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Higher Education and Scientific Research in Germany. Reconstructing the Nexus of Research and Teaching.

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Abstract : The foundational principle of the modern research university is the nexus of research and teaching. First established in Germany and spreading globally since, this idea and the resulting organizational form led to Germany's past eminence in modern science. Although this university type continues to dominate German higher education, despite establishment of dozens of universities of applied sciences, massive tertiary educational expansion paired with the rise of extra-university research institutes has challenged its foundational principle. As other countries continue to emulate the „German model," we chart institutional change on multiple levels, showing how the relationship between research and teaching within universities and systems of higher education and science has developed in its birth country. The dual structuring of universities and specialized extra-university research institutes affects research capacity and defies the foundational principle and the relatively equal status of Germany's research universities, which struggle to maintain the unity of research and teaching under conditions of austerity.

Keywords: university; research; teaching; Germany; institutional change

Building, Challenging and Defending the Nexus of Research and Teaching

The nexus of research and teaching is the fundamental principle of the modern research university. This innovative idea and the resulting organizational form, first established in Germany and spreading globally

since, led to that country's eminence in science rising over the 19th Century, lasting into the 20th. Up to today, this type of university has dominated German higher education, especially in higher education research and science studies. However, as it absorbed most tertiary educational expansion and with the rise of extra-university research institutes, the foundational principle and university research capacity have come under threat. Here, we reconstruct the institutional evolution of this model, the challenges it faced and faces, and its continued strengths. Charting institutional changes on multiple levels, from institutional and organizational to interactional, we analyze how the relationship between research and teaching within universities and systems of higher education and science developed in Germany. Parallel to the organizational division of universities and specialized extra-university research institutes, problems of capacity and underfunding have increased, with universities struggling to maintain the unity of research and teaching, although they remain highly productive (see Dusdal et al. 2020). Most recently, the „Excellence Initiative" since the early 2000s has called the relatively equal status of German universities into question. Instead of addressing the demands of massification and the structured duality of universities and extra-university research institutes, policymakers have forced universities to do more with less, while the research budgets of independent institutes continue to rise. Increasing stratification means some universities emphasize research, with others more teaching-oriented. While scholars defend the foundational principle of the nexus of research and teaching, policymakers have failed to authorize sufficient investments to maintain *university* research capacity, despite the centrality of the research university for both higher education and science systems. Here, we reconstruct the nexus that gave birth to that core organizational form of the modern research university—and chart the contemporary challenges facing it.

Whatever its current status in Germany, the „Humboldtian" university model has reached mythic proportions. Due to its enormous prestige, even „sanctity" (Pritchard 1998), it enjoys sustained attention worldwide. Yet sufficiently diverse elements have been ascribed for it to become

historiographically controversial (Ash 1999). Without a doubt, the German university has shared specific characteristics that constitute a significant contribution to higher education and science worldwide, in the decades before and after WWII, but with a massive decline under Hitler's regime. In the 19th Century, teaching and research in higher education institutions were uniquely melded together. This „unity" became more than the sum of its parts, especially when supplemented with the freedom to teach and to study, which strengthened the autonomy of and commitment to science (Phillips 2011: Ch. 5). In fact, the modern—research-oriented—university rose to prominence with its success based largely on these principles, which became a powerful, and self-referential, belief system (Watson 2010: Ch. 10). With this *Leitbild*, German science, continuously evaluating its own performance, came to lead the world in many disciplines, as evidenced by the extraordinary influence of German universities on Nobel prize winners (see Urquiola 2020).

Yet the evolving relationship between research and teaching also suffered growing pains and conflicts of interest. Up until the 1970s, most students were educated in state-funded and state-controlled research universities, which had continuously absorbed ever-larger numbers of students from the late 1800s onwards. These student flows were enabled by the higher-level secondary school form, the *Gymnasium*, whose university-educated teachers offered curricula oriented to scientific disciplines, optimally preparing students for graduate-level studies without having gone through undergraduate courses of study (see Mitterle/Stock 2021). The demands of expanding student bodies, however, threatened this symbiosis. Eventually, the weight of teaching reduced capacity for research, disturbing the delicate balance between the search for new insights and the transmission of knowledge to upcoming generations.

Connected to that challenge, with the founding of dozens, later hundreds, of extra-university research institutes, a structural duality was established: parallel worlds of independent institutes and research universities, with „favored sponsorship" of the latter (Dusdal et al. 2020). This built research capacity outside universities and increased teaching loads in higher

education. When the 1960s witnessed another tremendous phase of student population growth vocational schools (*Fachschulen*) were converted into vocational colleges (*Fachhochschulen*); now called universities of applied sciences—a prime example of „academic drift" seen in many countries (see Gellert 1993; Lenhardt 2005; Witte/van der Wende/Huisman 2008). Since this organizational form focused primarily on training and less on conducting fundamental research, this differentiation of higher education weakened the nexus of research and teaching. Yet rising qualification levels and the durable ideal encourage researchers to conduct research throughout higher education. Universities have maintained their positional status, even if they lack the resources enjoyed by the diverse institutes of the four large state-funded research associations (Max Planck, Helmholtz, Fraunhofer, Leibniz), each with many specialized institutes devoted fully to the pursuit of scientific advance and/or application. The universities' student numbers expanded continuously—without the equivalent growth in research staff; in particular, the non-professoriate teaching staff bore the brunt of this additional burden, their own careers not yet secured. University-based research declined as it retreated into the „shadows of teaching" (Schimank 1995).

Reputations still had to—and have to—be built on scientific output, which places scientists and scholars in teaching-intensive universities at a structural disadvantage. The new conditions strained the union or „unity" of teaching and research as well as individual intrinsically motivated truth-seekers. Nevertheless, the state maintains the dual structure of science: two separate organizational fields—universities and research institutes—at times ignore each other, at times compete. They less often cooperate, although in recent years such collaborations have been supported generously, in such programs as the International Max Planck Research Schools since 2000 or in the Karlsruhe Institute of Technology (KIT)—and networks among all German research-producing organizations have continuously grown and become denser (Dusdal/Oberg/Powell 2019). The hierarchy remains, with universities producing research despite often-abysmal conditions, and research institutes enjoying all the advantages of well-resourced, cutting-edge facilities and limited teaching duties.

Universities, with their monopoly on granting degrees (both doctorates and habilitations, the certificates once required to prove one's aptitude for teaching and thus prerequisite to apply for professorial positions), are more or less attractive partners for research institutes. Which major factors led to this situation?

Establishing Universities: Expansion to Limits?

Examining the founding dates of universities in Germany shows the sporadic establishment of what would become universities from the late-1300s to the mid-1700s, with gradual, but steady increases thereafter. Over the 18th Century, thirteen universities were founded. Beginning in the early 19th Century, the formation of such organizations becomes routine. The first year to see four or more universities inaugurated was during the Weimar Republic, in 1925, during a phase in which tremendous efforts were expended to build capacity in science after defeat in WWI, especially through the *Notgemeinschaft der deutschen Wissenschaft*, which became the German Research Foundation (DFG) (Powell 2000). If WWII was won on the basis of scientific prowess, Germany's preeminence in this arena was shattered. Yet the immediate post-WWII period also witnessed the (re)establishment of three universities in 1945, and five each year during immediate rebuilding. Not until the 1960s, as the country experienced a dramatic demographic boom and the „economic miracle" (*Wirtschaftswunder*) were universities founded *en masse*. In 1962 alone, seven higher education institutions (HEIs) opened their doors, four in 1964. The early 1970s saw the most dramatic expansion in the numbers of HEIs, with five founded in 1970, 34 in 1971, and seven each in 1973 and 1974. Not until reunification in 1990 would this period be matched. Nearly as many HEIs were founded in Germany from 1991 to 2006 (96) as had been in the four decades prior to reunification. If the rate of establishing universities at least doubled each half-century from 1800, the most recent period was by far the most active, with an average of 6 universities founded per year (HRK 2013).

The durability of these HEIs and the quantitative increase over time demonstrate the importance and flexibility of this organizational form, which regardless of critical junctures and developmental cycles in history has (re)gained strength and flourished (Windolf 2007). Yet university qualities and characteristics have changed in continuous feedback with the development of science. A crucial shift was the move beyond the professions so central to early universities.

Transitioning to the Modern Research University: Beyond the Professions and Academies

The premodern university was dominated by the classic professions of theology, law, and medicine. These highest three faculties managed branches of knowledge granted highest prestige in society as they determined diverse associations of human beings with internal and external powers (Stichweh 2005): the relationships to God (theology), to other people (law) and to their own bodies (medicine). These dominant faculties served the political interests and authority of the sovereign, who sought to influence and control his subjects by directing these relationships. Opposite these was the lower faculty, of philosophy. This became the nucleus of the modern university in the 18th Century. As Kant famously argued, in contrast to the three upper faculties, the philosophical should not be subject to state regulation but governed by the laws of reason because it is solely responsible to the truth of the lessons it conveys (Kant 1984 [1798]: 24). This independence secured the rise of the philosophical faculty, deciding itself what should be taught and how.

The German university model derived from a few key reform institutions, such as Halle (1694) and Göttingen (1737), with strengthened philosophical faculties. These represented a new type of university in which norms relating to autonomy of research and teaching were first established. The disciplines of the philosophical faculty began to differentiate via systematic, methodologically controlled means of creating knowledge (vom Bruch 1999: 392). However, these developments did not occur solely within the university.

Academies also acted to create independent, self-referential scientific research and to differentiate scientific disciplines with their publications. In the 18th Century, academies were founded alongside universities; the largest in Berlin, Göttingen, München, Mannheim, and Erfurt. The presence of a university was of less consequence for establishing an academy than was the existence of a royal court. Academies focused on research and on gaining new knowledge instead of teaching or transmitting a canon of knowledge (Kiefer 2010; Vierhaus 1999). Influenced by experiences in Paris and London, Gottfried Wilhelm Leibniz founded Berlin's Academy (1700), which reflects the leading associations of the time, namely the Parisian *Académie des Sciences* and the Royal Society in London. The research conducted therein was experimental and experiential (Münte 2004).

Where both universities and academies operated, they collaborated closely via their overlapping memberships. The academies established institutes—chemical laboratories, collections, observatories, botanical gardens, anatomical theatres—that were also used by universities (Kiefer 2010). They were the first to periodically publish scientific findings; the world of scientific publications was born. While members of the university could access these publications, the relationship between the two forms of scientific organization ran deeper. Often, university professors were academy members as were a range of learned individuals active in *Gymnasien*, cloisters, and laboratories, or practicing physicians and even private individuals who conducted research. Membership, then as now, depends on criteria of reputation, won through scientific publications. The universities and academies had close relationships, complementing each other (Kiefer 2010). The logic of experimental science transferred from academy to university, not the converse.

The philosophical faculty's rise was a driving force behind the modern university's development, represented in Berlin's university (1810). Firstly, scientific research becomes crucial for the knowledge that is transmitted in universities, fundamentally based on the „principle of free research and teaching" (Paulsen [1902] 1966: 55). Its subjects are selected according to its own criteria—and findings thus evaluated. Science gains independence

by differentiating immanent developmental regulations (Weingart 1976). Simultaneously, scientific findings must be made public (published), generally accessible, and subject to universal critique and assessment. Efforts to establish specialized media follow. With such organs, professorial evaluation derived from scientific publications, a fundamentally new way of allocating and ascribing reputation (Daston 1999: 79ff.).

Closely related and increasingly over the 19th Century, the scientific disciplines differentiated. In this „modern system of scientific disciplines" (Stichweh 1984, 1993), the discipline represents a community of researchers sharing its internal perspectives and who orient themselves toward its puzzles and questions. These scientists participate in its communicative arenas, such as conferences and journals. The disciplinary structure and boundaries of the sciences then provide the framework for university courses of study. Academic teaching relies on the autonomy of science and the logic of its internal development. The tight coupling between research, teaching, and learning is given, whether in the daily praxis of laboratory sciences or the theoretical discussion in the humanities seminar. University members transmit that which they have constructed; no longer does knowledge require an external authority.

Thirdly, this shift also changed the professional fields of the „upper" faculty. Although the state has yet to completely relinquish its control over the education and the certification of lawyers, physicians, and teachers, its authority over contents has declined. The philosophical faculty assumed the task (in the 19th Century) of developing specialized teaching occupations. From the late 1700s onwards it became the occupational grounds for the higher teaching posts (Titze 1995: 8), resulting in the content-based specialization of teachers (see Mitterle/Stock 2021).

These shifts led to the dramatic rise in the importance and relevance of the philosophical faculty in relation to the classic professions. This faculty became the „bulwark supporting the entire scientific enterprise" of the modern university (Paulsen [1902] 1966: 528; authors' translation). The expanding philosophical faculty generated the cognitive basis upon which university-based education could develop. In its seminars and institutes,

the faculty brought up its own scientific offspring and teachers of higher secondary schooling whose education and training was in sync with that of learned scholars and scientists.

With these advances based on the unity of research and teaching, universities began to overshadow academies (Hohlfeld/Kocka/Walther 1999: 415ff.). A range of academy institutes, from botanic gardens and scientific laboratories to astronomical observatories, were integrated into universities, resulting in the loss of academies' research capacity. Perhaps more seriously, academies had few scientific personnel to rely on. Yet, they continued to function crucially in scientific communication, whether in publishing, consulting or peer review. They organized „commissions" of university professors, mainly in the humanities, to plan and carry out long-term „editions". By contrast, natural science research increasingly took place only in universities in Germany, with academies in England and France, however, maintaining laboratories (vom Brocke 2001: 369).

By around 1830, Germany's universities had advanced to the global model of scientific education, copied by reformers—and with students from around the world enrolling or visiting (Rüegg 1999: 30). Later, Flexner (1930) claimed that the United States first had a university with the 1876 founding of Johns Hopkins in Baltimore, following the model of Berlin's university. The influence of thousands educated at the doctoral level, in places like Göttingen, of those who would teach in American universities and spearhead its expansive development should not be underestimated (see Meyer 2017; Reisz 2018; Levine 2021 on this extensive transatlantic exchange and influence). Two organizational forms, in particular, were pillars of this attractiveness and enabled the combination of research and teaching. Alongside the traditional lecture, the research seminar provided room to discuss research-related topics as the laboratory did for practical exercises. These forms of praxis, closely related to research, depended on direct interaction between students and professors; scientific habitus derived from socialization in these organizational forms (Daston 1999: 76). Communication occurred within the new disciplinary unit of university organization—the building blocks of the faculties—variously

called „institutes“ or „seminars,“ the latter having a double meaning: the immediate interactional context of a teaching/learning event and a disciplinary and organizational unit within the philosophical faculty (vom Brocke 2001: 371ff). Originating under the umbrella of the philosophical faculty, the humanities and social sciences first differentiated themselves as „seminars,“ e.g., Germanic seminar, while the natural sciences mainly chose „institutes“. Institutes and seminars were the forms through which disciplinary differentiation progressed. The humanities—classical philologists in Halle and Göttingen—had inaugurated the research seminar form of interaction in teaching. Over time, the natural sciences and medicine followed suit. Seminars and institutes replaced the purely taxonomic and classificatory exercises of the „cabinets“ and „collections“ (*Kabinette und Sammlungen*). Instead of orientation to collected materials, the seminars and institutes were founded by individuals, primarily professorial chair-holders, but they achieved independence as structural units, facilitating institutionalization.

Primarily Prussia engaged in establishing numerous institutes and the buildings to house them. The conditions and equipment of the seminars and institutes became the site of competition between the German regions or states (after foundation of the Reich in 1871) to win professors with excellent scientific reputations. The decentralized political structures in Germany thus supported the development of science and especially the research universities, which were controlled by the state ministries of culture (Ben-David 1984: 108ff.).

The extraordinary growth of science in Germany during the 19th Century relied almost exclusively on what became the modern research university. Higher education grew principally in universities that combined research and teaching. This nexus exists on multiple institutional levels. Organizations combined research and teaching; there were neither universities that specialized only on teaching, nor those in which only research was conducted. These activities were unified in roles as well, as no professors only taught or were completely free to conduct research; even the chair holders (*Ordinarien)* fulfilled both research and teaching

obligations. And interactively, professors and students met in both teaching/learning and research settings, in seminars and laboratories; the nexus of research and teaching was part of every student's socialization.

Most students entering higher education in Germany have participated in this connectivity. In numbers of students, other forms in higher education (e.g., organizations training in technical fields) have served only a minority (Titze 1987: 23ff.). The university proportion of students was nearly four-fifths in 1870, around 70 percent in 1900, and over three-quarters by 1930 (Titze 1987: 23ff.; 31f.). Research universities largely constituted the higher education system, a unique German situation, especially compared to more differentiated French and American systems (Ben-David 1984). Higher education expansion in Germany occurred in research-intensive contexts.

Participation in higher education demonstrates the rise of humanities and natural sciences, which still belonged to the philosophical faculty, which absorbed a quarter of all students in Prussian universities in 1854; by 1880 the proportion had risen to nearly half (Titze 1990: 139), mainly due to teacher training. The guiding principle was „that no one can do justice to the occupation of teaching who cannot achieve independent scientific work and attain universal education" (Paulsen [1902] 1966: 543; authors' translation). This faculty represented the occupational training grounds for discipline-based teachers aiming to work in higher secondary schools and the vast majority of its graduates became *Gymnasium* teachers, remaining in the educational system (Mitterle/Stock 2021). The philosophical faculty, by sending its graduates to work in the *Gymnasien*, systematically ensured that adolescents would be so educated and introduced to science—prepared to enter research universities. Only graduates of *Gymnasien* were eligible to begin university studies. This cross-referencing of organizational forms, in curricular terms, led to the systemic growth of German education overall, fueling the „self-development" (*Eigenausbau)* of the educational system's upper levels (Titze 1990, 1995; Müller-Benedict 2002, 2006). An educational elite developed, as teacher training expanded and the resultant demand for education in *Gymnasien* and universities stabilized and strengthened each other. Titze (1995: 29) notes that modern educational

aspirations diffused broadly, such that access to upper secondary schools and universities could no longer be limited, much less reduced, by administrative fiat. Politicians' responses to this self-reinforcing dynamic of modern educational and social status aspirations were limited to expanding existing forms while pragmatically attempting to channel pupil and student streams.

By 1900, the expansion caused by feedback loops between research universities and *Gymnasien* tested the limits of the nexus principle. „One of the major failures of Germany's scientific organization," leading bureaucrats in Prussia's Ministry of Education and Culture declared in 1906, is that „the *Ordinarien* are so busy with lectures, exams, and managing institutes that they have no time left for scientific work" (cited in vom Brocke 2001: 388; authors' translation). Expansion and increased teaching demands weakened the close teacher-student relationship. According to Prussian statistics, in the experimental natural sciences „from 1871 to 1911/12 the number of students rose dramatically by 638% in comparison to an increase in chair-holding professors of only 56%, of non-chair-holders by 133% and of *Habilitation*-holding *Privatdozenten* by 250%" (vom Brocke 2001: 389). The result was a dramatic rise in student-faculty ratios.

Simultaneously, expectations for publishing research results in established scientific journals rose. From 1880, the number of scientific periodicals jumped, especially in Germany (Daston 1999: 72ff.). Under the heading of scientific universalism, publication activities spread worldwide. Scientific performance became a new means for leading nation-states to compete. This international competition was animated by major research institutes, such as the *Institut Pasteur* in Paris (1888) or the *Carnegie Institution of Washington for Fundamental and Scientific Research* (1902) (vom Brocke 2001: 391). Such successful independent institutes threatened the leading position of German research universities, whose leaders feared that they could no longer compete. Organizational problems emerged, like the principle of naming chair-holders, who monopolized status, funds, and decision-making power. This *Ordinarienprinzip* was focused on individual

personalities, not on distributing authority or research tools to all who might profit. Institutes and seminars, controlled by chair-holders, also managed dependent researchers within strict hierarchies (Klüwer 1983: 83). This weakness would be exacerbated by growing rivalry with research institutes.

Founding Research Institutes—Independent of the Universities

At the beginning of the 20th Century, Germany experienced a remarkable alliance between representatives of science, of research-intensive industries, and ministerial bureaucrats of states, engaged in founding large research institutes—independent of universities. Private philanthropy of upper classes enabled the establishment of new research institutes. A whole new era began with the founding of *Kaiser-Wilhelm-Gesellschaft zur Förderung der Wissenschaft e.V.* (KWG) 1911 in Berlin. Continuing today as the Max Planck Society for the Advancement of Science (MPG)—Germany's leading umbrella organization for fundamental research—the KWG organized major research programs, especially in the natural sciences, outside the universities. Today, more than 80 Max Planck Institutes—across the sciences and throughout Germany—maintain Germany's position as a leading science nation.

The large research institutes threatened the universities' research monopoly. Despite the denouement of WWI, universities maintained their international rank. In fact, between war's end and Hitler's rise, 200 new natural science institutes were created, with 37 in universities, 98 in technical universities, 40 in federal and state institutions, and 21 KWG institutes (vom Brocke 1999: 398, 1996: 633ff.). Simultaneously, higher education developed new organizational forms to serve skill formation goals, including preparation for occupations in trade, industrial production, and technology. Gone was the nearly exclusive focus on producing civil servants of various stripes. If, during the transition to the modern

university, the state had lost its power to define knowledge to be taught and had failed to limit access to costly university studies after 1890, it refused to relinquish complete control. The state maintained authority over university administrations and regulated courses of study, examinations, and certificates, connecting these to civil service career ladders.

Universities continued to produce civil servants, yet the freedom of research and teaching had been introduced and constitutionally guaranteed in Prussia from the middle of the 19th Century, bolstering the scientific mandate. The connection between universities and the state may have resulted in the university's hesitance to educate for private occupational positions. While the university's partnership with the world of civil servants was solidified, areas beyond those of academic knowledge had little relevance. University professors represented a vision of science reflecting the principle that the aim of both research and teaching was inherent, needing no further justification. The consensus saw education (*Bildung*) as a process of self-awareness and self-actualization through the medium of science, revolving around knowledge for its own sake, not vocational preparation (Horlacher 2016). These educational principles, based on neo-humanist thought, were not solely the province of the philosophical faculty's humanities scholars, but also assumed by natural scientists. Applied disciplines beyond the classic professions of medicine, theology, and law were rejected.

In spite of these barriers, the time was ripe for technical and commercial training to be scientized, presaged by the foundings of technical universities in the early 19th Century. If their certificates were originally accorded less status than those of universities, the introduction of the diploma in Engineering (*Diplom-Ingenieur*) helped close the gap. Diverse higher education institutions, focused on technical knowledge, conferred degrees thought equal. The possibility to accept and evaluate dissertations provided academic offspring who could carry disciplinary traditions forward. Especially in the early 1920s, technical universities expanded quickly and engineering courses of study attained a considerable proportion of the overall student body: around one-fifth, declining to 15% by WWII (Titze 1987: 26 ff.).

Both engineering and, later, business, expanded. These vocational fields were not among the free professions or the classic civil service, established and connected to state administrations and schools. Scientifically qualified personnel began to capture increasing numbers of positions in industrial firms. The Census of 1939 manifests that four-fifths of engineers was employed by industry; only one-fifth as civil servants or self-employed (Sander 2008: 233). The tight coupling between higher education and civil service positions began to weaken due to expanding industrial labor markets from the 1850s, for chemists, for example (Lundgreen 1999: 325).

This trend of spreading academization was stopped by the National Socialist party. Dramatic consequences were visible at every level of academia and in Germany's universities—years before the outbreak of war. „Between the Winter semesters of 1931/32 and 1938/39, more than 3000 scientists—around 40% of all scientists in German higher education!—were forced to leave their positions, due to their Jewish heritage and/or because of their political views; many emigrated" (Köhler/Naumann 1994: 652). Germany lost its preeminence in research. The number of student also fell dramatically, from 138,000 to 57,000 in this period (Köhler/Naumann 1994: 652).

Universities Lose their Research Monopoly, but Continue to Connect Research and Teaching

After the transition to the modern research university, the disciplines in the philosophical faculty had gained ground vis-à-vis the classic professions as the educational system's dynamic, self-reinforcing expansion resulted from the rise of discipline-specific teacher training. After WWII, the traditional distinction between general lower schools, and scientific higher schools were no longer convincing, as even *Hauptschule* teacherswere supposed to teach science-based disciplinary curricula, not traditional folkways. The corresponding development in higher education was realized in the 1960s, as secondary school teachers began to be trained less by

master teacher-trainers than they participated in science-based education within HEIs. In 1967, teacher colleges advanced their status with the right to award doctorates (Lundgreen 2008: 68). From 1980, most were integrated into universities. Now, teachers in all forms benefited from university-based education. A large proportion of students originally belonging to the disciplines of the philosophical faculty now studied in teacher education programs. For example, to attain certification in math or German elementary schooling teaching now required explicit specialist university training in math or German.

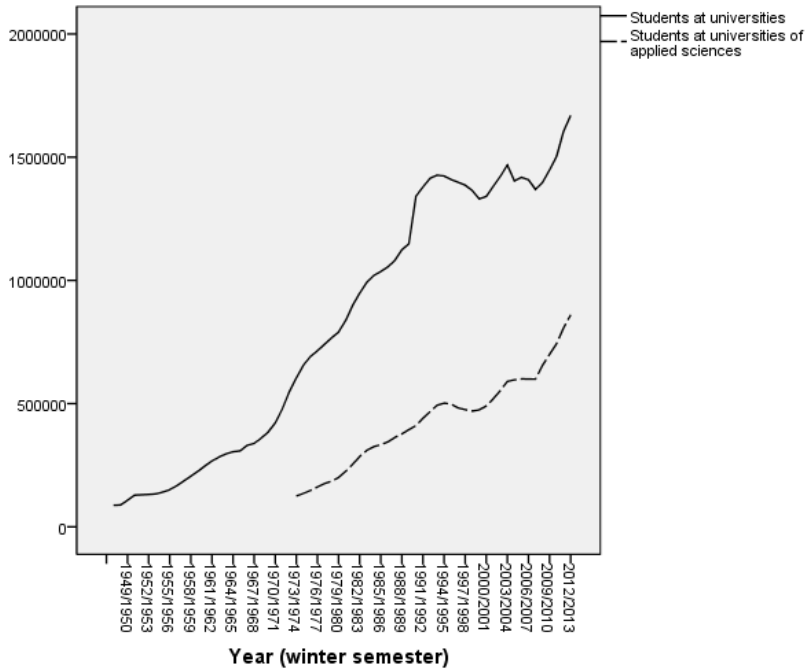
Universities expanded in the 1960s and 1970s mainly due to the educational system's self-reinforcing dynamics (Lundgreen 2003), especially due to teacher education and training, as the academization of the teaching profession raised the bar another notch. Other courses of study grew substantially as well, especially newer courses with either technological or client-oriented application (Reisz/Stock 2011).

Today's research universities in Germany are public, except one. Despite recent increases in the private sector (Stock/Reisz 2008), few question the state's central role in providing higher education (Pritchard 2004). Further, education as a civil right is constitutionally protected (Oehler 1989: 37). The state may not allow „unreasonably high" barriers to access higher education (Thieme 2004: 587). Although formal legal barriers to access higher education no longer exist, social barriers continue and in some fields certain grade point averages are required. The proportion of eligible individuals has continuously risen, especially since the 1960s due to the *Gymnasium*'s dramatic expansion.

To match this rising demand, a new organizational form, parallel to universities, was established: *Fachhochschulen*—called universities of applied science—in 1971. Originally developed from vocational schools, their courses of study have attained higher levels, with some equaling the ambition of universities. However, these HEIs mainly offer programs that are technical in nature or that are client-oriented and applied. Neither independent research nor the concept of the unity of research and teaching (at the levels of roles or of curricula) have been central to their mission.

Instead, the canon of existing applicable, practical knowledge (*Fachwissen*) is to be transmitted (Stock 2005).

Figure 1: Students enrolled in universities and universities of applied science, 1950–2013



Top line: Students enrolled in universities and equivalents (e.g., *Gesamthochschulen*) and art colleges.
Bottom line: students enrolled in universities of applied sciences (*FH*) and colleges of administration.
Source: Statistisches Bundesamt, Fachserie 11 Reihe 4.1 (zusammenfassende Übersichten), Sonderauswertung des BMBF, siehe: www.datenportal.bmbf.de/portal/K25.gus?rid=T2.5.20#T2.5.20, 18.10.2013, authors' calculations and representation.

At first, *Fachhochschulen* (FHs) conducted little research, with projects mainly applied (Webler 2008), yet in the meantime, these FHs have emulated research universities (Teichler 2005: 169; Lenhardt 2005). Leading this development were those FHs devoted to social work and social services (Maier 1999). Germany's Constitutional Court clearly

decided that professors at FHs can refer to the principle of freedom of science in the Basic Law (Az.: 1BvR 216/07). While most *Länder* continue to demand very heavy teaching responsibilities, some have reduced teaching loads to approximate university faculty. Some *Bundesländer* are debating whether to confer doctoral-degree granting rights, the Gordian knot; the production of scientific „offspring" could commence. These trends indicate the FHs aspirations and the assumption of the unity of the guiding principle of research and teaching—contrary to its origins in vocational schools. Despite considerable investments in *Fachhochschulen*, the research universities' hegemony in science continues. However, their position is threated by sheer numbers—of students.

Universities' faculty and staff developments have not kept pace with massive student expansion since the „decision to open up" (*Öffnungsbeschluss*) of the *Länder* minister-presidents in 1977 (Enders 2010), which actually represents a non-decision of stagnation (Naumann 1990: 383). Teaching loads, legally mandated, rose accordingly over the years. The faculty-student ratios worsened, especially in the social sciences and humanities (Lundgreen 2009: 52ff.). This development continued in the former FRG until 1989. After reunification, Eastern Germany's higher education system expanded and improved, albeit with large disparities by field of study. Stagnation resumed from 2000 (Pritchard 2004; Lundgreen 2009: 52ff.), dramatically deteriorating from 2007 (Bloch/Lathan 2012). Currently, the entire system has reached the breaking point, with the „universities permanently overloaded" (Enders 2010: 447), leading to an „institutional crisis" of the German research university (Baker/Lenhardt 2008).

Were these debts paid for with reduced research capacity? Because research and teaching budgets are one-and-the-same, pressures due to teaching demands displaced research from the mid-1970s (Schimank 1995: 96); even more since reunification. Lost capacity occurred on multiple levels. Each scientist has had less time to conduct research due to the teaching burden. As docents try to manage the situation, in each seminar, less creativity and individual support are possible. Especially given the Bologna-inspired three-year Bachelor's courses of study, the

standard program—of transmitting the canon in vocational preparation—has replaced intensive research-based teaching and independent study.

Thus, since the mid-1990s, attempts to further differentiate and indeed to stratify higher education are visible. Most clearly, the publically-funded „Excellence Initiative" relied on competitive grant-making for research funds. The vision of „making the peaks higher" within the universities counters the ideal that most of Germany's universities contribute to global scientific progress, despite not being ranked in the Top 20. Importantly for the structural challenge of the duality of higher education and extra-university research institutes, the initiative called for „strategic partnerships" to bridge these sectors (Huber/Mlynek 2012), yet the successes of such meso-level programs remains limited while the proportion of co-authored papers across the research university/research institute divide has been steadily increasing in an age of collaborative research (Dusdal et al. 2020).

Another major contemporary development is the introduction of BA and MA courses of study to replace the scientifically oriented, previously offered *Magister* and *Diplom* degrees. The reform's architects hoped to shorten the time-to-degree, and secondarily, reduce the dropout rates, by offering shorter-duration programs. The majority of students, policymakers reasoned, would leave the university after attaining one vocationally-oriented degree. The *Länder* Culture Ministers (KMK) reached minimal consensus that „the entry requirements for an MA-level course of study must be a vocationally-qualifying higher education degree" (KMK 2007: 5). Furthermore, because of the performance expectations, studying at the MA level should be subject to further entrance requirements. Nevertheless, constraints on access to MA-level studies are difficult to maintain if students wish to pursue them (Winter 2009).

If higher education policy in Germany today accepts that every citizen has a right to education, entitlement has eroded for decades via such mechanisms as set transition rates between levels or through caps on the number of entering students. Decades of underfinancing has placed university-based research at risk of losing in conditions of heightened intra- and international competition.

The Current State of Research

The duality of research structures in Germany was maintained after WWII. The *Kaiser-Wilhelm-Gesellschaft* morphed into the Max Planck Society (MPG) and further umbrella organizations collected dozens of research institutes of various disciplinary foci and size. These associations together invest nearly the same amount in research as does the entire higher education system (Bundesbericht 2012: 39). The extra-university research sector is considerably determined by federal *inter*dependence, as both the Federal and *Länder* governments jointly (to differing degrees) provide the funds for these institutes throughout Germany. Given the assumed benefits in terms of direct investment scientific capacity-building and innovation, governments support and attract such organizations (Hohn 2010).

Comparing R&D expenditures for 2009 by source and sector shows the dominance of industrial outlays (€43bn of a total €67bn), but also the significance of public investments in science as well as the assorted extra-university umbrella research organizations, representing the spectrum from applied to basic research: the HEIs (€11.8bn), Helmholtz Association of German Research Centers (HGF) (€3.1bn), Fraunhofer Society (FhG) (€1.6bn), Max Planck Society (MPG) (€1.5bn), Academies (€1.1bn), Wilhelm Gottfried Leibniz Association (WGL) (€1.1bn), federal institutions with R&D portfolios (€0.9bn), scientific libraries, archives and museums not in the WGL (€0.4bn), and public institutions (€0.3bn), among others (Hohn 2010). While the human and financial resources of the state-financed extra-university research organizations have grown faster than those devoted to the universities (Schimank 1995: 78f), the HEIs continue to expend considerable resources for R&D—and remain absolutely central as a collaboration platform for all research-producing organizational forms in Germany (Dusdal et al. 2020).

Despite the years of „Excellence Initiative“ funding, the hierarchy between the two sectors increasingly strains support for high-quality teaching and mentoring within universities. Simultaneously, notable attempts to build bridges between these sectors for their mutual benefit

increase. Cooperative agreements and programs provide students with research opportunities and researchers with opportunities to teach. For example, collaborative research centers (*Sonderforschungsbereiche*) are funded by the German Research Foundation to link universities and research institutes. Not a few extra-university research institutes (113) participated in collaborative projects (GWK 2008: 7). Yet such short-term projects maintain this initiative's stratificatory logic, even if some collaborations have been established that seem likely to survive long-term (see Hohn 2010: 472ff.). For Germany, such cross-sector cooperation is a recent situation. Pathbreaking hybrid types of research (and teaching) organizations have been created, such as the Karlsruhe Institute of Technology (KIT), an amalgam of the *Forschungszentrum Karlsruhe* and the University of Karlsruhe, yet such hybrids emphasize the time needed to engineer a joint organizational cuture (Pruisken 2014). The extent to which these new forms and their linkages will successfully decrease sectoral stratification remains to be seen (Schmachtenberg 2012: 77ff.; Dusdal et al. 2020). Universities that have working alliances with well-funded extra-university research institutes can concentrate on research and research-oriented teaching, while others must emphasize teaching the mass of students currently flooding their gates. Future research must examine comparatively the outputs of these sectors, especially as higher education participation rates rapidly rise and funding for R&D continues to increase, benefitting institutes far more than universities as they seek ever-more competitive third-party funding (see Baker/Powell forthcoming).

The foundational principle of the nexus of research and teaching continues to have mythic appeal— around the world. Yet in its birth country, policymakers have neither been willing to invest sufficiently to adequately fund, nor to institutionally restructure, the higher education and science systems to maintain universities' full research capacity. Both are necessary to achieve the idealized unity of research and teaching in the context of mass higher education—if Germany is to (re)gain the scientific eminence that its research universities originally provided.

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