlled experiments: no parasitic element can falsify the results of the experiment without the investigator being aware of it. The algorithms included in the model and the conditions on pre-established limits constitute an exhaustive set of "causes" for the results obtained.

These results are supposed to describe exactly what would happen, all else being equal. They will be less faithful to reality when reality is subject to shocks whose effect upon parameters or algorithms is too indeterminable to be integrated into the model. However, the meaning of parameters and algorithms, based on the formally constructed causal structure, is defined once and for all, at least implicitly, while the reality described by parameters does vary. More generally, when we attempt to express the phenomena we are studying in the language of the model, we necessarily impute the complex effects of real processes that are going on to parameters and algorithms that we have formally introduced into the process.

7) THE QUESTION OF THE VALIDITY OF FORMAL EXPLANATION

If there is a difficulty in properly estimating the acceptability of a theory that explains a social phenomenon based on a model of its generative mechanisms, the answer must be found in an examination of the validity of epistemic correlations that are postulated between formal and real factors. The question of empirical adequacy plays an important role in the falsification of a theory, but it contributes nothing to the process of validation. This is the argument of Joshua Epstein (2007, 53), which he expresses as a maxim: "If you didn't grow it, you didn't explain it". This maxim is really a necessary though not sufficient condition for explanation. The fact that, if we didn't simulate it, we haven't explained it, is equivalent to saying that if we can explain it, we can simulate it. But once again this condition is less determinant from the point of view of explanation, to the extent that a realism of "causes"- i.e. explanatory or logical realism - tends, as we have seen, to be opposed to a realism of effects, aiming at simulating observable data. In other words, not only is it the case that adequacy to observational data does not allow us to judge the explanatory pertinence of models, but a logical realism of hypotheses tends to run counter to their descriptive potentials. We could thus criticize Epstein for overemphasizing the question of empirical adequacy, all the while maintaining that such adequacy does not by itself assure the validity of an explanation.

A test involving prediction does not guarantee the pertinence of the explanatory structure proposed by a model. Thus the question is to know what does allow us to evaluate this pertinence. The question is more delicate because the elements of models are formal constructions. They are evolving in a closed system, while social reality is an open one. The investigator is in this respect at risk of deducing from a model nothing but what he has put in it a priori. The simplifications the investigator operates can also produce artefacts. Constructed categories, the simultaneity of decisions, spread of information, interrelations of individuals, the geometry and the size of populations, etc. can all falsify conclusions deduced from the model with regard to the comprehension of phenomena. Nonetheless certain simplifications are purely mathematical. For example, modelling the effects of an aggregation of many individual decisions allows us to ignore specific influences that underlie them, as long as these influences are not systematic; we then build hypotheses concerning the central tendency of actions (Goldthorpe 2000: 116; Mäki 2000: 323).

The problem of the validity of explanation can be summed up in the fact that the simple experimental confirmation of a theory (A), by means of the deduction of its observable consequences (B), does not prove that a different theory (C) might not have arrived at (B). According to Northrop (1950, 148), only the investigation of conceivable theoretical alternatives can allow us to appreciate the acceptability of theories that are valid from an experimental point of view. [7] This investigation must show that the theory, at least to some extent, is the only one that accounts for the observable consequences involved in the experiment. The analyst must associate his theoretical choices with justifications that are stronger than the ones he is accustomed to using. There is a tendency to consider this part of research something implicitly accomplished as long as the objectivity of an investigation appears to the investigator to be confirmed by empirical results; however, these results are only useful to some extent for the rejection of false or inadequate hypotheses.

Above, we defined the validity of explanation as the imputation, within the framework of the model, "of the right effect to the right real factor involved". No implicit factor should affect at one and the same time the factors assumed to be operating and the observable data. Latent factors, whose action occurs in a framework of descriptive hypotheses, must be explicitly identified and their non-interference with the explanatory factors of the model must be justified, at least as regards the most important of these factors. If this condition is not fulfilled, one risks imputing to formal explanatory factors the action accomplished by such implicit factors. In other words, the epistemic correlations assumed to exist between formal explanatory factors and real factors may be biased, even in cases where the empirical consequences of the model are satisfactory. It is a matter of anticipating the influence of implicit factors on the explanatory factors of the model. The essentially descriptive elements in the model must in effect be able to be developed from the perspective of logical realism without invalidating the explanatory kernel of the model, that is, the theory that the model represents. A theoretical investigation must lead to a guarantee of the relative autonomy of descriptive hypotheses that synthesize the effects of complex processes, and explanatory hypotheses applied to generative mechanisms strictly speaking, with respect to the reality that is represented (Bulle 2009).

We have justified our theoretical choices throughout the construction of the model of educational choice. The question of the interpretation of the explanatory factors of the model nevertheless is worth some further development. From this point of view we may take up again the explanation of the change in values over time within the educational system. The model "explains" the following phenomenon: the relative positions of *sections* within an educational hierarchy depend on the "system" formed by the various curricula, especially as regards their relative demands in terms of levels of achievement. This relative difficulty plays the role of a selective filter, revealing the average performance levels of the populations of different *sections*, and at the same time the educational value attributed to *sections*. This explanation of the meaning of values assigned to *sections* (average composition in terms of "performance level" of students) is compatible with the role played by general secondary education as regards educational certification or credentials. The general sensitivity of students to the "reputation" of *sections* is explained in this respect by an educational and economic context, dominated by problems related to the asymmetry of information.

The explanation of the internal values of the educational system is based on the factors that determine the "reputation" of *sections*. The explanatory power of the model depends on the pertinence of the postulated connections between formal explanatory factors—the average level of students' performances in previous years—and real factors that influence the relative values assigned to different *sections* when school decisions are made. In order to test the generative mechanisms of school values represented by the model of choice, it is necessary to specify all the factors that intervene in the choice of *sections* that can account for their hierarchy. Over and above individual educational or cultural preferences, the factor that determines in a relatively consensual way the "usefulness" of choosing a *section* may depend on two types of factors, in addition to the "average" level of student performance in that *section*.

This has to do, first, with openings leading to higher education and the job market as a function of the need for particular skills. In the model's framework the usefulness or utility attributed to determinate areas of knowledge influences individual preferences. It influences the choice of a *section* as a function of the weight given to specific areas of study in the curriculum of a *section*. This utility affects the value that students assign to *sections*, via the "reputation" factor, in the case of a specific value of acquiring competence in some discipline in a *section* that either does or does not emphasise them. "Reputation" would reflect the relative value attributed to a *section* that would be associated with particular areas of study. Such a level can be imputed just as much to the selection process for entering a *section*, as to the effects of the training offered—the human capital—without calling in question the general form of the model. This interpretation of the reputation factor nonetheless does not allow us to explain, as we have observed empirically, the essentially positive role played by studies of classical languages in the relative rise in value of *sections* dominated by scientific course work during the 20th century.

Another alternative is offered by interpretations of school values that draw their inspiration from neo-Marxist sources. Reputations are held to reflect the arbitrary value conferred upon certain educational credentials by members of the social groups that dominate the functioning of the educational system. The "reputation" factor expresses a selection of a cultural type that is related as before to particular areas of knowledge. This interpretation of the reputation factor nonetheless fails to explain the essentially positive role played by scientific disciplines, especially mathematics, in the relative promotion of the value of *sections* over the course of the 20th century.

Empirical observation of the evolution of the educational system during the 20th century show that the relative valuation of *sections* is not directly connected either to the dominance of scientific subjects, especially mathematics, nor to that of classical languages, but to both jointly. The general criterion that can be substituted for the idea of average level of performance could thus refer us to the social "distinction" associated with a characteristic that both these kinds of instruction share, namely their "academic" nature. This idea was defended, as we have seen, as an explanation of the evolution of values associated with curricula in the United States by a theoretician of conflict, Randal Collins (1979). The relative valuations of types of instruction are for Collins consequences of what is essentially a social competition. This interpretation leads in formal terms to the same conclusions as the model on some points. It requires that we substitute the idea of an arbitrary selection related to the academic nature of the culture being transmitted, for that of a selection or self-selection related to demands imposed by curricula. Preferences for disciplines would thus be influenced not so much by the relative performance levels of students, but by their social membership statuses. We have seen that various forms of social membership appear to affect the differential sensitivity toward the reputation of *sections*, in relation to differentiated risks of "social failure". The major difference between our interpretation and Collins's is not based on this differential social sensitivity, but on the factors that explain the reputations of *sections*. With regard to this question, Collins's interpretation is improbable, from both a theoretical and empirical point of view. Empirical analyses in particular tend rather to reveal a socially synchronic aspect of the changes in school preference across the entire school population (Cherkaoui 1982). This fact is difficult to reconcile with the idea of an arbitrary value, socially defined. And it is difficult to account for the phenomena of credentials that affect the relations between the educational system and the job market, by characterising them as "cultural money", in Collins' terminology, lacking either selective or formative rationality.

NOTES

1. Cf. J.B. Grize (1962), and Vygotsky (1934).
2. A scientific model gives us a selective, symbolic representation of an empirical phenomenon (or system or process). It is appropriate to start talking about models as soon as a reality that intelligence is able to manipulate is compared analogically with another reality in order to account for it in a way that is useful in economics or otherwise in science. In general though not exclusive terms a model is made up of concepts and relations (it can be made up of virtually any kind of element, material or ideal). The more models are formalized, the more the concepts employed approach the nature of scientific concepts. Formalization allows us to study the functioning of a constructed causal structure by measuring it in different ways and by performing tests on it, varying the associated hypotheses.
3. Thus we should not mix up "proof" and "truth" (Northrop 1947: 83). Proof is a formal relation between propositions. It belongs to the domain of pure mathematics and formal logic. Truth is a relation between propositions and empirical facts.

4. And if Friedman's essay really encouraged an excess of formalism in economic theory, it was misinterpreted. See on this topic D.W. Hands (2003).

   When Milton Friedman (1953) speaks of explanation, he appears only to be interested in the descriptive or predictive scope of models, that is, the weak sense of the idea of explanation. But the 1953 text, by its very ambiguities, points up the epistemological problems raised by a definite opposition between a strong and a weak sense of explanation (i.e. description), and this is perhaps its primary interest. We could sum up the point of view Friedman is defending, if we had to choose just one, in this assertion: *explanatory force has nothing to do with the truth.* "Explaining" for Friedman, refers to the possibility of describing, in accordance with some scientific objective, the behaviour of some phenomenon under consideration. The idea of truth on the other hand has as much to do with descriptive realism as with explanatory or logical realism. Thus there are different theses contained in the 1953 text, such *as explanatory power has nothing to do with descriptive realism*, which may refer to the function of scientific constructs in scientific explanation; *or predictive power has nothing to do with explanatory (or logical) realism*, which in turn refers to the function of formal constructs in forecasting. Nonetheless explanation appears to signify for Friedman something more than it would in a simply instrumental context. It is the definition of the domain of validity of hypotheses that implicitly differentiates the two senses of explanation in his text. It is as though we passed from the weak sense to the strong sense to the extent that the domain of validity of hypotheses widens toward greater generality. Still, circumscribing such a domain of validity presupposes the involvement of interpretive options that a confrontation between results from the operation of a model and data from experience could never manage to falsify. Thus the "methodology of positive economics", which maintains that the criterion of validity for a model is a test of predictive capacity, is defending an illusory empiricism. The conditions of validity for the second part of the hypothesis (or model), which Friedman says are supposed to specify a category of phenomena for which the model is an adequate representation, remain undefined.
5. While in numerous models used to simulate the outcomes of the composition of multiple social actions, the interdependence between decisions is indirect—i.e. affecting situations and not decision rules as such, in agent-based models, the effects of interaction between actors tend to affect decision-making processes themselves. These processes are therefore involved in a dynamic process of change, such as occurs with phenomena of learning or influence. Whereas we speak of agent-based models as soon as interdependence of actions is involved, the latter approach tends to characterize more recent trends of research.
6. CF. Epstein & Axtel (1996); Epstein (2006); Hedström (2005: 143–44); Sugden (2000).
7. Northrop cites Albert Einstein (1934) on this point: "The belief in an external world independent of the perceiving subject is the basis of all natural science. Since, however, sense perception only gives information of this external world or of "physical reality" indirectly, we can only grasp the latter by speculative means. It follows from this that our notions of physical reality can never be final ... even

experimentally confirmed theories are never absolutely guaranteed by the factual data."

Conclusion

PROPOSITIONS CONCERNING THE EVOLUTION OF THE FRENCH SECONDARY EDUCATION SYSTEM

Observation of the changes undergone by the French secondary education system between the major reforms of 1902 and 1965, the elements of the theory of educational choice presented here and the model of curriculum choice set forth here allow us to maintain the following group of propositions:

(1) Changes in macro-social conditions during the 20th century favoured an increase in students' educational demand as an alternative to productive work.

(2) Because of the productive and selective nature of subjects taught, curricula or streams of study tend to separate portions of the school population with different average levels of performance.

(3) Because of asymmetry of information, and as illustrated in the model of Spence, the school performance of a student plays the role of a signal in regard to the job market, being connected to an expected level of performance, and this role has tended to grow as the educational system itself expanded.

(4) Increased demand for education led to a decrease of the average socio-economic situation of the school population as a function of students' level of education, and for these very reasons tends to stimulate its own expansion. Educational demand thus increases according to an endogenous dynamic.

(5) For any given level of education, average performance levels of students has an influence on the relative value attributed to various disciplines or curricula.

The simulation model for educational choice proposed here allows us to verify the validity of this proposition with the help of a simulation of the choice of a stream of study or *sections* in French classical education between 1915 and 1965. This hypothesis is confirmed by the relative positions of *sections* after the 1965 reform, and particularly by the rise in value of the *C* stream.

(6) The changes in the distribution of the school population within the secondary education system respond to an endogenous dynamic.

In fact, to the extent that this distribution leads to differential values being assigned to various curricula chosen by students (proposition 5), it influences educational choice (proposition 3), which are for this very reason interdependent. The distribution of the school population over streams of study established different average levels of performance (proposition 2), creating differences in the value assigned to streams (proposition 5), and educational choice reacted to these differences in an endogenous manner. The simulation model proposed attests to the empirical acceptability of these assumptions. The organisation of curricula within the educational system defined by the major reforms of 1902, 1925, 1945 and 1965 allows us to explain changes in the dominant culture within the French educational system. Streams of study were vectors of differentiation in the school population and the assigned values that differentiation aroused.

(7) The evolution of the distribution of preferences relative to school knowledge is closely connected to the evolution of the school population.

Basing ourselves on preferences for different curricula as revealed by educational choice, we separated preferences for school subjects from preferences assumed to have been influenced by the interdependence of decisions. The resulting evolution of the distribution of preferences is correlated with the evolution of the school population itself. For example, as the educational system expanded, choices made exhibited a drop in preference for classical languages, and a lesser drop in preferences for scientific disciplines.

(8) The analysis of school decisions shows that the school imposes itself upon families as a rather opaque institution, in relation to the economic and social system as a whole.

The effects of the interdependence of decisions (propositions 2 and 6) and the evolution of the distributions of preferences with regard to school knowledge (proposition 7) shows that school decisions largely depend on criteria that are internal to the educational system.

(9) The evolution of educational systems does not follow a macro-social rationality.

On one hand, the educational offer does not change primarily as a function of exogenous needs, but as a function of the outcome of struggles for defining the education of the new school-attending populations in secondary education. On the other hand, the criteria that influence school decisions are, in the first place, internal to the educational system (propositions 2–8). Nonetheless the reputation of curricula, acting as constraints on choice, end up generating an emulation or competition effect within the school population, in favour of disciplines and streams of study that are academically demanding.

The model of choice deployed here displays the rational foundation of the creation of school valuations, at the same time exhibiting the contingent factors participating in the determination of those valuations. These are linked to the definition and the structure of the educational offer. The model has allowed us to verify, from an empirical point of view, the plausibility of the generative mechanisms assumed to operate. Their theoretical acceptability—i.e. the attribution of the right effect to the right factor involved—is also attested by the analysis of alternative hypotheses concerning the combination of explanatory factors that may generate the changes observed in reality.

THE CRISIS OF EDUCATION IN EXPANDING EDUCATIONAL SYSTEMS

The evolution of the French educational system during the 20th century corresponds fairly well to the emergence of the model of social mobility that Ralph Turner (1960) likens to a "contest mobility".

Turner distinguishes two major types of social organisation of mobility through schooling: a "sponsored mobility", and a "contest mobility". [1] In sponsored mobility future social elites are recruited at a young age based on certain merit criteria. In this sense they do not owe their status to any particular effort or strategy. A higher social status is given or denied to a candidate based on judgments by members of the elite, who decide whether a candidate has the qualities required to join their ranks. The same mechanisms govern conditions of access at every level of the social ladder. In a contest mobility system, social statuses are won like prizes in an open competition, and are supposed to be the fruit of the efforts of the contestants. The contestants are supposed to play fair, but they have considerable strategic latitude. The winners are not those who are the strongest, necessarily, but those who are the most "deserving". The two systems are distinguished as regards the actual fact of selection. Contest mobility schemes postpone selection, and give no advantage to early leaders. But sponsorship systems favour selecting a sufficient number of candidates as early as possible, in order to prepare recruits for their future roles, and to insulate candidates from external influences that might affect their suitability in a negative way. Turner suggests that it is quite likely that relative to a given level of actual aptitude, social advantages are more likely to influence individual success under contest mobility than under sponsorship. But the force of the sponsorship system is also its weakness, since in another respect there is less chance for social ascent when candidates do not benefit from the sponsorship of elder members of the elite.

That which interests us here, as concerns the ways in which the two mobility patterns are distinguished, is the difference in the value given to education. Under sponsored mobility, learning through instruction is given an intrinsic importance, while under contest mobility education has no proper value. It is only a means of maintaining all the candidates together within the competition. Education is viewed not so much as teaching what is good in itself, but rather as inculcating the necessary skills for fighting for "the real prizes of life". That is why technical, professional or job-related instruction appears to be more important; along the same lines, educational achievement does not constitute by itself individual merit and must be completed by proof of practical competence. We could add to Turner's perspective the fact that under competition, the meaning of personal accomplishment gets located outside individuals instead of within them. Culture and abstract knowledge no longer seem necessary. Personal accomplishment is no longer thought as gaining mastery in a moral sense, but comes to be viewed as social and economic success, in terms of the concept of achievement.

Up until the Second World War in France, the dominant pattern was sponsorship mobility in Turnerian terms. Selections were actually made at the end of elementary school that determined social trajectories. Instructional quality was the focus of early reform efforts, since education had to contribute to the training of individuals already marked out for elite social status. In this regard, a thorough grounding in classical languages was justified by its association with moral discipline. Since 1945, the competition model has gained ground steadily, and the evolution of the system as a whole, without question, is marked by a desire to postpone the separation of groups of students with various levels of school achievement. This postponement has been progressively extended into the later period of secondary education, the objective being to equalize the various academic curricula, with the aim of putting an end to the dominance of the scientific *section*. This objective governed the reforms from the 1980s onward. It has not succeeded yet because the policies put in place were not informed by an understanding of the generative mechanisms of school values. These reforms left standing the lycée structure according to different *sections*, emphasizing the vocational function of school knowledge.

A drop in the intrinsic value assigned to academic knowledge and a correlative tendency to see school values levelled off, more importance given to practical applications of subjects and learned qualities held to be more directly useful for everyday life, a drop in selection of academic-type instruction—these things characterise the transformation of educational values that have been variously endorsed by official policy over the period of expansion of the educational systems. But these traits cannot be held to be part of the "modernisation" of these systems or as functionally linked to the macro-social changes experienced in advanced industrial societies. A "functional" connection exists that can explain these changes, but it is in fact internal with regard to educational systems themselves. This corresponds to the impossibility of defending the academic quality of instruction without at least marking success versus failure among students, or differentiating levels of instruction itself. These differences, quite logical in terms solely of education, appear to be very controversial when considered as determinants of individual destiny. They are at the centre of dilemmas affecting education in modern democratic societies. Educational supply changes as a function of responses to these problems and their subsequent effects on school decisions. We can assume that the dynamic of school decisions favours the creation of new paths to school achievement that are less official, given that there is less public support for forms of educational sponsorship.

The evolution of curricula characterized by the passage from one Turnerian model to another, that is, by the passage from “sponsored mobility” to “contest mobility”, in turn characterizes a school system that is evaluated in terms of the role that it plays in the process of social mobility. This reduction of educational problem is a logical result in the development of contemporary systems of education, to the extent that it is marked by the problem of the ambiguity of educational sponsorship, and by the support it seems to lend to a culture associated with that of the social elite. The Turnerian categories thus allow us to understand why the progressive disappearance of forms of educational sponsorship is correlated with a weakening of the intrinsic value assigned to knowledge.

Depending on perspectives developed regarding the evolution of educational systems, two main categories of interpretation may seem to be pertinent. On one side, these transformations certainly appear to serve the capacity of the population to integrate itself into a social order and a productive system. The preference given to pedagogies of the adaptability of individuals over pedagogies of the transmission of knowledge, the evolution of the concrete and practical nature of studies, various specialisations, and an emphasis on socialisation processes, all satisfy the idea of an adaptation of the school to economic and social changes. In accordance with these views, a social mobility via competition is substituted for a social mobility via sponsorship in order to rationalise the selection of recruits for the job market, leaving the selection to processes that place a high value on qualities that are useful for the efficiency of the productive system. On the other hand, the distribution of students in different parts of the educational system that creates connections between educational opportunities and social stratification, and more generally the small degree of progress realized with regard to social mobility, all seem to support theories of social reproduction by means of school culture, and to encourage further weakening of the process of educational sponsorship. On one hand there is a vision of the school that sees it adapting itself to social changes; on the other hand there is a vision of a school system that does not change enough and whose selective processes amount to social triage.

The long-term study of transformations undergone by the French educational system renders these broad interpretations of the relationship between school and society invalid. The transformations in question were motivated in the first place by changes in the school population. The expansion of the school system and its endogenous dynamic contributed to the augmentation of the importance of the role which the school played in professional and occupational orientation and in processes of social mobility. But this expansion maintained a situation of educational crisis that made questions of social efficiency and curriculum-related equity critical. The struggles carried out on behalf of greater openness of the school and a higher degree of adaptation to the school population, orchestrated by actions on the part of public authorities, intended to maintain the formal product of studies, and by degrees, a levelling of school values. The educational pragmatism that developed opened the way to the challenges aimed at the most highly valued disciplines in the educational system, disciplines whose usefulness is less immediate but which are the most demanding in academic terms. The school culture and its role were progressively redefined by the critics and reformers. The latter promoted doctrinal concepts intended to discredit forms of instruction considered as obstacles to the adaptation of the educational system to mass education

But school values are not something that can be reformed by decree. We have shown that they emerged from an interaction, by means of educational structures, between the dominant interpretation of the needs and interests of the school population and individual decisions. The dominant interpretation changed as the educational system expanded, and became the advocate for a diversification of curricula, and a levelling of the educational value of various curricula. By influencing structures within the educational system as well as school knowledge, this dominant interpretation influenced the situations where individual choice operates. The result is that the difficulty in gaining what is at stake in education is resolved in favour of cultural and social advantages. The disappearance of patterns of educational sponsorship, which is followed by a drop in academic standards and a kind of scrambling of the rules of the educational game, underlies a reinforcement of social sponsorship at the level of general processes of social mobility. The effects of this reinforcement then reduced, to a degree that is hard to measure, the gains in terms of social opportunities that might have been hoped for, given a large increase in demand for education. Theories of conflict, and certainly those of the neo-Marxist types were wrong to suspect the solidarity that existed between educational sponsorship and social sponsorship. The first was a protection against the second. This is true not only because of the students' potential that educational sponsorship identifies, but also because of the types of intellectual training that it allows the system to provide.

The hypotheses that the choice model develops show that the values assigned to disciplines in secondary education depend less on the areas of reality they focus on than on a more general academic character that they share to a greater or lesser degree. This character distinguishes curricula in terms of their level of academic demand. In order to explain variations in individual preferences and their links to school performance, this academic character could lead us to restore to its rightful place the old idea of intellectual discipline in general, an idea discredited by pedagogical movements that have dominated changes in educational systems in advanced industrial societies.

NOTE

1. Turnerian ideal-types are thought to characterize American and British institutions in particular, as they were at the beginning of the 1960s.

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