

**Knowledge-Bearing Elites
and Industrial Performance in
France and Germany**

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Abstract

Most comparative studies of public policies for competitiveness focus on the links among public agencies and industrial sectors. This paper argues that the professions—or knowledge-bearing elites—that animate these organizational links are equally significant. For public policies to promote technological advance, the visions and self-images of knowledge-bearing elites are particularly important. By examining administrative and technical elites in France and Germany in the 1980s, the paper identifies characteristics that enable these elites to implement policy in some cases, but not in others. France's "state-created" elites were well-positioned to initiate and implement large technology projects, such as digitizing the telecommunications network. Germany's state-recognized elites were, by contrast, better positioned to facilitate framework-oriented programs that aimed at the diffusion of new technologies throughout industry. The linkages among administrative and technical elites also explain why French policymakers had difficulty adapting policy to changing circumstances over time while German policymakers managed in many cases to learn more from previous policy experiences and to adapt subsequent initiatives accordingly.

Knowledge-Bearing Elites
and
Industrial Performance in France and Germany¹

J. Nicholas Ziegler

Several strands of social science analysis have begun to redirect attention to the importance of knowledge-bearing groups in processes of political and economic change. This development has been clearest in studies of international policy coordination, where "epistemic communities" have been treated as important explanatory factors in areas ranging from arms control to environmental protection.² An interest in expert groups has been slightly less prominent in comparative politics, but studies of national economic policies have given considerable attention to different schools of economists and their political influence.³ At the level of practical knowledge, the accumulation of production skills has become a

¹ Institutional and financial support for this research was provided by the Center for European Studies, Harvard University, and the Max-Planck Institut für Gesellschaftsforschung, Cologne. Earlier versions were presented at the American Political Science Convention, Chicago, Illinois, September, 1992, and at the Sloan Comparativists Group, November, 1992. For assistance, comments, and criticisms, I would especially like to thank Edgar Grande, Mauro Guillen, Peter Hall, Jürgen Häusler, Richard Locke, Cathie Martin, Renate Mayntz, Robert Putnam, Richard Samuels, David Vogel, Margaret Weir, and Eleanor Westney. Interpretations and data are the responsibility of the author.

² See the essays in Peter M. Haas, ed., International Organization, 46:1 (Winter 1992).

³ See the essays in Peter A. Hall, ed., The Political Power of Economic Ideas: Keynesianism Across Nations (Princeton: Princeton University Press, 1989).

central question in comparative studies of work organization.⁴ Parallel to these discussions, sociologists and historians of the professions have embarked on broader efforts to compare knowledge-bearing groups and their emergence in industrial societies.⁵

This paper argues that the politics of knowledge-bearing elites can also help resolve many of the outstanding puzzles regarding comparative industrial performance. As technological innovation takes on a growing role in competitive outcomes, the knowledge-bearing occupations take a central role in public strategies for industrial change. The pathways by which these groups make different kinds of knowledge available to industrial enterprises can be decisive in the processes that lead some firms to flourish and others to disappear. Since the distribution of knowledge across public and private organizations varies dramatically from country to country, it imposes important conditions on the policies that public officials can effectively employ in different countries. Yet, the distribution of knowledge is more than a fixed constraint on policy. Knowledge flows through channels that reflect deeply engrained ideas about the prestige and authority of different professional groups. For this reason, policy depends in overlooked ways on the self-images and prestige hierarchies that inform relations among administrative and technical elites.

This paper develops this argument on the basis of cases drawn from France and Germany. In Part One, I review existing explanations of the state's efforts to promote industrial performance. In Part Two, I define more precisely how to classify policy efforts

⁴ See Charles Sabel, Work and Politics (New York: Cambridge University Press, 1982).

⁵ See the essays in Rolf Torstendahl and Michael Burrage, eds., The Formation of Professions: Knowledge, State and Strategy (London: Sage, 1990) and Michael Burrage and Rolf Torstendahl, Professions in Theory and History: Rethinking the Study of the Professions (London: Sage, 1990).

to promote competitiveness. In Part Three, I compare French and German policy efforts to boost competitiveness in two sectors, telecommunications and machine tools. In Part Four, I discuss the generalizability of results from the French and German cases.

I. EXISTING EXPLANATIONS

Several strands of inquiry support the view that knowledge has become a central determinant in the industrial performance of firms and countries alike. Theories of the firm have focused increasingly on internal resources, including human resources. Growth theorists are also actively trying to refine the treatment of human capital, including educational levels and inventive activities, in models of endogenous growth. Similarly, trade economists have found that R&D activities can exert decisive effects on industrial leadership in particular industries. Debates on the sources of competitiveness variously stress the importance of workforce skills, scientific knowledge and other intangible factor inputs.⁶ Despite these tantalizing results, political scientists have done little to integrate an analysis of knowledge-carrying elites into the comparative examination of explicit policy efforts to bolster industrial performance.

⁶ For developments in theory of the firm, see Michael Best, "Theoretical Perspectives on the Firm," chapter 4 in *The New Competition* (Cambridge, Harvard University Press, 1990); Birger Wernerfelt, "A Resource-Based View of the Firm," *Strategic Management Journal*, 5 (1984): 171-180; and Gary Hansen and Birger Wernerfelt, "The Determinants of Firm Performance: The Relative Importance of Economic and Organizational Factors," *Strategic Management Journal*, 10 (1989): 399-411. For growth theory and its use in models of trade performance, see respectively Paul Romer, "Endogenous Technical Change," *Journal of Political Economy*, 98:5, part 2 (October 1990): S71-S102 and Gene Grossman and Elhanan Helpman, *Innovation and Growth in the Global Economy* (Cambridge: MIT Press, 1991). For management theories, see Michael Porter, *Competitive Advantage of Nations* (New York: Free Press, 1990), esp. 74-77.

Earlier debates on industrial performance revolved around the categories of state capacity and market outcomes. Political scientists contributed to these debates by illuminating institutional levers that enabled public officials in different countries to shape market outcomes in different ways. This approach tended to inscribe knowledge-bearing groups within an organizational approach to state and non-state actors.⁷ The emphasis on organizational structure was largely a corrective to earlier pluralist approaches, which conceptualized public policy as a simple resultant of shifting societal pressures.⁸ In this sense, industrial policy represented an important area for exploring the state's capacity to allocate resources preferentially to sectors that were thought to contribute disproportionately to the state's long-term agenda.

There was little doubt that this strand of institutionalist writing treated technical expertise as an important resource contributing to the state's effectiveness. Theda Skocpol noted that the state's ability to retain "loyal and skilled officials" had long been counted among the "sinews of state power."⁹ The broader research program envisioned a "relational" approach to state and non-state actors. According to the editors of Bringing the State Back In, a full understanding of state interventions required "a better understanding of the historically evolved interrelations between states and 'knowledge-bearing occupations,'

⁷ Some of the principal works include William Atkinson and Michael Coleman, "Strong State and Weak State," British Journal of Political Science, 19 (January 1989); Peter Katzenstein, Small States in World Markets: Industrial Policy in Europe (Ithaca: Cornell University Press, 1985); Maurice Wright and Stephen Wilks, eds., Comparative Government-Industry Relations (Oxford: Clarendon Press, 1987); John Zysman, Government, Markets, and Growth: Financial Systems and the Politics of Industrial Change (Ithaca: Cornell University Press, 1983).

⁸ James P. March and Johan P. Olson, "The New Institutionalism," American Political Science Review, 78 (September 1984).

⁹ Theda Skocpol, "Bringing the State Back In: Strategies of Analysis in Current Research," in Peter Evans, et. al., eds., Bringing the State Back In (New York: Cambridge, 1985), 16.

particularly the modern social science professions." In terms of demonstrating state capacities, however, the editors recommended "the identification of specific organizational structures the presence (or absence) of which seems critical to the ability of state authorities to undertake given tasks."¹⁰ Partly because they were easier to document, the structural as opposed to the process or cognitive characteristics of organizations received priority.

This structural approach to organizations was extended to the concept of policy networks, which were seen as clusters of organizations linked together by resource dependencies.¹¹ The cognitive and informal aspects of these networks were usually brought into the analysis as contextual -- and causally subordinate -- factors.¹² The ability of non-state actors to mobilize expertise was recognized. But there was little attention given to the role of expert groups or any other transorganizational associations that might animate such policy networks.¹³

¹⁰ Peter B. Evans, Dietrich Rueschemeyer, and Theda Skocpol, "On the Road Toward a More Adequate Understanding of the State," in Evans, et. al., eds., Bringing the State Back In (New York: Cambridge, 1985), pp. 351, 359.

¹¹ Important examples include Peter Katzenstein, "Conclusion," in Katzenstein, ed., Between Power and Plenty: Foreign Economic Policies of Advanced Industrial States (Madison: University of Wisconsin Press, 1978); William Atkinson and Michael Coleman, "Strong States and Weak States: Sectoral Policy Networks in Advanced Capitalist Economies," British Journal of Political Science, 19 (January 1989); and Stephen Wilks and Maurice Wright, "Conclusion: Comparing Government-Industry Relations: States, Sectors, and Networks," in Wilks and Wright, eds., Comparative Government-Industry Relations: Western Europe, the United States, and Japan (Oxford: Oxford University Press, 1987), 274-313). Recent reviews of this literature are provided in R.A.W. Rhodes, "Policy Networks: A British Perspective," Journal of Theoretical Politics, 2:3 (1990): 293-317; Grant Jordan, "Sub-Governments, Policy Communities and Networks: Refilling the old Bottles?" Journal of Theoretical Politics, 2:3 (1990): 319-338; and Patrick Kenis and Volker Scheider, "Policy Networks and Policy Analysis: Scurtinizing a New Analytical Toolbox," in Bernd Marin and Renate Mayntz, eds., Policy Networks: Empirical Evidence and Theoretical Considerations (Frankfurt: Campus, 1991).

¹² For mentions of such informal links, see Peter Katzenstein, "Small Nations in an Open International Economy," in Peter Evans., et. al., eds., Bringing the State Back In, pp. 233, 243, and Wilks and Wright, pp. 284 ff.

¹³ One exception, which deals with health policy and transport policy, is R.A.W. Rhodes, The National World of Local Government (London: Allen and Unwin, 1986).

The tendency to focus on the structural characteristics of the organizations in a policy network has contributed to several difficulties in explaining the variations observed in state capacities. First, as is now well known, state capacities cannot be inferred directly from the structural characteristics of the state alone. State power clearly varies across policy sectors,¹⁴ and even highly centralized states are obliged to rely on external networks in important cases.¹⁵ Second, structural analysis tends to bracket out those aspects of the policy process that explain the links (or gaps) between policy formulation and policy implementation. Several studies have shown that the processes of bargaining and securing consent are central to the state's ability to implement policies in areas ranging from environmental regulation to energy sourcing.¹⁶ Third, a narrow focus on the structural characteristics of organizations, cannot explain the adaptation of policy over time. Organizational structures impose constraints on the actions of state and non-state actors, but the motives that lead to action in the first place also need to be specified.

More recent work on the comparative forms of capitalism seeks to ameliorate the stark dichotomy between state and market by examining a range of institutions from financial

¹⁴ Atkinson and Coleman, "Strong States and Weak States"; Wilks and Wright, "Conclusion: Comparing Government-Industry Relations: States, Sectors, and Networks."

¹⁵ Harvey B. Feigenbaum, The Politics of Public Enterprise (Princeton: Princeton UP, 1985) and Richard J. Samuels, The Business of the Japanese: State Energy Markets in Comparative and Historical Perspective (Ithaca: Cornell University Press, 1987).

¹⁶ David Vogel, National Styles of Regulation: Environmental Policy in Great Britain and the United States (Ithaca: Cornell University Press, 1986), esp. 284, and Samuels, The Business of the Japanese State.

systems and labor markets to supplier networks and business associations.¹⁷ While different authors emphasize different institutions, management theorists have entered the debate by stressing the links between country characteristics and company strategies. This approach is well represented by Michael Porter's Competitiveness of Nations. One of Porter's principal achievements is his demonstration that the most competitive firms in a particular industry do indeed "cluster" in particular countries. Owing to its compelling empirical foundation, Porter's work has established that explanations of country competitiveness must discriminate among different industries. Porter explains the performance of industry clusters through four types of variables: factor inputs; demand characteristics; the strength of supplier and buyer industries in the same country; and intra-industry rivalry.

One of the weaknesses of his approach is that Porter does not show why these explanatory categories have to change at the boundaries of national territories instead of (subnational) industrial districts or (supernational) blocs. Since Porter relegates "government" to peripheral status in his explanatory scheme (on the same par with "chance"), he cannot fully explore any of the institutions sustained primarily by the political order -- precisely those that covary most clearly with national borders. Porter's framework can also be faulted for providing little insight into the process by which public officials might strengthen the conditions for competitiveness in different countries.

While other works in the management literature on competitiveness give more attention to the problem of geographic scope and levels of analysis, none of them claim to

¹⁷ See, for example, Michel Albert, Capitalism Against Capitalism (London: Whurr, 1993); Jeffrey E. Garten, A Cold Peace: America, Japan, Germany, and the Struggle for Supremacy (New York: Times Books, 1992); Jeffrey A. Hart, Rival Capitalists: International Competitiveness in the United States, Japan, and Western Europe (Ithaca: Cornell, 1992); and Michael Porter, The Competitive Advantage of Nations (New York: Free Press, 1990).

untangle the mix of country and industry effects that explain why successful clusters emerge in some countries and not in others.¹⁸ This article approaches the problem by comparing institutional features that are constant within countries but that interact with industry characteristics in ways that plausibly explain sector-specific outcomes. For sectors characterized by rapid or extensive technological change, the expert professions are central.

II. ELEMENTS OF THE ARGUMENT

As technological change has taken on growing analytic significance in explanations of economic growth, it has also gained in political appeal. Political leaders in almost all advanced industrial countries have seized upon technology because it offers a politically more attractive response to international competition than shedding jobs or investing in long-term educational reforms that promise slim electoral payoffs. When they seek to justify and implement public efforts to promote the technology base for industry, however, politicians are powerfully constrained by the division of labor among knowledge-bearing elites.

¹⁸ See especially Bruce Kogut, "Country Capabilities and the Permeability of Borders," Strategic Management Journal, 12 (1991): 33-47; Giovanni Dosi and Bruce Kogut, "National Specificities and the Context of Change" and other essays in Bruce Kogut, ed., Country Competitiveness: Technology and the Organizing of Work (New York: Oxford, 1993).

A. Outcomes: Categories of Technology Policy

This paper focuses on state efforts to bolster competitiveness through promoting particular industrial technologies. As defined here, such technology policies exclude a range of related policy instruments including general education, trade protection, or anti-trust regimes. While these policies can all affect a country's competitive performance in important ways, their effects can be separated from those of explicit technology policies through carefully matched comparisons. This paper compares policies toward two industries in France and Germany in order to isolate the institutional factors that shape political efforts to promote technological levels. Technology policies necessarily involve the transfer of public funds -- sometimes to firms, but also to trade associations, research institutes, and other intermediary organizations. Yet it is not the allocation of resources alone that makes technology policies distinctive. They are also differentiated by the goals, the recipients, and the conditions attached to them by the state. One of the most useful ways of categorizing technology policies is the distinction, developed by Henry Ergas, between "mission-oriented" and "diffusion-oriented" policies. While these terms rest mainly on the goals of policy, they are also useful for purposes of analytic explanation because the specific instruments devised to achieve these objectives are produced by highly characteristic policy processes.¹⁹ It is these policy processes where the effect of knowledge-bearing elites becomes clear.

¹⁹ These terms are drawn from Henry Ergas, "Does Technology Policy Matter?" in B. R. Guile and H. Brooks, Technology and Global Industry: Companies and Nations in the World Economy (Washington, DC: National Academy Press, 1987).

Mission-oriented policies involve large-scale projects that aim at creating specific technologies of direct interest to the state, usually for pursuing a discrete public mission. Mission-oriented policies are typically defense-related, although they can also be found in health, energy, or transportation infrastructure. They are usually justified by reference to national autonomy, national development plans, or national prestige.

In addition to these goals, mission-oriented policies can be identified through their characteristic patterns of initiation, formulation, and implementation. Mission-oriented policies are typically initiated by the state. They are formulated by a small group of public officials who receive advice from at most a small group of non-state experts. And they allow public officials great discretion in choosing particular firms and specific technologies to be supported.

Diffusion-oriented policies aim at establishing mechanisms to encourage the dissemination of capabilities throughout the economy. These policies often involve the provision of consulting or training services, information resources, incentives for collaborative research, and small-grant programs to help firms master the use of new generic technologies.

Like mission-oriented policies, diffusion-oriented policies have characteristic patterns of initiation, formulation, and implementation. They are often initiated as much by non-state actors as by state agencies. They are typically formulated through discussion with a broad range of interested parties, including public officials, industry representatives, labor, and professional associations. Finally, diffusion-oriented policies are usually implemented by intermediary bodies such as professional or industry associations that distribute resources to

broad classes of recipients rather than a few firms selected by officials in the central administrations.

B. Explanations: The Use of Knowledge as a Policy Resource

Technology policies depend on different types of knowledge -- scientific learning, applied science and engineering, technical expertise, and practical know-how. These several types of knowledge cannot be allocated and reallocated like material resources, however, because they are carried by occupational groups. Since these groups have distinct occupational identities and particular avenues of access to the policy process, they shape public policies in patterned ways. These identities and avenues to political power in turn hinge on the historical processes by which knowledge-bearing elites emerge as recognized "professions."

The formation of the expert professions has been a central topic in postwar sociology. According to Talcott Parson, the professions occupy a critical place in the structure of all complex societies. Parsons wrote that the professions provided "the institutional framework in which many of our most important social functions are carried on, notably the pursuit of science and liberal learning and its practical application in medicine, technology, law and teaching."²⁰ One possible extrapolation of this view was that occupational prestige

²⁰ Talcott Parsons, "The Professions and Social Structure," in Essays in Sociological Theory (New York: Free Press, 1954), as quoted in Magali Sarfatti Larson, The Rise of Professionalism (Berkeley: University of California Press, 1977), xiii.

hierarchies were "invariant in all complex societies."²¹ Because all societies followed the same path of differentiation, particular occupations were granted the same degree of authority in all societies at the same stage of development.

More recent studies have shown, however, that these prestige hierarchies grow out of specific historical experiences rather than a general developmental pattern. Knowledge-bearing groups compete within one another to advance their claims for jurisdiction over the application of knowledge to solve particular tasks. While all expert groups appear to undergo a similar sequence of conflicts and internal changes as they gain professional status, the timing and scope of jurisdiction gained by different groups is not dictated by any abstract formula.²² On the contrary, the prestige and legitimacy accorded to professional groups are inseparable from complex histories of intergroup competition and institution-building in which bargains with political authorities often play a major role. According to Magali Larson, these histories represent a particular group's "professionalization project."²³

The drive for recognition sought by most professions entails a mix of material advancement, organizational autonomy, and social prestige. This mix of goals makes it difficult to illuminate the political role played by the professions through a lens focused only on the structural links among organizations. Everett Hughes, whose view of the professions

²¹ Donald J. Treiman, Occupational Prestige in Comparative Perspective (New York: Academic Press, 1977).

²² Andrew Abbott, The System of Professions: An Essay on the Division of Expert Labor (Chicago: University of Chicago Press, 1988). See also John Van Maanen and Stephen R. Barley, "Occupational Communities: Culture and Control in Organizations," Research in Organizational Behavior , 6 (1984).

²³ Magali Sarfatti Larson, The Rise of Professionalism (Berkeley: University of California Press, 1977), esp. pp. 50 ff.

hinged on the interplay of mandate and trust, also pointed to the normative basis of professional authority in questions of public policy.

Every profession considers itself the proper body to set the terms in which some aspect of society, life or nature is to be thought of, and to define the general lines, or even the details, of public policy concerning it.²⁴

On this view, prestige is as much a resource as organizational autonomy or material position in the efforts of professional groups to maintain their role in public affairs.

Since there is no abstract logic that dictates the trajectory of a professionalization project, the balance of power and prestige attached to a particular occupation can vary significantly across countries. Comparative studies show consistently that the knowledge-bearing occupations in Continental Europe were discernibly more reliant on state authorities in their pursuit of professional status than were their British or American counterparts.²⁵ While the British and American professions sought to maintain their autonomy and to achieve an exclusive license to provide their services, similar groups in Central Europe were either incorporated within the state bureaucracy or they traded some of their autonomy in exchange for recognition from the state and the increased social prestige that accompanied such recognition. For France and Germany in particular, one result of these distinctive histories

²⁴ Everett Hughes, "Professions," *Daedalus* (Fall 1963): 657.

²⁵ Jürgen Kocka, "'Bürgertum' and the Professions in the Nineteenth Century" and other essays in Rolf Torstendahl and Michael Burrage, eds., *The Formation of Professions: Knowledge, State and Strategy*. See also Charles E. McClelland, *The German Experience of Professionalization: Modern Learned Professions and their Organizations from the Early Nineteenth Century to the Hitler Era* (New York: Cambridge University Press, 1991), esp. chapter 2.

is that the English word, "profession," has no good translation -- the reason the term "knowledge-bearing occupation" comes closer to analytic neutrality.²⁶

These historical experiences mean that scientific learning and technical expertise are distributed very differently across the occupational maps that characterize different societies. For the policies examined in this paper, engineers are the central group. Their position in an occupational map is described by two dimensions. First, the degree to which the state itself defines the engineering profession has broad implications for the political access as well as the autonomy that engineers enjoy. Second, the distance that separates engineers from other knowledge-bearing groups in the occupational hierarchy has broad implications for the vertical flows of information among different groups involved in technological change. The differences that can be found along these dimensions are well illustrated by France and Germany.

C. The Argument

Since the occupational identities of expert groups are rooted in their relationship to political authority, they are shaped in important ways by each country's particular history of state formation. France is well known as a case where engineers quickly gained a central

²⁶ The French "profession" and German "Beruf" both translate as occupation, while the German "freie Berufe" refers specifically to self-employed rather than salaried specialists. These issues are discussed in McClelland, The German Experience of Professionalization, pp. 15-16, and Kocka, "'Bürgertum,'" 67 ff.

position in a system of "state-created elites."²⁷ In 1794, shortly after the Revolution, the new Ecole Polytechnique took over the training of military officers and became the prototype for the grandes écoles that trained France's civil servants in the nineteenth and the early twentieth centuries. By prohibiting guilds and occupational associations through the loi le Chapelier of 1791, the Constituent Assembly ensured that the self-images and organizational resources of the knowledge-bearing occupations would be stamped primarily by their training in state-run schools and career in public administrative services. Despite the social and political change that occurred during the nineteenth century, there were elements of remarkable continuity.²⁸ The educational system was one area where, even after the Second World War, the older attitudes "reigned supreme."²⁹ In particular, the pattern of centralized gate-keeping was extended in 1945 when the Ecole Nationale d'Administration (l'ENA) was established to provide training for civil servants with specialties outside the natural or engineering sciences.

A second characteristic of France's occupational structure was the deep gulf that separated the engineers trained in the elite grandes écoles from other technical occupations. For most of the postwar period, French educational hierarchies allowed surprisingly little possibility for continuing education, once an individual had begun active work life. Skilled workers and technicians had little chance of gaining further educational credentials. With

²⁷ This term is from Ezra Suleiman, Elites in France: the Politics of Survival (Princeton: Princeton University Press, 1978). See also Terry Shinn, "Reactionary Technologists: The Struggle over the Ecole Polytechnique, 1880-1914," Minerva, 22:3/4 (Autumn 1984).

²⁸ For example, George Weisz, The Emergence of Modern Universities in France, 1863-1914 (Princeton: Princeton University Press, 1983).

²⁹ Stanley Hoffmann, "Paradoxes of the French Political Community," In Search of France (Cambridge: Harvard University Press, 1963), 73.

sufficient seniority and internal promotion, technicians could sometimes become in-house engineers (ingénieurs maisons), but their knowledge tended to be plant-specific and their career trajectories were entirely different from the ingénieurs diplômés who had graduated from the elite engineering schools. This highly stratified educational system led in turn to a highly stratified career hierarchy for technically trained personnel.³⁰

If France's social investment in science and technology was focused on a cohesive group of state-created elites, Germany's included a broader group of technical occupations that were certified but not created by the state. In the German case, engineers enjoyed neither the access to state power nor the social prestige that their French counterparts had gained by the early nineteenth century. For one thing, the values of Germany's educated middle classes (Bildungsbürgertum) stressed humanism and classical learning more than technical prowess. More importantly, however, the sequence of industrialization and state-building allowed German engineers a much less vaunted status than their French counterparts. Since heavy industrialization began in Germany before the creation of a unified state, German engineers established a base in private industry. Given their private-sector roots, the engineers based their quest for public recognition on the problems of Germany's growing industrial economy. One typical issue where they pressed their claim to competence concerned the regulation of steam boilers (the Dampfkesselkontrollfrage). Through such debates, the goals of industrial safety and reliability became central to

³⁰ On the stratified nature of French occupational hierarchies, see Michel Crozier, The Bureaucratic Phenomenon (Chicago: University of Chicago Press, 1965); Marc Maurice, François Sellier, and Jean-Jacques Silvestre, The Social Foundations of Industrial Power: A Comparison of France and Germany, trans., A. Goldhammer (Cambridge: MIT Press, 1982, 1986); and Stephen Crawford, Technical Workers in an Advanced Society: The Work, Careers and Politics of French Engineers (NY: Cambridge, 1989).

the identity of the emerging profession. After the formation of the German Engineering Association (Verein Deutscher Ingenieure, VDI) in 1856, the German engineers further advanced their position by fighting to control technical education and to gain protected status for the title, "engineer."³¹

As German engineers gradually obtained state recognition, they remained part of a occupational hierarchy characterized by much stronger links among distinct occupations than could be found in France. Since German technical universities had strong regional ties, even the best known schools such as Aachen or Munich or Berlin could not generate as cohesive an elite as the French grandes écoles. Basic and middle-level technical training in Germany's "dual system" also differed dramatically from that in France. The critical importance of intermediary institutions for training emerged through the bargains struck among industry groups and public agencies in the nineteenth century.³² In the twentieth century, the curricula (particularly the articulation of workplace training and classroom work) have been laboriously negotiated at the local level by the firms and schools, while the standard requirements for certification were approved at the regional and federal level by representatives of employers and trade unions. Owing to such arrangements, Germany's institutions for technical training and education have provided a continuous spectrum of practical and theoretical competencies. These competencies in turn comprised a much more

³¹ Peter Lundgreen, "Die Vertretung technischer Expertise' im Interesse der gesamten Industrie Deutschlands' durch den VDI 1856 bis 1890," and other essays in Karl Heinz Ludwig, ed., Technik, Ingenieure und Gesellschaft: Geschichte des Vereins Deutscher Ingenieure 1856-1981 (Düsseldorf: VDI-Verlag, 1981), 67 ff. See also Werner Conze and Jürgen Kocka, eds., Bildungsbürgertum im 19. Jahrhundert: Bildungssystem und Professionalisierung in internationalen Vergleichen (Stuttgart: Klett-Cotta, 1985); Geoffrey Cocks and Konrad H. Jarausch, eds., German Professions, 1800-1950 (NY: Oxford, 1990); and McClelland, The German Experience of Professionalization.

³² Jürgen Schriewer, "Intermediäre Instanzen, Selbstverwaltung und berufliche Ausbildungsstrukturen im historischen Vergleich," Zeitschrift für Pädagogik, 32:1 (1986).

tightly linked, or "organic," occupational hierarchy than the sharply stratified hierarchy of technical occupations in France.³³ These organic links among occupational groups have become one of the most widely examined contextual factors shaping industrial strategies and developments in Germany.³⁴

These dimensions extract narrow elements from the complex histories of the technical elites in advanced societies, but they generate significant propositions about the types of technology policies that can be formulated and implemented in different countries. Countries where engineers enjoy high prestige in a hierarchy of state-created elites will show a predisposition toward mission-oriented policies. These elites are socialized in steep educational pyramids to see themselves as responsible for determining the public interest in matters of technology choice. Such elites are, in practice, often better trained for defining the state's activities in terms of specific, substantive missions than in terms of the indeterminate frameworks required for diffusion-oriented policies.

By contrast, countries whose engineers are positioned within a system of state-recognized occupations are predisposed toward diffusion-oriented technology policies. In such cases, engineers are based largely in the private sector. Acting as external advisory

³³ These links are analyzed in terms of "overlapping" skill sets in Arndt Sorge and Wolfgang Streeck, "Industrial Relations and Technical Change: The Case for an Extended Perspective," in Richard Hyman and Wolfgang Streeck, eds., New Technology and Industrial Relations (Oxford: Blackwell, 1988). For the complex negotiations required to change these skill sets, see Wolfgang Streeck, Josef Hilbert, K-H van Kevelaer, Friederike Maier, Hajo Weber, "The Role of the Social Partners in Vocational Training and Further Training in the Federal Republic of Germany" (Luxemburg: Amt für amtl. Veröffentlichungen der EG, 1987).

³⁴ These links are explored through individual career patterns in Charles Sabel, Work and Politics (New York: Cambridge University Press, 1982). Their implications for industrial strategies and change are explored in Michael Piore and Charles Sabel, The Second Industrial Divide: Possibilities for Prosperity (New York: Basic, 1984); Sorge and Streeck, "Industrial Relations and Technical Change"; and David Soskice, "The Institutional Infrastructure for International Competitiveness: A Comparative Analysis of the U.K. and Germany," in A.B. Atkinson and R. Brunetta, eds., The Economics of the New Europe (London: Macmillan, 1993).

groups, they have little opportunity to control detailed parameters of large public projects and more opportunity to influence policy if they champion such general concerns as safety, reliability, and efficiency. Positions within the public bureaucracy are more apt to be held by lawyers, macroeconomists, and other professionals whose expertise is largely procedural rather than substantive. Such officials see themselves as responsible for coordinating competing social interests and they are in practice better trained to design regulatory frameworks than to set technical parameters of mission-oriented projects. When they do attempt mission-oriented projects, these officials possess neither the technical expertise nor the informal contacts in external networks that they would need in order to monitor such projects directly.

The cross-cutting dimension that refers to linkages among occupations within a prestige hierarchy is more relevant to the implementation of policy. On this dimension, stratified occupational hierarchies may prove helpful in implementing mission-oriented policies but they are poorly suited for implementing diffusion-oriented policies. In stratified systems, the most prestigious occupations are sharply demarcated in status and competence from other occupations. If particular occupations span public- and private-sector organizations (as they often when members of state-created elites "descend" later in their careers to private organizations), then they can contribute to tight informal networks that facilitate the implementation of large-scale projects. Such marked separations, however, necessarily inhibit the implementation of diffusion-oriented policies. The same demarcations that create status distinctions in an occupational hierarchy tend very strongly to perpetuate

gaps in the kinds of skills that policy makers need to identify and mobilize in order to diffuse capabilities throughout an economy.

Organic occupational prestige hierarchies need not inhibit mission-oriented policies, but they greatly facilitate the implementation of diffusion-oriented policies. Organic occupational hierarchies imply that there are few gaps in the types of knowledge that extends across a range of occupations. When skills are well articulated across occupations, policymakers are better able to identify the skills and to fashion incentive frameworks that will help managers support the skills needed for assimilating new products and processes.

These propositions indicate that France and Germany should offer particularly clear cases of mission-oriented and diffusion-oriented policies. Leading an order of state-created elites, French policymakers are likely to think of their task as formulating mission-oriented policies. Moreover, with a highly stratified occupational hierarchy, France is poorly adapted to implement diffusion-oriented policies. Within an order of state-recognized elites, German policymakers are predisposed against mission-oriented policies. Moreover, Germany's organic hierarchy of technical occupations is likely to facilitate the implementation of diffusion-oriented policies. The cases that follow offer powerful evidence for these tendencies.

III. CASES

Technology policies aim to solve problems that are inherently characterized by sector-specific circumstances. Indeed, the success of such policies often hinges on whether officials can

adapt policy instruments to fit the problems of particular industries. In practice, however, national patterns in technology promotion show surprising persistence: public officials tend to apply similar recipes across sectors whether or not those recipes are appropriate. The economic consequences represent an interaction of preferred policy recipes with sector-specific circumstances.

The two cases compared here -- telecommunications switching equipment and numerically controlled machine tools -- display dramatic variations on these sector-specific circumstances. Given their centrality for modern economies, it is not surprising that public agencies in France and Germany launched ambitious programs to promote technological levels in both sectors. Yet the policy experiences of the two countries were almost precisely inverse to one another. Public officials transformed the French telephone system through an exemplary case of mission-oriented policy, but they failed to find instruments that could do much of anything to ameliorate the technological backwardness of the machine-tool sector. German officials had difficulty promoting the desired changes in telecommunications switching technology, but they assembled a remarkably successful bundle of policies for encouraging technological change in Germany's crucial machine-tool sector. In both countries, the contours of policy were shaped as much by the relations among technical and administrative elites as by the constraints of organizational structure.

A. Telecommunications Switching Equipment.

In both France and Germany, the telecommunications sector was a natural candidate for mission-oriented policy approaches. Telephone service was provided by public administrations in both countries, the PTT in France and the Deutsche Bundespost in the Federal Republic of Germany. In the 1970s, the public authorities sought to prepare the introduction of new digital, or computerized, switching exchanges into their networks. The technology in question was a large, lumpy investment good, which was necessary for the fulfillment of an important public mission. Although the French PTT and the German Bundespost were granted remarkable organizational autonomy to pursue their mission, they utilized very different approaches for promoting technology levels within the public telephone system.

1. Telecommunications -- France

Telecommunications emerged as a priority sector in postwar France during preparations for the Seventh Plan, scheduled to run from 1975 to 1981. French planners had previously focused largely on heavy industries and export promotion. Yet the country's phone system urgently required attention.³⁵ Although its elaboration was left to the new

³⁵ The main sources for this account include Catherine Bertho, Télégraphes et téléphones: de Valmy au microprocesseur (Paris: Livres de Poche, 1982); Louis-Joseph Libois, Genèse et croissance des télécommunications (Paris: Masson, 1983); and Elie Cohen, Le Colbertisme "High Tech": Economie des Télécommunications et du grand projet (Paris: Hachette, 1992).

cabinet appointed by Giscard d'Estaing in 1974, the telecommunications plan became an exemplary case of the Gaullist grand projet. As in other grands projets, the state conducted research and development in a public research installation, financed development of a commercial prototype, and provided a market through public procurement. This recipe had been successfully used for nuclear power technologies, oil exploration, aerospace, and rail transport. In the 1970s, it was to be applied to telecommunications as well.

A crucial element in these large-scale projects was the existence of specialist civil servants whose technical competence was adequate to monitor and link the various phases. Critics argued that the elite civil servants, or grands corps, were a closed network whose primary resources were political connections rather than genuine expertise. Indeed, for the large-scale technological projects, it was not sufficient to have the grands corps in the central Ministries unless other specialists with more specific capabilities could implement the programs. For France's massive effort to upgrade its telephone system, the implementation of specific measures was assured by the corps des ingénieurs des télécommunications. Ironically, the ingénieurs des télécommunications, who were not usually included among the vaunted grands corps in the 1970s, were one of the few administrative services or corps that did genuinely deliver the type of technical expertise on which the reputation of the grands corps had originally been established.

The ingénieurs des télécommunications coalesced in the early twentieth century, using research as a lever to advance the weight of the Direction Générale des Télécommunications

(the predecessor to France Telecom) within the PTT.³⁶ Their base was greatly broadened by the founding in 1944 of a federation of laboratories known as the Centre National d'Etudes des Télécommunications (CNET). In 1970, a group of the younger engineers articulated a new mixture of entrepreneurialism and dirigist solutions in a pseudonymous analysis of France's "crise du téléphone." By arguing that efficiency and performance could best be achieved through technical mastery, the authors highlighted the contributions of the ingénieurs des télécommunications in developing the public infrastructure. At the same time, they attacked the bureaucratic inertia of the PTT's administrative corps and argued for the kind of massive investments that were approved a few years later.³⁷

Through their research activities in the CNET, the ingénieurs des télécommunications performed much of the early work on fully electronic phone exchanges. A prototype known as the Projet Platon (after the Greek philosopher Plato) was developed at a CNET laboratory in Lannion. When installed as the model E-10 in 1970, it was the first fully-electronic switch to be used in a public operating network in the world.³⁸

Through their positions within the DGT, the ingénieurs des télécommunications were able to match the French state's procurement policies to the rapidly changing technical options being developed in the public laboratories. In 1976, fully-electronic switches such as the E-10 were still viewed as esoteric products that might never become widely installed.

³⁶ For the ingénieurs des télécommunications, see Thierry Vedel, "Les ingénieurs des télécommunications," Culture technique, 12 (March 1984); Catherine Bertho, "La recherche publique en télécommunications, 1880-1941," Télécommunications, hor série (October 1983); and Catherine Bertho, Télégraphes et téléphones: de Valmy au microprocesseur (Paris: Livres de Poche, 1981), 453 ff.

³⁷ Rugès, Le téléphone pour tous (Paris: du Seuil, 1970).

³⁸ Louis-Joseph Libois, Genèse et croissance des télécommunications(Paris: Masson, 1983).

The French state's commercial strategy favored the Thomson company, which had been asked to develop two models based on semi-electronic technologies.³⁹ In October, 1977, however, expert consensus shifted at a conference in Atlanta, Georgia, where speakers showed that component costs had declined enough to give fully-electronic switches superior cost-performance characteristics. Within a short time after the conference, the DGT shifted its commercial strategy to the newly favored fully-electronic technologies. This change created terrific difficulties for Thomson, which had no experience with fully-electronic designs. Suddenly the DGT expanded orders to the E-10 switch, whose development had been assigned to a group of ingénieurs des télécommunications working for Alcatel, a subsidiary of the Compagnie Générale d'Electricité. These changes in the French state's procurement priorities forced Thomson to exit the telecommunications sector in 1983, but they also helped Alcatel to become one of the world's premier suppliers of digital telephone exchanges.⁴⁰

³⁹ Semi-electronic switches (sometimes called space-division switches) are those in which all the control and billing functions were controlled by computers while the contact between parties was still made by miniature physical relays. Fully-electronic switches (time-division switches) are those in which the contact function is also effected by computer and voice signals are transmitted as digitized bit streams.

⁴⁰ For developments in the French telecommunications sector in the 1970s and 1980s, see J. Nicholas Ziegler, "The State and Technological Advance: Political Efforts for Industrial Change in France and the Federal Republic of Germany, 1972-1986" (Dissertation, Harvard University, 1989) as well as Alan Cawson, Peter Holmes, and Anne Stevens, "The Interaction between Firms and the State in France: The Telecommunications and Consumer Electronics Sectors," in Stephen Wilks and Maurice Wright, eds., Comparative Government-Industry Relations: Western Europe, the U.S., and Japan (Oxford: Clarendon, 1987), 10 ff.

2. Telecommunications -- Germany

In terms of organizational structure, the Deutsche Bundespost was remarkably similar to the French PTT in the 1960s. In addition, the challenges that digital switching technology posed for the German authorities were identical to those faced by the French. Yet, the policy responses were quite different. In the German case, the balance of technical expertise clearly lay with the private sector and the self-image of the Bundespost lacked the dramatic sense of technological vision found among the elite French engineers.⁴¹

In keeping with the general trajectory of the engineering profession in Germany, communications engineers developed their base in the private sector. Although they were blocked from positions of public authority, German engineers did not reject the principal of state authority. On the contrary, the German Engineering Association lobbied to have the state's authority devolved to its own committees for the resolution of technical disputes. In the case of Siemens, salaried engineers adopted the civil servant as their model. As the term, Beamter, came to be reserved for public officials in the course of the nineteenth century, employees at Siemens and other large firms came to be known as Privatbeamter or "private civil servants."⁴²

⁴¹ For German telecommunications, see Ziegler, "The State and Technological Advance"; Alan Cawson, et. al., Hostile Brothers: Competition and Closure in the European Electronics Industry (Oxford: Clarendon, 1990); Douglas Webber, "The Assault on the 'Fortress on the Rhine': the Politics of Telecommunications Deregulation in the Federal Republic of Germany," Paper delivered at the Conference of Europeanists, Washington, DC, October 30, 1987; and Raymund Werle, Telekommunikation in der Bundesrepublik: Expansion, Differenzierung, Transformation (Frankfurt: Campus, 1990).

⁴² Jürgen Kocka, Unternehmensverwaltung und Angestelltenschaft am Beispiel Siemens, 1847-1914 (Stuttgart: Ernst Klett, 1969), 148-192.

Early in the twentieth century, technical competence gravitated to the country's first substantial communications laboratory established by the Siemens company in Berlin.⁴³ Soon thereafter, the Imperial Technical Telegraph Bureau (Telegraphentechnisches Reichsamt) accepted Siemens designs as its own standards, provided that Siemens made its patents available to other smaller firms retained to fulfill public contracts.⁴⁴ This policy of uniform standards (Einheitstechnik) showed that the German state could control the procurement process more effectively through procedural authority than through technical expertise. By requiring Siemens to license all approved technologies to alternative suppliers, the state avoided a bilateral relationship where in terms of technical expertise it was clearly the dependent party.

The technological limitations of the Bundespost were not qualitatively different than those of its prewar predecessor, the Reichspost. The Central Office for Long-Distance Technology (Fernmeldetechnisches Zentralamt, FTZ) in Darmstadt employed about 2000 persons by the 1980s, but its activities were very different from those of the CNET in France. The FTZ never included product development in its mission. Most of its work involved evaluating equipment and supervising the development projects undertaken by industrial suppliers, and its applied research agenda was driven by these other tasks.⁴⁵

⁴³ Georg Siemens, Geschichte des Hauses Siemens, (Munich: Karl Alber, 1947-1953), vol. III, 38 ff.

⁴⁴ Karl-Heinz Loesche and Dieter Leuthold, DeTeWe Chronik: Technisch-historisch Betrachtung des Firmengeschehens (Berlin: Deutsche Telephonwerke und Kabelindustrie, 1970), 131 and 199 n. 72.

⁴⁵ Deutsche Bundespost, Geschäftsbericht, 1982, 1983, 1984; Walter Niopek, Innovationsverhalten öffentlicher Unternehmen: Determinanten, Typen und Funktionen (Baden-Baden: Nomos, 1986), 179, 181.

Although the Bundespost chose Siemens designs for its first two major equipment renovations in the postwar period, the technological transformation brought by microelectronics in the 1970s upset the received pattern. In 1967, Siemens had begun work on a semi-electronic switch known as the EWS (Elektronisches Wählsystem). Owing to progress in microelectronics, however, the EWS had to be almost continually redesigned in order to keep abreast of changing component technologies. Rapid changes in technology caused even more problems in the cumbersome process of confirming and then updating uniform standards among the different suppliers. As one official complained, once the Bundespost accepted a design, the FTZ "intrudes down to the 'last screw' in the development process itself and expects custom tailored technical systems from the firms."⁴⁶

Further problems arose when the Atlanta conference of 1977 made it clear that non-German purchasers would soon be demanding fully-electronic switching exchanges. After the conference, Siemens began taking signals from the international market. As it began work on fully-electronics technologies, the continuing problems with the EWS switch represented a growing liability. Finally in 1979, the EWS was abandoned and the Bundespost announced that it would evaluate prototypes for fully-electronic switches in 1981. In the end, the Bundespost solicited bids for digital switches, but it took a different and far more lengthy path to reach that point than had the French ingénieurs des télécommunications.⁴⁷

⁴⁶ Bundespost memorandum, quoted in Barbara Mettler-Meibom, Breitband technologie: über die Chancen sozialer Vernunft in technologiepolitischen Entscheidungsprozessen (Opladen: Westdeutscher Verlag, 1986), 301.

⁴⁷ Interview with former official of the Bundespost, Bonn, November 1988. See also "Schwarzer Freitag in München: die Entwicklung des elektronischen Wählsystems für des Telephon muß gestoppt werden," Die Zeit (February 2, 1979); "Die Post ist frei," Die Zeit (2 March 1979).

B. Machine Tools

The goal of technological advance posed a very different challenge in the machine tool sector than in telecommunications. In both France and Germany, the sector was a natural candidate for diffusion-oriented policies. The industry in both countries consisted of numerous, geographically dispersed, specialist producers. The challenge was to help these traditional firms master microelectronics and incorporate software control mechanisms into their products. The amounts of capital required were within the means of both countries, and the technologies were in many cases relatively well known. The policy problem was to make these generic technologies available to smaller firms so that they could adapt them for particular products and customers.

1. Machine Tools -- France

There were repeated efforts to support machine-tool producers in France between 1975 and 1985.⁴⁸ Sectoral plans were elaborated under the Giscard government and were

⁴⁸ French policies toward this sector are analyzed in Ziegler, "The State and Technological Advance." The organization and performance of the sector are also analyzed in Marc Maurice and Arndt Sorge, "Dynamique industrielle et capacité d'innovation de l'industrie de la machine-outil en France et en RFA: Analyse sociétale des rapports entre 'espace de qualification' et 'espace industriel'," (Aix-en-Provence: LEST, January 1989); and Burkart Lutz and P. Veltz, "Maschinenbauer versus Informatiker," in K. Düll and B. Lutz, eds., Technikentwicklung und Arbeitsteilung im internationalen Vergleich (Frankfurt and New York: 1989).

expanded when the Socialist party took power under Mitterrand in 1981. All of these plans involved a combination of the following instruments:⁴⁹

- preferential loans with which small manufacturing firms could purchase computer-numerically-controlled tools;
- public procurement plans, through which machine-tool users or public agencies were encouraged to purchase advanced tools;
- regional research centers outside Paris and in the eastern steel region near St.-Etienne;
- "growth" contracts with individual firms who agreed to use new technologies in exchange for capital grants;
- financial restructuring for failing firms to encourage greater concentration in the industry.

In practice, only the last two instruments -- growth contracts and financial restructuring -- had much effect. These were the familiar instruments of bilateral policies used by French officials. In his classic work on capitalist planning, Andrew Shonfield mentioned the "80-20 rule," which held that effective planning was only feasible in industries where 80% of the output came from 20% of the firms. The machine-tool sector was (along with textiles) one which clearly deviated from the 80-20 rule. As Shonfield noted, some of the planners felt that nothing would help these sectors more "than the demise of a lot of small businesses and the emergence of a few dominant large ones."⁵⁰

⁴⁹ This account is based primarily on interviews with former officials from the Ministry of Industry, December 1988. Supporting documentation includes Le Monde (13 January 1976); Nouvel Economiste, 297 (3 August 1981), 28-29; Le Monde (3 December 1981), 1; l'Usine nouvelle (3 December 1981), 66-68; and l'Usine nouvelle (10 December 1981), 82-83.

⁵⁰ Andrew Shonfield, Modern Capitalism (London: Oxford, 1965), 138.

The same preferences for central coordination and bilateral ties were extended to the task of technology promotion in the 1970s and 1980s. The government of Giscard d'Estaing assembled a bundle of instruments to assist the machine-tool sector in 1976. By 1979, however, the bankruptcy of the leading Ratier-Forest group led to a characteristic reorientation of policy. Two very different views of the automation process emerged within the competent committee, the Comité d'Orientation des Industries Stratégiques (CODIS). One group, known as the mécaniciens, advocated a bottom-up or piecemeal approach to automation, which would allow separate machine-tools to be linked gradually together. Another group, known as the electroniciens favored a top-down approach, in which machine tools and robots were viewed as peripheral equipment within a centralized computer system.⁵¹ The debate was unambiguously resolved in favor of the electroniciens in early 1981, when a new Director within the Ministry of Industry channelled resources to robotics and flexible manufacturing centers, mostly at large user firms such as Renault and Peugeot. Although the new emphasis did much to help some of France's large manufacturers, it did little to help the machine-tool producers themselves. Several of the country's oldest tool makers -- Dufour, Ernault-Somua, Graffenstaden, and Liné -- had mounting losses. Employment in the industry declined to 20,000 in 1980 from 27,000 in 1974.⁵²

After François Mitterrand's election in 1981, the Socialist Party announced a new "Plan Machine-Outil." The policy instruments were remarkably similar to those announced

⁵¹ This debate is related in Pierre Dacier, Jean-Louis Levet, and Jean-Claude Tourret, Les dossiers noirs de l'industrie française (Paris: Fayard, 1985), 345-354, an account by individuals involved in subsequent policymaking under the Socialists.

⁵² Le Monde (2 December 1980); l'Usine nouvelle (29 January): 52; l'Usine nouvelle (25 June 1981) 38.

by the Giscardiens six years before. There were somewhat enhanced intentions to bolster intermediate training in industrial electronics as well as to promote cooperative research in the industry. The main difference, however, lay in the increased funds (2.2 billion francs over three years) allocated to the sector.⁵³

In practice, the instruments of financial restructuring again took precedence. One of France's leading firms in heavy machines, the Liné group, neared insolvency almost immediately and prompted the Ministry of Industry to form a "pole" called Machines Françaises Lourdes (MFL) with the help of several nationalized manufacturing firms. Through 1982, officials at the DIMME (Direction des Industries Métallurgiques, Mécaniques et Electriques) spent much of their time planning similar mergers, often between weak firms that were longstanding rivals. One industrialist commented skeptically, "I can hardly see how one forms fruitful enterprises by marrying cadavers."⁵⁴

The industry's continuing problems prompted another policy reassessment. Under the influence of the Minister of Industry and Research, Jean-Pierre Chevènement, the new policy orientation again envisioned radical technological achievements that would integrate electronics, capital goods, and manufacturing industries. Designated the "Plan Productique," the new policy would encourage firms to undertake pilot projects with automated machine tools.⁵⁵ The ambitious technology goals of the Plan Productique left little room for

⁵³ For instruments and projected disbursements, see "Machine-outil: une industrie refaçonnée," *l'Usine nouvelle* (10 December 1981).

⁵⁴ unidentified observer quoted in *l'Usine nouvelle* (10 June 1982): 147: "... si les dépôts de bilan et les liquidations de biens se poursuivent, je vois mal comment on constituera des entreprises fécondes en mariant des cadavres."

⁵⁵ Eric Le Boucher, "Le Crise de la machine-outil française," *Le Monde* (11 June 1983).

attention to firm-level training or human-resource development. Union spokesmen criticized the plan for ignoring the existing qualifications of machine operators.⁵⁶ Policymakers noted that the utility of purchasing new machines through the Education Ministry was also limited, because so few of the teachers knew how to use them.⁵⁷

The problems confronted by the Socialists and the Giscardiens alike were clearly rooted in the weakness of France's mechanical engineering and metalworking occupations. Mechanical engineering gained educational status when the Ecole Centrale des Arts et Métiers was founded in 1829, but the occupation never achieved the same status or the same access to policy circles as the "state engineers" from the Ponts et Chaussées or from Ecole des Mines.⁵⁸ In addition, machine operators and technicians were mostly trained on the job in plant-specific skills. Such training limited the mobility of employees and their ability to assimilate new skills and capabilities.⁵⁹ In short, the occupations pertinent to the machine-tool sector -- mechanical engineers and skilled machinists -- were precisely those that were subordinated and marginalized in France's order of state-created elites.

The stark separation between the "state engineers" and the mechanical engineers made it difficult for policymakers to gain detailed information on the problems of the manufacturing sector. As participant-observers of the Plan Machine-Outil remarked,

⁵⁶ François Beaujolin, Vouloir l'industrie: pratique syndicale et politique industrielle (Paris: Editions ouvrières, 1982), 152.

⁵⁷ Dacier, et. al., 343.

⁵⁸ James M. Edmonson, From Mécanicien to Ingénieur: Technical Education and the Machine Building Industry in Nineteenth-Century France (NY: Garland, 1987).

⁵⁹ Marc Maurice, François Sellier, and Jean-Jacques Silvestre, The Social Foundations of Industrial Power: A Comparison of France and Germany, trans., A. Goldhammer (Cambridge: MIT Press, 1982, 1986), 35 ff.

As a group, French engineers preferred in the 1970s to join the ranks of the computer or electronics firms, or to make the jump into management positions. This disaffection for production, which touched an entire generation and which has probably not entirely disappeared, explained the current dearth of competent persons in this field.⁶⁰

Given these preferences among engineering graduates, the strong social networks that underpinned the state's relations with other industrial sectors could not be easily replicated in mechanical engineering.

To be sure, many French machine-tool firms were also weakened by their small size and traditional business practices,⁶¹ but even the larger firms with more "modern" management suffered from gaps between occupational groups that carried the crucial skills. The distinctions among engineers were exacerbated by the gap between software specialists and skilled machine-tool builders. These were the practical and theoretical skills that had to be brought together in order to adapt computer numerical control (CNC) technology for the traditional machine-tool producers. Even though France's main CNC producer (a company called la Société NUM) was very successful, its capabilities in software design did little to help the broader industry. During the 1980s, NUM spent 2.5% of its payroll -- more than twice the legal minimum -- for generic workforce training.⁶² In addition, NUM's business

⁶⁰ Dacier, et. al., 342.

⁶¹ This view is given in Maurice and Sorge, "Dynamique industrielle," who document the discontinuities in France's skill base for metalworking, but give primary emphasis to the structural mismatch between France's largely "artisanal" machine-tool producers and their more "industrial" or Taylorist customers. For an analysis that stresses the primacy of the the skill deficit, see Lutz and Veltz, "Maschinenbauer versus Informatiker."

⁶² Interview with Personnel Director, Société NUM, December 1988. This figure compares favorably to the legal minimum (1.1%), the average for mechanical -engineering (1.26%), as well as the average for all French business (1.83%). The latter figures are from Groupe de Stratégie Industrielle, no. 11, "De la mécanique traditionnelle à la productique" (Commissariat Général du Plan: April 1983).

was well-suited to benefit from France's dirigiste style of policymaking. Since the state encouraged large users of machine tools to purchase software controllers from NUM, the company was able to increase its market share within France steadily. At the same time, however, NUM also increased the proportion of its revenues from sales to non-French producers from 8% in 1981 to approximately 30% in 1987.⁶³ Indeed, as large French industrial users purchased their machine tools increasingly from non-French suppliers, NUM managed to adapt its CNC technology for the foreign machine-tool builders at least as quickly as for its French customers.⁶⁴ It was revealing that the French state was able to pull NUM into business relations with many of Europe's most sophisticated machine tool producers even though it had trouble fostering similar links between NUM and many machine-tool producers within France.

NUM's experience showed clearly that the difficulties between French machine-tool producers and their customers centered on the software knowledge in which NUM specialized. As a result of the gaps between software writers and machine-tool manufacturers, it proved nearly impossible for public officials to identify, much less bring together, employees with the skills that might have helped the smaller machine-tool firms to incorporate microelectronics into their products. Given these limitations, when policymakers in Paris encountered difficulties implementing their plans, they had few incentives to

⁶³ Revenues and exports from l'Usine nouvelle (26 March 1981), l'Usine nouvelle (10 June 1982), and information supplied by NUM.

⁶⁴ On NUM's relations with Swiss and German firms, see especially Les Echos (14 December 1981) and NC Fertigung (July 1988): 70 ff.

experiment and tended instead to cling ever more tenaciously to familiar policy instruments such as industrial concentration and capital-intensive pilot projects.

2. Machine Tools -- Germany

Like their French counterparts, German officials in Bonn also sought to support the machine-tool sector between 1975 and 1985. German producers were among the world leaders in output and export shares. In 1975, the sector employed approximately 100,000 compared to 27,000 in France. Since the machine-tool makers were essential to the country's entire metalworking complex, their ability to adjust to the changing conditions of the 1970s and 1980s was a major issue for German policymakers.

Nonetheless, German officials tended to design incentive-setting frameworks, which differed from France's discrete "plans" in several ways. Instead of focusing on bilateral discussions with individual firms, the German officials implemented most of their efforts through intermediary organizations. Rather than seeking mergers among the smaller firms, German policymakers designed programs specifically for the needs of small and medium-sized enterprises. Finally, the German policies did not aim only at spectacular new technologies of automation, but instead countenanced several pathways by which firms might automate their production.⁶⁵

⁶⁵ This account is extracted from Ziegler, "The State and Technological Advance." Some of the principal sources on the German machine-tool sector include H. Hirsch-Kreinsen, "Technische Entwicklungslinien und ihre Konsequenzen für die Arbeitsgestaltung," in Hirsch-Kreinsen and Rainer Schultz-Wild, eds., Rechnerintegrierte Produktion (NY: Campus, 1986); Burkhardt Lutz and P. Veltz, "Maschinenbauer versus Informatiker," in K. Düll and B. Lutz, eds., Technikentwicklung und Arbeitsteilung im internationalen Vergleich (Frankfurt: Campus, 199x); Gary Herrigel, "Industrial Order and the Politics of Industrial Change: Mechanical Engineering," in P. Katzenstein, ed., Industry and Politics in West Germany: Toward the Third Republic (Ithaca: Cornell, 1989).

Policy for the machine-tool sector emerged in the 1970s amidst a larger debate on the state's role in industrial development. The proponents of Ordnungspolitik prescribed an important but limited role for the state in maintaining proper framework conditions (Rahmenbedingungen) for healthy competition. The proponents of Strukturpolitik argued that the state needed to promote positive adjustment strategies by supporting particular firms and sectors through designated technology projects.⁶⁶

In practice, policy for machine tools reflected an uneasy compromise between these views. In line with the principals of Strukturpolitik, the Federal Ministry for Research and Technology (Bundesministerium für Forschung und Technologie, BMFT) provided a number of grants to Germany's major machine-tool firms during the 1970s. Later in the 1970s, civil servants in the Ministry also devised a set of instruments that came to be known as "indirect-specific measures," which were quickly showcased when the Christian-Liberal coalition took power in 1982.⁶⁷ Despite their infelicitous name, these measures effectively combined the priorities of Ordnungspolitik and Strukturpolitik. To avoid overturning market mechanisms for selecting technologies, these measures required that recipient firms finance at least 50% of that proposed development program. In addition, grants were capped at relatively modest levels (between 400,000 DM and 800,000 DM) to discourage firms from altering their own investment plans too dramatically. The measures were specific in that they provided funds

⁶⁶ The main statement of Strukturpolitik is found in Volker Hauff and Fritz Scharpf, Technologiepolitik als Strukturpolitik (Frankfurt: Europäische Verlagsanstalt, 1975). For further discussion, see also BMFT, Bundesbericht Forschung VI (Bonn: 1979), 15-16, and Wirtschaftswoche (14 March 1980).

⁶⁷ Osnabrücker Zeitung (22 October 1982); BMFT Brochure: "Neuorientierung der Forschungs- und Technologiepolitik" (Bonn: 1984). For further analysis of these developments, see Andreas Stucke, Institutionalisierung der Forschungspolitik: Entstehung, Entwicklung und Steuerungsprobleme des Bundesforschungsministeriums (Frankfurt: Campus, 1993), esp. 171, 173.

for precisely defined generic technologies. They were indirect in that special external agencies administered them.

The indirect-specific measures were complemented by a series of cooperative research projects (Verbundforschung), which linked a number of firms and research institutes in joint research efforts promoted by the Research Ministry. Like the indirect-specific measures, the cooperative research projects (Verbundforschung) represented a carefully designed new policy instrument that aimed at making know-how available to a number of participating actors.⁶⁸ For disseminating new generic technologies more broadly throughout the economy, the indirect-specific measures were the primary intended instrument.

The indirect aspect of the programs had several advantages. By relying on external, non-governmental agencies (Trägerorganisationen), the Ministry could reach out to smaller enterprises that were not accustomed to applying for federal grants. In addition, the implementing organizations themselves became important repositories of highly specific knowledge about the problems faced by firms in mastering the designated technologies. One of the most important implementing organizations was a new Technology Center in Berlin (the VDI-Technologiezentrum), established under the auspices of the German Engineering Association (VDI). Others included the research bureau within the industry association for mechanical engineering (Verein Deutscher Maschinen- und Anlagebau, VDMA) and the Cooperative of Industrial Research Associations (Arbeitsgemeinschaft industrieller Forschungsvereinigungen AIF). The metalworkers union and the Fraunhofer institutes for

⁶⁸ For analysis of this program and component projects, see Susanne Lütz, Die Steuerung industrieller Forschungsk Kooperation: Funktionsweise und Erfolgsbedingungen des staatlichen Förderinstrumentes Verbundforschung (Frankfurt: Campus, 1993).

engineering sciences were not implementing organizations per se, but they were frequently consulted on the writing of guidelines for the indirect-specific programs.

The indirect-specific measures proved extremely useful for encouraging smaller firms to experiment with microelectronics in their products and production processes. The first such program, entitled "Application of Microelectronics," was initiated on a trial basis in 1979 and was budgetted at 450 million DM for the three years from 1981 through 1983. It gave rise to subsequent programs in production technologies (Programme Fertigungstechnik), sensor technology (Mikroperipherik), and micro-machine systems (Mikroystemtechnik). All of these programs were administered by intermediary organizations.⁶⁹

Rather than the repeated reassessments and recentralizations of policy that occurred in France, German policies were characterized by the steady refinement of indirect-specific programs that complemented a number of joint projects administered directly from Bonn. A condition for this incremental change was the broad range of interlocutors involved in the process of formulating the policies. German administrative law required that the Research Ministry consult industry associations and organized labor while legislation was being drafted. When German officials brought engineers and other academic experts into their policy discussions, however, they were also following customary professional norms by recognizing the particular types of knowledge possessed by different groups outside the state.

⁶⁹ For the pilot program on the application of microelectronics, see BMFT, program brochures, and Heinrich Revermann, ed., Wirkungsanalyse zum "Sonderprogramm Anwendung der Mikroelektronik" (Markt & Technik, 1986). For the other programs, see BMFT, Program Brochures; Susanne Lütz, Die Steuerung industrieller, esp. 46-47; and Oliver Pfirrmann, "The diffusion of microsystem technologies: the case of the German innovation support programme 'Microsystem Technology,' Research Evaluation (April 1992).

The norms of consultation meant that German policies accommodated a number of different strategies. A significant example concerned the much-debated issue of factory automation. The advocates of centralized automation were based at the Fraunhofer Institute in Berlin; they were supported by some of the large engineering firms and tended to assign control functions in the workplace to white-collar computer programmers. A stepwise approach for decentralized automation was elaborated at the Fraunhofer Institute in Stuttgart. This approach proved more congenial to small firms that could not afford the risks of one-shot automation, and it relied more heavily on skilled machinists who were able to work with a changing mix of mechanical and computerized machines.⁷⁰ To the extent that it reflected the varied circumstances to which computer-assisted technologies could be adapted, the debate itself reflected the strengths of German policies. In France the electroniciens had triumphed decisively over the policy perspectives offered by the mécaniciens. In Germany, policymakers intentionally supported a range of alternative strategies for applying new technologies to industrial problems.

It is difficult to say whether the successful adjustment of the German machine-tool sector should be attributed to these federal policies or to the intrinsic strengths of the industry itself. It is indisputable, however, that the German policy measures were not accompanied by the same kind of dramatic decline that occurred in the French industry. As a share of world output, Germany's machine-tool production declined from 17.76% in 1975 to 14.75% in 1985; French production fell in the same period from 4.97% to 2.07% of world output.

⁷⁰ The German debate on computer integrated manufacturing can be traced through T. Martin, E. Ulich, and H.-J. Warnecke, "Angemessene Automation für flexible Fertigung," Werkstatttechnik, 78 (1988): 17-23, 119-222; Rainer Schultz-Wild, "An der Schwelle zur Rechnerintegration," VDI-Z, 130:9 (Sept. 1988): 40-45; Wolfgang Weber, "CNC Steuerungen für qualifizierte Facharbeit," Technische Rundschau, 28 (1988): 14-18; and other sources cited in Ziegler, "The State and Technological Advance."

Meanwhile, German employment in the machine-tool sector fell roughly 14% from 102,000 in 1975 to 88,000 in 1985; French employment fell by over 55% over the same period from 26,859 to 12,050.⁷¹

The ability of German policymakers to implement policies for diffusing electronics-based technologies hinged on the relationships among occupational groups. For the machine-tool sector, mechanical engineers and skilled machinists were the crucial occupations. In France, both of these occupational groups were separated from the central administrative elite by well-nigh insuperable barriers. Mechanical engineers were trained in practical skills that conferred much less status in France than the abstract, mathematical training of the state engineers in the public administration. Skilled machinists were represented strictly by French labor organizations. They had few ties to engineers of any kind and enjoyed virtually no access to policy discussions. The rigidities and impermeable distinctions that separated these groups weighed heavily in the frustrated efforts of French policymakers to incite technological change in the machine tool sector.

In the Federal Republic of Germany, the corresponding groups enjoyed more deliberate and communicative relations with policymakers. Mechanical engineers dominated the German Engineering Association. Although they did not have the same access to positions of public office that the elite French engineers had, the German engineers had gained recognition as the country's main repository of knowledge for questions of industrial performance. Skilled machinists were represented through the metalworkers union, IG Metall. Not only did they have a voice in policy through the union. Owing to the

⁷¹ Figures from the National Machine Tool Builders Association, Economic Handbook, various years.

possibilities for advancement through continuing education, the machinists had much less distant relations with engineers than did their French counterparts. To be sure, these groups were separated by hierarchical distinctions in Germany as in France. Yet, the hierarchical distinctions were different in quality. Rather than impermeable divisions, as in France, they were more permeable and organic links. The different occupations tended to recognize their respective areas of competence. The norms of competence and consultation that informed Germany's occupational hierarchy were one of the crucial factors that enabled policymakers to implement policies for boosting technological levels in the machine-tool sector.

IV. CONCLUSION

These cases indicate that cross-sector as well as cross-national variation in the state's ability to promote technological advance can best be explained by examining relations among knowledge-bearing occupations. The relations between policymaking elites and technical occupations are particularly important because they help determine whether policies, once formulated, can be implemented. In a very general way, these cases indicate that not all states should be expected to perform all tasks. Yet some of the more specific capabilities and constraints can be summarized.

In countries where technical expertise is concentrated among a group of state-created elites, public policymakers are predisposed to formulate mission-oriented strategies for promoting technological change. The distribution of expertise may also be well suited in

such countries for implementing mission-oriented policies, particularly if the linkages between state and non-state experts are close. French policy toward telecommunications in the 1980s exemplified such conditions.

Countries with state-created technical elites have no advantage, however, in formulating diffusion-oriented policies. Moreover, if the occupational prestige hierarchy is highly stratified, it will positively inhibit the implementation of diffusion-oriented policies -- and further discourage policymakers from attempting such policies in future initiatives. French efforts to support the machine-tool sector exemplify these conditions.

Countries where technical expertise is embodied in state-recognized occupational groups are not likely to formulate mission-oriented strategies. Civil servants trained in procedural disciplines will be predisposed toward regulatory instruments of policy and may be poorly qualified to monitor mission-oriented projects. German efforts to promote the development of digital switches exemplified these conditions.

If countries with state-recognized occupations are disadvantaged in the formulation of mission-oriented policies, however, they may be well suited for implementing diffusion-oriented policies. If such occupations are linked through organic and continuously graded occupational hierarchies, they can serve as powerful instruments for the transfer of new technologies among firms. The apparently successful policies that Germany assembled for the machine tool industry relied heavily on such conditions.

These conclusions raise the issue of generalizability. One question is whether occupational relations in countries besides France and Germany are correctly described by the dimensions of dependence on state legitimation and organic versus stratified linkages with

other occupational groups. It is sometimes noted, for instance, that white collar workers in Japan have little occupational identity independent of the organizations for which they work - - creating an organizationally bounded norm for professional status.⁷² In the United States, by contrast, the professions are said to be "self-regulating" and there appears to be more occupational effervescence in the sense of new groups claiming "professional" status.⁷³

At the same time, the dimensions generated by the French-German comparison provide unmistakable insights into public strategies for raising technological levels in other countries. It is clear that these dimensions are empirically and logically independent. For instance, an institutional framework supporting state-created elites need not necessarily -- as in France -- imply a stratified occupational prestige hierarchy. In a country where state-created elites presided over a more organic hierarchy among occupations, policymakers would be predisposed to formulate mission-oriented policy strategies but they would be able to draw on extensive societal resources in implementing diffusion-oriented policies. Such conditions appear to describe at least some important policy areas in Japan. The role of Japanese civil servants in mission-oriented technology policies is well known.⁷⁴ Yet, in the diffusion of new technologies, there is rich evidence of the pivotal role played by

⁷² For evidence of this phenomenon among electrical engineers, see Eleanor Westney and Kiyonori Sakakibari, "Designing the Designers: Computer R&D in the United States and Japan," Technology Review, 89:3 (April 1986).

⁷³ Harold Wilensky, "The Professionalization of Everyone?" American Journal of Sociology, 70 (1964): 137-158; Bonalyn J. Nelsen and Stephen R. Barley, "The Social Negotiation of a Recognized Occupational Identity:," Working Paper, National Center for the Educational Quality of the Workforce, University of Pennsylvania, 1993.

⁷⁴ The now-classic account is Chalmers Johnson, MITI and the Japanese Miracle: the Growth of Industrial Policy, 1922-1975 (Stanford University Press: 1982).

professional ties and associations in broad-based efforts for quality and process improvement among Japanese firms.⁷⁵

Similarly, there is no logical or "transhistorical" reason that countries with state-recognized professional groups need be organized into organic occupational hierarchies. In a country where more autonomous professional elites sat atop a highly stratified occupational prestige hierarchy, policymakers would shy away from mission-oriented technology policies but would also suffer from poor information and scattered societal resources in their efforts to implement policies for diffusing new technologies. Such conditions clearly describe the United States, where the federal officials have rarely welcomed explicit industrial policy and where efforts at skill development and technology diffusion have been left to a welter of uncoordinated experiments at the state and local levels.⁷⁶

The case for a broadened view of institutions that would include the visions and self-images of occupational groups cannot be established on the basis of four neatly paired cases of policy for competitiveness. Still, it is worth identifying some of the issues in comparative politics where such an approach could make a contribution. The cases examined here show

⁷⁵ The important role of the Japanese Union of Scientists and Engineers in supporting grass-roots efforts to promote quality and process improvement among Japanese firms is illuminated in Robert Cole, Strategies for Learning: Small-Group Activities in American, Japanese, and Swedish Industry (Berkeley: University of California Press, 1989), especially chapter 13 and pages 301-303. For the importance of professional ties in diffusing technologies in the Japanese aerospace and related industries, see Richard J. Samuels, "Rich Nation, Strong Army": National Security and the Technological Transformation of Japan (Ithaca: Cornell University Press, forthcoming, 1994).

⁷⁶ For state and local programs in the U.S. case, see David Osborne, Laboratories of Democracy: A New Breed of Governor Creates Models for National Growth (Boston: Harvard Business School Press, 1988), and Stephen Hamilton, Apprenticeship for Adulthood (NY: Free Press, 1990). For the very different type of coordination issues present in Germany's federal structure, see Fritz W. Scharpf, Bernd Reissert, and Hans Schnabel, Politikverflechtung: Theorie und Empirie des kooperativen Föderalismus in der Bundesrepublik (Kronberg: Scriptor, 1976) and, in the case of technology policy, Edgar Grande, "Staatliche Steuerungspotentiale in der Informationstechnik-Politik" (Manuscript: Max-Planck-Institut für Gesellschaftsforschung, Cologne, 1993).

that occupational identities and networks rank among the most distinctive institutional characteristics of advanced societies. Occupational identities rest on jurisdictional claims that elites are reluctant to jeopardize, while occupational networks help shape the information pathways by which state and non-state actors communicate. Substantive analysis of such identities and networks can explain why policymakers in different countries apply characteristic policy approaches, even when those approaches are clearly inappropriate to the specific challenges at hand.

These findings are especially relevant to areas of state action -- such as technology policy -- where there is high uncertainty and where abstract as well as practical knowledge is required for successful policy implementation. Yet, there are several reasons that the model of professional networks is likely to become more salient. As hierarchical forms of organization give way to more flexible forms, the interpersonal links fostered by professional affinities may begin to rival organizationally programmed contacts and routines.⁷⁷ From management's perspective, the professional network is an attractive model for inspiring trust and loyalty from employees who are expected to exercise discretion without much oversight.⁷⁸ Indeed, such a model appears increasingly attractive as the trend toward corporate downsizing takes away the firm's ability to assure its employees much job security. These developments render the internal politics of professional groups more salient as

⁷⁷ On the relative salience of interpersonal and interorganizational networks, see Walter Powell, "Neither Market nor Hierarchy: Network Forms of Organization," Research in Organizational Behavior, Vol 12 (1990) and Renate Mayntz, "Modernization and the Logic of Interorganizational Networks," Knowledge and Policy: The International Journal of Knowledge Transfer and Utilization, 6:1 (Spring 1993): 3-16. On professional networks and knowledge diffusion, see Annalee Saxenian, "The Origins and Dynamics of Production Networks in Silicon Valley," Research Policy 20 (1991): 423-437, and John Alic, "Technical Knowledge and Technology Diffusion: New Issues for U.S. Government Policy," Technology Analysis and Strategic Management, 5:4 (1993): 369-383.

⁷⁸ Rosabeth Moss Kanter, When Giants Learn to Dance: Mastering the Challenge of Strategy, Management, and Careers in the 1990s (NY: Simon and Schuster, 1989).

received recipes for the macroeconomic management of employment and investment give way to firm- and industry-level recipes for competitive performance.

While especially useful in explaining the persistence of policy approaches over time, the analysis of occupational identities and networks also helps to illuminate the conditions under which policy adaptation and learning can occur. Vertical as well as horizontal links are at issue. The vertical relations that link superordinate public agencies to private-sector organizations can be facilitated by interpersonal ties that have the character of horizontal linkages among members of the same professional groups. But vertical links among members of different occupational groups are equally important. As shown in the cases compared here, misguided or poorly implemented policies can only be corrected where the linkages among different levels in an occupational hierarchy can carry the information required for evaluating past policies and shaping future strategies.⁷⁹ If the first condition is satisfied, then particular knowledge-bearing groups that span state and non-state organizations can act as "transmission belts" that enable policy learning to occur.⁸⁰

Yet, possibilities for policy change are facilitated by professional formations only within certain constraints. While occupational identities can change, the scope for change is limited by the jurisdictional claims that occupational groups have established. Not only do claims to new or expanded jurisdictions have to be advanced through painstaking negotiations

⁷⁹ For the general problem of policy feedback, see Paul Pierson, "When Effect Becomes Cause: Policy Feedback and Political Change," *World Politics*, 45:4 (July 1993): 595-628.

⁸⁰ For policy adaptation through social learning, see Peter A. Hall, "Policy paradigms, social learning, and the state: the case of economic policymaking in Britain," *Comparative Politics*, 25:3 (April 1993). For policy change through negotiation and coordination, see Fritz Scharpf, "Positive und negative Koordination in Verhandlungssystemen," MPIFG Discussion Paper 93/1 (Cologne: Max-Planck-Institut für Gesellschaftsforschung, 1993).

or incremental legitimation; these new claims have to be compatible with the symbolic resources that an occupational group has invoked in the past. At a theoretical level, this analysis therefore develops the view that group interests cannot be inferred from organizational structure alone.⁸¹ If an occupational group enjoys the status of a recognized profession, its members will perceive opportunities partly from the organizations in which they work, but partly from within the larger transorganizational network of individuals to which they belong. As a result, the collective preferences of such knowledge-bearing elites are not formed within any single organization. Moreover, since knowledge-bearing elites gain professional status by appealing to a symbolic conception of society's general interest, their self-images are necessarily formed in terms that include more than the material utilities of their members. Together, the transorganizational and symbolic components in professional identities point to important aspects of institutional life that cannot be captured by structural analysis alone. The visions and commitments of knowledge-bearing elites exert their own persistent and sometimes decisive effect on public strategies for competitiveness.

If this analysis is correct, it suggests that professional identities comprise an important obstacle to the convergence of economic institutions in the advanced industrial countries.⁸² The movement toward integration of the internal market in Europe represents the most serious effort among advanced countries to bring domestic institutions into conformity with a single model. Much of the resistance to European integration so far has been attributed to

⁸¹ See Kathleen Thelen and Sven Steinmo, "Historical institutionalism in Comparative Politics," in S. Steinmo, K. Thelen, and F. Longstreth, eds., *Structuring Politics: Historical Institutionalism in Comparative Analysis* (NY: Cambridge University Press, 1992).

⁸² For the emerging politics of institutional convergence, see the conference proceedings reported in "Domestic Institutions, Free Trade, and the Pressures for National Convergence: the United State, Europe, and Japan" (Cambridge: MIT Industrial Performance Center Working Paper 93-002wp, 1993).

economic interest groups and nationalist political parties. Even if it were uncontested by these actors, however, EC policy for institutional "harmonization" could not directly transform the norms and practices sustained by professional identities. As long as knowledge-bearing elites are able to mobilize different kinds of political and symbolic resources in different countries, they will continue to sustain distinctive conventions for making policy and doing business.

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