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NEW STUDY PROGRAMS AND SPECIALIZATIONS: The Effect of Governmental Funding and Paradigmatic Development

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Studies on the emergence of scientific fields and disciplines produce a number of factors influencing these processes. The present study investigates whether these factors are also relevant in the teaching domain: the emergence of new study programs and specializations within programs. The classification of internal and external factors is applied to such processes of programmatic differentiation. Drawing on social exchange and resource dependency theory, the effects of the governmental funding mechanism of educational provisions (an external factor) and the level of paradigmatic development (an internal factor) are analyzed, using a large data set on processes of differentiation in the Dutch university sector between 1974 and 1993. The two factors proved to be relevant in explaining the emergence of new programs and specializations. In the final section some anomalies and suggestions for further research are discussed.

Various scholars in the field of higher education and the sociology of science have studied the emergence of new disciplines and academic fields within higher education systems. There is considerable agreement that a mixture of *internal* factors (the growth of scientific knowledge, often combined with the social factors that bind researchers together or move them into distinctive communities) and *external* factors (the broader societal, political, and economic situation, including governmental research policies and developments in industry) further or hinder the emergence of new areas of research.

Contrary to the attention paid to developments in research, less attention has been given to similar patterns in the teaching area. This article focuses on this area, taking processes of programmatic differentiation—the emergence of new study programs and specializations within programs in academic institutions—as

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a starting point. The present study considers an explanation that stresses an external factor (the dependency of actors involved in a study program on governmental funding) and one that takes into account an internal factor (the level of paradigmatic development of the discipline). The empirical proof is derived from a large data set on processes of programmatic differentiation that took place in the Dutch university sector in the period 1974–1993.

BACKGROUND

Explaining the Emergence of New Fields of Research and Teaching

According to Clark (1983, pp. 11–12), higher education is a social structure for the control of advanced knowledge and technique. Academics conserve and refine this knowledge (research) and instruct people and transmit knowledge to students (teaching). Knowledge is the material of the academic professional; research and teaching are the main technologies. Because of the close connection between academic research and teaching, it is challenging to investigate whether changes in the teaching domain are driven by the same *mechanisms* as those in the research domain. The comparison focuses on newborn disciplines/areas in the research domain versus similar developments in the teaching domain. The central question therefore is how to explain the emergence of new specializations and new study programs in academic institutions and how this relates to the emergence of new disciplines and academic fields. Since the latter topic has been investigated more intensively than the former, results of studies on the emergence of academic fields will be discussed first.

Central in many explanations is the idea that academic professionals form interest groups seeking status and prestige. Again following Clark (1983, pp. 218–223, but see also Blau, 1973, pp. 190–198; Becher, 1990, pp. 338–343), interest is divided between those vested and those seeking to become vested. Consequently, interest groups chose between seeking prestige within the original discipline or academic area, or protecting and enhancing self-interest by self-differentiation. Thus, interest groups in their struggle for status and power may try to find an unfilled niche by separating themselves from the established discipline. The success of their action depends on its legitimacy in the long run. When the interests are strong enough to institutionalize, the newly established discipline or field survives.

Although this broad generalization is appealing, some difficulties emerge. First, institutionalization and legitimacy are only visible after the event, which makes prediction of successful differentiation difficult. At the same time, it is open to tautological reasoning: Successful actions are in fact institutionalized or legitimate innovations, instead of leading to institutionalization. Second, the argument is clear on the process of differentiation but not specific on the causes that separate interest groups from each other.

Lemaine et al. (1976) extend the general notion of scientific differentiation or

migration—research groups moving into new areas of research (see also Hagstrom, 1965)—by discerning internal intellectual processes, internal social processes, external intellectual factors, immediate institutional context, specific economic and political factors, and diffuse social influences as factors of influence on the emergence of new disciplines. Their extension is based on a number of case studies on emerging fields and disciplines. The significance and the level of interaction of the factors mentioned above depend on the particular cases. In radio astronomy and radar meteor astronomy, for instance, technical advances and social groupings formed during the Second World War played a crucial role in the growth of these new research areas (see Mulkay and Edge, 1973; Gilbert, 1977). The existence of peripheral regions in the academic community and powerful new theories played an important role in the development of physical chemistry in German universities (Dolby, 1976). Ben-David (1971) gives an account—based mainly on external factors—of differences and similarities in scientific developments in the United States and Germany in the last part of the nineteenth and beginning of this century. More recent studies on the emergence of new disciplines also stress the role of social and cognitive factors while paying attention to external influences from the wider—political and economic—environment (Whitley, 1984; Leeuw and Van Gageldonk, 1984; Blume, 1985; Becher, 1989). The more recent studies also bear largely on the case study approach. Whereas these case studies differ considerably with respect to the objectives pursued and depth of the research, the classification of factors presented by Lemaine et al. (1976) at least offers a feasible framework for research on the emergence of new disciplines, which might be applicable to the teaching domain: the establishment of study programs and specializations within study programs.

Such a perspective—using the distinction cognitive/internal and external/sociopolitical factors and applying it to the emergence of new study programs—has been taken up by Karseth (1995) in a case study on the emergence of a study program on media and communication at the University of Oslo. The first set of factors matches the cluster of factors mentioned by researchers on the emergence of new disciplines and includes therefore the epistemological and cognitive aspects, such as knowledge structures, theoretical concepts, and methodological approaches. The second set refers to the broader sociopolitical environment and includes the economic and social situation, societal needs, and the needs of the labor market. Karseth (1995, p. 201) stresses—agreeing with studies on emerging fields of research—that the distinction is mainly analytical. However, she departs from these studies by lumping together external and social factors, whereas others distinguish internal social factors and external social factors (Lemaine et al., 1976) or bring social and cognitive factors together (Whitley, 1984; Becher, 1989). The present study endorses the point of view that discerning internal and external factors is mainly analytical, but in the empirical elaboration an internal (cognitive and social) and an external (but also social) factor will be clearly separated.

Curricula

Viewing curricula as sociopolitical constructs seems an attractive starting point for discussing factors of influence in the emergence of new specializations and new study programs. Gumport (1988, p. 50) describes curricula as "that part of the cultural life of academic organizations in which faculty, administrators, and students construct and revise their understandings and in which they negotiate about what counts as valid knowledge in particular historical and social settings." Such a view is in line with definitions in mainstream sociology of education, such as Young's (1971) description of curriculum as socially organized knowledge or Bernstein's (1975, p. 85) definition: "Curriculum defines what counts as valid knowledge."

Other definitions of curricula in instrumental terms of content, objectives, and matching structure are less appropriate for the current research. The sociopolitical conception allows, first, to consider curricula as social constructions, driven by the interest of the people participating in the curriculum. As a consequence, Clark's (1983) and others' general perspective on interest groups striving for status and defending their interests can be applied. Furthermore, the framework distinguishing internal versus external factors is of use. Influences on interest groups providing study programs either stem from internal (intellectual and cognitive) factors or from external factors (the broader environment of the interest group involved in the curriculum). Note that the set of social factors is deliberately taken out of the classification. The framework elaborated below assumes that all factors leading to change are social, or to be more precise, all processes of change are in fact social reactions of the particular interest groups to internal or external forces and conditions. Therefore it seems less relevant—or even impossible from this point of view—to allot social factors to either category. Social factors are connected to cognitive factors and consequently internal as well as related to the broader environment and consequently external.

Below, two explanations are offered for the occurrence of processes of programmatic differentiation. The first is based on *social exchange* and *resource dependency* theory and stresses external influences on the behavior of actors involved in study programs. The second elaborates on an internal factor: the paradigmatic development of the scientific discipline to which the study program belongs.

An External Factor Explaining Processes of Differentiation

In an attempt to explain processes of differentiation—the emergence of new specializations or study programs in the university sector—a theoretical framework has been developed, largely based on *social exchange* theory (Emerson, 1962, 1972a, b) and the *resource dependency* approach (Pfeffer and Salancik,

1978). In this framework the university sector is approached as a network of clearly distinguishable interacting groups and individuals, whose main objective is to survive and acquire status. In order to survive, it is assumed that actors need a sufficient supply of resources. These often cannot be produced by the actors themselves, but need to be obtained through exchanges with other actors. Actors in a network consisting of interrelated exchange relations are therefore dependent on each other (see Huisman, 1995, for an elaborate discussion).

Dependency is the keyword in this respect, for the social exchange theory states that when the level of dependency increases (when one of the actors in an exchange relation becomes more dependent), *balancing operations* are set in motion to restore the balance. In the Dutch situation, the level of dependency is largely determined by the number of first-year student enrollments. This number of students is particularly influential in determining the amount of resources the actors involved in a study program receive from government. The funding mechanisms dictate the exchange relations between Dutch government and the actors involved in study programs—as is the case in many other European higher education systems—and the budgets for universities are to a large extent driven by the number of students enrolled. If for a particular program, the number of first-year students drops, this increases its dependency on the other actor in the exchange relation (government), and thus leads to balancing behavior.

Social exchange theory argues that there are four basic balancing strategies: *withdrawal*, *status giving*, *coalition formation*, and *network extension*. Within the Dutch context, the first three are unlikely strategies for study program actors to pursue. Withdrawal from the exchange relation (with government) would imply the demise of the program, which contradicts the assumption of striving for survival. Status giving—an increase in the investment in the study program—is hardly possible in the Dutch university sector; the funding of the program is not controlled by the study program actors, and other forms of increasing investment (e.g., stressing outstanding quality) in a system that sticks to its egalitarian principles are hardly worthwhile. The strategy of coalition formation will only be used when positive results can be expected for the majority of the actors involved in the coalition. If a study program actor can decrease the level of dependency without cooperation and coalition formation, the latter will be preferred. The last type of strategy, network extension, seems to offer the best opportunities. In operational terms this means the creation of new study programs or new specializations (processes of differentiation). The objective of the strategy is to seduce new clients (students) to enter the program and consequently balance the decreased enrollments. Therefore, the basic proposition with respect to processes of differentiation is that when confronted with decreasing or strongly fluctuating first-year student enrollments, study program actors will attempt to create new programs or specializations to balance their increased dependence in the network.

The main difference with the work on the emergence of new disciplines is that

these authors assume that interest groups are actively seeking possibilities or are—more or less—confronted with opportunities to differentiate themselves from the mother disciplines. The theoretical framework built on social exchange theory pictures differentiation processes as responsive strategies to cope with the threatening and increasing dependency on governmental funding. Although the explanations seem to differ, one has to keep in mind that academic disciplines are far more stable over time than curricula. Most of the academic disciplines do not fear the threat of being abolished. Under the most negative circumstances disciplines can be under attack of the public opinion or under scrutiny of government, with possibly budgetary consequences. However, the demise of the disciplines is illusive, whereas this threat for some study programs is manifest. The life expectations of curricula are lower than those of the disciplines, which makes them different especially in their responsive behavior to environmental influences. Curricula losing their attractiveness for students or society at large (especially the labor market) resort to survival strategies of which network extension seems the most plausible in the context of the Dutch university sector.

An Internal Factor Explaining Processes of Differentiation

The perspective propounded by sociologists of science maintains that disciplines differ and that these differences matter. An often discussed difference is the one concerning the paradigmatic development of the discipline. One of the most influential works in this respect is Kuhn's (1962) *The Structure of Scientific Revolutions*. Whereas Kuhn initially referred to a distinction between paradigmatic and non- or multiparadigmatic sciences, the concept has been interpreted by others to distinguish disciplines or academic fields ranging from low paradigm development, so-called soft sciences, to high paradigm development, also termed hard sciences.

Apart from paradigm development other dimensions have been used to characterize academic disciplines. Biglan (1973b) confirmed the importance of the hard-soft dimension and added the dimensions application versus pure and life versus nonlife to classify academic areas. Biglan's classification has been widely used and validated (see Creswell and Roskens, 1981; Smart and Elton, 1982) and attempts were made to refine the classification (Stoecker, 1993).

Two other attempts to classification should be mentioned. Whitley (1984) developed two dimensions to distinguish intellectual fields or reputational organizations: the degree of mutual dependence of researchers and the degree of task uncertainty. Task uncertainty seems closely connected to the paradigm concept, for it relates to the extent to which work techniques are well understood and produce reliable results (technical task uncertainty) and the extent to which intellectual priorities, the significance of research subjects and preferred ways of tackling them, and the reputational payoff of research strategies are clear and certain

(strategic task uncertainty). The dimensions and their subdimensions were used to classify scientific fields, ranging from fragmented adhocracy (management studies) to conceptually integrated bureaucracy (postwar physics). Up to now, Whitley's classification has hardly been used, despite the sound theoretical—but complex—backing of the classification. Becher (1989) follows Biglan (1973a) in using the cognitive dimensions, hard versus soft and pure versus applied, and supplies these dimensions with two social dimensions, convergent versus divergent (referring to the sense of collectivity and mutual identity experienced) and urban versus rural (referring to fields having a high versus low people-to-problem ratio).

Only a few authors have investigated the consequences of features of fields of knowledge on teaching activities, for instance, the way academic professionals in different disciplines construct, evaluate, and revise curricula (but see, e.g., Lattuca and Stark [1994, 1995] on disciplinary visions on curriculum reform; Donald [1986] on differences in the way that disciplines approach knowledge in the university curriculum; and Moses [1990] on attitudes toward teaching and research). Elaborating on characteristics of scientific fields and disciplines, it seems tenable to apply these not only to the research domain but also to curricula. Following Clark (1983) in his view on teaching and research as the main technologies of the academic enterprise, and the definition of curricula above in terms of negotiated and socially organized knowledge, characteristics of the research domain seem appropriate in the teaching domain as well. Whereas different types of characteristics of disciplines have been discussed above, the focus below is on the omnipresent concept of paradigmatic development.

Paradigmatic Development

According to Kuhn (1962), a paradigm is the common possession of the practitioners of a particular discipline. It includes the accepted theory and findings, and preferred techniques and methodologies.[1] Disciplines differ to the extent that one or more paradigms are dominant. High-paradigm fields or hard disciplines display more consensus with respect to accepted theory, subjects worthwhile to investigate, methodologies, etc. Low-paradigm or multiparadigm fields or soft disciplines are loosely knit communities with diverging values and beliefs and internal disagreement on techniques and methodologies. That paradigmatic development matters has been proven by empirical research. Biglan (1973b) noticed differences in social connectedness, commitment to research and teaching, and scholarly output. Smart and Elton (1975) found differences in goal orientations of chairpersons in hard and soft sciences. Creswell and Bean (1981) also noticed distinctions with respect to scholarly output.

It should be noted that many of the studies on disciplinary differences focus on discovering these differences, instead of explaining them. Lodahl and Gordon

(1972) tried to predict differences in the level of conflict over time spent with graduate students, the number of teaching and research assistants, and the willingness to work with graduate students, using the paradigmatic development of the discipline to which researchers belong as an explanatory variable. Salancik et al. (1980) used paradigmatic development to explain differences in turnover of university department heads. Both studies stress that because disciplines differ in the paradigmatic development, this has consequences for the amount of conflict and level of mutual understanding within the field. Consequently—to give an example—Salancik et al. (1980) expect the rate of turnover to be higher in low-paradigm fields. The arguments set forth by these authors will be expanded to the teaching domain, that is, the occurrence of processes of programmatic differentiation.

If hard sciences indeed can be characterized by consensus or shared values and beliefs, and assuming that this applies to the research as well as the teaching domain, it seems difficult for actors or interest groups to deviate from the standards, norms, and values of the field. This leads to the expectation that it is hard to establish new programs or specializations in curricula that belong to well-established paradigms. Apart from the difficulties to deviate, curricula in high-paradigm fields may not need additional specializations. In these fields consensus over scientific objectives prevents interest groups from "deviant" behavior. In soft sciences there is less consensus over objectives, theory, and methodologies, which offers interest groups possibilities to deviate from the paradigm(s) of the field. Consequently, this may lead to establishing specializations and new programs without much objection and opposition. The emergence of new specializations or programs can even be seen as a strategy to forestall or reduce conflicts: Advocates of different paradigms can establish their own specialization or study program. The lack of consensus and shared norms and values does not—as in the case of hard disciplines—prevent interest groups from going their own way and institutionalizing their interest by means of a distinctive specialization or study program. Some evidence for the argumentation can be found in Lodahl and Gordon's (1972) test of the validity of the paradigm concept. Indeed, high-paradigm fields reported more agreement over content of courses than low-paradigm fields.

To summarize, two hypotheses can be formulated with respect to processes of programmatic differentiation. The first, drawing from *social exchange* and *resource dependency* theory, stresses an external factor to be important: Network extension seems the most obvious strategy to cope with increasing dependency. Therefore, the larger the level of dependency (on governmental funding), the more processes of differentiation take place. The second hypothesis takes an internal perspective. The rate of processes of differentiation is expected to depend on the level of paradigmatic development. Within hard disciplines departure from the established programs and specializations seems more difficult and less urgent (coherent paradigmatic norms and values) than in the soft disciplines (character-

ized as multiparadigmatic and lacking consensus). Therefore, the softer the study program, the more likely are processes of differentiation.

METHOD

The first hypothesis concerning processes of differentiation being prompted by increasing levels of dependency was tested as follows. The hypothesis—in more operational terms—is: The larger the level of dependency (in a particular period), the more processes of differentiation take place (in that period).

To start with the latter variable, for each study program with first-year enrollments provided by 12 Dutch universities,[2] it was recorded whether and how many processes of differentiation took place. The strategy of network extension is understood as the emergence of specializations as such. That is, a process of differentiation is considered taking place or not (dichotomous responses), irrespective of the number of specializations emerging in the particular study program. By comparing the study programs and their specializations from year to year, it could easily be concluded whether at least one new specialization per year emerged within each program.[3] With respect to new study programs, decisions were needed to "attribute" the emergence of a new program to a particular—already existing—program. Indicators to facilitate this decision were similarity of contents and emergence in the same faculty or department. A similar argument applies to situations where new specializations emerge in programs that do not have first-year enrollments.[4] The occurrence of processes of differentiation in these programs cannot be explained by changes in the enrollment patterns. When these programs are clearly connected to regular study programs (using the same indicators as in the case of attributed study programs), theoretically, changes in these programs can be attributed to the regular study program with first-year enrollments. To give an example: Dutch law is the only law program with first-year enrollments; students enter other law programs (notarial law, international law, administrative law) after completing the first year of the Dutch law program. Therefore, processes of differentiation of the other law programs are attributed to the study program of Dutch law. Using this method, for each program with first-year enrollments offered in the period 1979–1993, the number of processes of differentiation could be measured, theoretically ranging from 0 to 15 for each program.

Level of dependency was operationalized as follows. The theoretical framework stated that the level of dependency is largely determined by two dimensions of the enrollment pattern: the extent to which enrollments decrease or increase over time and the extent to which enrollments fluctuate (uncertainty). The theory, however, does not indicate how much weight should be attributed to each of the dimensions. The question is what influences the level of dependency most: strongly fluctuating enrollments or decreasing/increasing enrollments over time?

To estimate the relative effect of these dimensions a weighting procedure is followed.

First, 15 ideal-typical enrollment patterns for 21-year periods were constructed. For each of the patterns, five indicators—reflecting the two dimensions of the level of dependency—were calculated.[5] A factor analysis on these indicators confirmed the presence of the two—clearly distinguishable—dimensions: uncertainty and increase/decrease. The factor scores of the analysis were saved to use in a regression with the (average) rank order of the ideal typical patterns, based on expert judgments. Nineteen experts in the field of higher education were asked to rank the set of randomly ordered ideal typical enrollment patterns on a scale ranging from low level of dependency to high level of dependency. The experts agreed to a large extent on the rank order.[6] Second, the average rank order was used as input for a regression analysis, the average score being the dependent variable and the two sets of saved factor scores as independent variables. The weights of the regression analysis were used to control for the relative impact of the two dimensions (uncertainty and increase/decrease) of the level of dependency.[7] The five indicators, including the weighting procedure for the indicators and the two dimensions of the level of dependency, were applied to the enrollment patterns (1975–1992) of the Dutch study programs. This led to a number representing the level of dependency for each program: The higher the number, the higher the level of dependency.

Both variables were correlated to see whether the hypothesis could be falsified. Note that the period in which the level of dependency was measured (1975–1992) differs from the period in which the number of processes of differentiation were counted (1979–1993). The difference was chosen on purpose to allow a time lag between changes in the level of dependency and the actual occurrence of processes of differentiation. Although data on both variables were available for longer periods, enrollment data for the beginning of the 1970s proved to be unreliable, thus limiting the analysis to a shorter period.

The second hypothesis predicts a correlation between the number of processes of differentiation and the level of paradigmatic development. The softer the study program, the more processes of differentiation take place. To test the hypothesis, study programs could have been separated into soft and hard sciences. However, a more rigorous test seems possible. Lodahl and Gordon (1972) have constructed a ranking of seven fields or disciplines, which can be used in this analysis. In their research, 1,161 respondents ranked the fields of biology, chemistry, economics, political science, physics, psychology, and sociology into hard and soft categories. The ranking was validated by two tests concerning the agreement about content of undergraduate courses, and one concerning requirements and course content for degrees. Their findings supported the following ranking from hard to soft: physics, chemistry, biology, economics, psychology, sociology, and political science. These fields were chosen to test the second hypothesis. For each field the

corresponding study programs were selected.[8] The number of processes of differentiation was calculated similarly to the procedure in the first hypothesis, with two exceptions. The number of processes of differentiation was counted for the period 1975–1993 and study programs that were offered only in part of this period were also included. A rank correlation was used to test the hypothesis.

RESULTS

The upper line in Figure 1—marked with square bullets—represents all numbers of processes of differentiation (new specializations and new study programs) per year. The lower—marked with stars—indicates the number of new study programs per year. In the period under survey, 1,133 processes of differentiation took place. Of these processes of differentiation, 954 were within study programs (new specializations) and 179 indicated new study programs.

When in each year within each program a process of differentiation would have taken place, the maximum number would have been 6,756. Consequently, in 16.8% (one out of six) of all cases a process of differentiation took place. The discontinuous line—marked with plus signs—represents the relative number of processes of differentiation, that is, these numbers control for the total number of study programs offered in the years 1975–1993. Whereas in the 1970s the average percentage of processes of differentiation was about 10%, this number rose to about 20% from 1982 on.

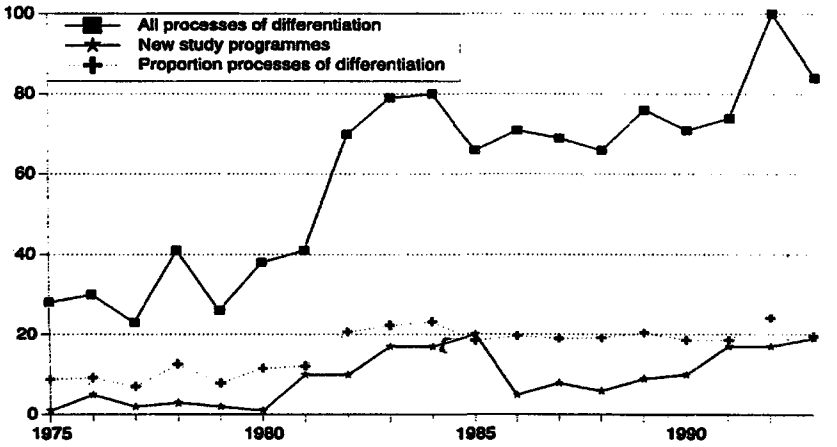

FIG. 1. Number of processes of differentiation 1975–1993.

Hypothesis 1

In line with the expectations formulated above, the first hypothesis could not be falsified. For the test, 190 study programs were used (of the 197 programs offered throughout the period 1975–1993). The correlation between number of processes of differentiation and the level of dependency was .18 ($T = 2.403$, $p < .05$). Indeed, the level of dependency played a small but significant role in explaining processes of differentiation.

To strengthen the importance of the finding, the testing of the hypothesis was repeated. Another design was chosen, leading to a more severe test. Instead of periods of 18 years, 4- and 5-year periods of enrollment were used to predict the occurrence of processes of differentiation in the year following the 4- or 5-year period. Such an approach follows more appropriately the argumentation that increasing levels of dependency *lead* to processes of differentiation. Level of dependency was measured in a similar way as above, applying the formula to 4- and 5-year enrollment patterns. The 4- and 5-year periods were chosen to anticipate an expected time lag between the period in which the level of dependency increases and the moment actions (implementing new programs or specializations) are undertaken. Using (much) longer periods seems unreasonable, for actors involved are unlikely to take into account events that happened more than about 6 years ago. The occurrence of a process of differentiation was considered a dichotomous variable: a process taking place or not in a specific year. Using a logistic regression model and parameter estimation by means of the maximum likelihood method, the hypothesis—again—could not be falsified. For the test for 4-year periods, 3,355 cases were used (data on 321 study programs with first-year enrollments existing for at least 5 years between 1975 and 1992 were included). A small but significant β in the regression equation ($\beta = .0734$, $p < .001$) was the result. For 5-year periods, 3,114 cases were used (data relating to the same set of 321 programs) and β was slightly larger ($\beta = .0831$, $p < .001$).

Thus, using the level of dependency based on enrollment patterns of 4 and 5 years instead of 18 years also leads to significant results: High levels of dependency correlate with the occurrence of processes of differentiation. Interest groups confronted with decreasing and/or strongly fluctuating enrollments are more inclined to establish new programs and specializations than those experiencing rather stable and/or increasing enrollments.

Hypothesis 2

Table 1 presents the number of processes of differentiation in the seven selected fields in order of their paradigmatic development (from high to low). Because the number of study programs involved and the periods in which the study programs were provided differ from field to field, the number of processes of differentiation need to be measured relative to the maximum number of processes

TABLE 1. Number of Processes of Differentiation in Seven Fields 1975–1993

Field	Total	Phy	Che	Bio	Eco	Psy	Soc	Pol
Events	232	35	34	26	36	43	40	18
Nonevents	977	253	181	121	156	95	104	67
Total events	1209	288	215	147	192	138	144	85
Perc. events	19.2	12.2	15.8	17.7	18.8	31.2	27.2	21.2
Programs involved	72	16	12	10	11	9	9	5

that could have taken place. Therefore the next to last row presents the events (processes of differentiation) as a percentage of the total number of events (the maximum number of processes).

In the hard sciences processes of differentiation occur less often than in the social sciences. In physics, for instance, the rate is .122 (one out of eight), whereas the rate of sociology is .272 (one out of four). The pattern of the rates is almost perfectly in line with the pattern of paradigm development, with the exception of psychology and political science. According to the hypothesis, it was expected that the rate of psychology would be somewhere between .190 and .270 (instead of the actual rate of .312), and that the rate of political science would be higher than the rate of sociology (larger than .272). A rank order test revealed that the correlation between paradigm development and rate of processes of differentiation was significant (r_s = .86, p < .025). The hypothesis that the number of processes of differentiation is dependent on the level of paradigm development (from hard to soft) therefore cannot be falsified.

Combining the External and Internal Factor

By changing the design slightly, the data collected allow a preliminary test to assess the relative impact of both the internal factor (cognitive characteristics of subject matter) and the external factor (level of dependency on governmental funding) on the occurrence of processes of differentiation. Since paradigmatic development is measured on an ordinal scale, the variable cannot be included in the regression equation of the first hypothesis. Nevertheless, a dummy variable representing hard sciences (0) and soft sciences (1) can be included. The hard sciences programs consist of—following Biglan (1973a, b) and Malaney (1986)—programs from the natural sciences and engineering disciplines. The soft sciences programs include study programs from the social sciences and humanities. The health sciences programs are split across the two types. Veterinary medicine, medicine, and dentistry belong to the hard sciences, whereas programs such as health-care policy and management and environment and health belong to the soft sciences. Law and economics programs were not rated in these studies and were therefore omitted in the following analysis.

Multiple regression using 172 cases (study programs) revealed that both the level of dependency and paradigm development contributed to the explanation of the occurrence of processes of differentiation ($R_M = .28$, $\beta_{PARADIGM} = .25$, $\beta_{DEPENDENCY} = .16$, $F = 7.116$, $p < .01$). In this research design, the level of paradigm development alone also significantly explains the occurrence of processes of differentiation ($\beta_{PARADIGM} = .23$, $T = 3.065$, $p < .01$).

DISCUSSION

The study suggests that both internal and external factors play a role in the occurrence of processes of programmatic differentiation in the university sector. The external factor relates to the governmental funding mechanisms of (study programs of) academic institutions. The amount of resources for study programs is to a large extent dependent on the number of first-year students enrolling in the program. Confronted with decreasing or strongly fluctuating enrollments, interest groups develop strategies to cope with the threatening situation. Network extension, by means of implementing new specializations or programs, seemed—based on a theoretical framework derived from resource dependency and social exchange theory—the most obvious solution in the given context. This expectation could not be refuted by the empirical research. An internal factor proved to be important as well. The disciplinary background of the study program—operationalized in terms of paradigmatic development—influences the rate of processes of differentiation. Assuming that the level of consensus is lower in low-paradigm disciplines and study programs, it was suggested that deviance from the disciplinary norms and values seems easier in these programs. Indeed, the empirical analysis confirmed that interest groups involved in soft study programs are more inclined to establish new specializations and study programs than those in hard programs. Combining the two factors in one model also leads to significant results.

Several of the results warrant discussion. Below the focus is on the consequences of the results and alternative and elaborating explanations.

The present study is one of the few large-scale and quantitative studies that addressed the effects of internal and external factors on the emergence of specializations and study programs. Because of the general effect of resource dependency on processes of differentiation, it is safe to say that the widespread common-sense opinion of differentiation facilitated by the growth of the student body needs readjustment. One would perhaps have expected a relationship between the number of programs and/or specializations and the number of students enrolled. This macro-level view cannot be supported by data on the Dutch university sector. Whereas the enrollment numbers increased in the 1980s—at a lower rate than in the 1970s—the enrollments dropped since 1991. In contrast, the number of programs and specializations offered grew from the beginning of

the 1980s. Not increases, but decreases in the number of students enrolled at the level of particular study programs, further processes of differentiation. Support for the findings above can be found in Manns and March (1978), who chose a comparable design. They found that curriculum changes—in terms of, for example, variety in course offerings, course accessibility, and course packaging and advertising—are more likely in departments facing financial adversity. Their findings are not at odds with the results of the present study, even though the focus was on different types of curriculum change. Case studies on new specializations and study programs often choose from a broader array of factors explaining the processes of change. Nevertheless, a number of these studies also report the stimulating effect of threatening cutbacks, financial pressures, and uncertain prospects on—especially—the emergence of new study programs (Karseth, 1995; for examples in the Dutch university sector, see Pollman and de Vries [1987]; Davids and Herwaarden [1993]).

While these findings support the present study, they point to some drawbacks. The case studies give a detailed account of several factors influencing the processes leading to new study programs. This research project included only two variables. Whereas the correlation coefficients were significant and add to understanding the relative impact of the variables, they also indicate that a relatively small part of the variance can be explained by the chosen variables. Obviously, perceived students' needs, labor market requirements (Boys et al., 1988), and demands from professional groups—often mentioned in the case studies—may as well lead to processes of differentiation. In these cases, interest groups actively respond to changes in their environment. Including such variables in further research on processes of differentiation seems a first step to strengthening the findings reported above.

The test of the impact of paradigmatic development on processes of differentiation was successful. However, repeating the test using another rank order of scientific fields leads to different results. Salancik et al. (1980) ranked 20 academic fields[9] on paradigmatic development using language parsimony (operationalized as the length of dissertation abstracts in the national *Dissertation Abstracts*) and the level of integration of knowledge (operationalized as the maximum chaining of sequential prerequisite courses in the curricula of the disciplines) as indicators of paradigmatic development. Despite a high and significant correlation between the rankings of Lodahl and Gordon (1972) and Salancik et al. (1980), a preliminary retest of the second hypothesis—using the latter rank order of twenty fields and the number of processes of differentiation in these fields—leads to results contrary to the expectations. Reconsideration of the theoretical framework and close inspection of the data set lead to the following speculations.

(1) The seven fields of Lodahl and Gordon (1972) are all pure in terms of Biglan's (1973a, b) classification. Other dimensions of classifications (Biglan, 1973a, b; Whitley, 1984; Becher, 1989) may as well be of influence on the occur-

rence of processes of differentiation. Including applied study programs from Salancik et al.'s (1980) study may disturb the rather regular pattern. It remains to be seen to what extent, for instance, applied study programs are more inclined to establish new specializations or study programs.

(2) In addition to the previous point, some of the fields chosen by Salancik et al. (1980) might not differ that much in their paradigmatic development. The authors do not report the values of the two indicators, but some support for this line of thought can be found in Biglan's studies. He included some figures representing two-dimensional similarity patterns. From Figure 1 (Biglan, 1973a, p. 198), for instance, it can be concluded that physics and chemistry hardly differ on the hard-soft dimension, whereas the "distances" between economy, psychology, and sociology are relatively great. Such insight in the relative differences in paradigmatic development may add to the understanding of differences in the number of processes of differentiation. In this context, it is also worth mentioning that many recently established programs in the Dutch university sector are intradisciplinary or interdisciplinary oriented, which makes it difficult to assess the paradigmatic development (Huisman, 1995, p. 180; see also Becher, 1989, pp. 5–17, on general difficulties involved in classification).

(3) A final point of concern stems from a closer inspection of the data set on processes of differentiation. It seems—at first sight—that study programs already having a relatively high number of specializations are more inclined to establish new specializations than those that have relatively few specializations. From a theoretical perspective it can be argued that the more specializations there are, the less internal cohesion of the program, and—consequently—the easier it is to establish a new specialization. The average number of specializations per study program varies largely. For instance, the eight medicine programs do not have specializations; professional requirements inhibit specialization in the first four years; options for further specialization are open to students who have finished the additional second tier of the program. In contrast, the three mechanical engineering programs have on average (1974–1993) 14.6 specializations and a rate of processes of differentiation of .350 (even exceeding the rate of psychology; see Table 1). The number of already existing specializations could therefore be an intervening variable worth investigating.

The speculations formulated are currently considered more deeply in order to integrate them in hypotheses and test them by empirical research.

NOTES

1. A critical discussion of Kuhn's work is left out. The vagueness of the concept of paradigm (see Masterman, 1970) and Kuhn's (1970) restatements are worthwhile to discuss. Since the focus is on the generally accepted idea of the level of paradigmatic development and operationalizations of the concept follow below, the lack of a critical discussion does not seem problematic.
2. The Wageningen Agricultural University is the only university omitted from the research, because of its many unique study programs and the fact that it is under the Ministry of Agriculture, Nature

Management and Fisheries, with respect to policymaking, instead of the Ministry of Education, Culture and Science.

3. For the universities all study programs and all but 1% of the specializations (1974–1993) could be mapped. The main sources were study catalogues; data were supplemented and checked by information from yearbooks, annual university reports, etc.
4. For the purpose of this research, two types of study programs can be discerned. Regular programs consist of a *propaedeuse* (first year) and a doctoral phase (three years), and consequently have first-year enrollments. So-called *bovenbouw* programs (without a specific *propaedeuse*) are only accessible after absolving a *propaedeuse* of another study program and therefore lack first-year enrollments.
5. The five indicators for the period $y_1 - y_n$ were *increase/decrease 1*: enrollment on y_1 divided by enrollment on y_n; *increase/decrease 2*: total sum of percentage increases in the enrollments from year to year minus the total sum of percentage decreases in the enrollments from year to year; *uncertainty 1*: the variance of the time series $y_1 - y_n$; *uncertainty 2*: the sums of squares of the differences of the successive numbers of the times series, adjusted for the length of the time series; and *uncertainty 3*: the von Neumann ratio (von Neumann, 1941).
6. The mutual rank correlations (Spearman's r_s) were all significant ($p < .01$); the rank correlations of the individual experts with the average score of all experts were also significant ($p < .0005$).
7. The formula for calculating the level of dependency is:
   Level of dependency = 2.24 * (.331 * *uncertainty 1* + .497 * *uncertainty 2* + .387 * *uncertainty 3*) + 3.50 * (.573 * *increase/decrease 1* + .472 * *increase/decrease 2*).
   See Huisman (1995, pp. 123–126) for an extensive treatment of the methodology.
8. The clusters consist of the following study programs: physics (applied physics, astronomy, environmental physics, meteorology and physical oceanography, natural sciences, physics), chemistry (chemical engineering, chemistry), biology (biology, environmental biology, medical biology), economics (economics, fiscal economics, international business), psychology (cognitive science, psychology), sociology (social and institutional economics, sociology), political science (political science).
9. The fields were (ranked according to paradigmatic development): mathematics, physics, electrical engineering, mechanical engineering, chemistry, civil engineering, finance, psychology, architecture, economics, business administration, home economics, geography, accounting, biology, anthropology, geology, history, sociology, and political science.

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