

DRIFT OR SHIFT? CONTINUITY, CHANGE, AND INTERNATIONAL VARIATION IN KNOWLEDGE PRODUCTION IN OR/MS

MELTEM DENIZEL, BEHLUL USDIKEN, and DENIZ TUNCALP

*Graduate School of Management, Sabanci University, Orhanli, 81474 Tuzla, Istanbul, Turkey
denizel@sabanciuniv.edu • behlul@sabanciuniv.edu • deniztuncalp@su.sabanciuniv.edu*

With the aim of contributing to the debate around OR/MS as a discipline, this study provides a historical comparative investigation of publicly available knowledge production in the field. The empirical investigation is based on a content analysis of 300 randomly selected articles from six major journals in the field. We have found: (1) since the late 1950s to the present day there has been no significant change in the types of published research in OR/MS in North America; (2) from the late 1950s to the present day, there have been significant differences in types of published research in OR/MS internationally. The imputed imbalance between theory and applications in published work had already occurred in the early stages of the development of OR/MS in North America and has since remained very much the same. Furthermore, research in the United Kingdom has been distinctly different from that dominant in North America and elsewhere. There are also indications that outside North America and the United Kingdom there is an emerging turn towards applications-oriented research. Over the last two or three decades there has been a significant increase overall in the share of articles published by academic authors.

Received April 2002; revision received February 2003; accepted February 2003.

Subject classification: Professional.

Area of review: OR Chronicle.

1. INTRODUCTION

The 1970s mark the beginning of a debate on the state and the future of operations research/management science (OR/MS) as a discipline and profession. Although there were earlier expressions of unease about OR/MS fulfilling its promise and adhering to its roots and assets (see Hansen 1989), the period until the mid-1970s has often been regarded as the “golden age” (e.g., Keys 1995, Kirby and Capey 1998), a “crisis” discourse emerging with some strength only by the end of that era. About a quarter of a century later, the concerns appear to be continuing. In a recent article, Meredith (2001) has suggested, for example, that the predicted contraction of the field might actually have arrived.

Authoritative reviews of the “crisis” literature, since its early appearance to the present day, have been provided elsewhere (e.g., Geoffrion 1992, Corbett and Van Wassenhove 1993, Keys 1995, Kirby 2000). Many of these authors have voiced concern about the profession, as well as some degree of optimism, resorting often to anecdotal evidence construed as symptomatic of an impending or actual crisis or, even, demise. Mentions have ranged from the disappearance of OR groups in industry to the loss of place in core MBA curricula and the fading away of independent departments bearing the name OR/MS. A few empirical studies have accompanied, expressing worries about the predominantly theoretical nature of published research (e.g., Reisman and Kirschnick 1994, 1995; Ormerod and Kiossis 1997; Ormerod et al. 2000).

Indeed, a major source of specific concern more recently has been the imputed imbalance between theory and application-oriented research published in leading journals (e.g., Ormerod 2000, Pidd and Dunning-Lewis 2001). It has been argued that OR/MS has been detached from its origins, which emphasized a scientific approach to “real-world” problems in an interdisciplinary manner. It has been further suggested that the disciplinary orientation and preoccupation with theory has led to less managerial relevance, building a gap between published research and real issues. Reisman and Kirschnick (1994), as well as Ormerod and Kiossis (1997), have reported that “untested theory” articles by far outweigh what they call “true” applications. In a somewhat different vein, Corbett and Van Wassenhove (1993) argue that the issue is not one of too many or too few publications on theory or applications, but an increasingly underpopulated area linking them together in the “true” spirit of OR/MS. They have postulated that a natural drift has taken place towards two polar ends that they label as “management science” and “management consultancy.” The middle ground, which they call “management engineering” and which they claim reflects the essence of OR/MS, has been fading away, thus resulting in perceptions of crisis.

Such thematic differences notwithstanding, the broad image that often appears to emerge from this literature is one of gradual change (or an academic “drift”), resulting in “regression” (Corbett and Van Wassenhove 1993), “devolution” (Reisman and Kirschnick 1994), or “contraction” (Meredith 2001), manifested as a singular “global” trajectory. This general picture is maintained despite the fact that

some empirical studies (e.g., Reisman and Kirschnick 1994, Ormerod and Kiossis 1997) have yielded results which raise doubts about its validity.

The present study addresses and empirically investigates this dominant representation of the historical evolution of public knowledge production in OR/MS by examining journal publications, a major medium through which knowledge production is made publicly available. First, we argue that the movement in published research from application to theory did not occur gradually, but at the very early stages of the development of OR/MS, particularly in North America. The *shift* took place as a part of developing a “science of managing” (cf. Smiddy and Naum 1954) that the United States pioneered in the aftermath of World War II (Locke 1989). What has been happening since then in the North American context can be characterized more by continuity than change. Second, there is a need to recognize and assess the ways in which research in OR/MS is characterized in different parts of the world. As with other forms of science-based managerial knowledge and education, OR/MS had been exported from North America to Europe and elsewhere beginning as early as the 1950s (Locke 1989). Nevertheless, the mix of theory and application outside North America has varied due to the conditions in the early stages of importation and development and the traditions that they have served to generate. More specifically, different patterns have prevailed, notably in the United Kingdom with its own pattern of early OR/MS activity, as opposed to other countries that have relied from the beginning on a model imported from North America.

2. PUBLISHED RESEARCH IN OR/MS IN HISTORICAL AND COMPARATIVE PERSPECTIVE

OR/MS in North America

At the center of the debate on published research in OR/MS has been the dichotomy between theory and practice (e.g., Pidd and Dunning-Lewis 2001) or “rigor” and “relevance” (Geoffrion 1992). Yet, when Ackoff (1962, pp. 7, 1) spoke of “science” and the “use of mathematical models, and other systematic and quantitative procedures” coupled with the “principal occupation” of “solving problems,” it was part of a broader “vision” of the time for developing a “science of managing” (cf. Smiddy and Naum 1954). This “new paradigm,” as Locke (1989, pp. 1, 24) calls it, envisioned the “application of science to the solution of management problems,” to which the “operations research movement did so much to advance.” OR/MS was the epitome of the combination of what were to become the central footings of management disciplines, particularly in post-World War II North America—namely, “scientism” and “managerialism” (Üsdiken and Leblebici 2001). Of the two, scientism involved the use of the scientific method and thus the emulation of natural sciences. Managerialism, on the other hand, related to being concerned with “executive-type problems” (Churchman et al. 1957) and “improving operations” (Ackoff 1962, p. 10) or, in Locke’s (1989, p. 24) words, “practical purposiveness.”

The post-World War II arrival of the new paradigm was essentially a U.S. phenomenon and carried with it the mission of improving management education (Whitley 2000, Locke 1989), articulated and popularized, for example, through the very influential Ford and Carnegie Foundation reports (Pierson 1959, Gordon and Howell 1959). At that time, business education had a vocational character (Locke 1989), and the management-consulting industry (Ackoff 1957) was already operating in North America. What was needed was to develop the “science” side (cf. Smiddy and Naum 1954). Not only was this in line with the new paradigm, but it also promised greater status for business studies within the university, and indeed for the management profession at large (cf. Abbott 1988). It appears to be in this spirit that in the specific case of OR/MS, Ackoff (1962, p. 11) for example, called for more research with students and faculty “devoting themselves *exclusively* to operational research” (emphasis in original). If this was not done, Ackoff (1962, p. 11) believed, “operational research (would) become incapable of retaining its place in the scientific community and to management it (would) become a mere tool.”

What was not envisaged at the time was that the turn towards science could result in becoming largely detached from immediate problem-solving concerns. Given OR’s affinity to hard sciences during its emergence, it was a forerunner within business disciplines in drawing on the science model (Locke 1989, Barley and Kunda 1992, Whitley 2000). It is therefore likely that in OR/MS, the unintended consequence of the move towards science at the expense of the science-management combination also happened relatively quickly and rather abruptly. This was expedited by the rather swift post-World War II shift of OR/MS to academic institutions in the United States (Trefethen 1954; Ackoff 1957, 1979; Locke 1989; Kirby 2000), altogether resulting in Ackoff’s (1957, p. 84) observation that “American operations research is very largely methods-and-technique oriented.” Rothkopf (1994, p. 31) observed that, “most papers” in the 1952 volume of *Operations Research* “dealt with applications.” Reisman and Kirschnick (1994), on the other hand, showed that by 1962 more than half of the space in this journal and, for that matter, in *Management Science* was occupied by articles that they categorized as “untested theory.” What they called “true applications” accounted for only 30% of the content in both journals. These findings reinforce the expectation that what has been expressed more recently as a source of concern about publishing in OR/MS had already occurred and taken hold to a large degree in North America by the late 1950s and early 1960s.

The United States continued to prevail in research not only in OR/MS, but also in all subdisciplines of management (Doyle and Arthurs 1995, Engwall 1997b). As Barley and Kunda (1992, p. 378) have demonstrated through counts of articles indexed in the *Business Periodicals Index*, “systems rationalism” was clearly on the rise in the United States throughout the 1960s and the 1970s. There were occasional challenges to what had set in as the dominant pattern. Ackoff (1973), for example, voiced his initial complaints that OR/MS was coming of age in 1973

and, like Hall and Hess (1978), tried to show the way for OR/MS to survive (Ackoff 1979). The appearance of *Interfaces* (in 1971) and the introduction of the “practice” section in *Operations Research* (in 1984) can be construed as community initiatives to redress the perceived imbalance in published research towards science. Nevertheless, by the latter part of the 1970s and throughout the 1980s, the crisis debate was clearly not a significant preoccupation in North America (cf. Dando and Sharp 1978, Dando and Bennett 1981). That nothing had really changed until the 1990s in dominant modes of published research is also apparent in the results of Reisman and Kirschnick’s (1994) study. These authors found that, early in that decade, their “untested theory” category accounted for more than half of the journal space, whereas the articles they identified as true applications again had less than a third.

OR/MS Elsewhere in the World

North America was distinct, however, both in the diffusion and institutionalization of the new paradigm and the specific early developments that pertained to the OR/MS discipline. The United Kingdom, as the other leading country in postwar OR/MS, constituted a contrast to North America. Only after the mid-1960s were the first American-modeled business schools founded in the United Kingdom (Whitley et al. 1981), and the absorption of OR/MS by academia was a much slower process (Locke 1989, Kirby 2000). For example, Ackoff (1957) observed that one major difference in formative years between the United States and the United Kingdom was the extent of academic participation. In fact, as Kirby and Capey (1998) have noted, when OR/MS eventually began to penetrate into the academia through the new universities in Britain, practitioners who took up academic positions led the way. Practitioners also took the lead in the formation and the development of the U.K. professional society, which, as Keys (1995) and Kirby and Capey (1998) indicate, made the society’s journal, in its early years, more sensitive to the needs of those practicing OR. Moreover, as Trefethen (1954) had observed earlier, OR applications in the United Kingdom were often at the industry level or involved the public sector and were therefore more likely to be made publicly available. Altogether, these observations would suggest a pattern for the United Kingdom that has been distinctly different, in the early stages, from the one in North America. The move towards science has not occurred to the same degree, as much of the work published by British authors is expected to have adhered to what has often been conceived of as the original spirit of OR/MS. Indeed, given the paucity of academic contributors, the British mold in the 1950s and 1960s was more similar to the state that Corbett and Van Wassenhove (1993) described for the World War II era. As Dando and Bennett (1981) have observed, however, the following decades would lead towards a greater science orientation, though possibly not at the same scale as in North America.

The export of American-based management know-how and education to Europe and the other parts of the world

began right after World War II (Byrt 1989, Gourvish and Tiratsoo 1998, Leavitt 1957). OR had already penetrated in the 1950s into countries like France, Switzerland, and Germany, in the form of chairs and institutes in universities (Locke 1989). As Pappis (1995) showed, OR societies had been established in eight European countries by the mid-1960s. Although practitioners were also active in the formation of these societies in many cases (e.g., Krarup 1995, Fleischmann 1995), the early infiltration of OR/MS to academia, coupled with the United States serving as the major source of learning, suggests that the formative years in these regions have been more similar to those in North America. Since then, North America continued to serve as a source of learning and a model in the study of and education for management, with “follow-the-leader” behavior setting in everywhere American influence could reach (Engwall 1997a). The outcome for the “followers” has been conformance to patterns in the leading country, given that the latter also dominated many of the outlets for dissemination of research (Engwall 1997b). This is hinted at by the work of Ormerod and Kiossis (1997), who found that in the 1978 volume of the *European Journal of Operational Research* (EJOR) the proportion of space devoted to “theory” versus “application” papers was around eight to one. The comparable figures for 1994 were about 14 to one. However, the interpretation of these results should be done with care, as this study did not distinguish between the country origins of authors. A later investigation (Ormerod 1997) showed that in 1994, for example, authors from the United States had more than a 40% share in EJOR.

Altogether, this discussion leads to two testable hypotheses:

HYPOTHESIS 1. *There has been no significant change in the types of published research in OR/MS in North America since the late 1950s to the present day.*

HYPOTHESIS 2. *From the late 1950s to the present day, internationally there have been significant differences in the types of published research in OR/MS.*

3. VARIETIES OF PUBLISHED RESEARCH IN OR/MS

We draw upon and extend the categorization offered by Corbett and Van Wassenhove (1993). These authors proposed and defined three main types of activity in OR/MS: (1) management consulting (MC), (2) management engineering (ME), and (3) management science (MS). MC and MS represent the applied and theoretical polar ends of the OR/MS activity spectrum. In MC, “the goal is to solve somebody’s practical problems using existing, standard methods,” whereas in MS, “the goal is to develop new results to contribute to the body of knowledge in the discipline” (Corbett and Van Wassenhove 1993, pp. 1, 24). ME falls in-between the two, where “the goal is to solve those practical problems for which it is necessary to adapt existing tools in fundamentally novel ways.” Management engineers, according to Corbett and Van Wassenhove (1993),

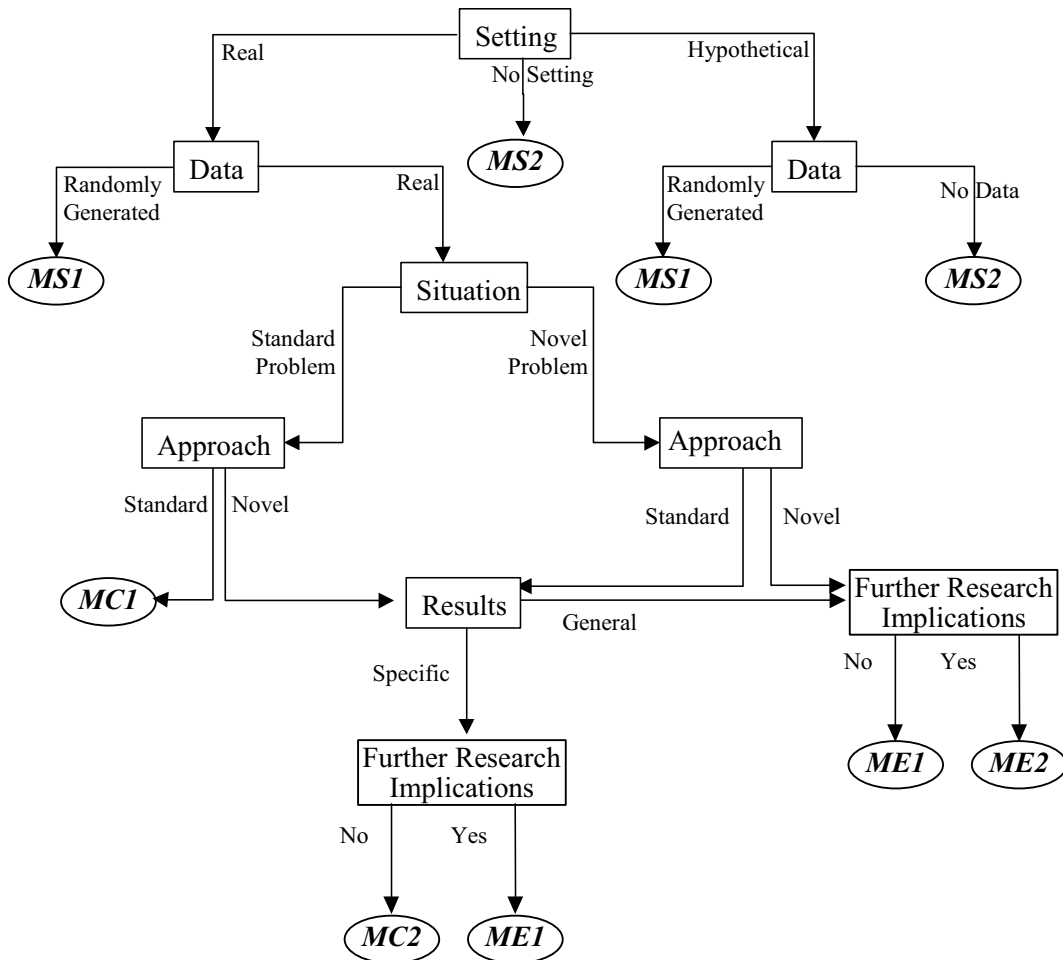
try to relate the real world to the body of knowledge developed in the area by studying a situation from an analytic viewpoint. They also signal to MS the areas that are of practical relevance and still need to be developed.

In extending Corbett and Van Wassenhove's (1993) classification, we considered six attributes, resulting in a further division of each category into two subtypes. These attributes relate to the central features of the published study and include the setting, data, situation, approach, results, and future research implications. *Setting* refers to the context in which the study has been conducted and distinguishes between real and hypothetical settings, as well as those without any application context and, thus, "no setting." Studies carried out within organization(s) involve real settings, whereas in those only implying an organizational context without reference to specific organization(s), the setting is hypothetical. The *data* dimension relates to whether "no," "randomly generated," or "real" data are employed. Data would be considered as real only when the organization(s) to which the data belong are involved in the study and may be logical or contextual. *Situation* distinguishes between whether the study is concerned with "standard" (well-studied in OR) or "novel" problems. Similarly, the

approach in the study can be standard (well-developed and frequently used) or novel in the sense of developing new methods or using extant ones in fundamentally new ways. *Results* can be distinguished in terms of whether the outcomes are "specific" to the organization(s) involved in the study or are "general" enough to be put to use in other organizations. Finally, reported studies can differ as to whether they suggest *future research implications* or not.

The refinement of Corbett and Van Wassenhove's (1993) categorization by considering possible combinations of the six study attributes is presented in Figure 1. MC- and ME-type research is fundamentally distinguished from MS in being based on real settings and in containing real data. MC1, typically, involves a consultancy-type study undertaken in a particular organization to address a situation already encountered in practice, which is dealt with by applying some standard procedure customized to the needs of that organization. MC2 differs from MC1 in that either the situation faced or the approach is novel, although eventually the study, as in MC1, leads to specific results without any implications for future research. Within ME, ME1

Figure 1. The scheme for classifying articles.



differs from MC2 either by providing general results that may later lead to development of standard practices or by indicating future research in the area. ME2 takes this further ahead in that it involves both general results and suggests further avenues for research. MS-type research, as noted above, is distinct from the other categories in that it does not directly relate to specific organizations. In MS1 the setting can be hypothetical or real. The data, however, are likely to be randomly generated to represent the events that would typically be encountered in the specified settings. Small examples to better explain the approach are not considered as data. The results provided by MS1 may or may not be of immediate use, but always have an organizational reference. MS2 research, on the other hand, is the most abstract. It either refers to no particular setting or, even if it does, no data are involved. The aim is the development of new results to contribute to knowledge without a concern for immediate use in a real-world setting.

4. METHODS

We content-analyzed articles published in six major journals, three from North America and three from Europe. The study spanned the period from the late 1950s to the present day. The scheme developed in the preceding section provided the basis for the coding of articles.

4.1. Journals and Sampling

The journals are *Operations Research (OR)*, *Management Science (MS)*, *Interfaces (I)*, *Journal of the Operational Research Society (JORS)*, *European Journal of Operational Research (EJOR)*, and *Omega*. We used four criteria to select the journals. First, some journals had to have publication histories spanning the entire period studied. Second, the journals had to come from different regions. Third, major journals had to be selected to assess what could be considered to be among the best published research in the field. Journal impact, based on the data available in the *Journal Citation Reports (JCR)*, was taken as an indicator of journal significance. Finally, the journals were not to limit their scope to an application context or to a particular OR/MS tool or technique. Three of the selected journals (OR, MS, and I) are considered by Reisman and Kirschnick (1994, 1995) to be “flagship” journals from the United States. Of the other three, JORS (formerly the *Operational Research Quarterly*—ORQ) and EJOR were identified by Ormerod and Kioussis (1997) as the British and European counterparts, respectively, of *Operations Research*. They also included *Omega* as the closest British journal to *Management Science*. Of the journals examined by Ormerod and Kioussis (1997), only *OR Insight* was not included in this study, as this particular journal fell far behind in journal impact.

We sampled a total of 300 articles. Of the sampled articles, those that were related to the history and the philosophy of the research in the field and those that were social science articles with empirical examination of hypotheses were not included and were replaced by additional

Table 1. Sampled articles.^a

Journals	1958–1962	1978–1982	1996–2000	Totals
<i>Management Science</i>	33	32	24	89
<i>Operations Research</i>	34	29	24	87
<i>Journal of Operational Research Society</i>	33	19	15	67
<i>Interfaces</i>	—	9	15	24
<i>Omega</i>	—	—	11	11
<i>European Journal of Operational Research</i>	—	11	11	22

Note. ^aBecause column totals add to 100, only frequency counts are reported.

rounds of random selection. We sampled from three distinct five-year periods, namely, 1958–1962, 1978–1982, and 1996–2000. One hundred articles were randomly sampled for each period with the following rules. For the first period, as impact factor data were not available, each of the three journals that existed at the time (OR, MS, and ORQ) was equally represented in the sample of 100 articles. For the other two periods, the number of articles sampled from each journal was determined with respect to their impact factors, as reported in the JCR of the final year of the corresponding five-year period (e.g., 1982 JCR for 1978–1982). The rationale was to ensure representation that accorded with the relative impact the journals had on research in the field.¹ Although *Omega* had begun publication in 1973, it had a very low impact factor in 1982 and was therefore not included in the 1978–1982 period, resulting in sampling from five journals. Sampling for 1996–2000 included all six journals covered by the study. The resulting number of articles sampled from each journal in each five-year period is shown in Table 1.

4.2. Variables and Coding

Coding proceeded in two steps. The first step dealt with the articles that provided a survey or review. An article that presented a survey of previous OR/MS applications in a particular area or location, describing and summarizing the undertakings and their impact was coded as MC2. If the article presented a descriptive study in a particular application area and opened up new venues for research, it was coded as ME2. These would be reviews based on observations and data obtained from environments showing similar characteristics leading to classifications, problem definitions, and/or taxonomies. Finally, when the article presented a review of the literature which depicted the state of the art in a particular area, it was treated as MS2.²

If the article was not a survey or review as defined above, the coder proceeded to the second step, where each article was assessed on the basis of the six attributes and configurations shown in Figure 1. Typically, the assessments for *setting*, *situation*, and *approach* could be gauged from the introduction and/or the initial discussion sections of an article, whereas information on the nature of *data* could be found in different sections. The features of the study with

respect to *results* and *future research* could be assessed from the ending discussion and/or conclusion. When assessing these two attributes, coders looked for explicit statements in the article. If the author(s) had not explicitly mentioned the generality of the results or talked about future research possibilities, the results were considered specific to the case at hand or with no further research implications.³

The first and the third authors coded the articles. To check for reliability, a subsample of 30 articles (10 for each period) was selected randomly from the 300 that constituted the entire sample for the study. These 30 articles were coded by the two authors as well as by a visiting professor of operations management from a different university who was not associated with the study. The intercoder agreement between the two authors was 77%. It was 80% and 83%, respectively, between each of these authors and the outside coder. An average intercoder agreement of 80% is considered adequate in the content analysis literature (Riffe et al. 1998). The average reliability figure of 0.76 obtained for the Scott's Pi test is also well above the acceptable level in content-analysis research (Riffe et al. 1998). Given acceptable reliability, the remaining papers were equally shared between the two authors for coding, each having an equal number of articles for each time period. The cases where there were discrepancies within the subsample of 30 articles used for the reliability check were resolved through discussion and coded according to the agreement reached.

The design of the study included two other variables, namely, *time* and *country affiliation*. The *time* variable was obtained by collapsing the three periods from which the articles were drawn into three data points, namely late 1950s–early 1960s, late 1970s–early 1980s, and late 1990s. These time periods were chosen to capture the critical junctions in the development of OR/MS. The initial period (around 1960) covers the immediate aftermath of the beginnings of building a discipline with the founding of journals and the formation of professional societies. The second data point (around 1980) corresponds with what has been considered the end of the “golden age” (e.g., Keys 1995). Finally, the last period (late 1990s) follows the extension of the “crisis” debate to North America. *Country affiliation* was measured by the location of the institution with which the author (or in the case of multiple authorship, the first author) was affiliated.⁴ The four categories employed were North America (United States and Canada), United Kingdom, Continental Europe, and non-European countries. The latter two groups were combined into an “other” category. In cases where the author had multiple affiliations located in more than one of these regions or countries, coding was based on the institution that was listed first under the author's name. As expected, contributions from North America (199 in total) dominated, constituting some two-thirds of the sample. Of the remaining 101, 39 came from U.K.-based authors and 31 each from authors affiliated with organizations in Continental European and non-European countries. Altogether, the articles in the latter two categories were from 25 different countries, with the Netherlands topping the list with seven contributions; followed by

Table 2. North America: Types of contributions by period.^a

Type	1958–1962	1978–1982	1996–2000
Management Science (MS)	56 (76.7%)	50 (68.5%)	37 (69.8%)
Management Engineering (ME)	12 (16.4%)	19 (26.0%)	12 (22.6%)
Management Consulting (MC)	5 (6.8%)	4 (5.5%)	4 (7.5%)

Note. ^a $\chi^2 = 1.369$ (MC and ME categories have been grouped together for the chi-square analysis).

India with six; and Australia, Belgium, and France with five each. These five countries account for slightly less than half (45.1%) of the articles in the “other” category.

For the complementary analyses on authorship of published research, author(s)' *organizational affiliations* were also coded. This variable distinguished between whether or not the author (or the first author) was associated with a university at the time of writing. In the case of multiple authorship, conventions similar to those for country affiliation were used.⁵ “Academic” authors, defined as affiliated with a university, authored (or first-authored) 212 of the articles, whereas 88 articles were by “nonacademic” authors working in organizations other than universities.

5. FINDINGS

5.1. OR/MS in North America

Table 2 contains the cross-tabulation of articles by authors (or a first author) affiliated with a North American institution according to time periods and the type of research. The category labeled here as “management science” (MS), accounts for more than 70% of the articles overall, clearly dominating published research from North America ($p < 0.0001$). Yet, as expected, there is no sign that its share has been increasing over time. If anything, there is an indication, though statistically not significant, that there may have been a slight fall in MS-type research, accompanied by a small increase in “management engineering” (ME) since the initial time period examined in this analysis (Table 2). The picture that emerges is one of no significant change in research patterns in North America over the 40 or so years examined here.

Additional analyses (not reported) that examined the nature of authors' (or first authors') institutional affiliations did, however, find significant changes. Over time, the contributions of authors affiliated with institutions other than universities have been falling in North America ($p < 0.001$). Whereas the proportion of articles authored by nonacademics was close to half (42.5%) in the late 1950s and early 1960s, they were outnumbered in the order of more than six to one in the late 1990s.

Moreover, for the first and the second period, the distribution of the type of research published by academic and nonacademic authors was almost identical. A marked

Table 3. Type of contributions from North America, the United Kingdom and other countries.^a

Type	North America	United Kingdom	Other Countries
Management Science (MS)	143 (71.9%)	12 (30.8%)	42 (67.7%)
Management Engineering (ME)	43 (21.6%)	17 (43.6%)	11 (17.7%)
Management Consulting (MC)	13 (6.5%)	10 (25.6%)	9 (14.5%)

Note. ^a $\chi^2 = 28.501$ ($p < 0.0001$).

change is observed, however, for the late 1990s. The proportion of MS-type research published by nonacademic authors (43%) is significantly less than those (74%) by academic authors ($p < 0.05$). So, not only have academic authors gained greater dominance in research outlets, but also, compared to those from outside academia, they are more likely to publish research in the MS category.

5.2. OR/MS Elsewhere

Table 3 contains the results of the analysis that relates to the second hypothesis. The comparisons are between North America, the United Kingdom, and the “other” category, which encompasses all other countries. The analysis yields highly significant results ($p < 0.0001$) showing, in support of the second hypothesis, marked differences among the three country categories. As expected, the most notable difference was between the United Kingdom and both North America and elsewhere, whereas the patterns in the latter two categories were similar to one another. Although research traditions may possibly differ among countries, further analysis (not reported) shows that, overall, there is no significant difference between the two subsets (Continental Europe and non-Europe) within the “other” category. In sum, when the entire 40 or so years are considered published research by U.K.-based authors has been distinctly different from those in North America and other countries. Notably, the overall pattern obtained for the United Kingdom appears to be somewhere in-between what Corbett and Van Wassenhove (1993) claimed as typifying OR/MS during World War II years and the 1950s and the 1960s. Research in the United Kingdom appears to have adhered more strongly to what has been claimed to be the authentic roots of OR/MS.

Separate analyses were carried out to examine evolutionary patterns in the two settings outside North America. The findings for the United Kingdom, which are reported in Table 4, suggest that the strength of the indigenous tradition has generated considerable resilience to the more purist science-oriented pattern dominant in North America. However, although separate tests of proportions comparing the share of MS articles in different time periods did not yield significant results, given the small subsample sizes, there are indications that a move toward a greater science orientation may be emerging there after a lag of some three or four decades.⁶

Table 4. United Kingdom: Type of contributions by period.^a

Type	1958–1962	1978–1982	1996–2000
Management Science (MS)	3 (20.0%)	3 (25.0%)	6 (50.0%)
Management Engineering (ME)	9 (60.0%)	3 (25.0%)	5 (41.7%)
Management Consulting (MC)	3 (20.0%)	6 (50.0%)	1 (8.3%)

Note. ^a $\chi^2 = 3.009$ (MC and ME categories and the first and second time periods have been grouped together for the chi-square analysis).

Interestingly, the analysis of evolution in other countries indicates that in the late 1990s, there is some degree of distancing from the pattern dominant in North America, culminating in an increase in the relative share of application-type (ME and MC) studies (Table 5).^{7,8} Although MS-type research is still predominant (57.1% of articles), published research coming from the other countries now leans more towards “applications” (42.9%) compared to the pre-1980 period (18.5% altogether) ($p < 0.05$). Somehow, the countries in the “periphery” appear to have been more influenced by the debates around theory versus application orientations in research.

Together, these results indicate convergent dynamics between the United Kingdom and the other countries, as they appear to have moved recently in opposite directions. Indeed, when the analysis in Table 3 is conducted separately for the three data sets, significant differences are observed only for the 1958–1962 and 1978–1982 periods (not reported). As of the late 1990s, research from outside North America appears to be converging around a more balanced distribution between theory-type studies (MS) and application-type studies (ME and MC).

Additional analyses (not reported) pertaining to authorship showed stronger convergence, though this time around the North American pattern. In the late 1950s–early 1960s, nonacademic contributors significantly outnumbered academic authors both in the United Kingdom and other countries, constituting 80% and 75% of the authorship, respectively. The analysis that compared authorship distributions for this period across the three country categories yielded

Table 5. Other countries: Type of contributions by period.^a

Type	1958–1962	1978–1982	1996–2000
Management Science (MS)	9 (75.0%)	13 (86.7%)	20 (57.1%)
Management Engineering (ME)	2 (16.7%)	2 (13.3%)	7 (20.0%)
Management Consulting (MC)	1 (8.3%)	—	8 (22.9%)

Note. ^a $\chi^2 = 4.132$ ($p < 0.05$) (MC and ME categories and the first and second time periods have been grouped together for the chi-square analysis).

highly significant ($p < 0.01$) results, indicating marked differences from North America where the comparable figure, as noted above, was 42.5%. When the same analysis was repeated for the following two periods the differences disappeared, indicating, especially for the last period (late 1990s), almost complete homogenization with respect to the dominance of academic authorship. Nowadays, across the board, nonacademic authors constitute a small minority in the authorship of articles published in major journals.

Comparative examination of the relationships between organizational affiliations of the authors and the type of studies they publish in journals (not reported) revealed, for the initial period (around 1960), significant ($p < 0.001$) differences between the United Kingdom and North America as well as the other countries. In the latter two, for that particular time period, contributions by nonacademic authors were preponderantly of an MS kind, 77.4% and 66.6%, respectively. In the case of the United Kingdom, the comparable figure was around 16%. Although comparisons become less meaningful for more recent periods due to the small numbers of nonacademic authors, it is notable that in the United Kingdom all (four) cases were studies with an application orientation. There is uniformity, on the other hand, between North America and the other countries, with around 40% of the contributions by nonacademic authors still being of an MS kind.

6. DISCUSSION AND CONCLUSIONS

The empirical examination has largely supported the two hypotheses guiding the study. With regard to the first hypothesis, findings do show that the imbalance between theory and applications in published research had already occurred very early in the development of OR/MS in North America. The dominant pattern that emerged as a result of this early *shift* towards “science” has prevailed since then in very much the same manner. A more gradual change, or a *drift*, seems to have occurred only in the increasing domination of published research by academic authors. Even in this case, however, dominance by academics had already taken hold in North America by the late 1950s and continued in the ensuing four decades.

The findings also show that an international dimension needs to be brought into the debate around the evolution of published research in OR/MS. For one, in support of the second hypothesis, the results have demonstrated that OR/MS research in the United Kingdom has developed in ways distinctly different from that in North America and other parts of the world. Patterns rooted in a strong indigenous tradition have persisted, though apparently they are beginning to change. On the other hand, countries other than the United Kingdom have, overall, largely followed the pattern set by North America, though there are signs of change there as well.

The changes indicated by the findings for the late 1990s point to increasing convergence among the regions delineated for analysis. The difference between the United Kingdom and North America and other countries, as well as the

similarity between the latter two, was most pronounced in the early stages. More recently, there appears to be some degree of rapprochement, notably between the United Kingdom and the countries in the other category. After closely following North America for three decades or so, a move seems to be taking place in these countries towards research that is more applications oriented. Though the findings suggest the possibility of a limited change in the same direction for North America too, it appears that recent calls for returning to “authentic” OR/MS have found greater resonance in the periphery rather than the core of research activity. Indeed, published research from these other countries is now more convergent with that in the United Kingdom, where balancing in the reverse direction seems to be happening, with a science drift apparently emerging after a long lag.

The organizational affiliations of the authors were also markedly different in the late 1950s and early 1960s, this time between North America and not only the United Kingdom but also the other countries, where a significantly larger share of North American contributions were by academic authors. The evolution in the United Kingdom as well as elsewhere has converged over time towards the North American pattern, resulting in what appears to be complete homogenization in the domination of published research by academic authors.

Altogether, these findings imply that the more frequent expressions of concern recently about the slant in published research towards theory may have less to do with substantive changes in publicly available knowledge production. Given that the source of concern has been there for a long time, more recent calls for “resurrection” in OR/MS, particularly in the United States, could perhaps be located within a broader discourse relating to management education and research. The essence of this discourse, spanning a broad range of management disciplines, is to reinstitute practical and managerial relevance as a focal concern (cf. Porter and McKibbin 1988). The resurgence of this theme recently may be more associated with changes in the material and institutional conditions surrounding research activity. Significant, perhaps, are changes in funding environments of research in the United States, culminating in greater interest on the part of academic institutions to relate to and align with practitioner needs and demands (Rynes et al. 2001). Moreover, a ranking industry based primarily on assessments of MBA programs has become institutionalized and important for business schools (Trieschmann et al. 2000), possibly serving to increase the pressure for greater relevance. However, the more rapid response outside North America (except the United Kingdom) suggests that the institutional structures surrounding academic activity in North America may be more entrenched, thereby constraining change in view of such pressures. Indeed, the results of this study indicate that, despite global convergence towards academic authorship and the science drift in the United Kingdom, a more balanced panorama is emerging outside North America. Coupled with the recent increase in the share of contributions in journal publications of countries from the other category (not reported), the balance sought between theory

and applications may be within sight globally, though possibly in a regionally unbalanced way, for some time to come.

ENDNOTES

1. To check whether this particular sampling procedure which privileged journals with higher impact factors in any way affected the results, 44 additional papers were sampled for the 1996–2000 period so that each of the six journals was represented by an equal number of (in this case 24) articles. Repeating the analyses by using this data set for 1996–2000 yielded similar results in all but one case (see Note 6). Results of these analyses as well as others that have not been reported due to space considerations can be obtained from the first author.

2. The following articles constitute examples of such survey or review articles and their classification: Kao, Lee, and Chen (1997)—MC2; Charnes and Cooper (1957)—ME2; Wright and Mehrez (1998)—MS2.

3. The following are representative of articles classified on the basis of Figure 1: Morton (1958)—MC1; Steer and Page (1961)—MC2; Taha and Wolf (1996)—ME1; Smith, Willis, and Brooks (2000)—ME2; Hausman and Scudder (1982)—MS1; Topkis (1978)—MS2.

4. Of the 300 articles, 126 had single authors. Among the remaining 174 coauthored contributions, in 158 cases all authors were from the same regional category specified for this study. When the 16 “mixed” cases (5.3% of the sample) were excluded, results did not differ in any notable way with the exception of one analysis (see Note 7).

5. Of the 174 coauthored articles, 32 (10.7% of the sample) constituted “mixed” cases with authors from both types of institutions. When these articles were excluded from the analyses, marked differences in results again emerged in only one case (see Note 8).

6. When the same analyses were conducted comparing the distribution for late 1950s–early 1960s with the late 1990s using the larger sample that contained an equal number of articles from the six journals for the latter period, results were significant at the 0.10 level.

7. When articles with authors from different regions were excluded, the result was not significant at the 0.05 level, although the same pattern was there.

8. Excluding articles that had both academic and nonacademic authors showed limited difference among the periods, suggesting that a notable part of the recent turn in other countries towards a greater application orientation had to do with research in which both academic and nonacademic authors were involved.

REFERENCES

- Abbott, A. 1988. *The System of Professions: An Essay on the Division of Expert Labor*. The University of Chicago Press, Chicago, IL.
- Ackoff, R. L. 1957. A comparison of operational research in the U.S.A. and in Great Britain. *Oper. Res. Quart.* **8** 88–100.

- . 1962. Some unsolved problems in solving problems. *Oper. Res. Quart.* **13** 1–11.
- . 1973. Science in the systems age: Beyond IE, OR, and MS. *Oper. Res.* **21** 661–671.
- . 1979. Resurrecting the future of operational research. *J. Oper. Res. Soc.* **30** 189–199.
- Barley, S. R., G. Kunda. 1992. Design and devotion: Surges of rational and normative ideologies of control in managerial discourse. *Admin. Sci. Quart.* **37** 363–399.
- Byrt, W., ed. 1989. *Management Education: An International Survey*. Routledge, London, U.K.
- Charnes, A., W. W. Cooper. 1957. Management models and industrial applications of linear programming. *Management Sci.* **4** 38–91.
- Churchman, C. W., R. L. Ackoff, E. L. Arnoff. 1957. *Introduction to Operations Research*. John Wiley, New York.
- Corbett, C. J., L. N. Van Wassenhove. 1993. The natural drift: What happened to operations research? *Oper. Res.* **41** 625–640.
- Dando, M. R., P. G. Bennett. 1981. A Kuhnian crisis in management science. *J. Oper. Res. Soc.* **32** 91–103.
- , R. G. Sharp. 1978. Operational research in the U.K. in 1977: The causes and consequences of a myth? *J. Oper. Res. Soc.* **29**(10) 939–949.
- Doyle, J. R., A. J. Arthurs. 1995. Judging the quality of research in business schools: The UK as a case study. *Omega* **23** 257–270.
- Engwall, L. 1997a. Mercury and Minerva: A modern multinational academic business studies on a global scale. J. L. Alvarez, ed. *The Diffusion and Consumption of Business Knowledge*. Macmillan Press, London, U.K., 81–109.
- . 1997b. The Vikings versus the world: An examination of Nordic business research. *Scandinavian J. Management* **12** 425–436.
- Fleischmann, B. 1995. Operations research activities in Germany. *Eur. J. Oper. Res.* **87** 440–444.
- Geoffrion, A. M. 1992. Forces, trends, and opportunities in MS/OR. *Oper. Res.* **40** 423–445.
- Gordon, R. A., J. E. Howell. 1959. *Higher Education for Business*. Columbia University Press, New York.
- Gourvish, T. R., N. Tiratsoo, eds. 1998. *Missionaries and Managers: American Influences on European Management Education 1945–60*. Manchester University Press, Manchester, U.K.
- Hall, J. R., S. W. Hess. 1978. OR/MS: Dead or dying? RX for survival. *Interfaces* **8** 42–44.
- Hansen, P. 1989. A short discussion of the OR crisis. *Eur. J. Oper. Res.* **38** 277–281.
- Hausman, W. H., G. D. Scudder. 1982. Priority scheduling rules for repairable inventory systems. *Management Sci.* **28**(11) 1215–1232.
- Kao, C., C.-K. Lee, C.-Y. Chen. 1997. Overview of OR practice in Taiwan companies. *J. Oper. Res. Soc.* **48**(6) 569–579.
- Keys, P., ed. 1995. *Understanding the Process of Operational Research: Collected Readings*. John Wiley and Sons, Chichester, U.K.
- Kirby, W. K. 2000. Operations research trajectories: The Anglo-American experience from the 1940s to the 1990s. *Oper. Res.* **48** 661–670.
- , R. Capey. 1998. The origins and diffusion of operational research in the U.K. *J. Oper. Res. Soc.* **49** 307–326.

- Krarp, J. 1995. EURO 20th anniversary: The prospective future. *Eur. J. Oper. Res.* **87** 415–421.
- Leavitt, H. J. 1957. On the export of American management education. *J. Bus.* **30** 153–161.
- Locke, R. R. 1989. *Management and Higher Education Since 1940*. Cambridge University Press, Cambridge, U.K.
- Meredith, J. R. 2001. Reconsidering the philosophical basis of OR/MS. *Oper. Res.* **49** 325–333.
- Morton, G. 1958. Linear programming—An application in a textile mill. *Oper. Res. Quart.* **9**(3) 198–206.
- Ormerod, R. J. 1997. An observation on publication habits based on the analysis of MS/OR journals. *Omega* **25** 599–603.
- . 2000. Is content analysis either practical or desirable for research evaluation? *Omega* **28** 241–245.
- , I. Kiossis. 1997. OR/MS publications: Extension of the analysis of U.S. flagship journals to the United Kingdom. *Oper. Res.* **45** 178–187.
- , P. Delibassi, C. Morris. 2000. Research strategies used by OR/MS workers: Extension of the analysis of U.S. flagship journals to the United Kingdom. *Oper. Res.* **48** 527–534.
- Pappis, C. P. 1995. OR in Europe: Facts about EURO member societies. *Eur. J. Oper. Res.* **87** 424–429.
- Pidd, M., P. Dunning-Lewis. 2001. Innovative research in OR/MS? *Eur. J. Oper. Res.* **128** 1–13.
- Pierson, F. C. 1959. *The Education of American Businessmen*. McGraw-Hill, New York.
- Porter, L. W., L. E. McKibbin. 1988. *Management Education and Development: Drift or Thrust into the 21st Century?* McGraw-Hill, New York.
- Reisman, A., F. Kirschnick. 1994. The devolution of OR/MS: Implications from a statistical content analysis of papers in flagship journals. *Oper. Res.* **42** 577–588.
- , ———. 1995. Research strategies used by OR/MS workers as shown by an analysis of papers in flagship journals. *Oper. Res.* **43** 731–740.
- Riffe, D., S. Lacy, F. Fico. 1998. *Analyzing Media Messages: Using Quantitative Content Analysis in Research*. Erlbaum, Hillsdale, NJ.
- Rothkopf, M. H. 1994. Ten years of the OR practice section. *Oper. Res.* **42** 31–33.
- Rynes, S. L., J. M. Bartunek, R. L. Daft. 2001. Across the great divide: Knowledge creation and transfer between practitioners and academics. *Acad. Management J.* **44** 340–355.
- Smiddy, H. F., L. Naum. 1954. Evolution of a “science of managing” in America. *Management Sci.* **1** 1–31.
- Smith, K. A., R. J. Willis, M. Brooks. 2000. An analysis of customer retention and insurance claim patterns using data mining: A case study. *J. Oper. Res. Soc.* **51** 532–541.
- Steer, D. T., A. C. C. Page. 1961. Feasibility and financial studies of a port installation. *Oper. Res. Quart.* **12**(3) 145–160.
- Taha, H. A., H. M. Wolf. 1996. Evaluation of generator maintenance schedules at Entergy electric system. *Interfaces* **26**(4) 56–65.
- Topkis, D. M. 1978. Minimizing a submodular function on a lattice. *Oper. Res.* **26**(2) 305–321.
- Trefethen, F. N. 1954. A history of operations research. J. F. McCloskey, F. N. Trefethen, eds. *Operations Research for Management*, Vol. 1. Johns Hopkins University Press, Baltimore, MD.
- Trieschmann, J. S., A. R. Dennis, G. B. Northcraft, A. W. Niemi Jr. 2000. Serving multiple constituencies in the business school: M.B.A. program versus research performance. *Acad. Management J.* **43** 1130–1141.
- Üsdiken, B., H. Leblebici. 2001. Organization theory. N. Anderson, D. S. Ones, H. K. Sinangil, C. Viswesvaran, eds. *Handbook of Industrial, Work & Organizational Psychology*, Vol. 2. Sage Publications, Thousand Oaks, CA, 377–397.
- Whitley, R. 2000. *The Intellectual and Social Organization of the Sciences*. Oxford University Press, Oxford, U.K.
- , A. Thomas, J. Marceau. 1981. *Masters of Business? Business Schools and Business Graduates in Britain and France*. Tavistock Publications, London, U.K.
- Wright, C. M., A. Mehrez. 1998. An overview of the representative research of the relationship between quality and inventory. *Omega* **26**(1) 29–47.