

**FROM STREETS TO SUITES:  
THE IMPACT OF THE GERMAN ANTI-BIOTECH  
MOVEMENT ON GERMAN PHARMACEUTICAL FIRMS**

Klaus Weber  
Kellogg School of Management  
Northwestern University  
2001 Sheridan Rd  
Evanston, IL 60208-2001  
847 491 2201  
[klausweber@kellogg.northwestern.edu](mailto:klausweber@kellogg.northwestern.edu)

LG Thomas  
Robert Goizueta School of Business  
1300 Clifton Road  
Atlanta, GA 30322  
[LG\\_Thomas@bus.emory.edu](mailto:LG_Thomas@bus.emory.edu)

Hayagreeva Rao  
Stanford Graduate School of Business  
518 Memorial Way  
Stanford, CA 94305  
[hrao@stanford.edu](mailto:hrao@stanford.edu)

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## **ABSTRACT**

Social movement scholars have consistently lamented the relative inattention to the study of movement consequences, particular to understanding the cultural effects of movements. We examine how social movements may shape material culture by affecting the fates of new technologies. In particular, we focus on how organizations, which play a crucial role in commercializing and distributing new technologies, are influenced by movement activism opposed to a technology. The context is anti-biotechnology activism in Germany during the 1980s and 1990s and its effect on the ability of German pharmaceutical firms to commercialize this technology. Using detailed analyses of six German companies as an “extreme case” for building understanding of processes and mechanisms, we find that variable movement pressure interacted with internal organizational processes and structures. Rather than simply acting as an external force, the movement was able to penetrate core organizational structures and processes.

Although social movements manifestly emerge to produce political and cultural change, sociologists consistently have lamented the disproportionate emphasis on movement origins and the relative inattention to the study of movement consequences (Giugni 1998; McAdam, McCarthy, and Zald 1988; Tarrow 1994). Within the existing literature on movement impact the focus has been on changes in laws and regulations (Burstein 1999) which are administered through the state apparatus and apply to all members of a polity. By contrast, research has “given short shrift to understanding the cultural effects of movements” (Bernstein 2003: 354; Melucci 1996), such as how social movements reshape material culture by affecting the fates of technologies. A number of social movements have arisen explicitly to oppose technologies from nuclear power to the steam engine. Yet we know little about how the proponents and opponents of a technology compete to frame the meaning of new technologies (Dowell, Swaminathan, and Wade 2002) or how organizations, which play a crucial role in commercializing and distributing new technologies, are influenced by movement activism (Hargrave and Van de Ven 2005). The emerging synthesis of social movement theory and organization theory (see, e.g., Davis, McAdam, Scott, and Zald 2005) would be the natural starting point for this endeavor, but it, too, has yet to account for how social movements shape material culture via the fates of technologies.

The dearth of research on whether and when movements opposing a technology succeed reflects a lack of understanding of how movement demands actually penetrate organizations as opposed to state actors (McAdam and Scott 2005; Zald, Morrill, and Rao 2005; Clemens and Cook, 2004). Organizational theorists use the imagery of “force” and “pressure” to refer to social movements. But we know little about how concrete social movements generate such forces, and how the more or less abstract demands that are being forced are translated into organizational choices and practices. To do so, we need to understand and elaborate the role of the internal polity of organizations in inhibiting or facilitating the effectiveness of movement demands. In short, a

pressing area for research is how collective action in the street makes its way to and is acted upon by executives in the corporate suite.

If movements opposed to the commercialization of technologies have received little attention from social movement scholars, they have been virtually ignored by students of strategy and organization. For the most part, students of strategy and organization have focused on the internal constraints to technology commercialization – whether senior executives realize the opportunity inherent in a technology (Burgelman 1994; Tripsas and Gavetti 2000), the heuristic logics of top managers that connect a technology with economic value (Chesbrough and Rosenblom 2002), the existence of search routines (Winter 2003), and insight and execution competences (Teece, Pisano, and Shuen 1997). As some researchers have analyzed non-market strategies, they have paid attention to how firms collaborate to influence laws and regulations (Barron, 2004; Brady, 2004) but given short shrift to the how social constraints that are neither laws nor regulations impinge on a firm's ability to develop and exploit new knowledge and competences. Such more proximate constraints may take the shape of financial analysts who monitor the coherence of the firm (Zuckerman, 1999), or, in our case, of social movements opposing the commercialization of a technology by a firm or by an industry.

We investigate how a social movement opposed to genetic technology in Germany in the 1980s affected the ability of German pharmaceutical firms to commercialize biotechnology. We focus on Germany as an “extreme case” (Eisenhardt 1989) to develop an understanding of how social movements may penetrate firms and affect their ability to commercialize a new technology. The fate of German pharmaceutical firms' biotechnology efforts presents a fascinating puzzle in four regards. First, German firms did not significantly differ from comparable American counterparts in the number of patents they obtained or number of alliances initiated; however, they introduced fewer biotechnology products and were commercially less successful with this

technology. If those firms put forth the effort, had knowledge, capabilities and connections, then why were they unable to exploit them? Secondly, the German pharmaceutical industry had a formidable track record of collective action – so even if a movement opposed to biotechnology targeted them, the interesting question is how did quite powerful firms apparently succumb to this pressure? The German anti-biotech movement was a relatively narrow and short-lived movement relying on a small group of core activists and a larger coalition of sympathizers. Lastly, it appears that German pharmaceutical firms' success with the technology and their vulnerability to movement influence varied significantly. It is therefore difficult to argue that the movement affected them uniformly as for example laws would. What caused those variations in movement impact on the commercialization of biotechnology by German pharmaceutical firms?

We suggest that the answer to this puzzle lies in how the strength of the anti-bio technology movement interacted with the internal polity and processes of the pharmaceutical firms such that such that regulatory uncertainty made investments riskier, and the portrait of biotechnology by movement activists jeopardized the legitimacy and identity of pharmaceutical firms and the scientists working in them. The strength of the anti-bio technology movement derived from the framing efforts of activists, the tactics and networks of mobilization, and the political opportunity they enjoyed because of access to allies such as the Green party. The internal polity of the firm was shaped by the composition of the executive boards and the identities of scientists themselves.

Movement activists gained an advantage by framing biotechnology as against nature, of incalculable risk and redolent of approaches to public health under the Nazi regime. As a result, core activists were able to emotionalize the technology and cultivate a following among school-teachers and private citizens, who preached the dangers of biotechnology to the children and neighbors of scientists working in German pharmaceutical firms. Such a portrait of biotechnology undercut the legitimacy of pharmaceutical firms as being safe and responsible and also undermined the identity of

scientists as individuals working to harness science for the benefit of humanity. Variation in movement impact arose as anti-biotechnology activists had greater influence wherever their mobilizing networks were extensive and the political opportunity structure was favorable. Activists had access to the state apparatus through the parliamentary representation of the Green party in some states but not in others. Where they had access to allies in parliament or government, anti-biotechnology activists were able to increase the regulative uncertainty for pharmaceutical firms, which affected the expected payback period and financial attractiveness of technology investments. Radical activists in the anti-biotechnology movement also resorted to unconventional tactics (such as embarrassing senior executives in the annual general meeting of the shareholders) which were unfamiliar to the executives of large, publicly owned German firms and thus impeded their ability to effectively respond. Internal organizational factors contributed to the varied long-term effect of the movement: Some of the firms were publicly traded and had large chemical divisions. Their executive committees were dominated by chemical engineers and financially trained executives who did neither fully understand nor were strongly committed to biotechnology and therefore, were reluctant to choose ventures with legal uncertainty, long payback periods and the risk of public censure. And the internal structure of larger firms impeded the effective exploitation of the technology when activities were initially located abroad to circumvent the domestic movement.

Our paper is organized as follows. We begin by establishing quantitatively that on the aggregate German pharmaceutical firms were similar to American counterparts in the number of biotechnology patents obtained and the number of alliances entered, but had lower numbers of biotechnology products and sales. We also show significant variance in these outcomes among the leading German firms. We then turn to a discussion of how the movement's activities interacted with the internal polity of German pharmaceutical firms to produce those puzzling patterns. In this process, specifically focus the mechanisms that created aggregate and firm-level outcomes.

To illuminate the processes behind the pattern emerging from our quantitative analyses, we used a comparative design wherein we initially selected and then tracked in detail two types of firms – those which found a way to successfully enter biotechnology and others which did not. Companies included in the first category Boehringer Mannheim (BM), Schering AG and Boehringer-Ingelheim (BI), and the second category Bayer, Hoechst (now part of Sanofi-Aventis) and BASF (which bundled its pharmaceutical activities in its Knoll subsidiary). This set of companies accounts for about 80% of the research-intensive pharmaceutical industry in Germany at the time. In addition, we obtained more selective information of smaller companies, such as Grünenthal , Rentschler, Merck KG and Altana, to verify overall patterns and working hypotheses.

We analyzed archival data, such as press and company documents, TV coverage of debates and documentaries, publications by industry associations, activist groups and parties, and government reports. In addition, we interviewed 18 (so far) executives, scientists, movement activists, industry lobbyists and political decision-makers that were active at the time. We used these interviews both to complete and validate the depictions and interpretations given by archival sources, and to understand the processes through the personal experiences of these informants. As an interim step, we then created detailed case histories for the main company cases from these data. We also extracted themes from interviews and archival records to gain a sense of central events, prominent framings and recurrent processes. We are in the process of validating the analytic narrative that emerged from this process through follow-up questions to interview partners and additional archival data.

### **THE PUZZLE: VARIATIONS IN BIOTECHNOLOGY CAPABILITIES AND COMMERCIALIZATION**

We begin by asking whether German pharmaceutical firms significantly differed from their American counterparts in terms of efforts and outcomes, i.e., the number of their patents and alliances, and the number of biotechnology products that generated revenue. We are also interested

in knowing whether there were variations among the German pharmaceutical firms themselves.

To examine whether German firms attempted to enter into biotechnology in the first place, we examined their patenting and alliance behavior in this area. Table 1 displays the results from fixed effects regression models of biotechnology related patents and alliances<sup>1</sup>. Figure 1 plots the temporal dispersion of patents and alliances by firm against a baseline of the 14 major U.S. pharmaceutical firms. Figure 1 also maps the introduction of biotechnology products that were developed either in-house or through licensing agreement on the same timeline. Developing products to the point of approval for marketing is a key step in the commercial exploitation of the technology.

Insert Table 1 and Figure 1 Here

Table 1 and figure 1 show that German pharmaceutical firms did not *collectively* differ from American firms in their patent and alliance behavior. Rather, some *individual* firms were ahead of U.S. pharmaceutical companies, while others' patenting and alliance behavior was at par or lagging comparable firms in the USA. In particular, Hoechst, Bayer and Boehringer Mannheim did more strongly try to develop expertise than both their German and American counterparts as measured by their patents, especially in the early years. None of the German firms differed significantly from the U.S. baseline in its alliance formation once size is controlled in the form of revenue.

However, panel C in figure 1 suggests that these efforts paid off for Boehringer Mannheim<sup>2</sup>, but did not translate into advantages in terms of licensed products for Hoechst and Bayer, especially in the 1990s. By contrast, BASF/Knoll, Boehringer Ingelheim (BI) and Schering had lower-than expected numbers biotechnology patents, but BI and Schering were successful in terms of own and licensed products. Thus, some German firms had the desire, knowledge and connections but could

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<sup>1</sup> We treat these analyses as suggestive rather than definitive and complete. The main focus of the paper is to account for the patterns that can be detected by these analyses. While table 1 reports regressions, using zero-inflated negative binomial regressions with robust standard errors yields substantively equivalent results. Ideally, we will be able to also obtain sales data for each product as a measure of true commercial success. However, this is not readily available for earlier years.

<sup>2</sup> Boehringer Mannheim focused primarily on diagnostics, while data shown in figure 1 only presents therapeutic products.

not develop these resources into products, while others fared better with less effort expended.

It is particularly intriguing to examine at the temporal pattern of product launches. Hoechst and Bayer were early movers with recombinant insulin (although Bayer never sold much), but could not convert that early advantage and their considerable knowledge base into a stream of new products in the 1990s. This is even more vexing as both developed early R&D structures in the United States. Hoechst started a high profile cooperation with the Massachusetts General Hospital in 1981, which included the training of Hoechst's R&D scientists there. At Bayer, molecular genetics started to be taken seriously around 1982/83 with an alliance with Genentech in the area of hematology (blood clotting, recombinant factor VIII) and the beginning of its North American research center in New Haven. Boehringer Mannheim and Boehringer Ingelheim were similarly early movers but were able to maintain a relatively consistent stream of new products. Schering was a late entrant and, together with BI and BM, was the only German pharmaceutical company to discover and develop own biotechnology products. BASF struggled with both patents and products. It is also the company with the smallest pharmaceutical business unit of the six. The question is why did Hoechst and Bayer begin to lag the others despite their capabilities and connections? And why were the two Boehringer companies and Schering seemingly able to be more effective in their commercialization efforts?

#### **THE GERMAN BIO-TECH INDUSTRY; AN OVERVIEW**

Although Watson and Crick described the structure of DNA as early as 1952, it took about 25 years until their basic discovery started to impact the diagnosis and treatment of illnesses. Biological processes, such as fermentation, had been used by pharmaceutical companies for a while; however, the possibility of manipulating and recombining gene sequences in organisms, or “recombinant DNA technology”, had profound implications, and over time shifted the scientific paradigm of the industry from organic chemistry to molecular biology (Henderson, Orsenigo, and

Pisano 1999). Recombinant biotechnology offered new methods for diagnosis, drug discovery and production, but required the reconfiguration of organizational routines as well as access to new forms of knowledge for pharmaceutical companies (Powell, Koput, and Smith-Doerr 1996). It should be noted that scientists were initially quite aware of potential dangers of genetic engineering. In 1975, a group of prominent U.S. researchers organized a conference in Asilomar, CA, on how to deal with the opportunities of genetic manipulation and for a short while called for a moratorium on genetic research until hazards could be evaluated. However, these debates remained largely within the scientific community and did not enter public awareness until the technology started to be adopted for industrial purposes by business organizations.

By the late 1970s, a number of specialized companies in the U.S.A. and some large pharmaceutical companies worldwide moved towards commercial applications of recombinant DNA technology. The initial focus was on the production of known therapeutic substances through biotechnological procedures. For example, instead of extracting insulin from pig's pancreases and blood clotting proteins from donor blood, both could be extracted more efficiently from recombinant cell cultures. Such recombinant versions of known therapeutics began to be launched in the early 1980s, as were initial applications in diagnostics. The second wave of applications of recombinant technologies was the discovery of novel therapeutic and diagnostic substances. Erythropoietin (EPO), a hormone that stimulates the growth of red blood cells, was the first novel and commercially viable "biotechnology" drug. EPO was first approved for marketing in 1989. The third wave of the biotechnological revolution, taking hold in the mid to late 1990s, led to the integration of genetics-based knowledge and platform technologies into basic research and development processes, e.g. in the form of target screening or stem cell research.

In Germany, these efforts by pharmaceutical companies collided in the mid 1980s with a surging opposition to recombinant technologies that were fuelled by the environmentalist

movement and championed by the Green party. Although genetics had not originally been central to the emerging Green movement, it became a salient issue when pharmaceutical companies started moving into large-scale biotechnological production processes in the mid 1980s, and a useful issue for the party to demonstrate its environmental position beyond issues such as nuclear energy and pollution. The Green party had emerged from a set of loose local election coalitions among leftist and environmental movement groups in the late 1970s and maintained a strong grass-roots structure and culture during the 1980s. A national Green party was formed in 1980 and it gained representation in the national parliament for the first time in 1983. In addition to environmentalists, church groups objected to the manipulation of life, a stance that had been sharpened in the debate over abortion during the mid and late 1970s. Feminist groups were also prominent in this coalition and among the most radical and violent voices. A group close to the terrorist Red Army Faction, “Rote Zora” carried out a series of nine arson attacks on genetic research institutes and companies between 1984 and 1989.

Activism in the biomedical domain was greatest during a short period between 1984 and 1991. Opposition to medical biotechnology faded after the passage of a federal law in 1990 that regulated facilities in which biotechnological processes were used. A watershed in public sentiment occurred with a 1992 revision of this law, which was supported by a broad parliamentary majority and eased overly restrictive provisions. The mid 1990s even witnessed a small boom of biotech start-ups in Germany. Opposition against genetically modified food in more recent years did not affect the acceptance of biotechnology in medical applications. Issues such as stem cell research and the creation of transgenic animals remain controversial and tightly restricted.

As is apparent from this historical sketch, the move of biotechnology from universities into commercial organizations was critical both for the further development of the technology and for the opposition of movement activists. It is therefore critical to examine the fate of pharmaceutical

companies as key players in these processes. By the late 1990s, some German firms had arguably fallen behind in utilizing the new technology while others were more successful in moving forward. We focus on this initial period from 1980 to the mid 1990s to understand how the movement affected this new technology via its effects on pivotal organizations. Appendix 1 provides a detailed time line of key events for each company.

## **THE GERMAN ANTI-BIOTECH MOVEMENT AND ITS IMPACT**

Social movements may be defined as organized collective endeavors to solve social problems. The consensus in the social movement literature is that the ability of institutional entrepreneurs and activists to bring about change depends upon framing processes, political opportunities and mobilizing structures (McAdam, McCarthy, and Zald 1996). We discuss each in turn and show how each element accounts for an essential part the process that lead to the outcomes described above.

### **Framing Processes**

The anti-biotechnology movement was driven by a small band of radical activists – our informants agreed that there were no more than 100 real activists in total even at the heyday of the movement. This band of core activists was diverse – some were solely dedicated to the campaign against biotechnology, others had joined from the peace movement dedicated to preventing the deployment of nuclear warheads in Europe, from the women’s movement, or from the anti-nuclear energy movement. For example, Ulrike Riedel had been active in nuclear energy protests and became the ministerial secretary of Joschka Fischer who came from a socialist background and became Minister for the Environment in the state of Hesse from 1985-87. Regine Kollek was a biologist at the *Ökoinstitut Freiburg* who had studied in the US, Jens Katzek was active in BUND (a moderate environmental organization in Germany), but there were also more ideological groups

from the *GENEthische Netzwerk* and a few militants with ties to Feminist and Anarchist groups. How could such a small and initially peripheral group of radicals have such an impact?

Institutional entrepreneurs can mobilize legitimacy, resources, and personnel only when they are able to frame the grievances and interests of aggrieved constituencies, diagnose causes, assign blame, provide solutions, and enable collective attribution processes to operate (Snow and Benford 1992:150). Strong enemies are psychologically salient targets of negative attention that enable activists to dramatize a system's inherent contradictions and vulnerabilities (Gamson and Meyer 1996; McAdam 1994) and to articulate an insurgent identity in opposition to the dominant identity (Bernstein 1997).

Recent cultural theory has emphasized the role of cultural or semiotic codes in the regulation of social action and their relevance to framing. Semiotic codes are collectively known systems of meaning that define what our actions will mean to others (Swidler 2001: 179). Codes relate signs to each other and often take the form of binary oppositions that contain a value dimension of moral good and bad (Barthes 1967[1964]; Levi-Strauss 1974). In doing so, they provide the underlying dimensions along which specific events can be “de-coded”, i.e., understood, interpreted and evaluated. Such codes have special status as a form of culture as they regulate behavior without the need for acceptance or internalization. Indeed, the key to semiotic constraint on action is that “one is constrained not by internal motives but by knowledge of how one's actions may be interpreted by others” (Swidler, 2001: 163). Semiotic codes are institutionalized to the extent that they are widely available as an external resource, not because they are widely comprehended as truths. Cultural codes are elaborated and given reality by practices that embody the meaning system and by the enforcement of codes in the case of breaches. For example, the work of labor courts and union actions in cases of contract violations elaborate and give reality to the code underlying the employment relationship. In contrast to the emphasis on internalized beliefs, which preclude

actions that are “unthinkable” within existing institutions, the external nature of semiotic constraint contains the possibility of local variation and deviance. In rather colloquial terms, the question shifts from, Can you imagine an alternative? to, Do you get away with it?

Movement activists deftly activated pre-existing semiotic codes to depict the actions of their targets – German pharmaceutical firms as dangerous, unsafe, immoral and illegitimate. Public relations executives of German pharmaceutical firms also sought to frame biotechnology as technically safe and beneficial for curing disease, but were unable to counter their antagonists in the ability to arouse *emotions*. In particular, activists at the forefront of the anti-bio technology movement deployed two codes that evoked deep binary oppositions: nature as pure versus man as impure, and genetics as immoral versus the humanism as moral.

A Romanticist ideal of nature as purity: This logic is entrenched in German culture and idealizes nature as whole and sacred, but also as mysterious and unfathomable by the human mind. Nature is best left alone and when men meddle with it they are bound to abuse their power or cannot control the consequences of their actions. Although most strongly associated with 19th century philosophy and art, Romanticist ideas about the relationship between man and nature permeate present-day society, from the centrality of the Faustian theme in German literature and environmental protection policies to the prevalence of “natural” medicines and more holistic medical practices (Payer, 1996). Using this logic, anti-biotechnology activists framed biotechnology as a man-made technology that meddles with nature to produce “Frankensteins.” The underlying semiotic structure of this code can be sketched as revolving around the binary “nature – human” where nature is pure, beautiful and sacred, and human intervention is limited, corrupt, and monstrous.

The taboo of genetic discrimination: Anti-biotechnology activists also exploited a deep seated German aversion to the recognition of genetic and hence unchangeable differences that

would suggest evolutionary selection instead of humanistic self-improvement as the path to higher quality. The taboo arises because such differences are associated with the racial ideology, genocide and eugenics campaigns during the Nazi regime. This public code recurrently surfaces, for example, in debates around euthanasia. The acknowledgement and exploitation of genetic differences, for example in genetic diagnostics, violates a need to bestow dignity on individuals by making them “equal in nature” to others. Once again, a binary opposition was exploited with genetics being Nazi, dangerous for society and immoral, and the opposite embodying modern Germany, community and human dignity.

The successful deployment of such emotionally resonant framings resulted in several advantages for opponents of biotechnology. Perhaps most critically, the power of culturally anchored semiotic codes allowed the small group of core activists to recruit a wide range of allies and sympathizers that were not structurally linked to either the activists or the Green movement. Such unlikely allies included groups of radical workers within pharmaceutical companies, school teachers, neighbors of scientists, church groups and leaders, politicians *across* the political spectrum and part of the scientific community. Such alliances created additional resources for the movement. One example is the *Ökoinstitut*, an independent environmentally oriented think tank and supplier of expert reports that was founded in 1977 by respected scientists opposed to nuclear energy. Biologists affiliated with the institute resonated with the view of nature evoked by opponents of biotechnology and were frequently asked by courts and politicians to supply expert opinions. Their reports lent scientific credibility to arguments against biotechnology.

As a result of these broad-based semiotic codes, the debate over biotechnology in pharmaceutical companies also quickly became one about basic principles rather than specific cases and decisions (a *Grundsatzdiscussion*), which made it difficult for defenders of the technology to argue the safety of specific projects. Biotechnology swiftly became conjoined with “incalculable risk”, a

focus borrowed from the parallel debate about nuclear energy. Thus, as early as 1984/1985, a parliamentary *Enquete Kommission* (a multi-party ad hoc commission constituted on key societal issues) was entrusted with a task of writing a report on biotechnology. The precipitating factor was that the Office of Technology Assessment in the United States had released a report titled “Commercial Biotechnology,” which reviewed the economic prospects of the technology and how the Federal government could support the industry. However, the report of by the *Enquete Kommission* was to be titled “*Chancen and Risiken der Gentechnik*” (Opportunities and risks of genetic technology). As one of our informants, a scientist who supported genetic engineering noted,

*“The name was pushed by environmentalist left, the Green party got into federal parliament for the first time in 1983, it needed issues to push besides nuclear energy and anti-missiles. With this title, the debates in that commission became very controversial and ambivalent about the entire project – they HAD to look at risks and strike a balance, and this controversy was taken out of this commission and shaped the character and content of the public debate at least until 1992”.*

Drawing on the ideal of natural purity and the fear of genetic manipulation, anti-biotechnology activists inflamed public anxiety about the “incalculable risks” of biotechnology, especially around the issue of “emission control,” another framing borrowed from nuclear energy. E-coli bacteria that were manipulated to produce insulin were portrayed as posing risks that were “incalculable” if they were ever to seep into the natural environment. Opponents suggested that the possibilities and dangers of gene transfer across species were unknown and unpredictable due to the holistic complexity of nature. Until all such risks were known and ruled out, the technology was not safe because the consequences of accidents would be irreversible. Activists often staged dramatic spectacles to garner TV coverage and make the dangers of biotechnology more vivid: headless chickens strutting before demonstrations, gorillas wailing over pox-speckled bananas, or mutant apples in radiation suits passing out leaflets.

While Green activists focused on the emission of transgenic organisms into an unspoiled nature, religious conservatives and the women’s movement became enraged in 1988 when the

Christian Democrat led German government endorsed the European Human Genome project which included a “predictive medicine” program focused on prenatal genetic screening techniques. This also quickly became a lightning rod issue to members of the Green party as proof of the dubious motives and worldviews of proponents of genetic engineering. Religious conservatives inveighed against it as “a European abortion program motivated by eugenics”, and women’s groups attacked genetic counseling as “continuations of Nazi eugenics”.

This controversy was fuelled by the infamous “Singer Affair,” which put the spotlight on just how sensitive issues of bioethics were in the light of Germany’s Nazi past. Peter Singer, a controversial Australian bio-ethicist, had written a book (with Helga Kuhse) called “Should the Baby Live?” (1985, German translation in 1993) They suggested that fetuses with severe disabilities could be ethically aborted because they lacked the basic human capacities to experience agony and determine their own fate. At a bio-ethics conference in which Singer was invited to lecture, protesters assailed and jeered him. Oliver Tolmein, a lawyer, journalist, self described “anti-bioethicist” and leader of the “Cripples Movement,” wrote that debating with Singer was “as senseless as debating a theory arguing for the superiority of the Aryan race”. As a consequence of such events, public anxiety about biotechnology increased and broadened into an ever wider set of concerns. One of our informants described the strategy of activists as follows:

*“The problem also should be diffuse, not concrete, look threatening and dangerous, almost mysterious, a mystical global angst, look at the Frankenstein images, lots of blood and deformations, etc in activist stunts. And if you get that mix, you’re almost unbeatable, this is exactly the propaganda principle of dictators like the Nazis and Stalinists, very effective and smart.*

Public relations executives in the German pharmaceutical industry did seek to counter these efforts by framing biotechnology as safe and beneficial. They sought to exploit the logic of progress and enlightenment, portraying biotechnology as the continuation of the positive development of medical science, and depicting opposition to it as superstitious and backward. A corollary argument was that science and progress required objective data, a focus on concrete cases, and faith in experts

rather than an ill-considered process of abstract deliberation by the public at large. Often, representatives of pharmaceutical firms, usually scientists, were chosen to debate biotechnology opponents in public forums. However, these debates only put pharmaceutical firms further on the defensive because they failed to address the emotional fear created by activists' framings. As one PR veteran confessed:

*"I went to a panel at the nearest high school with a Green member of the state parliament. There were 500 people in attendance and it was packed. I was winning the argument, and suddenly [his opponent] started to scream and cry. So I said to her, "don't you think we should stop being so emotional and be more objective/factual about this?" At that point a 50 year old lady in the audience stood up and said, "Mr. [name], are you only a brain or do you actually have a heart in this issue, too?" That's when it became very clear to me that...the problem for the big corporations is that they are already anonymous, diffuse and faceless, perfect target for activists, they can't win with the rational stuff and have to show a human face.*

An added problem for German pharmaceutical firms was their inability to build coalitions that could have accelerated a counter-framing of biotechnology that emerged in the late 1990s, as a hotbed of innovation and entrepreneurship. The genetics departments of universities as well as prestigious institutes like the Max Planck desisted from entering the fray, partly because they sought to protect their scientific independence from commercial interests, partly because a sizeable minority within the scientific community of biologists sympathized with the Green movement. Moreover, venture capital was exceedingly scarce until the late 1990's, and as a result, there was a dearth of small biotech companies.

Consequently, biotechnology became associated with large pharmaceutical firms who at the time were yet to cast off the shadow of recent scandals. For example, Thalidomide, a drug made by mid-sized German manufacturer Grünenthal under the trade name Contergan had amongst other indications been approved to treat morning sickness during pregnancy, but was found to cause birth defects. An estimated 10,000 victims worldwide attracted extensive media coverage, and the refusal by Grünenthal to take the drug off the market until forced by the health authorities in 1962 permanently damaged the industry's reputation. German pharmaceutical firms also operated large

chemical units, and in the early 1980's, dioxin, a poisonous waste-product of chemical processing, leaked into densely populated areas in Europe and caused public outrage.

Activists' skillful activation of culturally embedded semiotic codes for understanding biotechnology goes a long way towards addressing one aspect of our puzzle, how a small group of activists were able to affect large and powerful companies in a well-organized industry. However, such framings affected all German firms alike and hence, another part of the puzzle remains unexplained: Where does the observed variation in outcomes among firms come from?

### **Variation in Mobilization Ability and Available Influence Tactics**

As the semiotic codes and framings described above only take effect when they are actively enforced and mobilized, the pressure that activists were able to exert on particular organizations was still contingent on their ability to recruit people, mobilize resources and deploy effective protest repertoires (Meyer & Tarrow 1998, Tilly 1978, McCarthy & Zald 1977). We suggest that this ability to apply pressure on specific companies varied on two dimensions. On the one hand, regional variations in pre-existing mobilizing structures facilitated or prevented the more immediate and timely application of pressure around key events. On the other hand, the salience and accessibility of the target firm and its biotechnology activities directed attention and energy towards some firms and away from others.

Anti-biotechnology activists on aggregate used a broad repertoire of tactics to further their cause. Public street protests and marches, often involving vivid images and spectacle were frequently used and had high media appeal. Activists protesting a planned facility for producing recombinant EPO in the town of Marburg in 1989 staged a traditional street march of about 600 people, while a Greenpeace group peacefully blocked off the access road to the Bayer headquarters through a human chain, a format widely used in 60s student protests and opposition to US missile facilities in the early

1980s. TV talk shows and panel discussions at the local level were often initiated by sympathizers close to the Green party and by religious groups. In some neighborhoods close to pharmaceutical companies, activists distributed leaflets to employees and residents, a practice that had been successfully used in the past by environmentalist groups protesting water and air pollution. More ingenious tactics that showed keen knowledge of the legal system were pioneered by core activists in the green movement and party. Starting in 1982, activists exploited a law that gives every shareholder the right to ask questions and speak at the Annual Meeting (AGM). Ten to fifty activists would each buy a single share in a company like Bayer or Hoechst and use the AGM to voice their allegations, force a vote on the resignation of the management and press environmental demands. News coverage and the public embarrassment of the company's management heightened the effectiveness of this tactic. Opponents would use provisions in building and environmental regulations to demand public hearings when new facilities were being planned, and file objections that needed to be addressed by the permit applicant before the approval process could be continued. In several cases, e.g. at Hoechst, Grünenthal and Behringwerke, activists distributed ready-made forms that local residents only had to sign and file. Finally, some core activists resorted to exhausting legal means, suing companies in court for violating emission control legislation and procedural violations. The latter two tactics had been used by environmentalists in earlier cases of opposition to large construction projects, such as the Frankfurt airport extension, motorways, and nuclear and chemical plants.

Diverse as this repertoire is, the movement lacked a national command structure and so the ability to deploy a tactic learned in other contexts depended on the number, experience and sophistication of local activists. Within Germany there was significant spatial variation in the anti-biotechnology movement's mobilizing ability. Large cities and university towns could draw on existing activist networks developed in the 60s and 70s, and a large radical leftist population that was

generally sympathetic to Green causes. The cities of Frankfurt, Cologne and Berlin in particular had large and well-connected activist communities centered around left-leaning universities that had played a key role in the student protests of the 60s, the emerging Green party and around left-wing union organizers. The Frankfurt area, for example, had seen some of the earliest and most confrontational environmentalist protests in the late 1970s around nearby nuclear power plants and the airport extension. By contrast, in most rural areas, and in some cities like Munich, opponents of biotechnology lacked both critical mass and experience.

Local mobilizing structures drive movement effectiveness because some protest repertoires require sufficient numbers (e.g., public marches and protest events, filings of objections to new facilities), but also because activism that is focused by events requires experience that permits speedy detection of opportunities and quick reaction. For example, the tactic of filing objections to a planned biotechnology facility hinges on local activists that understand the opportunities provided by local regulations, on having access to information about the intent of the company, access to media and networks for mobilizing support, and on procedural political skills.

A second factor in the ability of the movement to deploy influence tactics has less to do with activists' local mobilizing structures and experience, but with the targeted company itself. A company's size, ownership structure and history affect its saliency and accessibility as a protest target and hence the repertoires and resources that can be mobilized against it. For example, privately held pharmaceutical companies do not hold AGMs, eliminating one access point available in the case of public companies. Family owned businesses are more secretive about their activities and thus receive less coverage in the media. Large companies serve as exemplars for the industry and are highly visible in the news, while smaller companies are more likely to go under the radar screen. Companies with a history of environmental violation are already targets and have fostered a set of vigilant activists.

Mobilizing opportunities are also greater when the specific projects and events that draw attention are tangible and vivid. Much German anti-biotechnology activism during the 1980s was directed at industrial-sized production facilities that used recombinant cell cultures. The physical size and scale of these facilities, as well as their novelty, made them the focal point of the struggle between opponents and the pharmaceutical companies. By contrast, slowly expanding laboratory scale research institutes and corporate facilities received far less attention. Movements are in part opportunistic and seek to target salient and easily accessible actors and projects for which it is easier to mobilize resources. Such targets can serve as showcase cases for broader objectives, but that also means that less salient actors and projects may go unnoticed under the radar screen of the movement.

Variations in mobilizing ability and available influence tactics account in part for the varying degree of success among German companies in commercializing biotechnology. In terms of regional exposure to the movement, the operations of Hoechst, Bayer, BASF and Schering were located in left-leaning cities, Boehringer Mannheim's and Boehringer Ingelheim's biotechnology activities were created in conservative rural areas. Hoechst, Bayer, BASF and Schering were publicly traded, while Boehringer Mannheim and Boehringer Ingelheim were family owned. Hoechst, Bayer and BASF were large companies with chemicals business units that already drew the ire of environmentalists, while the others were smaller pharmaceutical specialists. Hoechst, Bayer, BASF, Boehringer Ingelheim and Boehringer Mannheim sought to build recombinant production facilities between 1984 and 1989. Not surprising when the factors location, size, ownership, business scope and plans for large-scale production plants are combined, Hoechst, Bayer and BASF were more strongly pressured by opponents to genetic engineering than Schering, Boehringer Mannheim and Boehringer Ingelheim. Schering, although publicly traded and located in Berlin, never sought to enter large-scale biotechnological production in Germany.

Perhaps the most striking contrast is between the efforts of Boehringer Mannheim and Boehringer Ingelheim on the one side, and Hoechst on the other. BM and BI respectively were able to build biotechnological production complexes in Biberach and Penzberg in 1986. Both locations are small towns in conservative rural areas in southern Germany. Neither facility was strongly opposed or even minimally delayed by local opposition according to media sources and our informants. In fact neither event received much national coverage at all. Hoechst's plan for a facility to produce recombinant insulin near Frankfurt faced fierce resistance from a wide and well coordinated coalition of Green activists, workers, church groups, and other leftist groups. Hoechst's insulin production became the main showcase event for the opposition to biotechnology and included disruptions at its AGMs, expert reports from the Ökoinstitut, 350 filed oppositions to the plans, and a series of protracted lawsuits that were instrumental in ushering in national legislation in 1990. One highlight was a multi-week "National action campaign against Hoechst", orchestrated by the Green party in 1986. Hoechst filed for the first permit in 1984, the facility started operations in 1993.

That local activist networks are a factor independent of firm size and ownership is supported by a comparison of two smaller companies, Grünenthal and Rentschler. Both are small, private and made forays into biotechnology early in the 1980s, Rentschler with interferon, Grünenthal with t-PA. Yet, Rentschler is located in the rural south while Grünenthal is located near Cologne. Rentschler's application for a permit to produce gamma-interferon faced virtually no resistance in 1985. Against Grünenthal's plans for a t-PA plant, anti-biotechnology activists filed 6000 objections, staged several protest events and filed two law suits. The facility was ultimately approved in 1991, three years after the initial filing for the permit.

Variations in mobilizing ability and availability of tactics provide a central but incomplete explanation for the varying degrees of pressure the movement could exert on specific companies.

For example, BASF was a large, public chemicals company located in a metropolitan left-leaning area but it was less affected by the movement than Bayer and Hoechst. And while Bayer and Hoechst were similar in many respects, Hoechst seemed to take the brunt of the conflict and the most high profile actions. The missing element is state-level variations in access to the political structure, which in the present case is primarily tied to the role of the Green party in different state parliaments.

### **Variations in Access to The Political Structure**

The German environmentalist movement differed from many of its international counterparts in that it was able to enter the parliamentary system relatively quickly and permanently and before long started entering coalition governments with the social democrats (SPD) at the local, regional and ultimately nation level. Within three years of its founding, the Green party found its way into the national parliament and over time into virtually all state assemblies. Representation in parliament and government makes available additional tactics, arenas and resources that are tied to the state apparatus. One example at the national level is the formation of the *Enquete Kommission* described above. As one of the parliamentary parties, the Greens were able to shape the scope of the report and could nominate members to the commission that were critical of genetic technology.

Yet, the federal structure of Germany made regional representation, at the city and state level, equally important. Significantly, approval and monitoring of industrial facilities that were regulated by federal or state law was delegated to the state level and to regional administrative units within states which were headed by political appointees of the state government (*Regierungspräsidien*). States could also implement additional environmental regulations. In addition, city governments could implement zoning laws and building restrictions. The Green party gained access to state parliaments in rapid succession during the 1980s: Baden-Württemberg (BI, BM) in 1980, Berlin

(Schering) in 1981, Hesse (Hoechst) in 1982, Bavaria (BM) in 1986, Rhineland-Palatine (BASF) in 1987, and Northrhine-Westphalia (Bayer) in 1990.

Although parliamentary representation was important for the attention and legitimacy accorded to Green causes it gave Green activists little real power in states that under the stable rule of mainstream parties. For example, Baden-Württemberg and Bavaria have had conservative CDU/CSU governments since WWII, Northrhine-Westphalia was consistently governed by the SPD between 1966 and 2005. However, the Greens formed their first coalition government with the SPD in the state of Hesse between 1985 and 1987, with Joschka Fischer as Minister of the Environment. Participation in other state governments did not reoccur until the 1990s.

The implications of this short episode for Hoechst's biotechnology efforts are informative. In late 1984, Hoechst had applied for a permit to operate a facility for producing recombinant insulin near Frankfurt. The permit was filed under the existing emission control law (*Immissionsschutzgesetz*) as a "facility for biological fermentation." The *Immissionsschutzgesetz* contains no special provisions for bioengineered organisms and the category of biological fermentation was also used, e.g. for breweries. The facility was approved by the regional *Regierungspräsidium* in June of 1985, based on a recommendation of the ZKBS, a national panel of scientists for the voluntary safety assessment and self-regulation of biotechnological facilities. In December of 1985, the Green Party entered a coalition government with the SPD in Hesse, and Joschka Fischer became Minister for Energy and the Environment. Also in December, Hoechst applied for a construction permit for the second stage of the insulin facility, which involved the chemical synthesis of the protein produced by recombinant e-coli bacteria. The application was filed as an "essential modification of existing facilities." However, in March of 1986, the *Regierungspräsidium*, under advice from the Ministry of the Environment, classified this second stage of the insulin plant as a new chemical processing plant of industrial scale, which would require a public hearing process and full inspection of the plant.

Hoechst withdrew the application, modified the plans to lower the volume of hazardous chemicals used and reapplied for operation of an “experimental facility” that could be approved for an initial period of two years without public hearings. This permit was granted in May of 1986. However, on January 26, one week before the break-up of the SPD-Green coalition, the Ministry of the Environment Undersecretary Kerschgens (Greens) revoked the permit for the biofermentation stage and requested that Hoechst submit more information and comply with a public hearing and inspection process. A pro-business CDU-FDP government emerged from state elections in April, and the new Minister of the Environment, Weimer (CDU) immediately overturned the revocation of the permit and re-approved stage II as an experimental facility. In September, the *Regierungspräsidium* came to the same conclusion that the initial approvals were legally correct and no public hearings were required. At this stage, Green activists resort to alternative tactics, filing objections and suing Hoechst in court.

Although short-lived, this episode demonstrated that the Green party would not hesitate to use the political apparatus to block biotechnology projects if it was in power. As this situation was a realistic medium-term possibility in states such as Hesse, Northrhine-Westphalia and Berlin, approval procedures for biotechnology facilities in these became less predictable. By contrast, Boehringer Ingelheim had applied for the operation of its general purpose biofermentation plant in Biberach the same year as Hoechst. The approval was granted within 3 months. This speed was attributed by our interview partners to unbureaucratic support from state government in Baden-Wuerttemberg and its Ministerpraesident Lothar Spaeth, well known for being business and technology friendly. In the state of Baden-Wuerttemberg, the Green party was represented in parliament, but Spaeth’s CDU held a safe absolute majority.

Differences in the mobilizing capacity of opponents of biotechnology and their access to the political system via the Green party therefore accounts for the varying degrees of external pressure

that German pharmaceutical companies faced regarding biotechnology in the mid to late 1980s. What remains unclear are the specific mechanisms that translated such pressure into organizational decisions that affected the technological capabilities of these companies. Did powerful companies like Bayer, Hoechst and BASF simply succumb to the pressure of activists and public sentiment? Such a view would appear over-simplistic. As one senior executive put it,

*“We operate in a regulated industry. We are used to politics and being attacked all the time, you only have to think about animal testing, drug prices and so on. We are normally not affected in our decisions by public sentiments and demands.”*

And yet, the progress of early champions of biotechnology in Germany, such as Hoechst and Bayer, appeared to have been slowed down to the extent that they were not able to convert their exploration of the technology into commercial returns of investment, such as new therapeutic drugs and significant revenues. We argue that in order to theorize the mechanisms through which social movements actually affect organizational outcomes, an understanding of organizations’ internal operations and politics, their decision processes and decision makers, is needed.

### **HOW DID THE ANTI-BIOTECH MOVEMENTS PENETRATE ORGANIZATIONS?**

Research on social movements has primarily examined the effect of movements on the state, and hence, more is known about how and when activism penetrates the political system than about how and when it may penetrate private corporations. In contrast to political action directed at a democratic state, anti-biotechnology activists faced three problems with respect to penetrating organizations. First, regular citizens do not have institutionalized access to the control structures that govern organizations. Corporate boards are elected by shareholders, not by citizens, and are to some extent buffered from movement effects on voting and public opinion. Second, movement activists lacked legitimacy in addressing organizations directly because organizations are normatively private and rational rather than public and political entities. And lastly, although they constituted a vocal minority, anti-biotechnology activists initially lacked power to use the more traditional route of

changing national policies. Only in 1990 did national legislation about come into effect that regulated biotechnology, and when it did, it restricted but also legalized genetic research – a partial defeat of more radical demands for a complete ban.

In order to theorize the mechanisms by which external movement penetrate organizations, we briefly describe salient aspects of the internal operations and the polity of organizations that proved consequential for impact of activists on technology development. Organizations can be seen as normatively rational political coalitions (Cyert and March 1963) that use decision-making routines for allocating resources, including for the development and exploitation of technologies (Nelson and Winter 1982).

Most executives of German pharmaceutical firms approached biotechnology projects from an investment perspective, i.e. as the commitment of financial and human resource with the expectation that future returns exceeded expenditures. This approach evoked the calculus of risk-return considerations and of choice between alternatives. Investment decisions in the pharmaceutical industry are often long-term, and take into account the life cycle of any expected products due to patent expiration and of market share gained by competing products. Although the formality and strictness of analysis varied, such considerations were central to decisions about facilities, R&D programs, acquisitions and location. The consistency of this approach to many incremental decisions over time created the larger pattern of technology development by different firms.

Investment decisions do of course require a large measure of judgment by decision makers, especially in decisions about an emergent technology in an industry with long time horizons in product development. The background and formal position of managers systematically bias their judgments and interests. For example, the composition of the board and executive team influences how biotechnology investments are seen because members personal experience and identities color

their assessments. Pharmaceutical specialists, chemists, executives trained in business and finance or law all bring different levels of understanding and commitment to biotechnology with them. Some were more motivated to make favorable assumptions than others. As one of our interview partners, a pharmaceutical R&D executive pointed out in the context of location decisions:

*“The only way to justify the [biotechnology] investment at home [in Germany] was to fudge the calculation and paint a more rosy picture – this worked sometimes but it also costs credibility if it repeatedly doesn’t pan out.”*

Hence, executive level champions with biotech know-how and commitment seem to have played a large role in early forays into the technology by German firms. For example, Boehringer Mannheim’s long-time CEO and family owner Engelhorn was trained in pharmacology the US and made early investments on his sheer faith in the inevitability of a biotechnological revolution in the industry. By contrast, chemists at Bayer were strongly opposed to significant investments in molecular biology at that time, even before environmentalists had discovered the issue. Hoechst CEO Hilger, with 27 years of experience mainly in inorganic chemistry and purchasing declared upon taking the helm in 1985 that *“High tech is in industrial applications. We are and will remain chemists.”* His first action as CEO was a very large acquisition in ceramics. His successor, Dormann, had a background in finance and business. Dormann eventually broke up the companies disparate units and merged the remainder with Rhone-Poulence to create Aventis in 1997.

A board’s tendency to see biotechnology investments in a more or less rosy light is of course as much driven by the company’s business model and identity as by personal preferences. Companies with large chemical businesses had alternative investment opportunities in chemicals that could be compared to pharmaceutical investments, while pure pharmaceutical companies such as BI, BM and Schering evaluated alternatives only within pharmaceuticals. As one executive noted,

*“the question often was, Why spend money on this biotech thing, where we may make some money in 10 years or not, when we could spend it on a chemical product or a product line extension where we can make money within two or three years?”*

Public diversified companies such as BASF, Hoechst and Bayer, also were more likely to use a portfolio management approach and held each business unit accountable for generating positive returns and were reluctant to cross-subsidize early stage developments. The position of the pharmaceutical unit within the company of course also feeds back into the personnel likely to make critical decisions.

Movement activists were able to penetrate these general decision support and political processes, by shifting key parameters of the processes. In our analyses, we identified two central mechanisms: The creation of greater legal and social uncertainty tilted decisions away from investments in domestic biotechnology. In addition, the stigma arising from the negative emotional framing of biotechnology in public created legitimating concerns that heightened existing biases against further technology investments.

### **The Creation of Uncertainty in Technological Investment Proposals**

One important way in which the activities of anti-biotechnology activists surfaced in organizational decision processes regarding the technology was through the creation of uncertainty. Uncertainty was created at three levels. First, and especially in the earlier years of the movement, activists were successful to raise a very diffuse sense uncertainty about the basic viability and safety of the technology. Second, movement activists succeeded in creating legal and regulative uncertainty during the second half of the 1980s and into the early 1990s. Legal uncertainty referred as to what the legal basis for regulating biotechnology should be, self-regulation by the industry, existing laws such as the emission control and chemical processing regulations, or a separate piece of legislation. Legal uncertainty also arose from the declining reliability of regulative and administrative procedures and interpretations. Various levels of local, regional and national authorities had a say in the approval of facilities and the interpretation of laws and administrative procedures often depended on the particular people involved. This form of legal uncertainty continued even after the passage of

the federal *Gentechnikgesetz* in 1990. Lastly, the challenges and delay tactics of activists created uncertainty for the companies regarding the speed with which they could bring products to market and consequently their returns on investment. We illustrate the nature and consequences of each form of uncertainty in turn.

The anti-biotechnology movement generated a diffuse sense of uncertainty about the viability and safety of genetic engineering. Reports from independent scientists and those at the *Oekoinstitut*, as well as the dissemination of scientific studies critical of genetic engineering through organizations such as the *Genetischen Informationsdienst (GID)*, operated by the radical *GENetisches Netzwerk*, created the impression of serious scientific debate about the basic merits of biotechnology. (Note the reminiscence of these tactics to religious conservatives' portrayal of "intelligent design" as a viable scientific counter-theory to Darwinian evolution in the present days USA). This line of argument gave way to more ethics-based reasoning in the 1990s, as medical successes of biotechnology became apparent and predicted disasters failed to materialize. This sense of diffuse uncertainty about the technology per se seemingly had only a moderate immediate impact on decision processes within pharmaceutical firms. It contributed to a "wait and see" position among decision makers with little immediate knowledge of biotechnology and weakened the position of pharmaceutical staff trying to promote investments with highly uncertain and very long terms returns. The public acceptance of this uncertainty framing, however, raised the spectre of further backlashes against technological advancements at a later stage.

Legal and regulative uncertainty played a greater and more immediate role in decisions regarding biotechnology. On the one hand, the legal basis for operating biotechnological plants remained under dispute until 1990. Operating permits that were already granted could potentially be revoked, and the requirements for future procedures remained unknown. The limited electoral success of the Green party in Hesse played a key role. The cycle time of a biotechnology investment

is 10-20 years, much longer than the electoral cycle of parliaments and governments. To the extent that frequent changes in parliamentary majorities could be expected in some states and even at the federal level, uncertainty about the future viability and protection of initial investments arose. For example, when Schering was looking to start production of betaseron in 1995, the company did not even try to create a facility for in-house production in Berlin, because majorities in the Berlin state government frequently alternate between SPD-Green and CDU-FDP coalitions. Instead, Schering outsourced production to Boehringer Ingelheim's existing plant in Baden-Wuerttemberg. Even with less ambiguous laws in place from 1990 on, the interpretation of these laws remained open to interpretation by multiple agencies involved in the process. For example, a court in Kassel (Hesse) who ruled that Hoechst lacked a legal basis for its insulin fermentor and a planned EPO facility in 1989 saw recombinant bacteria cultures as posing environmental risks similar to nuclear facilities. A court in Neustadt (Rhineland-Palatine) however, dismissed objections to a similar BASF plant in Ludwigshafen in 1992, stating that "the risks from the plant are about the same as from driving a car". With the outcome of regulative and legal proceedings dependent on seemingly idiosyncratic and changing factors such as the current state or city administration or the composition of courts, the time needed to obtain approval for operating larger biotechnological facilities in Germany seemed highly uncertain in areas with high activism and narrow political majorities

Even once the legal situation became more predictable in the 1990s and the outcome of applications for operator permits became predictable, another source of uncertainty remained, that is, the time it would take to go through the process. As activists became increasingly skilled in delay tactics, e.g. by demanding hearings, filing objections and attacking plans for genetic facilities on procedural grounds, the duration of the process could vary from a couple of months (in the case of Boehringer Mannheim's expansion of its facility in Penzberg, Bavaria) to a year or two (in the case of BASF and Gruenthal's efforts in Ludwigshafen and Cologne).

Why is the speed of approval such a critical factor for pharmaceutical companies' investment decisions? One of our interviewees explained the following rule of thumb in the industry:

*"It's a very simple calculation. Take the total return on any pharmaceutical product over the life cycle. As a general rule,*  
*- if you go 50% over budget in development costs, the total return drops 10%*  
*- if you go 50% over budget in production costs, the total return drops 15%*  
*- if you delay the launch by 1 year, the total return drops 30%*  
*Speed is key in the market we're in... Speed is very critical in biotechnology, because the knowledge turns over so quickly and because patents can very quickly lock you out of a lucrative area"*

For many of the money-making drugs, such as EPO, recombinant insulin, Factor VIII, betaseon, etc., either several companies were trying to bring them to market or, the patent protection would not last very long to recoup development costs.

Hoechst's struggles with its insulin and EPO production illustrate the effect of delays on the attractiveness of investments. When Hoechst finally was ready to start its insulin plant in 1993, Lilly and Novo Nordisk had already taken up a large share of the European market. Lilly had built a facility in Strasbourg, Novo in Denmark years before Hoechst, even though they initiated the process not much earlier than Hoechst. Hoechst executives decided as early as 1988 that future investments involving biotechnology would be made outside Germany, initially in France and Belgium at Hoechst's Roussel-Uclaf subsidiary, later also in the US and Japan. The German insulin and EPO plants remained for limited use and as "demonstration facilities" without subsequent expansion investments until at least the mid 1990s.

At Bayer, a decision was made at around the same time about the location for a plant to produce recombinant Factor VIII, developed by its US subsidiary, Cutter Labs in collaboration with Genentech. A former executive described the analysis of alternative locations that would routinely be preformed for such a decision. Besides the financial returns and the basic physical requirements, such as water quality and labor, the report to the executive committee also included a risk assessment. Two locations, one in Germany and one in California came out as the finalists for the

location of the plant. The main risk factor for the German location was the uncertain time it would take to get permit, the main risk factor in California were earthquakes.

*“You can build a facility that is earthquake-proof. In Wuppertal, the time to get the permission for the facility was incalculable because of the political situation and that became a non-acceptable factor.”*

Construction on that facility began in California in 1988. Time was again critical, because Bayer feared being beaten to market by its main competitor in this market, Baxter.

It should be noted that the uncertainty generated by the anti-genetics movement in Germany not only affected corporate investment decisions, but also individual scientists. Bayer scientists who had the opportunity to spend time at Berkeley and later came back to Germany, and some Hoechst scientists that could spend time at the MGH were at times hesitant to take up those opportunities, because it was not clear whether there would be jobs for their biotechnology skills outside universities upon their return. Why invest in a skill that one may not be able to practice? The person promoted to plant manager for Hoechst’s insulin facility essentially was without his job for the 5-6 years in which the approval was delayed, a situation that must have instilled concerns about his future career path and promotions.

### **Legitimacy Threats and The Internal Polity of The Firm**

Thompson (1967) suggested that domain consensus was essential for an organizations and described it as a set of normative agreement between the dominant coalition in a firm and its external stakeholders as to what the organization could and could not do. Anti-biotechnology movement activists framed biotechnology in such a negative light that any foray by a pharmaceutical firm into biotechnology became perceived as a breach of the domain consensus by internal and external participants.

The emotionally resonant framing of biotechnology as unsafe, dangerous, and embodying the immoral pursuit of profit at the expense of human dignity. These threats to the legitimacy of German pharmaceutical firms led to the feeling of siege from all sides (*Belagerungsmentalität*) for top

managers and weakened their resolve to invest resources in biotechnology. One informant, a former senior executive at Bayer, outlined the causal link between the internal polity of the firm and concerns about biotechnology as follows:

*“Bayer is a chemical company; grew out of dyes. Later, after much discussion it was called, a chemical pharmaceutical company. The CEO was a chemist and out of the 12-14 people on the board, I was the one person from pharmaceuticals. When I joined the board, there was no pharmaceutical predecessor before for me on the board...Chemists are dedicated to think precisely but pharmaceuticals were much less predictable...Everyone could read the numbers...the drug industry was never liked...chemists never believed that drugs could grow and be profitable”.*

A second executive who at some time headed their R&D activity from Hoechst put it the impact of the threat of legitimation on decision-making as follows:

*“Hoechst had enough on its plate financially and trouble from environmentalists [about chemicals], and didn't want to get even more tainted with opposition to genetics...In Germany, the initial opposition to recombinant technology delayed the launch of recombinant insulin by several years – lost a lot of money on a high volume product”.*

The negative portrait of biotechnology as rife with incalculable risks also generated debate within the scientists working at universities and in the German pharmaceutical firms. One informant at Hoechst stated:

*“There was at a very early stage indeed some debate and uncertainty among scientists about the potential dangers of recombinant cell cultures. It's an issue because you deal essentially with viral material, known to be hard to contain. It was novel stuff. At Behring, we took this very seriously, but you can deal with it”*

Another informant summarized the situation at Bayer as follows:

*“There were debates mainly inside Bayer between chemists and molecular biologists. Chemistry was so dominant for 100 years and some chemists at Bayer were strongly opposed”*

Some Bayer scientists who were at Berkeley and later came back to Wuppertal in Germany were disinterested in pursuing biotechnology. The reason was that their children were being exposed in school to the evils of biotechnology by activists who were schoolteachers. These scientists did not want to have to justify their involvement in biotechnology to their children. One Bayer executive summarized it as follows:

*“We built a laboratory in Berkeley, sent people from Germany, but they would come back and not want to work on biotechnology in Germany. The movement was such that our scientists could not tell their kids what they worked on because their teachers would criticize them.”*

Both uncertainty and legitimacy concerns thus brought the movement’s activities into ordinary decision processes and organizational practices such as investment and career decisions. The movement affected organizations not directly through the highly visible activities on the streets and PR battles, but by filtering into and tilting the outcomes of existing organizational routines. It is thus not so much that pharmaceutical companies simply succumbed to social pressure, rather the iron law of rational business decision making and the internal polity of large organizations drove them into a direction where increasingly, investments in the new technology were curtailed or shifted abroad.

### **Internal Organization and Path Dependent Technology Development**

A potential objection to our analysis is that as the anti-biotechnology movement subsided or shifted to alternative targets such as genetically modified food, its impact on German pharmaceutical firms was short-lived rather than lasting, and affected the location rather than the level of technological development. In other words, how could the German anti-biotechnology movement have more than a localized and fleeting impact on multi-national firms such as Bayer and Hoechst and BASF? Our analyses point to two mechanisms that contributed to the perpetuation of early movement effects beyond activists’ immediate pressures: Self-reinforcing feedback processes of early failures and successes, and the unintended consequences of location decisions, both of which made biotechnology less commercially attractive and lessened some organization’s commitments to a more aggressive technology strategy.

The movement against biotechnology was certainly most active between 1984 and 1990, and so the timing of companies’ serious forays into biotechnology was a contributing factor to their success with the technology. Boehringer Mannheim was a very early entrant and had established

facilities and expertise before the movement gained strength. It had the added advantage that due to its location, it faced a weaker movement during the peak period. Boehringer Ingelheim and Hoechst made pivotal decisions at the onset of movement activity, but were very unevenly affected due to variations in the movement strengths and access to the political structures at their respective locales. Bayer and BASF-Knoll made key decision when the movement was at its peak, while Schering's major commitment to commercial biotechnology came after the peak period. As a result, BM, BI and Schering experienced some early successes, while Hoechst and BASF-Knoll had early negative experiences and Bayer's case is mixed.

Self-Reinforcing Feedback and Strategic Technology Commitment. The dynamic consequences of early decisions and experiences can be understood as self-reinforcing feedback loops in which initial failures or successes strengthened or weakened organizations' commitment to a still commercially risky technology. Of the firms that made key decisions when they faced high uncertainty and legitimacy threats between 1984 and 1990, BASF/Knoll appears to have ended up lacking the commitment to carry through a technology-focused strategy in the face of commercial set-backs. Knoll had been developing TNF as a potential cancer treatment since 1985. While early trials of this potentially quite lucrative drug looked promising, phase III clinical trials were disappointing and development of the drug was terminated in 1993. A year later, and in the face of several years of only marginal profitability with very high R&D expenditures, BASF fundamentally changed its strategy and focused on its strengths in galenics and drug delivery instead. BASF sold its pharmaceutical business in 2000. Similarly, Bayer in the late 1980s had to turn down offers to in-license EPO and t-PA because they lacked the ability to produce them, depriving the company of a potential revenue stream that could be clearly linked to biotechnology investments. Both Bayer and Hoechst, which also failed to generate revenues early on due to the opposition of movement activists to its insulin and EPO plans, later attempted to build more immediately profitable and less

risky generics businesses.

Unintended Consequences of Location Decisions. Companies affected by the movement also decided to locate their biotechnology operations overseas and thus seemingly evaded opposition in Germany. In 1988, Bayer set up production operations in Berkeley, Hoechst invested in a recombinant insulin facility in France (at Roussel-Uclaf) and BASF/Knoll decided to locate its main future biotechnology research center in the Greater Boston area. Yet, shifting biotechnology investments abroad during the period of strong movement opposition proved consequential, because initial choices locked organizations into locations, as subsequent investments were more often used to expand existing initial locations rather than create new ones in Germany. Even Bayer, which did build a small biotechnological fermentation facility in Wuppertal after 1990, “for local knowledge development,” concentrated subsequent investments in initial investment locations in the U.S. and Japan. A major reason for this pattern is that biotechnology involves a high degree of tacit knowledge and routines. There is also significant knowledge spillover between, for example, biotechnological fermentation in production and research and development activities. Note that these forces for path dependency apply equally to companies that had initially created capabilities in Germany. For example, when Boehringer Ingelheim restructured in the early 1990s, it decided to concentrate pharmaceutical research and development in Ingelheim. However, biotechnological research and development was exempt from this decision and remained in Vienna and Biberach, the two locations of existing production and development facilities.

Early location decisions were not only magnified, they directly affected the ability to make biotechnology commercially viable in terms of product innovations and sales. As biotechnology activities became located at foreign subsidiaries that were not originally designed to perform them, these activities became disconnected from existing pools of tacit knowledge, organizational structures and routines of commercialization. They also became more distant from the center of power at

headquarters. The barriers to exploiting overseas expertise in terms of product innovations and commercial success at Bayer and Hoechst were primarily organizational, in the form of coordination of work and knowledge transfer. For example, at Bayer, different aspects of biotechnological research, development, production and marketing became distributed across several business units in the U.S.A., instead of being more tightly and routinely coordinated by central R&D in Germany. Bayer's U.S. operations were the result of several acquisitions and Greenfield sites. It operated conventional biotechnology production facilities and performed some genetics research for biological at its Miles subsidiary in Elkhardt, IN, had created capacities to produce recombinant Factor VIII at Cutter Labs in Berkeley, CA, and ran its conventional diagnostics business out of Ames in North Carolina. Between 1983 and 1990, Bayer had also created a new R&D center in New Haven, CT, which was funded by the pharmaceutical unit, not least via the U.S. sales of one of Bayer's main blockbuster drugs, Cipro. One of our interviewees described the history of a biotechnological discovery made in the New Haven lab, at a unit focusing on applications of biotechnology to diagnostics. An antibody discovered there had to be marketed and its further development funded by Ames, as Bayer's North American diagnostics subsidiary. However, Ames had no capabilities in production, was only marginally profitable as a unit and hence very focused on its bottom-line. On the other hand, Bayer's therapeutics division in New Haven had a blockbuster drug in Cipro that generated enough money. Cutter Labs was small and focused on hemophilic therapeutics. Miles had little experience with medical biotechnology of the type required for this product, but ended up developing the production process in a complex arrangement with Ames, Miles and the New Haven unit. It took 10 years to get this product to market, quite long for a diagnostic product.

Such a constellation was not uncommon. Since foreign units had traditionally been treated as satellites of the main German divisions, they had little experience working with each other and often

had incomplete capabilities across the value chain. Initial coordination costs were therefore high. Because these subsidiaries were also treated as independent profit centers by headquarters, incentives for coordination and transfer were, however, low. Hoechst faced similar dilemmas. One informant summarized Hoechst's solution to the coordination problems, and the continued structural incentives working against that solution, as follows:

“The solution at Hoechst was to create decentralized research groups that focused on therapeutic areas, so vaccines and blood at Behringwerke in Marburg, cardiovascular in Frankfurt, antibiotics in France. Each would take overall responsibility for all aspects within their areas. That was complicated by working against a very bottom-line driven headquarters: pharmaceuticals were high margin within Hoechst, and Hoechst struggled to make money, so why reduce the margins of these units by pumping money into a technology with remote returns. The squeeze became harder the fewer good products we had and the thinner the pipeline, there was great pressure to make money, and biotech products are often not very high volume.

Initial investment decisions thus created a path dependency effect on subsequent decisions.

At Hoechst and Bayer, for example, decisions to shift key investments abroad to evade the domestic anti-biotechnology movement cost time in a fast-moving technological environment, but also caused coordination costs to increase as existing routines and structures could not be exploited and new ones proved organizationally difficult to establish. This in turn complicated and delayed the development and commercialization process, which lowered already uncertain expected returns. The ability to generate returns on investment, one of the critical issues in internal debates about how aggressively biotechnology should be pursued, was thus further hampered.

The absence of early facilities to generate an early revenue stream, e.g. via fermentation plants, and the delay of commercially viable products and revenues due to coordination costs, kept these companies from embracing biotechnology in a more determined way. As new problems arose from shifts in location in response to the domestic movement, the same rational business calculus as in initial decisions, and the same internal polity as before, further disadvantaged biotechnology in subsequent corporate decisions.

## CONCLUSION

This paper was motivated by two symmetrical gaps in the literature. On the one hand, social movement researchers have devoted little attention to the cultural effects of social movements, and in particular, to how social movements affect the trajectories of technologies, and to how they actually penetrate organizations and constrain the strategic choices of managers. On the other hand, students of strategy and organization have yet to develop a systematic account of how cultural and social constraints outside the organization shape an organization's ability to exploit its knowledge and commercialize technology. These considerations spurred our study of how the German anti-biotechnology movement affected the ability of German pharmaceutical firms to gain commercial advantage from this new technology. Our study shows that the answer lies in the interaction of an organization's exposure to the movement with its internal routines and the internal polity. Social and regulatory uncertainty made investments riskier in the eyes of managers and the portrayal of biotechnology by movement activists as anti-nature and eugenic jeopardized the legitimacy and identity of pharmaceutical firms and the scientists working in them. Our study contains a number of implications for students of both social movements and organizational theory, which we discuss in turn.

**Contributions to Social Movement Theory:** Much of the impact of social movements on social change comes via their impact on *organizational* policy and practice. As obvious as the statement is, the literature on the impact and outcomes of social movements has largely ignored it (Zald, Morrill and Rao, 2005). A recent major edited collection dealing with movement outcomes (Giugni, McAdam, and Tilly 1999), for instance, does not even raise the issue. Social movements lead to the formation of new understandings, new theories and new sentiments, and these understandings and sentiments can penetrate and even become constitutive of organizational life. By the same token, organizations can also seek to counteract and influence understandings and

sentiments, with more or less success. Thus, the study of movement impacts on organizations should be seen as another bridge across the chasm that has tended to separate the study of culture from the study of politics.

One implication of our study is that social movements penetrate organizations at multiple entry points and that organizations may thus be viewed as open polities. The polity of an organization combines the constituting norms (e.g. decision-making) and commitments (e.g. to technologies) of the organization with the formal or legitimated system of authority and its distribution and the informal power and influence system (Zald 1970). The notion of an *open* polity prompts an analysis of the *interplay* between movements and organizations because it treats the boundaries of organizations as porous and permeable. It is one in which actors and groups in different locations in organizations operate within a variety of institutional processes and rules, and are linked by beliefs, identity, resources and networks to movement issues and to external actors. As a consequence, these actors and groups come to pursue or resist movement related goals.

Our study adds texture to the construct of open polities by highlighting how routine organizational processes, corporate business structures, and executive demography amplify and mediate the demands of movements. As commercial organizations, the pharmaceutical firms we examined required internal proponents of biotechnology to base their commitment to technology development on the logic and tools of rational investment analysis. Large German firms had boards dominated by chemists rather than pharmaceutical executives; chemical business was predictable and precise in calculating returns on investment and the pharmaceutical business was unpredictable. When movement activists portrayed biotechnology as an assault on nature and linked it to eugenics, top managers who were dealing with a full agenda of threats, from price controls to environmental scandals in their chemical units, sought to avoid further trouble. Moreover, the local strength of the movement by virtue of its access to political allies in states such as Hesse made the regulative

process more variable and delays in approvals possible. German executives acted on their mere anticipation of regulatory changes and delays that threatened to lengthen payback periods of technology investments, by deferring investments in biotechnology, by diverting resources to safer chemical and generics businesses, and by shifting resources for technology development away from their traditional domestic centers.

Moreover, our study also suggests that personal identities of scientists also amplified the effect of the anti-biotechnology movement. Initially, there was disagreement between chemists and biologists in the R&D units of German pharmaceutical firms about the risks and the potential of biotechnology – a debate in part spurred by the emphasis of movement activists on the incalculable risks of biotechnology and the dubious benefits. Even more decisive was the role played by schoolteachers and neighbors who supported the anti-biotechnology movement – by preaching the evils of biotechnology to the children and friends of R&D scientists, they carried the positions of movement activists into the personal space of scientists and made it untenable for some of them to work on projects that they would have to justify to their children, family and friends.

An important task for research on movement impact is to delineate the boundary conditions under which organizations respond to movement demands and implementation regimes, and when they are able to create their own environments and influence the design of implementation regime (Zald, Morrill and Rao, 2005). Our study shows that the anti-biotechnology movement exerted asymmetric effects on German pharmaceutical firms. Firms located in states where the Green party, a key ally of the anti-biotechnology movement, was powerful were exposed to pressure from the movement – hence Hoechst was particularly vulnerable. By contrast, firms such as Boehringer-Ingelheim and Boehringer Mannheim were located in states, such as in Bavaria or Baden-Wuerttemberg, where the anti-biotechnology movement was weaker and lacked access to the political system. They were consequently more propitious to pursue biotechnology. Moreover,

although the larger German pharmaceutical firms such as Bayer and Hoechst were used to dealing with negative public opinion, they were less effective than before due to the unconventional tactics of movement activists that included highly effective use of the media and grassroots to influence the population and politicians across the conventional spectrum. By contrast, privately held firms such as Boehringer-Ingelheim were under the radar screen of activists. The prominence (as proxied by size and visibility) may be a liability more than an asset in organizations' struggle for control over their technology decisions.

Finally, our study also shows how social movements shape the trajectories of technologies by influencing the choices of organizations. A pressing issue in research on technological change is how framing contests affect technologies (Dowell, Swaminathan and Wade, 2002). Our study shows that a small group of determined activists could gain a decisive advantage by framing biotechnology as an emotional issue of principles and basic values, as an assault on nature and as a slippery path to eugenics. As a result, core activists were able to emotionalize the technology by arousing fear and anxiety and were able to cultivate a following among private citizens, scientists, politicians and school teachers, who carried these concerns into German pharmaceutical firms through a multitude of entry points.

**Contributions to Organizational Theory:** Our study has implications for organizational theory and strategy. One clear implication is that that external social constraints limit an organization's ability to exploit its knowledge and capabilities. For long, students of strategy have depicted the dearth of competences or the lack of external connections as constraints on a firm's ability to develop new products. Our study suggests that social movements and constituencies can sharply constrain a firm's determination and ability to exploit its basic knowldege. In doing so, our study injects fresh life into the notion of domain consensus – first proposed by Thompson (1967) when he suggested that firm's had to abide by normative expectations held by stakeholders of what

it could and could not do. However, Thompson (1967) neither specified how social groups and movements articulate and enforce these expectations nor how they alter the cognitions of members of the dominant coalition. Our study suggests that domain consensus also exists at the level of an organizational form – the pharmaceutical firm rather than at the individual level, and in doing so, echoes Polos, Hannan and Carrol's (2002) argument that organizations belonging to a form have to subscribe to a genetic code (blueprint) and a penal code (they face social penalties from critics and other audiences for code violations). Our study suggests that such codes are not merely there to be detected, but that such codes, and any violations thereof, are selected, interpreted and constructed by activists at the vanguard of social movements.

A related implication of our study is that social movements can be one powerful source of imprinting. Stinchcomb (1965) argued that the social technologies available at the time of founding permeate organizations. Since then researchers have demonstrated how, e.g., founders and social structures are sources of imprinting (Baron, Hannan, and Burton 2001; Lounsbury and Ventresca 2002; Marquis 2003) but have not elaborated at the imprinting effects of social movements. Organizations seeking to enter biotechnology at the peak of the movement's presence in Germany such as Heochst and Bayer located operations far away from their natural base, and in turn, such a decentralized pattern of organizing biotechnology capabilities increased coordination costs and hampered commercialization. By contrast, entrants such as BM who pre-empted, and Schering who out-waited the peak of the movement could benefit even when they had no more patents and connections than others.

Our study also points to a number of future directions. By design we focused on an extreme case – where the movement was narrow, negative and short-lived, and its adversary enjoyed competences, connections and a track record of collective strategy. Nevertheless, we were able to show that the movement had asymmetric effects on firms. Future research needs to be comparative

and look at the effect of movement across firms in the same industry in multiple countries to understand the boundary conditions of movement strength and its interaction with the internal polity of the firm. Moreover, our study looked at the effect of a movement on one business area (pharmaceuticals), and future research also needs to show how movements expand their scope (e.g. from pharmaceuticals to agricultural products) and how diversified and multinational firms respond to such more diversified movements. Finally, we focused on a movement that was clearly opposed to a technology that organizations sought to promote. Yet, the sides can also be opposite, where social activists seek to promote technologies, such as sustainable energy or recycling, and face organizations that are wedded to the status quo. Can such movements with a positive (offensive) agenda deploy tactics that are as effective those with a negative (defensive) goal? Research into these and related questions is needed to enhance our understanding of movement impact and the social determinants of the scope of the firm.

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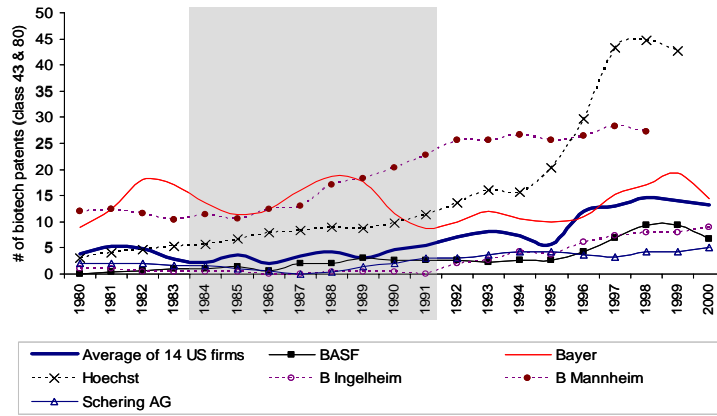
**Table 1: Firm's engagement in biotechnology: patents and alliances**

	OLS Panel Regression Estimates	
	# of biotech patents	# of biotech alliances
Corporate drug sales, annual (natural log)	-.25* (.12)	1.23** (.49)
Drug patents, annual (natural log)	.42*** (.05)	-.07* (.03)
Average patents/alliances of top 14 US firms (natural log)	.52*** (.13)	.80* (.35)
Ratio of corporate drug sales to average drug sales, 14 US firms (natural log)	.27* (.13)	.27* (.13)
BASF (binary)	-1.10*** (.17)	-.08 (.15)
Bayer (binary)	.47** (.15)	-0.13 (.11)
Hoechst (binary)	.27* (.15)	-.06 (.16)
Boehringer Ingelheim (binary)	-1.14*** (.18)	.01 (.16)
Boehringer Mannheim (binary)	1.04*** (.17)	.17 (.19)
Schering AG (binary)	-.95*** (.15)	-.10 (.14)
Intercept	-1.57 (.98)	-8.72* (4.01)
R-Square (Adjusted)	.64	.72
F Statistic	40.2	34.8

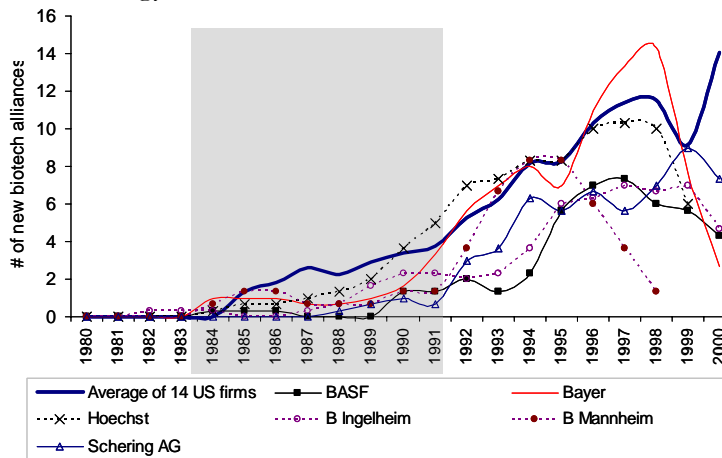
N = 432 observations, standard errors in parentheses  
fixed effects for years included and are jointly significant  
\* significant at 5%, \*\* significant at 1%, \*\*\* significant at 0.1%

Figure 1: Plots of biotechnology patents, alliances and products, 1980-2000

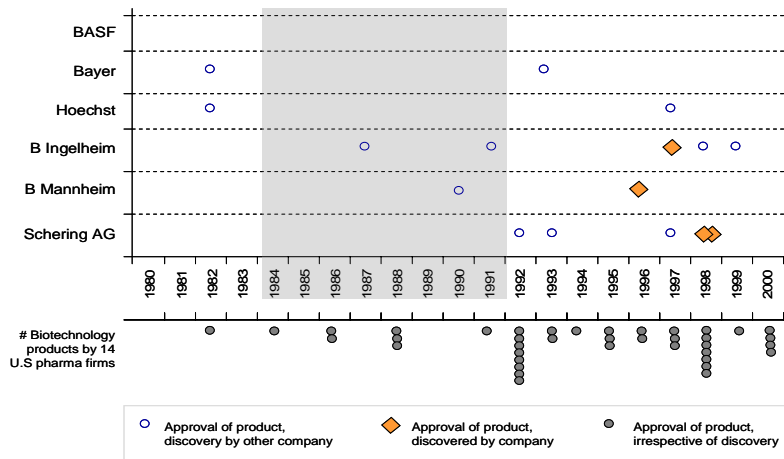
Panel A: Biotechnology Patents



Panel B: Biotechnology Alliances



Panel C: Approval of Biotechnology Products



\* Patent and alliance plots: 3 year moving averages for smoothing; shaded area marks years of main movement activity.

## Appendix 1: Timeline and Company Facts

<b>Year</b>	<b>Hoechst</b>	<b>Bayer</b>	<b>BASF</b>	<b>Boehringer Ingelheim</b>	<b>Boehringer Mannheim</b>	<b>Schering</b>
Profile	Large Public Pharma ~ 20% of sales Frankfurt (Hesse)	Large Public Pharma ~ 20% of sales Leverkusen, Wuppertal (Northrhine-Westphalia)	Large Public Pharma ~ 4% of sales Ludwigshafen (Rhineland-Palatine)	Small Private Pharma ~ 85% of sales Ingelheim, Biberach (Baden-Wuerttemberg)	Small Private Pharma 100% of sales Mannheim, Penzberg (B-W, Bavaria)	Small Public Pharma up 46 -> 85 % Berlin (Berlin)
Pre 1980	Starts work on recombinant insulin, interferon and monoclonal antibodies in 1977	No push into biotechnology, minimal basic research at central R&D in Wuppertal and at Miles in Indiana	No notable biotechnology activities	Starts genetic research (therapeutics) at its Austrian subsidiary (1979)	Begins genetic research on diagnostics and biochemicals in Tutzing, Germany	Engaged in conventional fermentation, minimal inhouse genetic research to evaluate scientific developments
1980	Hoechst has about 20 scientists in Germany working on molecular genetics (medical and agricultural)					
1981	Awards a multi-year, \$70M grant to the MGH, includes training of German scientists			Trial production of recombinant interferon	Production of immunoassays with recombinant e-coli bacteria in Tutzing	
1982	Recombinant insulin process from e-coli (in-house development)	Bayer engages in several cooperations with universities (Cologne, MIT, Rochester); First disruption of AGM by environmentalists	Initial interest in biotechnology focuses on biologicals (carotin), 3 active scientists		Recombinant alpha-galactosidase (food diagnostics)	Founding of Berlin Institute for Genetic Research jointly with City government
1983	Subsidiary Behringwerke expands genetics research labs; First disruption of AGM by environmentalists	Alliance with Genentech for development of Factor VIII; Bayer to intensify R&D spending in biotechnology		In-licensing of gamma interferon and tPA from Genentech		

<b>Year</b>	<b>Hoechst</b>	<b>Bayer</b>	<b>BASF</b>	<b>Boehringer Ingelheim</b>	<b>Boehringer Mannheim</b>	<b>Schering</b>
1984	Cooperation with genetics institute in Munich; Application filed for phase I of the insulin fermentation facility					
1985	Approval of first stage of insulin plant; Greens join the state government in Hesse; Application for operating permit for stage II of the insulin plant	High profile media seminar for about 120 journalists about Bayer's biotech activities; R&D distributed in Berkeley, Indiana, New Haven and Wuppertal	Knoll starts two biotechnology development projects: TNF (cancer, from biogen) and t-PA (cardio, from Integrated Genetics); Seen mainly as a learning strategy	Approval of in-house developed recombinant alpha-interferon; Decision to build biotechnological fermentation plant in Biberach, Germany, approved within 3 months		Schering sees limited commercial potential in biotech fermentation techniques, more in R&D processes
1986	Approval for stage II denied; "National campaign" against Hoechst; Objections filed against insulin plant			German fermentation plant operational, start sales of Activase (tPA)	Builds additional biotech R&D and production complex in Penzberg, Germany	Berlin Institute opens, focus is on plant biology
1987	Permit for stage I revoked and later reinstated by changing state governments					
1988	Behringwerke applies for permit to operate a plant for recombinant EPO in Marburg. 1800 objections filed; Insulin plant approved but contested in court	Decision to greatly expand R&D facility in New Haven; location for producing Factor VIII will be Berkeley, not Wuppertal	BASF invests to create a biotechnology R&D lab in Worcester, MA		Inlicence of recombinant EPO from Genetics Institute, approval for production in Penzberg	
1989	Street protests against EPO plant; Appeal court revokes permits for insulin plants; Decision to build new plant in France		Knoll applies for permit to operate a plant for TNF in Ludwigshafen, in parallel examines alternative sites abroad in case it won't receive speedy approval			

<b>Year</b>	<b>Hoechst</b>	<b>Bayer</b>	<b>BASF</b>	<b>Boehringer Ingelheim</b>	<b>Boehringer Mannheim</b>	<b>Schering</b>
1990	Federal genetics law comes into effect, EPO and insulin plants approved, but challenged again in court	Bayer and Max-Planck Institute start first field trial of genetically modified plants in Germany – triggers strong protests and trial is a scientific failure	Objections are filed and considered against the Ludwigshafen TNF plant		Launch of recombinant EPO (Recorman) and HIV test (own development)	Acquisition of Codon (cardio) and Triton (betaseron patent with Chiron) in the US
1991	Hoechst starts production of recombinant Factor XIII in Japan		TNF plant is approved, but challenged in court	Launch of recombinant gamma-interferon	Expansion of Penzberg facility, two additional recombinant diagnostics launched	
1992	Behring's EPO patent is challenged by Amgen		Court rejects appeal against TNF plant permit			
1993	Production of insulin begins in Frankfurt and France	Launch of recombinant Factor VIII in North America	TNF fails in phase III clinical trials, Knoll terminates development work		Acquisition of Protein Design Labs in the US	US Launch of betaseron , production for US at Chiron, for Europe at BI
1994		European launch of Factor VIII; Acquisition of Streling OTC business and rights to Bayer name in USA	Change in strategy for BASF's pharmaceutical business: focus on galenics and drug delivery	Concentration of biotech production in Biberach, Germany, research in Austria		
1995	Hoechst acquires Marion Merill Dow, begins to diversify Behringwerke					
today	Hoechst merged with Rhone-Poulence to form Aventis in 1999. Biotechnology activities are distributed in France, the USA, Japan and Germany. Aventis was taken over by Sanofi in 2005	Bayer performs most of its biotechnology research in the U.S. and Japan, operates a small fermentation plant in Germany; has been unable to launch new biotechnology products since Factor VIII	BASF sold its pharmaceutical business in 2000, citing lack of critical mass and unsatisfactory profitability	BI boasts largest biotech fermentation facility in Europe (Biberach, Germany) and an active biotech R&D and production site in Austria	BM was acquired by Roche in 1997, Penzberg/Tutzing complex is one of Roche's main biotech R&D and production facilities	Schering has been able to develop additional biotech drugs while making good profits with betaseron as a MS treatment