Macrostructures, careers and knowledge production: a neoinstitutionalist approach

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Abstract: Scientific careers are theoretically and practically important because they link individuals with institutions as well as social structures with knowledge production. These mediating functions have to date not been systematically dealt with. In this article, a neoinstitutionalist framework for the analysis of careers in science is developed. Careers in science are treated as products of overlapping institutions belonging to the different social contexts in which scientists act simultaneously. These contexts (their specialty, society and employment organization) yield specific institutions that shape different work roles, which can be analytically distinguished. With regard to a specialty’s knowledge production, four different career stages (apprentice, colleague, mentor and sponsor) can be distinguished on the basis of dominant work roles. Society’s institutions (e.g., language, education and employment system) structure the international specialties, which can be said to consist of national subsets. Organizations provide work roles that integrate knowledge production into the employment system. Job sequences become institutionalized as career lines that structure international internal labour markets. While there is agreement in the literature that academic organizations do not provide internal labour markets, so far it has been neglected that specialties have these properties. The stability of these international internal labour markets currently seems to be endangered because both organizations and specialties can only balance the conflicting demands for fixed-term contracts and permanent positions when they grow. As a conclusion of the theoretical discussion, a research program is outlined.

Keywords: Career theory; new institutionalism; scientific communities; scientific labour markets.


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Introduction

The career in science as a theoretical challenge and opportunity

Like all other working people, scientists go through a sequence of jobs and work experiences, that is – a career. As several observers note, these careers are becoming
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Precarious because more and more younger scientists compete for few and fewer jobs [1]. The causes of worsening career conditions are seen in macrostructural changes: the diminishing number of jobs available for scientists caused by the transition of science to a ‘dynamic steady state’ characterized by constant rather than growing resource flows [2,3]. Changes in the individual scientists’ ways of conducting research resulting from their precarious careers are discussed by several authors, e.g., with regard to risk-taking, competitiveness and publication behaviour (e.g. [3, pp.167–212]).

These discussions indicate that careers are links: they link individuals and institutions and they link social structures with knowledge production. If this is correct, careers provide a channel for societal influences on knowledge production. By changing its funding of science, society also changes the number (and quality) of jobs that are available to scientists. This change influences careers and in this way unconsciously modifies conditions of knowledge production. The same linkage function makes careers a fascinating subject for the sociology of science: careers seem to be one of the phenomena that mediate between the scientific and non-scientific social structures, on the one hand, and knowledge production, on the other hand.

Considering this twofold interest, it is disturbing how little we know about careers as linkages between the micro-level of the scientist’s individual work history and the macroscopic structures that shape career conditions. Numerous quantitative studies described scientists’ geographical [4] and job mobility [5] or investigated connections between scientists’ career achievements (productivity, academic rank, tenure, etc.) and variables such as entrance into academia and initial career conditions (e.g. [6–8]), academic mentorship/sponsorship [9], gender (for an overview, see Zuckerman [10]), etc. However, these studies focused on limited time spans, investigated only few variables and related careers neither to institutions nor to knowledge production. Qualitative studies have used a more complex approach but are focused on the individual level and on empirical phenomena (e.g., [1,3, pp.167–212;11–13]). Several older studies in the sociology of science did not address the complex problem of careers but did contribute ideas as well as empirical work which can be related to careers, for example

- intellectual mobility and its consequences for the dynamics of research areas (for a summary, see Chubin [14]),
- scientists’ individual ‘research trails’ [15],
- age-related effects [16], stratification (e.g., Cole and Cole [17]).

Since the career’s mediating functions have to date not been systematically dealt with in the sociology of science, it is quite natural to look around for help from other fields dealing with careers, such as organizational sociology, occupational sociology, sociological labour market research and economics. These fields have, however, so far paid little attention to the specificity of science. In career theory it is often supposed that a career primarily takes place within a single organization [18–21]. This assumption, which underlies most of the literature on careers, cannot be accepted for careers in science without further discussion. Similarly, the conceptualization of science as a profession and the concept of academic labour markets presuppose what has yet to be proved – that science and scientific research can be subsumed to the categorical system of the other disciplines. Difficulties in the application of other fields’ concepts to science have been noted by Schein et al. [22] for career theory and by Sørensen [23] for labour market research. The problems become most clearly visible in the case of economics.
Paula Stephan sums up her discussion of the human capital model's application to science as follows:

"The failure of the model is undoubtedly related to the fact that the production of scientific knowledge is far more complex than the human capital model assumes, and that these complexities have a great deal to say about patterns that evolve over life cycle". [24,p.1230]

Other examples of inadequate approaches to careers in science are the usage of statistics that do not differentiate between scientific fields [24-26], or models that use reduced assumptions about scientists' goals [24,pp.1224-1225;27].

Neither the sociology of science nor the other disciplines considering careers offer a framework that allows for the systematic treatment of careers as linkages between institutions and individual knowledge production. The aim of this article is to develop such a framework and to integrate the different contributions referred to above. To emphasize the career's role as a link, a neoinstitutionalist approach is adopted here that allows conceptualizations of career phenomena as dependent and as independent variables (Section 2). The institutions in the different social contexts shape different work roles, which can be analytically distinguished (Section 3). These work roles' overlaps constitute jobs. Some job sequences become institutionalized as career lines that structure international internal labour markets, whose stability, however, currently seems to be endangered (Section 4). The conclusions outline a research program which would allow us to exploit the theoretical potential of the career concept (Section 5).

2 A neoinstitutionalist framework for the study of careers

The basic assumption underlying my proposal to develop an integrative framework for dealing with careers in science is that the career problem's complexity is caused by the fact that scientists act simultaneously in several social contexts. At least three of these contexts yield specific institutions that influence careers: scientists are members of a scientific community respectively specialty, which is the most important social context for their work. At the same time, they earn their living by conducting scientific work, thus being workers in a society that influences their education, employment, earnings, retirement, etc. Since research takes place in formal organizations, scientists are members of an organization which provides them with the resources necessary for their research and, at the same time, mediates societal influences on scientific research.

In order to synthesize institutional influences from these different social contexts, a neoinstitutionalist approach is used here that draws upon recent developments in social sciences. Whereas a new institutionalism is well established in economics (e.g., Williamson [28]), policy studies (e.g., March and Olson [29]) and organizational sociology (e.g., Powell and DiMaggio [30]), the sociology of science is rather slow in adopting these ideas. However, for analysing careers in science an institutionalist perspective seems to be almost unavoidable.

New institutionalism has given up reductionist assumptions about actions being completely determined by institutional environments. Institutions are seen as only one of several factors shaping actions alongside actors' goals and interests and non-institutional conditions of action. Moreover, institutions are no longer understood as clear-cut rules that unambiguously prescribe human behaviour. Instead, they are seen as diffuse environments that are subject to actors' interpretations. This perspective rests, however,
upon a very wide concept of institutions that includes all regular social patterns. Though such a perspective is certainly possible, a narrower definition is chosen here that facilitates empirical analysis as well as theoretical discussions. Institutions are defined as systems of (formal and informal) social rules [31,32,33,p.38]. This definition, which excludes belief systems, actions and social entities like organizations [34] is used relatively seldom, although it has several advantages. Firstly, it allows us to conceptualize institutions not only as being subject to evolutionary change, but also as formed as purposeful actions. Thus, institutions can be independent as well as dependent variables in institutional investigations. Secondly, the restriction to systems of rules makes it clear that institutions are only one of the factors influencing actions. A concept of institutions that comprises all social patterns, including cognitive and symbolic elements, tends to be quasi-deterministic because it embraces all determinants of action and leaves no room for an intentional actor. Thirdly, this narrow concept supports an empirical search for institutions because it may be operationalized to a certain extent.

Although the definition of institutions as systems of societal rules may resemble the frequently criticized old portrayal of clear-cut, unambiguous institutions, the latter idea is not necessarily a consequence of the former. The ambiguity and diffuseness of the institutional conditions of actions claimed by the new institutionalism quite naturally result from the overlap of the different rules within one institutional system and from the overlap of different institutional systems. These overlapping rules and institutions confront the actor with incomplete and contradictory expectations, which are to be interpreted and applied to the specific situation. Thus, the understanding of institutions as systems of rules allows the flexible treatment of institutional conditions of actions required by neoinstitutionalism. At the same time, it allows us to analytically distinguish institutions that are related to the same phenomenon, but rooted in different social contexts. This is especially important because institutions belonging to more than one social context are to be analysed with respect to their impact on careers in science.

To systematize the institutions that must be included in the analysis of careers, we use the basic definitions of career theory. As mentioned above, careers are defined as sequences of the jobs [35,p.3]. The career’s element, the job, can be defined as follows:

"Jobs are considered to be a set of work roles... that have requirements for entry, imply a set of routines that characterize the content of the work role, and provide rewards for work-role occupancy and performance." [35,p.16]

This definition relates jobs and careers to the concept of work roles. Work roles are systems of rules (i.e. institutions) that emerge in a certain social context. A set of work roles related to one position constitutes a job. Therefore, being overlaps of institutions from one or more social contexts, jobs are institutions too. The sequence of jobs an individual goes through – the individual career – is a singular phenomenon and thus no institution. Careers are, however, the basis of an institutionalization process: some sequences become more likely to be passed through than others because jobs become linked by entry conditions, possible transitions to ‘neighbouring’ jobs, opportunities for advancement, etc. Thus, career lines become institutions that govern an individual’s movement through sequences of jobs. They are understood by career theory as the more general patterns of job sequences that are likely to be passed through by a greater number of individuals [35,pp.1–25;36,p.560]. By connecting jobs whose features make transitions more likely, career lines mediate general institutions’ influences on individual careers. Scientists are expected to (try to) follow these lines.
3 Scientists’ work roles in different social contexts

Specialties

The type of social collectivity scientists constitute in their production of knowledge is a singular social phenomenon which expresses the cognitive and social particularity of science and of the activity science is centred around – research. In the sociology of science, the term specialty has been introduced to denote a collectivity of scientists who directly or indirectly interact in the production of knowledge [14]. The empirical studies on interactions in specialties have demonstrated that a specialty constitutes a ‘microenvironment of research’ [37, pp. 10–11]. The formulation of research problems (i.e., the task), the selection of methods (i.e., the means) and the evaluation of the produced knowledge (i.e., the results) depend on what a scientist’s colleagues all over the world are doing. The exchange of knowledge with colleagues continues in the course of research. If a scientist is anticipated by others in the presentation of research findings, his or her work often becomes worthless [38]. For these reasons, it is justifiable to regard specialties as the primary social loci of knowledge production [39, 40, p. 313].

Continuous participation in a specialty’s knowledge production constitutes a scientist’s unique ‘cognitive career’ [41] and produces an individual ‘research trail’ [15]. In the course of their cognitive careers, scientists accumulate knowledge by creating it and by memorizing knowledge, references to knowledge and references to knowledge retrieval procedures. This accumulation and creation process usually broadens scientists’ knowledge base in the course of their career [42]. Moreover, each cognitive career produces a new combination of knowledge from the fields a scientist is working in (as a rule scientists work in more than one field simultaneously [37, 43]. Through this recombination and extension of knowledge, the cognitive careers provide the ground for scientific innovations. They allow new personal research plans to emerge that are based on new, individual recombinations of knowledge and permanently tested and adjusted in the scientist’s research work. These permanent processes of variation and selection are the main source of scientific innovations [14, 44, 45, pp. 336–339].

Scientists not only acquire and produce knowledge, but also pass it on to their colleagues. This process is especially important with respect to tacit knowledge. The mobility of scientists – i.e., their movement between fields and research groups – is connected with a ‘honeybee effect’. They transport tacit knowledge and pass it on to other scientists by way of personal interactions [46]. Thus, the intellectual and spatial mobility of scientists has an important cognitive function not only for themselves, but for the specialties as well.

Individual knowledge production is constrained by work roles that are parts of the specialties’ institutional system. This institutional system is mostly formed by informal rules. Important institutions are the scientific language used, the methodological standards and the institutionalized research interest [37]. Institutionalized research interests and methodological standards are the basis of the reward system governing the allocation of recognition for scientific contributions. A scientist’s reputation is built upon this recognition within one or more specialties. Reputation is the basis for social stratification, i.e., for a scientist’s social position in his or her specialties [17, 48].

The work roles defined by these institutions relate the researcher’s age, skills, experience and reputation to types of work roles, which define work content, autonomy and influence. The work roles in specialties correspond to the four stages of
professionals’ careers described by Dalton, Thompson and Price [49]. These authors’ analysis of professionals’ careers in organization is based on the dynamics of the content of work and relates it to autonomy, relationships and psychological issues. Thus, a model is proposed that can be adopted for careers in specialties. The model comprises four stages: that of an apprentice (I), that of a colleague (II), that of a mentor (III) and that of a sponsor (IV) [50]:

“In Stage I, an individual works under the direction of others as an apprentice, helping and learning from one or more mentors. In Stage II, he demonstrates his competence as an individual contributor. In Stage III, he broadens and acts as a mentor for others. Those in Stage IV provide direction for the organization.” [49, pp. 22-23].

Although many of the details included in the model do not apply to scientific research, the general pattern seems to fit well to work roles in the specialty. As it follows from the understanding of career stages as overlapping work roles, the model describes different work roles and the career stages that are distinguished by the dominance of one role, or rather role set. We can identify the role of an apprentice as that of a doctoral student. The other roles correspond to the work of researchers who have acquired sufficient knowledge and experience to design their work independently (colleagues), and those who have acquired a reputation that is sufficient to make them responsible for younger colleagues (mentors). Of course, in every specialty only few scientists go beyond the mentor stage and then, belonging to the elite characterized by an exceptional reputation, influence the direction of their community (sponsor role) [51].

Obviously, not all scientists achieve all work roles. Scientists may become independent researchers and never achieve mentor or sponsor roles. Moreover, more than one role may be achieved by a scientist simultaneously. Dalton, Thompson and Price describe three different roles linked to the mentor stage – “informal mentor, idea man, and manager” [49, p. 29]. In science, the mentor stage is often associated with some independent work as a postdoctoral researcher. The colleague role may overlap with the apprentice role if the scientist’s education is not regarded as completed with their PhD. However, the different roles are interconnected: it is almost impossible to become a colleague without having been an apprentice (although the apprentice role must not be linked to doctoral study), and it is impossible to become a mentor without having been a colleague.

As the description of the work history indicated, the content of a scientist’s work is only weakly connected to certain career stages. The acquisition and recombination of knowledge take place during their entire career. Today, the apprentice role is very often connected with an extreme specialization, a fact which is occasionally criticized [47, 52, 53]. Since the specialization is caused by the sciences’ dynamics, it seems, however, not to be a subject of arbitrary change. The colleague’s role corresponds to the scientist’s cognitive broadening through knowledge acquisition. However, the different stages are not only related to the accumulation of more knowledge, but to a change in more general capabilities as well. The apprentice who conducts research on problems defined by a ‘mentor’, under the supervision of a ‘mentor’ or a ‘colleague’, must somehow turn into a ‘colleague’ who is able to define problems, conduct research independently, develop research programs, etc.
3.2 Society

Scientists are neither born as such, nor do they leave society when they become members of specialties. General societal institutions influence the scientists' work roles no less than that of other people, as is demonstrated, for example, by the occurrence of gender stereotypes in science [54, pp. 183-186] or the different cultures of American and Japanese research groups [55]. Scientists must respond to institutionalized patterns of life course and are included in a system of social stratification. From society's perspective, science is a profession that requires the general education all people receive, subsequent special training leading to certification and special conditions for the work. This relates scientists to an institutional background that governs education, social security conditions, employers' and employees' rights, etc. The jobs available in a society are defined as part of a national employment system. This employment system defines earnings as well as subsidies in the case of unemployment, career lines within science as well as transitions between careers in science and career paths outside science. The society's institutions govern resource allocation for the sciences as well as resource distribution within science, thus influencing the number of jobs available for scientists, the working conditions within science and competing careers. Thus, the societal institutions exert a very complex and strong influence on scientists' career conditions.

The work roles defined by society are positions in the national employment system. These positions are defined by the type of contract (fixed-term or permanent, responsibilities, earnings, etc.), which, in turn, is linked to certain formal requirements an employee must meet. Insofar as scientists meet the requirements of positions outside science, the national employment system provides jobs that allow scientists to leave science and work in other societal subsystems. Thus, a society's employment system not only institutionalizes science as a profession but simultaneously provides environments whose employment is related to science by possible transitions.

The institutions that define scientists' positions in the national employment system are applied by formal organizations who hire scientists and negotiate their contracts. Thus, from the perspective of direct institutional influences on work roles it seems unnecessary to treat societal institutions as an independent context. They are nevertheless conceptualized independently here for three reasons: firstly, the general institutions mentioned above affect scientists regardless of their organizational affiliation. Secondly, the employment system's institutions form a system that can be assumed as being perceived as such by scientists and influencing their decisions. Finally, some employment opportunities provided especially for scientists (e.g., grants) are negotiated neither with scientists' current nor with their future organization, but with an independent funding agency. For these reasons, it seems methodologically justified to treat society as a social context that provides an independent institutional system.

3.3 Formal organizations

To regard the specialty as the social locus of knowledge production does not mean that the formal organizations in which today's research is carried out are less important. Although it is the specialty that defines the cognitive aims and means of research, it would be impossible to conduct the research without the financial and material resources provided by the organization. Thus, by directing resources to its scientists, the formal organization enables their participation in the collective enterprise of knowledge production. Furthermore, and most important to our topic, it is the formal organization
that provides the jobs and in this way makes it possible for scientists to earn their living as professional scientific workers.

Today, a specialty can be said to exist in the form of organizational subsets [56,pp.201-203], i.e., as a compound of groups that are located in formal organizations (research institutes, universities, firms, etc.). These organizations employ the scientists and provide them with resources for their scientific work. The resources given to science are often ‘loaded’ with specific expectations concerning science’s contributions to the society’s problem-solving. These expectations may regard research results that are somehow useful for the society or, in the case of a firm’s R&D, of specific use to the organization. In other cases, the expectations regard services: teaching in universities, routine work, etc. The organization mediates such expectations by translating them into organizational work roles. Conflicting demands (and, subsequently, conflicts over tasks as well as role conflicts) may emerge if non-researcher roles (a teacher role, a developer role) are allocated to the scientists additionally to their researcher role [57,pp.82-85].

The formal organization’s institutional framework contains institutions that define their scientists’ work roles, autonomy, earnings, etc. They govern internal mobility by defining other jobs available to a scientist working in the organization and by defining the mode of decision-making regarding the allocation of scientists to jobs. Many of these decisions are delegated to the organizational subset of the specialty because only these subsets are competent to decide on the researchers’ work roles and to evaluate their work. The delegation is formally realized by giving a subset’s leading scientist a higher position in the organizational hierarchy [58].

The scientists’ work roles in formal organizations depend mostly on the type of organization. For scientists in industrial enterprises, organizational careers are enabled by so-called ‘dual career ladders’, which lead either to a distinct researcher’s position or to a managerial position [49,p.21]. These career ladders are often problematic because they in fact merge and it is not possible to promote scientists sufficiently without forcing them to spend more time on managerial work or to leave the scientific career ladder [59]. There is, however, room for internal mobility in these organizations.

In academic organizations, the internal vertical or horizontal mobility is strongly limited. A specialty’s stratification is projected to organizational functions by giving scientists with a good reputation posts of group leaders or department heads. This way their capability and responsibility for directing research is supported by granting them the formal rights to do so in the organization. However, the projection of stratification to organizational posts is strongly simplified because the permanent changes in scientists’ stratification are not caught. Thus, only two significant moves can be assumed to exist in most academic organizations: the move from a fixed-term contract to a permanent position and the move from a normal scientist’s position to a leading position in the organization subset of the specialty, i.e., to the position of a department head. A separate managerial career line seldom exists because managerial positions are filled with scientists who directly control the resources allocated to their research groups, and changing to another department is usually impossible because it would imply working in another field [23,60].

There is, however, significant mobility between organizations. Today, many scientists work in at least two organizations in the course of their careers since they usually leave their university after completing their PhD. Moreover, interorganizational mobility is promoted by fixed-term contracts and by fellowships enabling scientists to have fixed-term stays in other organizations.
Scientists' mobility facilitates the innovative capability of academic organizations. By hiring new scientists, organizations may import knowledge required to approach new fields, and create new combinations of knowledge. Thus, the mobility of scientist between organizations, and the organization's ability to develop certain fields of competence by hiring new scientists, are crucial to the innovativeness of organizations. This is why the importance of fixed-term contracts for organizational flexibility and innovativeness is always emphasized [3,p.169].

Although fixed-term contracts are necessary for the organization to make jobs available for new scientists and as a means for probation [60], it is just as important for an organization to have permanent positions to offer. Because the prospect of changing to a permanent position is highly attractive for every scientist, organizations which cannot offer such a prospect are much less attractive and are therefore unlikely to succeed in hiring the best scientists [60,p.192].

4 Career lines as sequences of interconnected work roles

4.1 The work roles' overlap

In the previous three sections, I have analytically distinguished the content of scientific work and work roles in the different social contexts of scientific work. The specific combination of work roles constitutes a job, and sequences of jobs constitute a career line. Thus we must now ask how the different work roles are combined, and how career lines become institutionalised.

Although specialties are international communities of scientists, this institutionalisation is a national process. It is effected by important societal institutions and by non-institutional condition. Various factors usually make it easier to build a national career that may include limited stays abroad: language as an important institution, the system character of the national employment system and other institutional boundaries that exist between national states. Of at least equal importance are family, other personal relations, culture, property, etc. – factors that bind people to their homeland. Thus, most scientists look for posts within their own country in order to continue their career. And since most careers are predominantly national ones, the institutionalised career patterns share this feature.

Jobs for scientists are interlinked sets of work roles from the three social contexts. The specialties' work roles are delineated in the national employment system by linking types of employment systems' formal work roles to work roles defined by the specialties; a process that usually includes negotiations between science and policy. At least some types of jobs are created explicitly for scientists, e.g., that of a doctoral student (dominant apprentice role) and that of a university professor that includes a mentor role. Between and around these jobs lies a system of grants, fixed-term contracts, permanent contracts for researchers, lectureships, etc., which is only partially specific to science. Together, these jobs (and the principal tasks and earnings connected with them) form a system in which the professional scientist's career takes place. Formal organizations offer jobs whose definition in the employment system matches both the tasks defined by the organization and the salaries the organization can pay. Since the tasks are a matter of negotiation within the community, the link between requirements and job-type can be changed.
The types of jobs created for scientists already reflect both the specialty’s and the society’s expectations regarding careers in science. Since the work roles are related to career stages in specialties, the scientists are expected to go through the sequence of jobs that the sequence of work roles in specialties is linked with. This behaviour is partially enforced by grants and fixed-term contracts. Nevertheless, “scientists’ careers in reputational terms dominate careers in terms of employment statuses” [40, p.316].

Career lines in science become institutionalized by:

- the institutionalization of career expectations in jobs, e.g., in specific jobs for scientists at the outset of their careers,
- the institutionalization of career expectations in the rules applied by employers to govern the allocation of scientists to jobs of certain types, and by
- repetition, that is, by the way in which most scientists pass through sequences of jobs.

As a result, institutionalized career lines emerge that guarantee both the specialties’ control of education and recruitment, and the prerequisites for the research and educational organizations’ flexibility and innovativeness. The scattered empirical evidence available [61] indicates that there are currently three clearly distinguishable phases in academic science: first, the doctoral student phase, in which the scientist has one fixed-term contract as a low-paid scientific worker and his or her research is expected to culminate in a dissertation. Second, in a subsequent postdoctoral phase, the scientist has one or a sequence of fixed-term contracts. In a third phase, the scientist has a permanent position. The careers of scientists employed in industry may reveal a different pattern, e.g., without the doctoral student phase or with a permanent position right from the beginning.

The institutionalization of career lines in science leads to increased inflexibility: scientists are expected to be in well-defined, age-related career stages to which different job-types are assigned. Career lines in academic science reveal an institutionalized, age-related upward mobility. If a mismatch of age, career stage and job-type occurs, it leads to problems for the scientist as well for employing organizations. This inflexibility is only partially compensated for by the emergence of alternative career patterns that make it possible for scientists to move into careers outside science.

4.2 Scientific labour markets

Since the concept of career lines is closely related to labour markets [36], the question arises whether conclusions drawn from the discussion of career lines in science can be related to scientific labour markets. It seems very difficult to conceptualize scientific labour markets in a similar manner to other labour markets for at least three reasons. First, although they are heavily influenced by national institutions, scientific labour markets span national boundaries. This not only means that positions are offered to scientists all over the world; the informal networks governing the allocation of scientists to jobs are international, too. Second, since scientific labour markets are structured by boundaries between specialties, the quantitative measures applied by labour market research do not comprise suitable units of analysis. That is why only larger entities such as academic labour markets, which in fact are markets of an academically educated labour force, can be studied with these instruments. Third, the application of the internal
labour markets model to academic organizations fails for several reasons (see below).

I propose here to regard specialties as internal labour markets. According to Doeringer, an internal labour market can be understood as:

"an administrative unit within which the market functions of pricing, allocating and often training are performed. It is governed by a set of institutional rules which delineate the boundaries of the internal market and determine its internal structure." [67,p.207]

This concept was modified by Althauser and Kalleberg [68,p.130] who, among other things, included the feature "a progressive development of knowledge or skill" which fits well with career lines in science. Usually, two types of internal labour markets are distinguished:

"firm internal labour markets (FILMs), established by and confined to a single employer (organization, corporation), though not necessarily embracing all jobs in a firm; and occupational internal labour markets (OILMs) existing for incumbents of one occupation or of two or more associated occupations and not necessarily confined to a single employer." [68,p.130]

It is difficult to speak of FILMs in academic organizations for several reasons: little internal mobility (see 4.2), short internal career ladders, little investment in the employees' organization-related education and external recruitment to non-entry positions [23,60]. However, the concept of internal labour markets may be applied to specialties. Specialties are institutionally bounded by reward mechanisms and decision structures, which enable the evaluation of scientists' work and, on this foundation, decisions to be made about an allocation of jobs to scientists. Furthermore, there are well defined entry positions. Following the model described in 3.1, the PhD student's position (which presupposes the completion of a first degree in the discipline) can be determined as the entry position for the specialty's career line. The 'job ladders' or work role sequences in specialties were described in Section 3.1. Beginning with undergraduate studies, a specialty controls the education of its prospective members; a process which contains on-the-job training, the proportion of which initially increases and thereafter declines in the course of the career. Since the career stages are somehow linked to types of positions that vary with respect to their earnings, the specialties' decisions about who gets which job imply not only an allocation function, but a (mediated) pricing function as well.

Thus, specialties have many features of internal labour markets if one takes into account that internal labour markets’ basic features, such as employment security, earnings and benefits, are granted by the other social contexts’ work roles always linked to the specialties’ work roles. This mediation is guaranteed because the relevant decisions are delegated to the specialties’ organizational subsets.

So far decisions about the allocation of scientists to jobs have been ascribed to the specialty, which would be both the collective employer and the group of employees. Although this is correct in a general sense, it is possible to identify the ‘employer’ who governs the specialty’s internal labour market more precisely. This role is played by the networks of the scientific elite’s members, who decide about jobs in ‘their’ organizations, act as referees for other organizations and may influence the decisions made even if they are not directly involved. Moreover, an ‘exchange’ of apprentices between the elite’s members is practised on the basis of informal decisions within the networks [47,57,69]. For these reasons, it seems justified to speak of strong ties that structure the specialties’ internal labour markets.
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Although the specialties share basic features with internal labour markets, objections to this view can be raised. The concept ‘internal labour market’ has so far only been applied to entities whose institutional boundaries are unambiguously delineated – a presupposition that is not fulfilled by specialties whose institutions’ produce diffuse boundaries. These boundaries are permeable for scientists who can migrate from one specialty into another or into the much bigger labour markets that encompass all workers who have graduated in the respective field [70]. Even the specialties’ entry position (PhD student) is also a stage of careers in the general academic labour market and thus may lead outside the specialty. Thus, neighbouring labour markets’ states influence scientists’ career decisions. Specialties are also internally structured by institutional boundaries. Many specialties extend through academic as well as industrial organizations. The likelihood of careers and the institutionalization of career lines that cross the boundaries between academic and industrial research depend on the institutional boundaries created by these institutions.

Although a closer examination of the institutional boundaries and structure of specialties may require a certain ‘softening’ of the concept of internal labour markets, this approach seems to be a theoretically more promising link to labour market research than the other variants discussed above. The adaptation of concepts is necessary because specialties are a collectivity that cannot be subsumed to existing classifications but rather represents a special type whose integration into theories challenges the latter’s basic concepts.

4.3 Career stability and knowledge production

As already mentioned in the introduction, scientists are becoming increasingly aware that their careers are threatened. Aside from the several comments on this subject in journals like Science and Nature [47,53,71–73], at least one book explicitly addresses the issue of careers’ increasing precariousness [1]. The background of this trend is discussed by Ziman with reference to “science in a steady state” [3].

What is happening? Our discussion of work roles and career lines has uncovered some special features of institutional conditions for careers in science. Firstly, an upward mobility is institutionalized which presupposes that almost all scientists at universities reach a mentor stage and thereby leave the positions related to earlier stages. Secondly, the academic organizations face contradicting necessities: they must be able to award scientists permanent positions on the one hand, and to maintain a certain proportion of fixed-term positions as a basis for their flexibility on the other. Third, the later career stages last much longer than the earlier stages, which are connected with fixed-term contracts. Fourth, the number of PhD students increases in fields where they can be used as low-paid research workers.

These features of career lines in science result in a permanent disproportion between jobs available for early and late career stages – a disproportion that has long been compensated for by the growth of science and of academic organizations. Under conditions of a ‘dynamic steady state’, however, neither specialties nor organizations are able to compensate for the disproportion. If an organization wants to maintain its flexibility by retaining the share of fixed-term positions and is not able to grow, then it can offer no future permanent positions to the scientists being hired. The situation worsens if organizations face a decrease in resources. In this case, the necessary downsizing usually starts with the fixed-term positions because they are easy to deal with
when they are not filled. By reducing the fixed-term positions, the organization loses its most important means of knowledge acquisition and endangers its innovative potential. Thus, scientists’ mobility and organizations’ innovativeness only promote each other if the organization is able to grow. Otherwise, satisfying solutions exist for neither the scientists’ careers nor the organizations’ innovativeness and flexibility.

For scientists, under ‘steady state’ conditions a ‘career jam’ emerges. It is characterized by

- extending the employment stage of fixed-term contracts more or less independently of the cognitive side of the career
- the increasing probability of scientists being forced to leave science because no contracts are available.

Having so far been a necessary employment stage related to a certain career stage in specialties, fixed-term contracts now gradually become the scarce and fragile societal basis of entire careers in science. As career theory has discerned, under such conditions the career becomes more important for the individual and subject to intense reflection [74] for science see Ziman [3,pp.167-212] and Tobias, Chubin and Aylesworth [1]. Some or all of the following consequences might ensue (and some have already been empirically observed):

- decreasing attractiveness of careers in science in general [3,pp.170-172], also affecting the career choices of the most promising young scientists
- increasingly fierce competition, hindering collaborations and diminishing the quality of research [1,p.47;38]
- increasing negative impacts of fixed-term contracts on knowledge production, such as restrained creativity and risk-taking [1,p.47;3,p.171;75,p.30]
- incongruity between the cognitive career that leads to personal research plans and an extended phase of reduced autonomy
- an increase in the proportion of older scientists [3,pp.168–169;16,pp.505–506].

For these reasons, the ongoing changes in careers may have consequences for knowledge production that are largely unknown. It seems necessary to investigate them for reasons of theoretical as well as practical importance. The approach to careers proposed in this article may serve as a conceptual framework for empirical investigations that are able to take the complexity of careers in science into account.

5 Conclusion: research on careers is needed

The aim of this article was to propose an approach that allows

1 the exploration of the heuristic potential of the career concept by treating careers in science as mediating links between meso- and macro-levels of institutional dynamics and micro-levels of knowledge production as well as between different social contexts, and,

2 the integration of knowledge from different fields dealing with careers.
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Consequently, it seems appropriate to conclude by proposing some lines of further empirical research. A first topic to be investigated is the structure of careers. The transitions between work roles are especially puzzling: what happens to a scientist who leaves at one point as an over-specialized PhD candidate and comes back at another point with his or her own research program, supervising other PhD students? To be honest, we don’t know. Moreover, the career structure causes selections in two different ways. The peer review system and the specialties’ informal networks select people who seem to be useful for the respective communities. From the scientist’s point of view, career options must be chosen that are often unattractive. Both processes lead to the recruitment of specific people for science, and we need to know who is recruited and why.

An important weakness in the treatment of careers so far has been the neglect of specialty-dependent variations in careers. It is very likely that careers vary at least according to the specialties they take place in [76, pp. 204–205]. Since a ‘cognitive career’ is a constituent part of every career in science, we can assume different careers in ‘little science’ and ‘big science’, natural science and social science, or career patterns that depend on the degree of knowledge codification, as was discussed by Zuckerman and Merton [16, pp. 506–519].

A third topic which follows from the approach proposed here is that of nation-dependent variations in careers within specialties. Three questions immediately arise from the identification of specialties as internal labor markets deeply structured by national institutions: first, we must ask how national career patterns maintain their openness for internal careers, and whether variations in this openness matter. Second, we know next to nothing about systematic differences between national career patterns. One question of theoretical as well as political interest is whether there is a ‘critical mass’ of scientists that leads to the emergence of national subsets of specialties (analogous to the organizational subsets). If this is the case, countries in which the number of a community’s members is below the critical mass should show a more intense international orientation both in hiring practices and in their scientists’ careers. Third, it is not clear what the globalization of institutions means for careers in science. Two contradictory hypotheses can be derived from the assumption that there is an international harmonization of societal career conditions:

a. The harmonization facilitates international mobility and, thus, the specialties’ knowledge production.

b. Specialties are about to loose their requisite variety provided by nationally different career patterns and, thus, both some of the incentives for innovative knowledge recombination and the capability to compensate national deficiencies in careers on the international level.

Finally, we have yet to find out what all this means for knowledge production. The literature this article draws upon provides only scattered evidence for the influence of careers on knowledge production. This topic must be systematically investigated because both the theoretical and the practical importance of careers rest on its mediating functions.

What empirical strategies can be chosen for an investigation of careers? The choice and empirical identification of a suitable unit of investigation seems crucial. We must retrieve, and if necessary, renew our means of identifying and analysing collectivities in science. There seems to be no alternative to the specialty as point of departure for an empirical investigation of careers. Since the analysis of individual careers must include
the investigation of different social contexts, (biographical) interviews are an important method here. To analyse career patterns in science, quantitative methods must be included. Scientometric methods can be used to analyse the scientists individual production as well as his or her mobility between fields and organizations. Finally, an interdisciplinary collaboration with science historians would allow us to use historical data for investigating changes in career lines.

These strategies for empirical investigation suggest that we must combine several methods, quantitative as well as qualitative, in order to accommodate the complexity of problems related to careers. But this challenge is just one more provided by the complex of social puzzles that opens when we look more closely at careers in science.

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References


34 From the definition of institutions as systems of rules follows that organizations do contain an institutional framework for their members, but are not identical with it [33,p.38].


42 Although ageing surely influences the way knowledge is accumulated and recombined, we lack in-depth knowledge about which changes occur and what the consequences for knowledge production are [16].
46 This is why scientists’ mobility is sometimes compared with that of the travelling journeymen (e.g. [47]).
48 There is a striking contradiction between a specialty’s strong institutions and its fluid character and diffuse boundaries. In this regard, specialties principally differ from other actor constellations: although a whole institutional system affects the actions of scientists who consider themselves (and act as) members of a specialty, there is no institutional rule about membership. Membership in a specialty is a perceived rather than an ascribed status. Specialties share this feature with some other communities, such as social movements of ‘cyber-communities’.
50 This useful exception in career analysis was possible due to the sample that was used to analyse professionals’ careers: among the 550 interviewed professionals were 75 professors in three universities, 155 scientists in four laboratories, 268 engineers in four organizations and 52 accountants in three firms [49,p.22]. Thus, the specific content of scientific work had a significant influence in the model building process.
51 This description is incomplete because it (purposefully) neglects work roles in organizations. To act as mentor or sponsor, it is not sufficient for a scientist to be accepted for such roles by his or her specialty. Additionally, the scientist must be in an organizational position that provides them with the necessary autonomy, formal rights and resources (e.g., that of a university professor). This correspondence is usually guaranteed by the delegation of hiring processes in the specialty.
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58 This does not mean that only specialty’s institutions matter for organizational scientists: organizational subset’s research trials, research conditions and organizational tasks create a locally specific ‘technology’ and corresponding organizational institutions that influence hiring practices.


61 Since the quantitative studies of the 1960s and 1970s did not address career structures and qualitative studies have not been conducted, we have very little information about national career patterns. Reports in the leading scientific journals *Science* and *Nature* and some other sources indicate the emergence of a postdoctoral phase in the 1970s [62–66]. The model described here should at least apply to careers in Germany, Great Britain and the USA.


